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Research paper

Identification and risk mitigation strategy of cocoa commodities supply chain using fuzzy house of risk method (Fuzzy-HOR)

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Abstract

Supply Chain Management should be considered in a business entity as it relates to the process of managing the flow of goods from upstream to downstream. The supply chain process involves multiple parties, in which each of the parties involved may pose a supply chain risk so that supply chain risk management is required to manage supply chain activities. PT. XYZ as the research place is located in Blitar, East Java which is one of the business entities engaged in cocoa commodities. Currently, PT. XYZ has not had a structured supply chain risk management yet to identify and mitigate risks. This study aims to identify supply chain risk and determine risk mitigation strategies that need to be applied. The method used was Fuzzy-HOR. This study involved expert respondents consisting of cocoa farmers and employees (production managers and operational managers). The result of risk identification found 11 risks on farmer's activity which was composed of 15 risk agents. Next, 19 risks were found on company's activity which was consisted of 25 risk agents. Calculation results using Fuzzy-HOR on phase 1 resulted in 9 risk agents on farmer's activity and 18 risk agents on company's activity that required mitigation strategies design. In Fuzzy-HOR phase 2, there were 17 farmer's mitigation strategies and 30 company's mitigation strategies.

Keywords: *Cocoa; Fuzzy-HOR; Risk Mitigation; Supply Chain.*

1. Introduction

The needs of modern human consumption at this time cannot be separated from various types of food ingredients. One of them is chocolate. Chocolate is made from cocoa beans that have undergone a series of processing procedures so that it has a distinctive shape and aroma. Indonesia is the third largest cocoa producer in the world after the Ivory Coast country and Ghana [1]. In 2014, the area of Indonesian cocoa plantation is 1,719,087 Ha with cocoa seed production of 709,331 tons [2]. The rapid development of food technology has contributed to the development of processed cocoa products [3]. These developments will open opportunities in developing cocoa beans' trade and processing.

PT. XYZ is a business entity engaged in the trading of cocoa beans in regional, national and export markets. PT. XYZ also processes cocoa beans into several chocolate products. As a developing business entity, PT. XYZ strives to meet the needs of the market and consumers well and also continues to improve its management capabilities in order to compete with other similar business entities. [4] declares supply chain management in a business entity is very important because it is closely related to the process of design, planning, and coordinating the flow of material, information, and money [4].

The supply chain process involves several key stakeholders. The actors who play a role in the supply chain of cocoa commodities consisted of farmers, farmer groups, collectors, exporters, and industries. Each member of the supply chain involved may pose a variety of risks. Risks identified in the cocoa supply chain include risks related to quality, price, finance, market, policy, information, and policy [5]. Good risk management is needed to manage the risk of the cocoa supply chain in order to produce a strong supply chain and enhance cocoa competitive advantage [6]. PT. XYZ needs to do a good supply chain risk management to get profit and be able to manage the sustainability of its business to keep on running. Furthermore, the cocoa beans' products are agricultural products that have great supply chain risk potential.

The supply chain management of agricultural commodities deals with the uncertainty of demand fluctuations that can increase supply risk. The escalating complexity of the problem should be followed by proper consideration of the management of product, financial, and information flow within the overall supply chain environment [7]. Currently PT. XYZ has not conducted a structured supply chain risk management to identify and design risk mitigation strategies. Therefore, the purpose of this study is to identify supply chain risks and determine risk mitigation strategies that need to be implemented. Supply chain risk management is an intergovernmental collaborative effort that utilizes quantitative and qualitative risk management methodologies to identify, evaluate, mitigate, and also to monitor unexpected macro and micro events as well as conditions that could adversely affect the supply chain [8].

The method used in this research is Fuzzy-House of Risk (Fuzzy-HOR). HOR phase 1 identifies risks and risk agents that have the arising potential then conducts a fuzzy assessment of Severity (S), Occurrence (O), and Correlation (R) factors to obtain Fuzzy Aggregate Risk

Potential (FARP). Thus, it can be determined the order of priority and designed risk mitigation strategies to reduce the probability of the emerging risks. Selected risk agents will be included in HOR phase 2 to design risk mitigation strategies. The fuzzy approach is also used in the second phase of HOR to assist in the assessment of Correlation (E) and Degree of Difficulty (Dk) in order to avoid bias. The design of mitigation strategies for risk agents in the supply chain is expected to reduce the risk, to facilitate the supply chain at PT. XYZ so it is able to run well.

2. Materials and methods

This research was conducted at PT. XYZ in February until March 2017. The limitation problem in this research was the identification of supply chain activity. It was carried out only on behalf the farmers as the supplier and PT. XYZ as the processor. The research procedure began with: literature review and field study; problem identification; problem formulation and goal setting; data source classification and data collection methods; respondent classification; supply chain activity mapping; identification of occurrence and risk agents; questionnaire preparation; questionnaire validity testing; risk analysis; risk evaluation; risk mitigation; and the last part are conclusions and suggestions.

a) Respondents Classification

The sampling method used was purposive sampling method. Purposive sampling was a deliberate selection method of participants because of the quality of the participants. Researchers decided what needs were to be known and determined. It was required to find people who were willing and were able to provide information based on knowledge or experience [9]. The assisting respondents in this research were those who had sufficient knowledge and understood well the condition of supply chain in PT. XYZ. They were the cocoa farmers and the PT. XYZ. Farmers' respondents were one big farmer and one small farmer, on the other side on behalf of the company, they were employees: operational managers and production managers. Fuzzy method required the determination respondents' weights where the respondent farmers were given weight of 0.6 for big farmers and 0.4 for small farmers. Additionally, PT. XYZ was given a weight of 0.4 for operational managers and 0.6 for production managers.

b) Mapping of Supply Chain Activity

HOR had two useful phases for identifying risks and emerging risk agents and designing risk mitigation strategies. The fuzzy approach was used to assist in the assessment of the HOR phase in order to avoid bias. Phase 1 HOR was an identification stage of risks and the risk agent to be used to determine the priority of risk agents. The early stage of HOR phase 1 was mapping the supply chain activity on the enterprise based on the SCOR model (plan, source, make, deliver, and return) [10]. The reason for using the SCOR method was because this method could help understanding the supply chain by mapping it in business processes. This mapping would demonstrate the relevant supply chain processes that existed within the particular supply chain in the study [11].

c) Identification of Occurrence and Risk Agent

The identification of risk occurrence carried out for each business process had been identified in the previous stage. These risks were all occurrences that may arise in the supply chain process that resulted in company losses. Based on those risk occurrence then the risk-causing agent could be identified, i.e. any factor that could lead to the occurrence that had been identified earlier [12]. This identification was done using respondents interview method. The questions being asked included what were the arising risks, what were the impacts and what were the risks agents.

d) Designing Questionnaire and Testing Validity

The questionnaires used in the HOR method were as follows: a risk assessment questionnaire; a risk agency valuation questionnaire; a risk assessment and risk agency review questionnaire; a mitigation strategy and risk agent relationship assessment questionnaire; and an assessment of the degree of difficulty of a mitigation strategy. In addition, Fuzzy approach were also involved a questionnaire. It was a factor weight assessment questionnaire. Before the questionnaire was disseminated, it was necessary to validate the test. Testing validity was related to the issue whether the intended instrument was able to measure accurately. [13]. This validity testing was implemented with the help of internal company in risk assessment.

e) Risk Analysis

This stage calculated severity of risk occurrence, occurrence of risk agents, correlation between risk occurrences and risk agents, and calculated the value of Fuzzy Aggregate Risk Potential (FARP). The value of severity (Si) indicated how much a disruption posed by the risk to the supply chain activity of a business entity. Occurrence value (Oj) was the opportunity occurrence of occurrence frequency when risk agents were causing the happening of several risk occurrences at once. Correlation value (Rij) was useful to know the relationship / correlation between risk occurrence and risk agents. Based on the above three assessments, then the calculation value of Fuzzy Aggregate Risk Potential (FARPj) was conducted.

f) Risk Evaluation

The design of an effective mitigation strategy to reduce or mitigate the probability of an existing risk agent was being undertaken at this stage. The initial stage was to determine the priority of risk agents with the help of Pareto diagrams. The steps in making Pareto diagrams were as follows: arranging the risk agents of those having FARP values from the biggest into the smallest, forming a frame diagram with the left vertical axis showing the cumulative FARP. Thus, following the created Pareto diagram, the priority of the risk agent that would get handling, could be determined.

g) Risk Mitigation

The risk mitigation stage was including the process of identifying, evaluating and selecting mitigation strategies [14,15]. The identification of mitigation strategies was performed with the consideration that an agent of risk could be the cause of some risks so that a mitigation strategy could prevent or mitigate some risk agents. The identified mitigation strategy would undergo a correlation assessment with risk agents (Ejk) using a fuzzy approach. Next, Total Effectiveness (TEk) assessment was used to find out how effective a strategy was designed to address the risk agent and an assessment of Degree of Difficulty (DK) by using Fuzzy approach was applied in order to be able to know the difficulty level. The last was calculating the Effectiveness to Difficulty (ETDk) ratios to determine the priority ranking of existing strategies. By obtaining the result of ETDk value calculation, then priority ranking of each mitigation strategy (Rk) would be known. The highest ETDk value indicated the most effective strategy.

3. Result and discussion

a) Supply Chain Management

Supply chain management was an approach used to achieve more efficient integration of organizations from suppliers, manufacturers, distributors, retailers, and customers [16]. PT. XYZ possessed a network consisting of 48 cocoa farmer groups scattered in Blitar district and also a part of cocoa farmer group in East Java. PT. XYZ acted as a product marketing for cocoa beans produced by farmers who were both, partnering farmers and non-partnering partners. At the beginning of field pioneering, the cultivation of cocoa plants by farmers was executed with the help of seeds from PT. XYZ.

Farmers were also given education by PT. XYZ such as: to be able to plant, maintain, and harvest cocoa to produce qualified cocoa beans. Other activities were processing of cocoa beans into a variety of chocolate products and marketing. On supply chain of cocoa beans products PT. XYZ there were two main members involved, suppliers and processors.

b) Supply Chain Member

1) Supplier

Supplier was the source for providing the first material, in which the supply chain would start. The first material here could be in the form of core materials, raw materials, auxiliary materials, spare parts, or trading product [16]. The suppliers of cocoa beans were cocoa farmers. PT. XYZ had growing partnership with 48 cocoa farmers consisting of individual farmers and cocoa farmer groups spread in Blitar Regency. It was also a part of group of cocoa farmers in East Java.

2) Processor

Processors were those who processed core materials or raw materials into semi-finished goods or finished goods or finished goods that contained higher usage value [17]. The involving party that became cocoa bean processor products was PT. XYZ. The business entity played a role to promote back cocoa beans products in regional, national, and export markets and also to process cocoa beans into various chocolate processed products and promote their products to consumers.

c) Supply Chain Activity

The supply chain could be defined as a series of network of business members involved in the production process that convert raw materials into finished goods or services to meet the needs [18]. There were three types of flow from the entire supply chain flow process, in which they were all important in the supply chain management process [19].

d) Occurrence and Risk Agent Identification

Identification of risk occurrence was performed on each supply chain activity of each member. It would be then identifying the risk agent or causes of the occurrence of the risk. The thing to remember was that one risk occurrence could be caused by multiple risk agents and one risk agent may result in several risk occurrences. The result of risk identification and risk agent occurrence from both, farmer side and PT. XYZ side is listed on Table 1 and Table 2.

Table 1: Identification of Risk and Risk Agent in Farmers

Activity	Risk Occurrence	Risk Agent
Planning of seeds to be ordered	Risk of misplanning of ordered (E1)	• Needs calculation error (A1)
Planning fertilizer provision	Risk of misplanning the purchased fertilizer (E2)	• Needs calculation error (A1) • Restriction from government (A2)
Planning of fungicides provision	Risk of wrong purchase of fungicides (E3)	• Needs calculation error (A1)
Planning for cocoa planting	Risk of misplanning cocoa planting (E4)	• Wrong planting method (A3)
Planning for cocoa plant	Risk of misplanning cocoa plant (E5)	• Lack of experts (A4)
Purchasing fertilizer	Risk of fertilizer stock difficulty (E6)	• Unavailability of fertilizer stock (A5) • Scrambling with rice farmers (A6)
Purchasing fungicides	Risk of fake fungicides and insecticides (E7)	• Less competent producers (A7)
Planting cocoa plants	Risk of pests (E8)	• Too strong pests (A8)
Managing cocoa plants	Risk of poorly managed cocoa plants (E9)	• Too strong pests (A8); Cocoa plant diseases (A9) • Flood (A10); Careless grass cutting (A11) • Unready human resources (A12)
Harvesting cocoa beans	Risk of uncertain time harvesting (E10)	• Unready human resources (A12) • Weather factor (A13)
Processing cocoa beans	Risk of moldy cocoa beans (E11)	• Rain (A14); Wet cocoa beans in long term (A15)

Table 2: Identification of Risk and Risk Agent at PT. XYZ

Activities	Risk activities	Risk agents
Provision of seed planning	Risk of misplanning seed provision (E1)	• Inaccuracy in planning (A1)
Planning cocoa beans provision	Risk of misplanning cocoa beans provision (E2)	• Fluctuation of cocoa beans price (A2) • Farmer is less productive (A3)
Planning brown powder provision	Risk of misplanning brown powder provision (E3)	• Inaccuracy in planning (A1)
Planning additional raw materials provision	Risk of misplanning additional raw materials provision (E4)	• Prediction / Forecast errors (A4)
Planning packaging materials provision	Risk of misplanning packaging materials provision (E5)	• Inaccuracy in planning (A1)
Planning the production process	Risk of production process planning error (E6)	• Prediction / Forecast error (A4)
Packaging planning and labeling of chocolate products	Risk of packaging and product labeling error (E7)	• Less supplier's production capacity (A5)
Marketing planning of chocolate products	Risk of product marketing planning error (E8)	• Employee fluctuations and • production capacity (A6)
Planning for shipment of cocoa beans	Risk of cocoa bean shipment mismanagement (E9)	• Less qualified human resources (A7)
Ordering the seeds	Risk of seeds unavailability (E10)	• Inadequate gallery capacity (A8)
Taking cocoa beans from farmers	Risk of the incompatibility of specifications of cocoa beans (E11)	• Unresolved licenses (BPOM) (A9)
Receiving brown powder from the third party	Risk of delay in receiving raw materials (E12)	• The quality of cocoa beans is not suitable (A0)
Ordering additional raw materials to the supplier	Risk of delay in receiving raw materials (E12)	• Non-compliance of cocoa beans prices (A11)

Ordering packing material to supplier	Risk of shortage of packaging materials (E13)	• Late seed supply (A12) • The quality of cocoa beans is not suitable (A10) • There is a problem in the manufacturer (A13) • Delivery delay (A14)
Producing chocolate products	Risk of machine jamming (E14)	
Packing and labeling chocolate products	Risk of broken packaging (E15)	
Checking the quality of chocolate products	Defective product risk (E16)	
Marketing chocolate product	Unsold product risk (E17)	• There is a problem in the manufacturer (A13) • Delivery delay (A14) • Less supplier's production capacity (A5) • Overload (A15) • Lack of maintenance (A16) • False procedure (A17)
Finishing process of cocoa beans	Risk of the incompatibility (E11)	
Process of sorting and grading cocoa beans	Risk of carrying a foreign object (E18)	
Packing cocoa beans	Risk of broken packaging (E15)	
Delivering cocoa beans to a third party	Delivery delay risk (E19)	
Delivering cocoa beans	Delivery delay risk (E19)	

Based on Table 1, it was found that there were 11 farmers activities that contained risks. There were 11 occurrences of risk incidences that occurred in each activity and each of them had a various impact. The appeared risk occurrence were equal in number to the activities performed because different risk occurences appeared for different activities. The risk agents or cause of the occurrence could be identified as many as 15 agents.

Based on Table 2, it could be perceived that there were 23 activities on farmers that consisted of risks. There were 19 occurrences of risk incidences that occurred in each activity and the impact caused varied. The arising risk incidence was less in number than the activity due to the similar risk incidence for different activities. There were 15 risk agents or cause of the occurrence.

a) Risk Occurrence and Risk Agent Assessment

Severity was an assessment of an effect seriousness or the consequence of a potential failure on a particular component affecting a work which was being analyzed. The impact of risk occurrences was assessed using a scale of up to 10 based on their significance [20]. This assessment was conducted with a questionnaire where a score of 1 showed no impact until a value of 10 indicated the most harmful impact. The results of the assessment of the impact of risk occurrences on farmers and PT. XYZ can be seen at the right of Table 3 and Table 4.

Assessment of risk agents was performed after assessment of risk occurrences. Assessment of risk agents was performed to determine the occurrence rate of each risk agent. Based on the rate of occurrence, occurrence was assessed using a scale of 1-10 [21]. This assessment was carried out using a questionnaire, where a value of 1 showed the rate of occurrence was one time in more than 1.5 million times of the activity. The value that was up to 10 values indicated the rate of occurrence was more than once from the double activity.

The value of Fuzzy Aggregate Risk Potential (FARP) was calculated based on the three values (severity, occurrence, and correlation). The calculation of the ARP value was meant to determine rank and risk prioritization which had an aim to establish the order priority of the risk agent to be mitigated first. It was employed by deciding which rank had the highest priority that had been identified based on the ARP risk agent value [22,23].

It could be perceived that on farmers' side, the highest FARP value was in A8 risk agents. It was too strong pests' factor with a value of 11.68. The magnitude of this value of FARP was due to the frequent occurrence of risk agents and it resulted in more than one risk occurrence. It was where the risk occurrence had a large impact, and its correlation with some risk occurrences was also high. The lowest FARP score was A3 (planting error) which had 2.46 score value. This was because these risk agents were rare, affecting only one risk occurrences, where the risk incidence had less impact and the correlation was small.

It could be assumed that at PT. XYZ, the highest FARP value was on A5 risk agent. It was the less supplier production capacity and value was equal to 11,35. The magnitude of this FARP value was because the risk agent often occurred and resulted in more than one risk occurrences. The lowest FARP value was A21 (less desirable product variant) that was equal to 2.67. This risk agent was rare. It affected only one risk occurrence.

b) Risk Evaluation

The risk evaluation stage was intended to determine the priority of risk agents for which mitigation strategies should be developed. The prioritization of risk agents that need to be addressed was analyzed based on the FARP score ranking. This stage was done by using Pareto diagram. Pareto diagrams were useful for prioritizing which actions and processes needed to be focused. This diagram used a bar chart to classify problems by frequency, impact level, or source and indicate which issues were most vital [24]. The step of creating a Pareto chart based on the FARP value were as follows: the first to do was to sort the FARP value from the largest value to the smallest value; calculating the cumulative value of the risk agent; calculating the cumulative percentage value; and the last one made the diagram. Risk agents that were on a cumulative percentage of FARP scores of up to 80% for mitigation strategies.

c) Risk Mitigation

Risk mitigation was a process of prevention in the handling of risks in determining appropriate treatment to address risks that occurred. Each of the risks had different treatments: avoidance of risks, transferring risks, reducing opportunities or impacts, and taking risks [25]. Risk mitigation strategies that had been designed for farmers and PT. XYZ was listed on Table 3 and Table 4.

Table 3: Design of Supply Chain Mitigation Strategy of Farmers

Code of Risk Agent	FARP Value	Mitigation Strategy	Code of Risk Agent	FARP Value	Mitigation Strategy
A8	11.72	• Applying good sanitation (PA1) • Conducting spraying (PA2) • Harvesting cocoa more frequently (PA3) • Adding human resources (PA4)	A6	5.84	• Buying fertilizer from other farmers (PA12) • Ordering more fertilizer stock (PA13) • Mixing fertilizer (PA14)
A1	11,.35	• Reorder seeds (PA5) • Make your own seed (PA6)	A14	5.72	• Properly storing seeds (PA15) • Estimating the weather well (PA16)
A12	10.10	• Provide training on labor (PA7) • Employing temporary labor (PA8)	A15	5.58	• Extend the life of the fermentation process (PA17)

A9	6.14	• Applying good sanitation (PA1) • Conduct routine checks (PA9) • Conducting spraying (PA2) • Buying fertilizer at another store (PA10) • Rent people to buy fertilizer (PA11)	A2	5.21	• Rent people to buy fertilizer (PA11)
A5	5.84				

Table 4: Design of Supply Chain Mitigation Strategy at PT.XYZ

Code of Risk Agent	FARP Value	Mitigation Strategy	Code of Risk Agent	FARP Value	Mitigation Strategy
A5	11.35	• Evaluating suppliers that have made agreement (PA1) • Improving contracts with suppliers (PA2) • Selecting new suppliers (PA3)	A16	5.18	• Supervising the production process (PA18) • Make regular maintenance schedules (PA19) • Bringing technicians and replacing parts (PA20)
A1	10.04	• Creating a market demand mapping strategy (PA4) • Conduct inventory control (PA5) • Create a scheduling system (PA56)	A15	5.14	• Create a scheduling system (PA6) • Adding machines or production equipment (PA21) • Supervising the production process (PA18)
A4	8.36	• Conduct inventory control (PA5) • Create scheduling system (PA6)	A13	5	• Evaluating suppliers that have made agreement (PA1) • Improving contracts with suppliers (PA2) • Selecting new suppliers (PA3)
A10	7.35	• Perform finishing process (handling post-harvest) cocoa beans well (PA7) • Develop new methods and technologies on cocoa beans processing (PA8)	A7	4.93	• Provide training and development on labor (PA17) • Increase experienced workforce (PA14) • Implementing SOPs well (PA22)
A19	6.38	• Periodically clean the warehouse storage (PA9) • Rearrange storage in the warehouse (PA10) • Fixed or renovated warehouse storage (PA11) • Sorting gradually (PA12)	A3	4.91	• Provide counseling and training for farmers (PA23) • Supervise farmers (PA24) • Provide support facilities for farmers (PA25)
A23	6.17	• Provision of machines or sorting tools (PA13) • Increase experienced permanent workforce (PA14) • Perform quality control gradually (PA16)	A24	4.75	• Create a scheduling system (PA6) I • mprove a clear coordination mechanism (PA26)
A20	5.28	• Provide training and development on labor (PA17) • Increase experienced permanent workforce (PA14) • Always update the price information of the world cocoa beans (PA15)	A8	4.69	• Increase gallery capacity (PA27) • Marketing products outside the gallery (PA28)
A2	5.25	• Creating a market demand mapping strategy (PA4) • Conduct inventory control (PA5)	A9	4.69	• Complete permission files (PA29) • Improve a clear coordination mechanism (PA26)
A14	5.18	• Creating a market demand mapping strategy (PA4) • Conduct inventory control (PA5) • Create a scheduling system (PA6)	A6	4.54	• Creating a market demand mapping strategy (PA4) • Increase permanent or temporary labor • Create a scheduling system (PA30)

Table 5: House of Risk Phase 2 of Farmers

Risk Agent	Preventive Action																	FARP
	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	PA10	PA11	PA12	PA13	PA14	PA15	PA16	PA17	
A1					2,47	2,47												11,
A2											5							5,21
A5										7	4,6							5,84
A6												5,8	4,6	5,8				5,84
A8	7	4,6	7	2,47														11,72
A9	7	4,6							7									6,14
A12							5,8	2,47										10,1
A14															4,6	4,6		5,72
A15																	2,47	5,58
TEk	125,0	82,2	82,0	28,9	28,0	28,0	58,6	24,9	42,9	40,8	52,9	33,9	26,9	33,9	26,3	26,3	13,8	
Dk	2,6	2,6	2,6	2,8	1,6	2	3,2	2,4	2,6	2,4	2,4	3,4	2,8	2	2	2,4	2	

ETDk	48,1	31,6	31,6	10,3	17,5	14,0	19,3	10,4	16,5	17,0	22,1	9,96	9,59	16,9	132	10,	6,89
Rank	1	2	3	14	6	10	5	13	9	7	4	15	16	8	11	12	17

Table 6: Summary of house of Risk Phase 2 of PT XY

Preventive Action	Tek	Dk	ETDk	Rating
PA1	108.45	2.6	41.71	4
PA2	86.29	2.4	35.95	5
PA3	90.27	4	22.57	6
PA4	135.55	3.2	42.36	3
PA5	137.8	3	45.93	2
PA6	162.08	3	54.03	1
PA7	30.87	2.6	11.87	12
PA8	39.69	3.6	11.03	14
PA9	29.35	3	9.78	16
PA10	31.9	3.6	8.86	18
PA11	31.07	4	7.77	24
PA12	30.85	3.2	9.64	17
PA13	43.19	3.6	12.00	11
PA14	71.62	3.67	19.51	8
PA15	24.15	2	12.08	10
PA16	22.18	2.6	8.53	20
PA17	59.21	4	14.80	9
PA18	51.63	2.6	19.86	7
PA19	26.57	3	8.86	19
PA20	27.97	3.4	8.23	23
PA21	35.98	3.6	9.99	15
PA22	22.68	3	7.56	25
PA23	24.55	3.4	7.22	26
PA24	18.66	4	4.67	29
PA25	20.62	3.4	6.06	28
PA26	14.07	3.6	3.91	30
PA27	29.69	2.6	11.42	13
PA28	21.57	2.6	8.30	22
PA29	27.2	3.2	8.50	21
PA30	19.07	3	6.36	27

Based on Table 5, it could be inferred that from 80% or as many as 9 selected risk agents on farmers' side, there were 17 strategies for mitigation strategy design. Based on Table 6, it could be seen that from 80% or as many as 18 risk agents selected at PT. XYZ, the obtaining design of mitigation strategy were 30 strategies. A mitigation strategy was made with the consideration that a risk agent could be the cause of some risks so that a mitigation strategy could prevent or mitigate some risk agents.

The designed strategy was then evaluated, beginning with a correlation assessment of mitigation strategies with risk agents. The assessment on the degree of correlation between preventive action and risk agents was conducted to determine the magnitude of the relationship and the effect of recommended precautions with the selected risk agents to be addressed [26].

This assessment was carried out by filling out a questionnaire of correlation assessment between mitigation strategies and risk agents with a rating scale of 0, 1, 3, 5, 7, and 9. The value 0 indicated no correlation meanwhile value 9 indicated a very strong correlation between risk occurrences and risk agents. The results of correlation assessment between risk agents and mitigation strategies for farmers can be seen in the middle of Table 5.

The next step was to calculate the value of total effectiveness. The purpose of this assessment was to assess the effectiveness of mitigation actions [27]. Result of calculation of total effectiveness of each strategy to farmers and PT. XYZ can be seen at the bottom of Table 5 and Table 6.

The designed strategy was also measured by the degree of difficulty. The purpose of this assessment was to know the degree of difficulty of applying strategic action [27]. This assessment was implemented by completing a degree of difficulty questionnaire from a mitigation strategy on a scale of 1 to 5. The value 1 indicated a mitigation strategy was very easy to be implemented. Next, the value of 5 indicated a very difficult mitigation strategy to be applied. The level of difficulty was assessed with the consideration of human resource capacity and financial capability owned by farmers and PT. XYZ. The results on the assessment of difficulty degree of each strategy on farmers and PT. XYZ can be seen at the bottom of Table 5 and Table 6.

Based on the total effectiveness and degree of difficulty of the mitigation strategy, then the effectiveness to difficulty ratio was calculated. The purpose of this calculation was to determine the priority ranking of all strategic action [25]. The results of calculation of effectiveness to difficulty ratios of each strategy on farmers and PT. XYZ can be seen at the bottom of Table 5 and Table 6.

Based on Table 6, it was known that at PT. XYZ the most effective strategy to be implemented was the strategy with the greatest ETDK value. The first strategy was PA 6 (making the scheduling system) in the planning, production, and delivery activities that was equal to 54.03. Strategy with the second largest ETDK value was PA5 (inventory control) for planning and delivery activities that was equal to 45.93. next, the strategy with the third largest ETDK value was PA4 (making market demand mapping strategy) that was equal to 42,36. This assessment was conducted with consideration of the mitigation strategies effectiveness designed to address the risk agents and the difficulty level of mitigation strategies to be implemented by judging the ability of PT. XYZ, as well as the degree of correlation between the risk agents and the designed mitigation strategy.

4. Conclusion

The research result showed there were 11 risks identified along with 15 risk agents on the supply chain activity on farmers' side. On the other side, at PT. XYZ there were 19 risk occurrences along with 25 risk agents. 9 potential risk agents were selected to design their mitigation strategies from 15 risk agents on farmers' behalf. The selected risk agent with the highest FARP score was A8 (pest that was too strong) that was equal to 11.72. In addition, the lowest was A2 (the limitation of government) that was equal to 5.21. 18 risk agents

were selected. They were chosen to get mitigation strategies design out of 25 risk agents at PT. XYZ. The preferred risk agent with the highest FARP value was A5 (less supplier production capacity) which was equal to 11.35 meanwhile the lowest was A6 (employee fluctuation and production capacity) which was equal to 4.54.
There were 17 strategies for farmers and 30 strategies for PT. XYZ obtained from the design of mitigation strategies undertaken against the selected risk agents. On farmers' side, the results of the strategy evaluation revealed that the best strategy to apply was PA1 (applying good sanitation) with ETD value of 46.08 while the smallest effect was PA17 (extending the life of the fermentation process) with an ETD value of 6.89. At PT. XYZ, from the strategy evaluation, it could be concluded that the best strategy to be implemented was PA6 (making scheduling system) with ETD value of 54,03 whereas the smallest effect was PA26 (fixing clear coordination mechanism) with ETD value 3,91.

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