A Proposed risk model for the halal supply chain

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Abstract
The purpose of this research is to propose a new risk assessment model for the halal supply chain. The case study selected in this research is the chicken meat industry in Malang city. This research used three steps and combined several approaches to propose a new risk model to manage the halal supply chain risks. In the first step, this research identifies the risks to the input of the Failure Mode and Effect Analysis (FMEA) Table. There are 26 risk events were identified in this case study. In the second step, it does the risk assessment to assess the risk event by FMEA and analysis the risk event by Pareto Diagram. Analysis of the Pareto Diagram shows the problems that must be solved were risk A9 and risk A1. Finally, it does a halal action plan with Risk Matrix and Multi-Phased Quality Function Development (QFD) in the third step. Risk Matrix to mapping the risk event and Multi-Phased QFD to measure the value of halal integration and the effectiveness from the proposed risk mitigation. The finding of the third step is the Risk Matrix shown the risks of A1, A4, A9, and A12 were in the red zone (very high risk). In addition, the Multi-Phased QFD has two phases. Phase 1, the top rank for risk priority, is cutting processing. Phase 2, the four mitigation options to the RPH management based on a risk matrix result.

Keywords
FMEA, Multi-Phased QFD, Risk Matrix, Halal Risk Model

1. Introduction
The world Muslim population is increasing by 1.5% per year with a population percentage of 26.4% of the world's population. (Jaafar et al. 2011). The halal market formed by the Muslim population emerged in the community into a global market that meets the needs of halal goods for Muslims (Amalia et al. 2020). This industry is expected to grow annually by $560 billion with an average annual rate of 20% (Reuters 2018). Halal is universal. Muslims who consume halal food and non-Muslims also prefer halal food (Aziz and NyenVui 2012). Halal products can be accepted and have demand in non-Muslim countries (Kawata et al. 2018; Bashir 2019; Wilkins et al. 2019). Non-Muslims prefer halal products because they reflect cleaner, healthier, and tastier products (Burgmann 2007).
This research was conducted in Indonesia. Indonesia and Malaysia are known as "powerhouse" for halal industrial areas (Talib 2020). Therefore, the demand for halal products increased after the Indonesian Constitution Law Number 33 of 2014 legalized. The law has been a regulation on Halal Product Guarantee (JPH). The law confirms that products entered, circulated, and sold in Indonesia must have a halal certificate (DPR-RI, 2014). Then, it has indicated that halal certification that was initially voluntary for businesses became mandatory. The categories of products that must be halal certified according to the JPH Law are (1) Food and Beverages; (2) Cosmetics and Medicines; (3) Chemical Products, Biological Products, and Genetically Engineered Products; (4) Goods; and (5) Services. Based on the Regulation of the Minister of Religious Affairs (PMA) Number 26 of 2019, the implementation of the JPH Law was implemented gradually, starting from the category of food and beverage products on 17 October 2019 to 17 October 2024. Therefore, if the businessperson has not performed halal certification until the deadline, they will get the consequences.
Besides in the law of the countryside, in the Islamic Laws (Syariah) are obliged to consume halal products. It was accorded in Quran Surah Al-Baqarah (2:168), which means "O mankind, eat from whatever is on earth [that is] lawful and good and do not follow the footsteps of Satan. Indeed, he is to you a clear enemy." That Surah said that Syariah unequivocally states that Muslims are forbidden to consume the haram. Halal products did not only have halal qualifications from Syariah. It was also clear, safe, and healthy. The products which those criteria could be called *Toyyib*. Indonesia's products must have certificates from the Food and Drug Administration (BPOM) to approve that the products were clear, safe, and healthy. However, many products found in the market do not have BPOM licenses

or halal certificates in practice. Products with halal labels must be traced to meets halal standards. Therefore, this research creates a risk model for the halal supply chain in the chicken meat industry. This research used a combination of Failure Mode and Effect Analysis (FMEA) and Multi-Phased Quality Function Development (QFD) for making risk models and mapping risk activities using Risk Matrix. There is currently no research using a combination of the three methods.

2. Literature Review

Risk management is an urgency approach for companies to mitigate risk events. The application of risk management is not only an urgency in a single company but also an urgency a long business process in supply chain (Vanany and Zailani, 2010). This research more focus on halal risks particularly halal food. Scopus database with the keyword "Halal Risk" contains several sources that can be used as a reference for research. Several previous research in risk assessment model for halal risk such as House of Risk (HOR), Bayesian Network, Fuzzy-AHP, Fuzzy-BMW, DEMATEL, Vector Autoregressive (VAR). In recent years, application of the multi approach were conducting to provide more comprehensive solutions and objectives of research (Leksono et al., 2019)

Maman et al. (2018) research under the title "Halal risk mitigation in the Australian–Indonesian red meat supply chain" using qualitative and quantitative methods. It aims to identify halal risk events, halal risk agents, measure halal risk levels, and formulate mitigation models on the meat supply chain from Australia to Indonesia using the House of Risk. Risks of halal supply chains that appear on Feedlot, Beef Processing, and Retailing. In that research, there is not assessment model for halal integration. Integration of food safety and halal risk is already present in Wahyuni et al. (2020) research, but the mapping of risks to overcome the problem first does not exist. Yaacob et al. (2018) focus more on the risks of the halal supply chain in transportation. S. Khan et al., (2019) research entitled "Prioritizing the risks in Halal food supply chain: an MCDM approach" uses Fuzzy AHP method to prioritize which risks need to be addressed first. Kabir et al., (2020) using quantitative method, namely VAR (Vector Auto Regression) with Error Correction Model. That paper discusses the risks that occur in the trading process so that the scope is narrower than the research in this paper.

3. Methods

Primary data is collecting with observation, interviews, and Forum Group Discussion (FGD) with stakeholders. The results of interviews and FGD with stakeholders and halal supervisors in the form of risk identification. Identification of risks has been used for input in Failure Mode and Effect Analysis (FMEA). The analyses of risks are also limited to halal risks and food safety risks. Then the risk assessment analysis can be done by giving questionnaires to the parties who audit the Halal Industry related to halal products that understand the overall supply chain activity. In addition, to using interviews and questionnaires, risk assessment analysis can also use existing company historical data.

There are three phases in the creation of Halal Assessment Model, including:

Step 1: Risk Identification

Identification of risk factors helps determine the impact of a risk event on the business processes (severity). The potential causes of risk (occurrence) and risk management that the company done (detection) are also determined by the level to obtain the RPN score. Then, the flow of the process from Halal Product can also be obtained from the company manager. The plan, source, make, delivery, and return process is adjusted to be required in halal assessment can be determined by halal auditors. This paper described the processes as match as Standard Operating Procedure (SOP) in the Chicken Meat Halal Industry.

Step 2: Risk Assessment

This halal risk assessment use three methods, there are FMEA, Risk Matrix, and QFD Phase 1. FMEA determines the severity of a risk event, the potential cause of a risk event (occurrence), and risk management (detection) that has been done by the company using the Linkert scale 1-5 in the FMEA Process Table. Moreover, risk causes are sorted from those with the largest to smallest RPN values and then ranked. The cause of risk with the same RPN value has the same rank. Then, further analysis had been using the Pareto Diagram. Based on Pareto Diagram, 20% problem solving will give 80% result. Next, it should make risk mapping with the risk matrix method. In risk mapping, the severity score was changed to magnitude and the occurrence score become the likelihood score. Each risk can be placed in the ordinate according to their respective scores. After that, the risks can enter the red, orange, yellow, or green zone depending on risk importance. Next, halal integration analysis and risk mitigation are conducted using QFD Phase 1 method. The relative importance of halal risk with halal integration in the chicken meat industry was assessed using a Linkert scale of 1-5. Relative Important in the form of a percent (W_i) can be done by dividing the Linkert score on an activity with a total score and then the result multiplied by 100. As for risk value assessment (H_i) was using assessment

1-9 (1=weak; 3=moderate; 9=strong; blank=not existent). The most significant risk impact would make the enormous risk value. Then the score value for each halal supply chain activity (S_{ijk}) is obtained from the multiplication of Wi with Hi. Absolute Importance ($\sum_{j=1}^{j} S_{ij}$) was obtained from the total score of halal integration risk factors. Percent (%) Importance was obtained from absolute importance risk factors divided by the amount of absolute importance of all risks and then the result is multiplied by 100%. Then the result Percent (%) Importance is sorted from largest to smallest to Rank of Priority (Vanany et al. 2019).

Step 3: Halal Action Plan

QFD Phase 2 (Mitigation Strategies)

The risk is mapped into the red zone must be mitigated immediately. Then, it must be discussed the mitigation strategies with experts. Experts are asked to reassess the effectiveness of the proposed risk mitigation. Then the expert assessment results are poured in a 1-5 Linkert scale and filled into the Table (QFD Phase 2). The value of Absolute Effectiveness ($\sum_{j=1}^{j} S_{ij}$) was obtained from the total score of each mitigation strategy. Percent effectiveness of each mitigation strategy (P_i) was obtained from the absolute value effectiveness of each mitigation strategy (S_{ij}) divided by the total of absolute value effectiveness ($\sum_{j=1}^{j} S_{ij}$) and multiplied by 100%. P_i was sorted from the biggest to the smallest into Priority Ranking. The result will show the presence of the effectiveness of the recommended mitigation strategies for halal industry objects.

4. Data Collection

Data collection was obtained from documentation, observations, interviews, and questionnaires at chicken processing company (RPH) X. RPH X had an average demand every day of 300-700 kg of chicken meat. Suppliers come from various regions in East Java. The data of cutting processes were collected from direct observation and documentation. The slaughtering process in RPH X was shown in Figure 1. The data of risks were obtained from interviews with the slaughter and direct observation. The halal assessment was collected by interview the expert (Halal Auditor from LPPOM MUI) and gave questioner to the manager of RPH X. Proposed mitigation strategies and assessment of those proposal's effectiveness based on consideration from the expert and owner of RPH X.

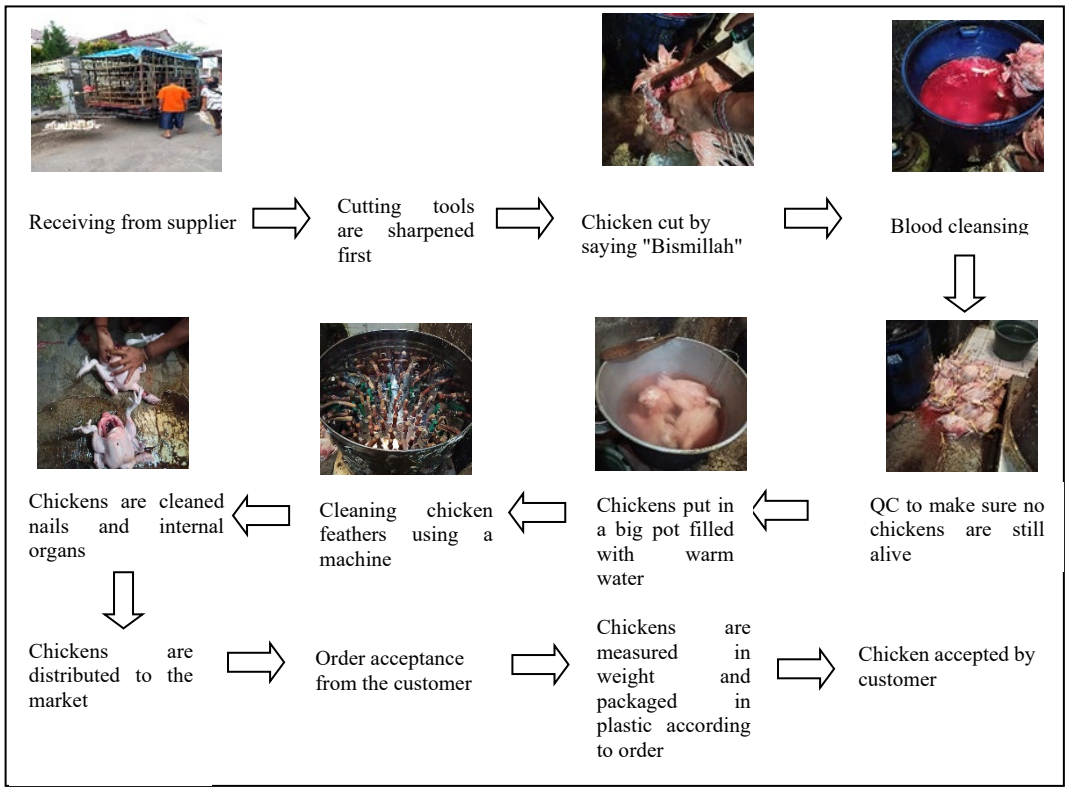

Figure 1. The slaughtering process in RPH X

5. Results and Discussion

Risk identification results were included in the FMEA Table. Then a risk assessment is conducted based on the questionnaire results. Table 1 and Table 2 indicates that there are six processes in slaughtering chicken meat. The processes were receiving raw material, cutting process, blood cleansing, feather cleansing, packaging, and delivery.

Table 1. FMEA Process in RPH X

FMEA Process								
Process Steps	Potential Failure Mode	Potential Effect of Failure	Severity (S) Linkert Scale 1-5	Potential Causes of Failure	Occurrence (O) Linkert Scale 1-5	Current Control, Detection	Detection (D) Linkert Scale 1-5	RPN
Receive raw material	There are bruises on chickens	Chicken quality become bad	4	Chicken pinched during delivery	4	Bruises visible after feather removal	4	64
	There are physical defects in chickens	Chicken quality become bad	5	Physical defect from genetic factor/ poor animal care	3	Can be seen before the cutting process	1	15
	The physical condition of the chickens is weak	Chicken quality become bad	1	Animal care that is not qualified	3	Can be seen before the cutting process	1	3
	The chickens are sick	Chicken quality become bad and not halal	5	Animal care that is not qualified	3	Reddish meat like a village chicken	3	45
Cutting Process	Production facility do not clean from *najis mutawassithah*	The chickens become *najis*	2	Lack of hygiene	5	Nothing	2	20
	The slaughterers do not say bismillah	The chickens become *najis*	5	Lack of religious understanding	1	Nothing	5	25
	Chickens do not die immediately when they're first cut	The chickens became haram	5	Lack of slaughterer skills and ignorance of halal cutting standards	2	The chicken is still moving around after being cut	1	10
	When cutting has not been cut 4 vessels: throat, esophagus, and 2 blood vessels	The chickens became haram	5	Lack of slaughterer skills and ignorance of halal cutting standards	2	The chicken is still moving around after being cut	1	10
	Slaughterers do not know the process of slaughtering by Islamic law	Chicken becomes haram	5	Not attending training for halal cutting procedures	3	None	5	75
	Less sharp cutting tools	Chicken becomes haram	3	Not sharpening cutting tools	1	The tool looks blunt	1	3

Table 2. FMEA Process in RPH X (continued)

FMEA Process								
Process Steps	Potential Failure Mode	Potential Effect of Failure	Severity (S) Linkert Scale 1-5	Potential Causes of Failure	Occurrence (O) Linkert Scale 1-5	Current Control, Detection	Detection (D) Linkert Scale 1-5	RPN
Blood cleansing	There is blood left on the chicken	Chicken becomes not clean	2	Lack of cleaning process	5	None	1	10
	Chickens are still alive during blood cleansing	Chicken becomes haram	5	Slaughter is not competent enough	1	None	5	25
				Slaughter does not know the slaughtering halal standard	2	The chicken is still moving around after being cut	2	20
	Damage to chicken meat because it contains microbes	Poor chicken quality	4	Unhygienic production facilities	3	Facility looks dirty	4	48
Feather cleansing	The water temperature is too hot when boiling so it damages the meat	The shape of the chicken becomes not good	4	Boiling process takes too long	1	None	3	12
				Fire is too big when boiling	2	None	4	32
	Chicken feathers are still left	Chicken is not clean	1	Less thorough during cleaning	5	None	1	5
Packaging	Chicken products are damaged due to imperfect packaging process	Chicken becomes rotten	4	Lack of packaging skills	3	None	4	48
Delivery	Contamination during delivery	Chicken becomes haram	5	Use share facility	1	None	5	25
	Chickens damaged due to unstable temperatures	Chicken becomes rotten	4	Not using frozen	2	None	4	32
	Transportation equipment was once used to carry non-halal products	Chicken becomes haram	5	Use share facility	1	None	5	25

5.1 FMEA and Pareto Results

FMEA results show the order of potential failure based on the RPN score. The top five risks in RPH X based on FMEA Table are A9, A1, A13, A16, A4, A12, and A14. Some risks have the same rank because the total RPN has the same value. The examples such as A13 with A16 and A4 with A12. The highest rank is A9 (Slaughterers do not know the process of slaughtering by Islamic law). The impact if that risk happens is chicken become haram. The risk cause was the slaughter not attending training for halal cutting procedures.

Table 3. Rank of FMEA Process

RANK	CODE	Potential Failure	RPN	Percent
1	A9	Slaughterers do not know the process of slaughtering by Islamic law	75	13,3%
2	A1	There are bruises on chickens	64	11,3%
3	A13	Damage to chicken meat because it contains microbes	48	8,5%
	A16	Chicken products are damaged due to imperfect packaging process	48	8,5%
4	A4	The chickens are sick	45	8,0%
	A12	Chickens are still alive during blood cleansing	45	8,0%
5	A14	The water temperature is too hot when boiling so it damages the meat	44	7,8%
6	A18	Chickens damaged due to unstable temperatures	32	5,7%
7	A6	The slaughterers do not say bismillah	25	4,4%
	A17	Contamination during delivery	25	4,4%
	A19	Transportation equipment was once used to carry non-halal products	25	4,4%
8	A5	Production facility do not clean from *najis mutawassithah*	20	3,5%
9	A2	There are physical defects in chickens	15	2,7%
	A10	Less sharp cutting tools	15	2,7%
10	A7	Chickens do not die immediately when they are first cut	10	1,8%
	A8	When cutting has not been cut 4 vessels: throat, oesophagus, and 2 blood vessels	10	1,8%
	A11	There's blood left on the chicken	10	1,8%
11	A15	Chicken feathers are still left	5	0,9%
12	A3	The physical condition of the chickens is weak	3	0,5%
Total			564	100%

Table 3 can be used to analyze using pareto charts. The pareto diagram was as follows:

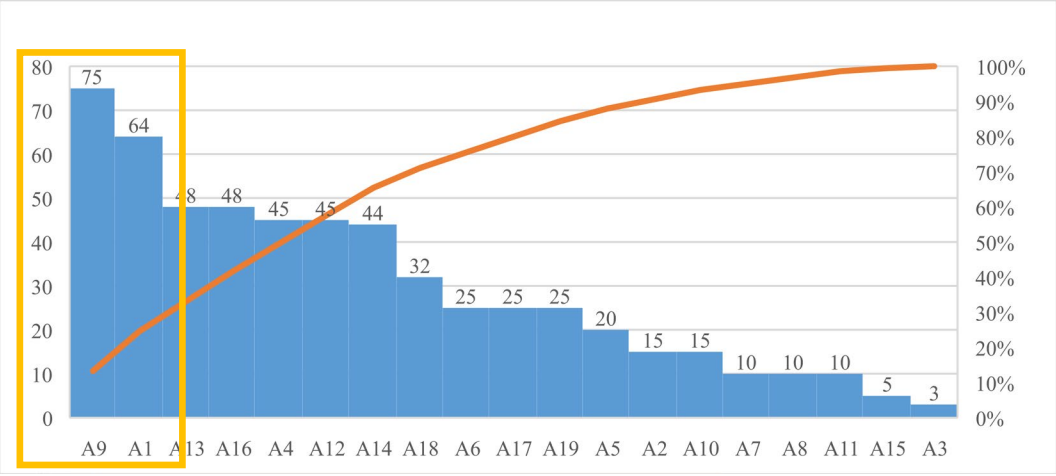

Figure 2. Pareto Diagram of Risk in RPH X

Analysis of the Pareto Diagram in Figure 2 shows problem that must be solved was A9 and A1. They were representing 20% of all problem in this case. The cause of A9 risk happen was the slaughter not attending training for halal cutting procedures. The mitigation strategy was to advise RPH management to follow training for halal cutting process. It did not need for all slaughters to follow halal training. RPH X could ask a management representative from one of the slaughters. A management representative must share the knowledge gained from halal slaughtering training held by LPPOM MUI. It would help the other slaughters understand well the halal cutting rules correctly. The cause of A1 risk happen was chickens pinched during delivery. The mitigation strategy was to conduct a physical examination of chickens before being received from the supplier. Another strategy was choosing a better supplier in maintaining the

quality of the chickens. If they have had better suppliers, then the chickens do not have bruises on their bodies. The impact of A9 risk is more immediate than A1 risk because if A9 risk happens, the chicken would be haram. The risk of A1 has impacted in quality of products. The quality would be not good, and the company could not sell it to the customer.

5.2 Risk Matrix

The form of risk matrix to mapping the known risks are seen in Figure 3 in bellow:

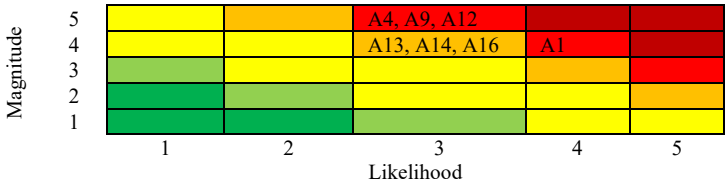

Figure 3. Risk Matrix in case study of RPH X

The risks of A1, A4, A9, and A12 were in the red zone (very high risk), so immediate mitigation has required so that no unwanted things happen. The risk of A13, A14, A16 is in the orange zone (high risk), so immediate mitigation has also needed.

5.3 Multi-Phase QFD

Application Multi-Phase QFD models in chicken meat processing company shown in Table 4, Table 5, Table 6, and Table 7. Two halal auditors from LPPOM MUI input their suggestion for HAS (Phase 1). The relation of the risks with the halal integration be analyzed. The top rank priority based on the Multi-Phase QFD Models in Phase 1 is cutting processing. It has the value importance 3,20 and percent importance 18,9%. The cutting processing has a significant risk that must be mitigated. The factors that influence the risk in cutting processing happen such as the cutting tools are not sharp and made from nail/bone of animals, animal welfare like as sharpened the cutting tools in front of the chickens, the slaughterer did not know cutting halal processing, the chickens were still alive in the first cut, and unhygienic location of production. Farouk et al. (2014) and Farouk et al. (2016) pointed out that animal welfare was key in halal supply chain. Raising and slaughtering animals should be gently to meet halal standard, included it forbidden to scare the chickens by sharpening the cutting tools/slaughtering other chickens in front of them. Farm level is the beginning of the halal supply chain (Omar and Jaafar 2011). It is important to do traceability for halal integrity. The potential risks can make something halal become haram. Those need to be mitigated.

Data observation of processing chicken meat in RPH X provided to arrange kind of risks (Phase 2). The relation integration of halal risk with strategy mitigation be analyzed. The top rank priority based on the Multi-Phase QFD Models in Phase 2 is Process Method. The problem integrity halal factor was “The slaughterers not cut four vessels: throat, esophagus, and 2 blood vessels”. If that risk happens the halal meat can become haram. The slaughterer should know chicken will die immediately by cut four vessels (throat, esophagus, and 2 blood vessels). If there one vessel is not cut correctly, it will undoubtedly cause the chicken to come back to life or even die as a carcass due to cutting it many times. The researcher offers four mitigation options to the RPH management based on a risk matrix result, those are strategy 1 (conduct a physical examination of chickens before being received from the supplier), strategy 2 (choose suppliers that aware of halal and food safety), strategy 3 (advise RPH management to follow training for the halal cutting process), and strategy 4 (always sharpen the cutting tool before using it for slaughtering). Multi-Phase QFD (Phase 2) shown in Table 7. It analyzes that strategy 1 is 48%, strategy 2 is 31%, strategy 3 is 17%, and strategy 4 is 4%.

Table 4. Application of QFD Models Step 1

Code	HAS	Linkert Scale	Relative Importance	Halal Risk Integration									
				Raw Material		Labour						Equipment	
						Supplier		Producer		Distributor			
		(1-5)	Linkert score /total score*100(%)	Score	Risk Value	Score	Risk Value	Score	Risk Value	Score	Risk Value	Score	Risk Value
R1	The risk meat contaminated by physically, biologically, and chemically.	4	3,88	0,35	9	0,12	3	0,12	3				
R2	The risk of chickens died before being cut	5	4,85	0,44	9	0,15	3						
R3	The risk of chickens in poor condition (sick)	4	3,88	0,35	9	0,04	1						
R4	The risk of chickens has bruises	2	1,94	0,17	9	0,06	3						
R5	The risk of supplier sells dead chickens	5	4,85	0,15	3	0,44	9						
…	…	…	…	…	…	…	….	…	…	…	…	…	…
R26	The risk of transportation equipment carries not only halal products	4	3,88							0,35	9		
	Total	103	100										
	Absolute Importance				2,07		0,80		1,63		0,47		1,97
	%Importance				12,2%		4,7%		9,6%		2,8%		11,7%
	Rank of Priority				3		7		5		12		4

Table 5. Application of QFD Models Step 1(continued)

Code	HAS	Linkert Scale	Relative Importance	Halal Risk Integration							
				Process Method						Location of Production	
				Cutting Process		Blood cleansing		Feather cleansing			
		(1-5)	Linkert score /total score*100(%)	Score	Risk Value	Score	Risk Value	Score	Risk Value	Score	Risk Value
R1	The risk meat contaminated by physically, biologically, and chemically.	4	3,88								
R2	The risk of chickens died before being cut	5	4,85								
R3	The risk of chickens in poor condition (sick)	4	3,88								
R4	The risk of chickens has bruises	2	1,94								
R5	The risk of supplier sells dead chickens	5	4,85								
…	...	…	…	…	…	…	…	…	…	…	…
R26	The risk of transportation equipment carries not only halal products	4	3,88								
	Total	103	100								
	Absolute Importance				3,20		0,65		0,64		0,76
	%Importance				18,9%		3,8%		3,8%		4,5%
	Rank of Priority				1		9		10		8

Table 6. Application of QFD Models Step 1 (continued)

Code	HAS	Linkert Scale	Relative Importance	Halal Risk Integration										
				Logistic								Halal Traceability System		The value of "integration halal"
				Receiving		Packaging		Storage &Warehouse		Delivery				
		(1-5)	Linkert score /total score*100(%)	Score	Risk Value	Score	Risk Value	Score	Risk Value	Score	Risk Value	Score	Risk Value	
R1	The risk meat contaminated by physically, biologically, and chemically.	4	3,88	0,35	9							0,04	1	0,97
R2	The risk of chickens died before being cut	5	4,85	0,15	3							0,44	9	1,17
R3	The risk of chickens in poor condition (sick)	4	3,88	0,12	3							0,04	1	0,54
R4	The risk of chickens has bruises	2	1,94	0,06	3							0,02	1	0,31
R5	The risk of supplier sells dead chickens	5	4,85	0,44	9							0,15	3	1,17
R6	The risk of the cutting tool is used not sharp	4	3,88									0,12	3	0,82
R7	The risk of the cutting tool is made by nail/tooth/bone of animal	3	2,91									0,03	1	0,55
R8	Cutting tool size does not suit the chicken neck	2	1,94									0,02	1	0,27
R9	The cutting tool is sharpened in front of the animal to be slaughtered.	2	1,94											0,43
R10	The risk of the cutting tools should not be contaminated with *najis* from dog/pig (*najis mughalazhah*)	5	4,85									0,05	1	0,63
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
R26	The risk of transportation equipment carries not only halal products	4	3,88							0,35	9	0,12	3	0,82
	Total	103	100											
	Absolute Importance				1,11		0,47		0,61		0,35		2,20	16,92
	%Importance				6,5%		2,8%		3,6%		2,1%		13,0%	
	Rank of Priority				6		12		11		14		2	

Table 7. Application of QFD Models Step 2

Integration of Halal Risk	Problem in integration halal factor	Total relative importance	Relative importance (Linkert scale score x %/total score 53)=W		Strategy Mitigation								Critically	Rank
					Strategy 1		Strategy 2		Strategy 3		Strategy 4			
					Score	E1	Score	E2	Score	E3	Score	E4		
Raw Material	Lack of care for chickens before slaughter	7,14%	4	7,14%	0,21	3	0,64	9					0,86	3
Labor	Suppliers are not aware of halal and food safety	25,00%	5	8,93%			0,80	9	0,09	1			0,89	2
	The slaughter does not know the halal slaughtering procedure		5	8,93%					0,80	9			0,80	4
	Distributors do not know the standard delivery of halal products		4	7,14%					0,07	1			0,07	9
Equipment	Cutting tools make from nails / teeth / bone of haram animals	14,29%	3	5,36%							0,05	1	0,05	10
	The cutting tool was time validated sharpness		5	8,93%							0,80	9	0,80	4
Process Method	The slaughterers not cut 4 vessels: throat, esophagus, and 2 blood vessels	16,07%	5	8,93%					0,80	9	0,27	3	1,07	1
	The water temperature is not warm (too hot/ too cold) when boiling		4	7,14%					0,07	1			0,07	9
Location of Production	Unhygienic production facilities	7,14%	4	7,14%					0,64	9			0,64	6
Logistic	Lack of manpower to check the quality of chicken received from suppliers	21,43%	4	7,14%	0,07	1	0,64	9					0,71	5
	Extra packing is needed to ensure the product is not contaminated by non-halal products or by bacteria/microbes/others		4	7,14%					0,21	3			0,21	8
	Using shared transportation (it is not guaranteed if it deliver halal products only)		4	7,14%					0,21	3			0,21	8
Halal Traceability System	There is no barcode used for tracing halal meat products produk	8,93%	5	8,93%					0,27	3			0,27	7
Total			56	100%										
Absolut Effectiveness						0,29		2,09		3,18		1,13	6,68	
Percent Effectiveness						4%		31%		48%		17%	100%	
Rank of Priority						4		2		1		3		

6. Conclusion

The demand for halal products in Indonesia is increasing. Then, it must be balanced with the availability of halal products. If majority of producers have halal awareness and have certified all their products, it makes be balance. The case study of this research provided halal risk in the chicken meat processing company and the strategies mitigation for the risks. According to the results of the Pareto analysis, the halal risks that must be mitigated are risk A9 and risk A1. While according to the risk matrix analysis are risk A1, risk A4, risk A9, and risk A12. Analysis with a risk matrix contains more risks to be mitigated so that it is chosen to minimize the failure of halal products. Then the Multi-Based QFD Models to know the most effective mitigation strategy for mitigating risk. The most effective mitigation strategy for mitigating risks is strategy 3 (advise RPH management to attend training for the halal cutting process). Its presentation of effectiveness is 48%. The other mitigation strategies are strategy 1 (conduct a physical examination of chickens before being received from the supplier), strategy 2 (choose suppliers that are aware of halal and food safety), strategy 3 (advise RPH management to follow training for halal cutting process), and strategy 4 (always sharpen the cutting tool before using it for slaughtering). The strategy mitigation for the primary potential failure is to advise RPH management to follow animal slaughter training following Islamic law. Management representatives can do this mitigation advice. It is not necessary to do by all slaughterers in RPH X. Management representatives can share with others the knowledge gained from halal cutting training held by LPPOM MUI. Then, all slaughterers on RPH X can know the halal cutting rules correctly.

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References

Bashir, A. M, Awareness of purchasing halal food among non-Muslim consumers: An explorative study with reference to Cape Town of South Africa, *Journal of Islamic Marketing*, vol.11, no.6, pp. 1295–1311, 2019.

Burgmann, T, Halal Flexes Its Marketing Muscle, The Star, Retrieved from http://www.thestar.com/business/article/238551, 2007.

DPR-RI, UNDANG-UNDANG REPUBLIK INDONESIA NOMOR 33 TAHUN 2014 TENTANG JAMINAN PRODUK HALAL, Available in https://www.dpr.go.id/dokjdih/document/uu/1615.pdf, May 2021.

Farouk, M.M., Al-Mazeedi, H.M., Sabow, A.B., Bekhit, A.E.D., Adeyemi, K.D., Sazili, A.Q. and Ghani, A, Halal and kosher slaughter methods and meat quality: a review, *Meat Science*, Vol. 98, No. 3, pp. 505-519, 2014.

Farouk, M.M., Pufpaff, K.M. and Amir, M, Industrial halal meat production and animal welfare:a review", *Meat Science*, Vol. 120, pp. 60-70, 2016.

Jaafar, H. S., Endut, I. R., Faisol, N., Omar, E.N, Munich Personal RePEc Archive Innovation in logistics services – halal logistics, *Proceedings of the 16th International Symposium on Logistics (ISL)*, (34665), pp. 844–855, 2011.

Kabir, S., Shams, S., and Lawrey, R, Trade diversion risk for halal food exports, *Journal of Islamic Marketing*, 2020.

Kawata, Y., Htay, S. N. N. and Salman, S. A, Non-Muslims' acceptance of imported products with halal logo: A case study of Malaysia and Japan, *Journal of Islamic Marketing*, vol.9, no.1, pp. 191–203, 2018.

Khan, S., Khan, M. I., Haleem, A., Jami, A.R, Prioritising the risks in Halal food supply chain: an MCDM approach, *Journal of Islamic Marketing*, 2019.

Leksono, E. B., Suparno, S., and Vanany, I, Integration of a balanced scorecard, DEMATEL, and ANP for measuring the performance of a sustainable healthcare supply chain. *Sustainability (Switzerland),* vol.11, no.13, 2019.

Maman, U., Mahbubi, A. and Jie, F, Halal risk mitigation in the Australian – Indonesian red meat supply chain, *Journal of Islamic Marketing,* vol.9, no.1, pp. 60–79, 2018.

Omar, E. N. and Jaafaar, H.S., Halal supply chain in the food industry – a conceptual model, Business, Engineering, and Industrial Applications (ISBEIA), *IEEE Symposium*, pp. 384-389, 2011.

Talib, M. S. A, Halal logistics in Brunei: Current constraints and future potentials, *Islamic Research Journal of Emerging Economies & Islamic Research*, vol.8, no.1, pp. 69–76, 2020.

Vanany, I. and Zailani, S, Urgency in managing the risk in supply chain amongst Indonesian manufacturing companies. *International Business Management,* vol.4, no.4, pp 199-208, 2010.

Vanany, I., Maarif, G. A. and Soon, J. M, Application of multi-based quality function deployment (QFD) model to improve halal meat industry, *Journal of Islamic Marketing*, vol. 10, no.1, pp. 97–124, 2019.

Wahyuni, H. C., Vanany, I., Ciptomulyono, U., and Purnomo, J.D.T, Integrated risk to food safety and halal using a Bayesian Network model Integrated risk to food safety and halal using a Bayesian Network model, *Supply Chain Forum: An International Journal*, vol.21, no.04, pp. 260-273, 2020.

Wilkins, S., Butt, M.M., Shams, F., Pérez, A, The acceptance of halal food in non-Muslim countries: Effects of religious identity, national identification, consumer ethnocentrism and consumer cosmopolitanism, *Journal of Islamic Marketing*, vol.10, no.4, pp. 1308–1331, 2019.

Yaacob, T. Z., Rahman, F. A. and Jaafar, H. S, Risk categories in halal food transportation: A preliminary findings, *Int. J Sup. Chain. Mgt*, vol.7, no.6, pp. 453–461, 2018.

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