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RISK IN THE SUPPLY CHAIN OF ORGANIC RICE: AN EXAMPLE FROM MOJOKERTO REGENCY, INDONESIA

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Abstract—The aims of this study were determining the priority of risk agents and determining the risk mitigation in the supply chain of organic rice. An empirical study was carried out at "Manajemen Usaha Tani Hasil Organik Seloliman" (MUTHOS) as a business organization of organic rice in Seloliman Sub-district, Trawas District, Mojokerto Regency, East Java, Indonesia. This research used 2 phases of the House of Risk (HOR) method. Risks and risk agent identification were done in HOR 1 then the risk mitigations determined in HOR 2. The results of this study showed that 29 risks caused by 26 risk agents were identified in business activities of MUTHOS; as a result, 2 risk agents to be mitigated were chosen based on the value of Aggregate Risk Potential (ARP). There were 12 risk mitigations to be considered in mitigation of the chosen risk agents. These risk mitigations then were prioritized based on their effectiveness when being applied. The first priority of risk mitigation to be put into practice was training employees in the handling of the rice after it was harvested and in the management system.

Keywords—Aggregate risk potential, Organic rice, Risk Agents, Risk mitigations, Supply chain

I. INTRODUCTION

Organic products are becoming popular nowadays due to the public's increasing awareness of the importance of consuming chemical-free food products. Agricultural products are said to be organic if the product comes from an organic farming system that has the principle of not using or limiting the use of inorganic fertilizers. It must also be able to provide nutrients for plants and control pest attacks (Sriyanto, 2010). The increase in public awareness regarding organic agricultural products has an impact on the increasing demand for them. It has become an opportunity to develop a business in organic agricultural commodities, especially for rice as a staple food in Indonesia. Rice as an organic agricultural commodity should be given special treatment. It has greater supply chain risk compared to non-agricultural products.

According to Suharjito (2010), the supply chain risk management of agricultural products is different from the supply chain risk management of manufactured products. The supply chain risk management of agricultural products is more difficult because of several sources of uncertainty from the characteristics of agricultural products and the complex relationships between actors in the supply chain. An appropriate supply chain risk management should be carried out to minimize losses and run a sustainable organic rice business because organic rice is an agricultural commodity that has a large potential supply chain risk.

Risk agents are contributing factors that create risk. One risk agent can create more than one risk event. Several risk events can be reduced by mitigating a risk agent. The aims of this study were to determine the priority of the risk agents and the risk mitigations based on their effectiveness when applied in the supply chain of organic rice.

II. LITERATURE REVIEW

Rice is a strategic food commodity that has a high political, economic and social vulnerability in Indonesia. A slight disruption in rice production will disturb its supply and selling price. The increase in the public's awareness of organic rice has an impact on the increasing demand for it. Organic rice is grown with the use of organic fertilizers and is friendly to the environment while ordinary rice is grown using chemical fertilizers and pesticides (Andoko, 2014). According to Sutanto (2002), the production system of organic rice does not pollute the environment, increases the productivity of agricultural ecosystems, and creates sustainable ecosystems. Furthermore, organic rice is also healthier due to its high level of vitamins and nutrients (Sutanto, 2002).

Organic rice as an agricultural commodity has some specific characteristics, such as the process of planting, growing, and harvesting which depends on climate and season, the yields have varied shapes and sizes, and the commodity is perishable and voluminous. The production system of organic rice involves some stakeholders in a supply chain which impacts the quality of the organic rice received by the end

consumers. Supply chain management (SCM) is very important to keep the good quality of the organic rice received by the end consumers. According to Wang (2010), SCM connects all the important elements such as suppliers, processors, distributors, retailers, and consumers as a whole to ensure the business process is run well from the supplier's supplier to the end consumer.

Some stakeholders' involvement in the supply chain of organic rice from the supplier's supplier to the end consumer will generate some risks. Risk management of the supply chain is important to be done in the supply chain of organic rice to minimize the risks. According to Suharjito (2011), supply chain risk management focuses on how to understand and overcome chain influences when a large or small risk occurs at a point in the supply chain. Supply chain risk management also ensures that the company has the ability to return to normal conditions and continue its business when a disruption occurs. The supply chain risk management process in general consists of risk identification, risk analysis, risk evaluation and risk mitigation (Suharjito, 2011).

Some research on the management of supply chain risk of fresh agricultural products has already been done by Astuti *et al.* (2013), Slamet et al. (2017) and Astuti *et al.* (2018). Astuti *et al* (2013) identified potential risks of mangosteen supply chains in West Java, Indonesia using Fuzzy Analytical Hierarchy Process (FAHP) and analysed the interrelationships between strategies using Interpretive Structural Modelling (ISM) for mitigating those risks. Slamet *et al.* (2017) identified and analysed various risks in the papaya supply chain in Indonesia then assessed the risks and prioritized them to be mitigated appropriately using the Failure Mode and Effects Analysis (FMEA), The Fuzzy Analytical Network Process (FANP), and Weighted Risk Priority Number (WRNP). Both types of research recommended some risk mitigations without considering the risk agents. In fact, risk agents are sources of risks. According to Pujawan and Geraldin (2009), one risk agent can cause more than one risk events so several risk events can be reduced by mitigating a risk agent. Astuti *et al.* (2018) then considered the order of priority risk agents using the House of Risk (HOR) method in determining risk mitigation strategies that should be implemented in a supply chain of mangosteen in Blitar, East Java. HOR is also considered to be an appropriate method for the identification of risk agents in the organic rice supply chain because organic rice as a specific commodity is considered to have more risk events which are caused by several risk agents in its supply chain. agents in its supply chain.

III. METHODS

An empirical study using descriptive quantitative approach was carried out at "Manajemen Usaha Tani Hasil Organik Seloliman" (MUTHOS) as a business organization of organic rice in Seloliman Sub-district, Trawas District, Mojokerto Regency, East Java, Indonesia. The identification of risk agents was done only for the 2 stakeholders of organic rice which were farmers as suppliers and MUTHOS as a processor. A purposive sample was used to ensure the representation of experts within each member of the supply chain. The respondents were 3 farmers who represented 3 farmer groups and 3 MUTHOS employees.

The activities of the business in the chain were mapped using Supply Chain Operation Reference (SCOR) model version 11.0 level 2. SCOR is composed of three process levels. Level-1 processes are SCOR processes which are defined for each member in the supply chain, meanwhile, Level-2 is generally associated with a narrower subset of processes. A set of standard notations was used throughout the model. i.e. P, S, M, D, and R depict Plan, Source, Make, Deliver, and Return elements respectively. Return element has 2 types of return, i.e. SR (Source Return) and DR (Deliver Return) (Supply Chain Council, 2012).

After the mapping phase of the business activity, the House of Risk (HOR) was used in this study. According to Pujawan and Geraldin (2009), the House of Quality (HOQ) model was adapted to the HOR model which determines the priority of risk agents for preventive actions. Priority is given to risk agents based on the magnitude of the aggregate risk potential of each risk because one risk agent could induce a number of risk events. The House of Risk phase 1 (HOR 1) was carried out to identify risks and risk agents. The identification of risk events was done on each identified business process. Risk assessment then was done by identifying the level of impact or severity of a risk *I* (Si), the occurrence of a risk agent *j* (Oj), and the correlation assessment between a risk *i* with a risk agent *j* (Rij) using a scale of 1-10. The description of the scale is shown in Table 1.

TABLE 1. THE SCALE OF SEVERITY AND OCCURRENCE

Level	Severity	Occurrence
1	No	Almost Never
2	Very Slight	Remote
3	Slight	Very Slight
4	Minor	Slight
5	Moderate	Low
6	Significant	Medium
7	Major	Moderately High
8	Extreme	High
9	Serious	Very High
10	Hazardous	Almost Certain

The value of the Aggregate Risk Potential caused by risk agent *j* (ARPj) then was calculated as a consideration to determine the priority of risk agents that need to be mitigated. The Aggregate Risk Potential

(ARPj) of *n* activities of the supply chain based on the assessment of *m* respondents was calculated using the following formula:

$$\text{ARPj} = Oj \sum_{i=1}^{n} Si \text{ x Rij } \forall j \quad (1)$$

$$\text{Si} = \sqrt[m]{Si1xSi2x \dots xSil}\forall i \quad (2)$$

$$\text{Oj} = \sqrt[m]{Oj1xOj2x \dots xOjl}\forall j \quad (3)$$

$$\text{Rij} = \sqrt[m]{Rij1xRij2x \dots xRijl}\forall ij \quad (4)$$

The output from HOR 1 was used for HOR 2. According to Pujawan and Geraldin (2009), the initial phase of HOR 2 is choosing a high priority risk agent. The selection of risk agents was performed by ARP data analysis using the Pareto diagram to rank the ARP from the most significant to the least significant. The appropriate mitigation strategies for mitigating the risk agent were then designed. The next stage was to assess the correlation between risk agent *j* and the mitigation strategy *k* (Ejk). The Total Effectiveness value of mitigation strategy *k* (TEk) based on the assessment of *m* respondents was then calculated using the following formula:

$$\text{TEk} = \sum_{j=1}^{n} ARPjEjk\forall k \quad (5)$$

$$\text{Ejk} = \sqrt[m]{Ejk1xEjk2x \dots xEjkl}\forall jk \quad (6)$$

The assessment of the degree of difficulty in performing mitigation strategy *k* (Dk) was done using Likert scale 3-5 and the Effectiveness to Difficulty ratios in performing mitigation strategy *k* (ETDk) were calculated to determine the priority rank of mitigation strategy *k* (Rk) by using the following formula:

$$\text{ETDk} = \frac{TEk}{Dk} \quad (7)$$

IV.RESULTS AND DISCUSSION

The supply chain of organic rice in MUTHOS consists of farmers as raw material suppliers. MUTHOS as raw material processors and the driver of the chain, distributors, and retailers which distribute the organic rice to end users. The organic rice supply chain activities consist of the flow of goods in the form of seeds, grain, and rice; the flow of money; and the flow of information which can be seen in Figure 1.

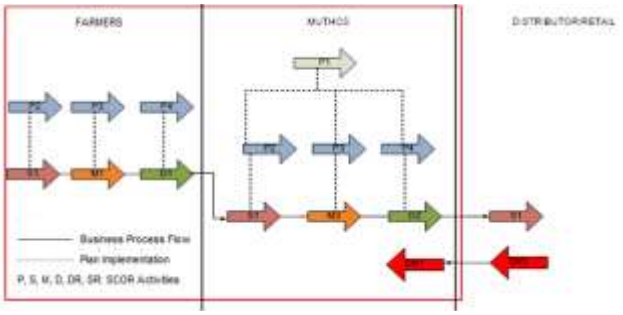

Fig 1 Organic rice supply chain activities

The result of the identification of risk events and risk agents for each supply chain activity showed that 29 risk events are caused by 26 risk agents. The value of the Aggregate Risk Potential (ARP) was based on the assessment of the severity of the risk events, the occurrence of the risk agents, and the correlation between the risk events and the risk agents as the result of HOR 1 (Table 2). The risk agent that has the highest ARP value was the error of planning management of MUTHOS (A4). This risk agent can pose various risks such as errors in machine maintenance planning and lack of packaging materials.

HOR 2 was then carried out to determine the mitigation of risk agents. The Pareto diagram (Figure 2) was used to determine the priority of risk agents to be mitigated. The Pareto Principle (also known as the 80-20 rule) states that for many phenomena, about 80% of the consequences are produced by 20% of the causes (Dunford *et al.*, 2014).

TABLE 2. HOR 1.

		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25	A26	Severity
	E1	3																										1
	E2				3																							2
	E3			3	9																							4
Plan	E4				9																							5
	E5				3																							4
	E6		3		3																							2
	E7				3																							4
	E8						3	1	3							3												5
	E9									1	9	3	1															3
	E10													3														3
	E11										1				3													3
	E12				9					9																		4
Source	E13				1					3																		5
	E14																	9										6
	E15				3																							4
	E16																										9	6
	E17														3		9	9										5
	E18														3		3		1									5
	E19									3		3	3															6
	E20														9		3											3
Make	E21										9		3		9		9			9	9							5
	E22										3																	5
	E23					9																	9					5

	E24																9				3						5
	E25																				9						5
	E26			1															9								4
	E27												9								3		3				4
Deliver	E28				3	3							9														4
	E29																							3	9		4
Occurance		5	5	6	6	6	5	2	6	6	6	5	7	6	4	5	4	6	5	6	4	5	7	3	6	6	7	
ARP		**15**	**30**	**96**	**1092**	**342**	**75**	**10**	**90**	**432**	**540**	**135**	**252**	**486**	**444**	**75**	**456**	**864**	**25**	**486**	**180**	**360**	**315**	**36**	**72**	**216**	**378**	
Rank		**25**	**23**	**17**	**1**	**11**	**19**	**26**	**18**	**8**	**3**	**16**	**13**	**4**	**7**	**20**	**6**	**2**	**24**	**5**	**15**	**10**	**12**	**22**	**21**	**14**	**9**	

Ei = risk event
Aj =risk agent

Correlation between **Ei** and **Aj**:
Empty: no correlation, **1**: low, **3**: medium, **9**: strong

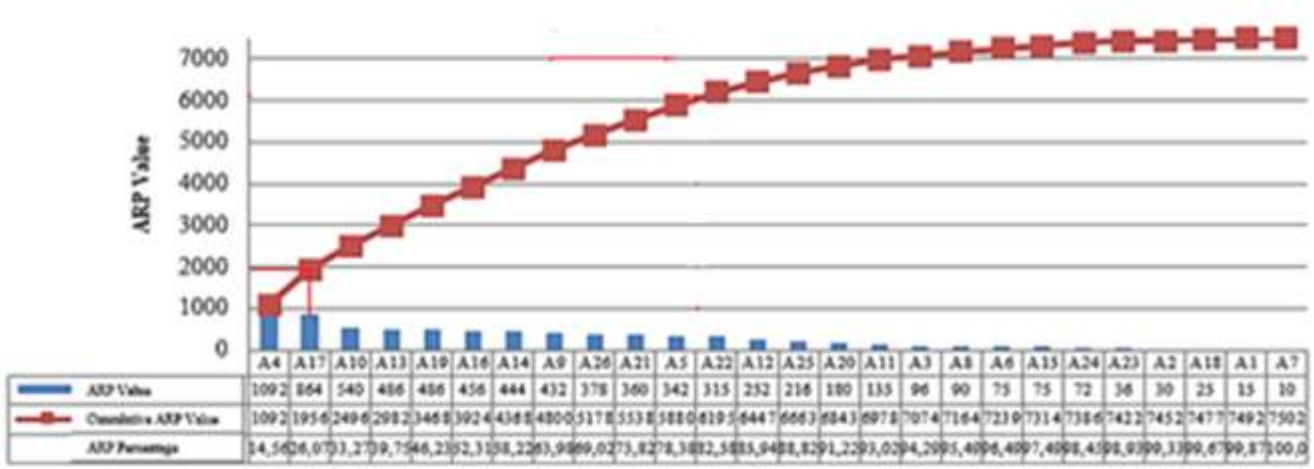

Fig 2. Pareto diagram of ARP

The result of HOR 1 showed that 20% of the ARP was caused by the error in management planning at MUTHOS (A4) and their unskilled employee (A17). The error in management planning (A4) was the risk agent of planning errors in some activities such as seed supply (E2), procurement of packaging materials (E3), the maintenance of tools and machines (E4), determination of the number of employees (E5), determination of grain stock (E6), and shipping (E7). The other risk events caused by A4 were lack of packaging material (E12), late machinery maintenance (E13), and no inventory of organic rice (E28). Meanwhile, the risk events caused by A17 were errors in machine maintenance (E14), bad drying of grain (E17), and rice damage during milling (E24). Several strategies to mitigate risk agents of A4 and A17 were then designed, i.e. a demand forecasting organic rice (PA1), controlling the inventory of raw materials and supporting material (PA2), scheduling of delivering and picking up the grain (PA3), improving the coordination of internal management of MUTHOS (PA4), improving the coordination with the other actors in the chain (PA5), improving the plan of employees in MUTHOS (PA6), the training of MUTHOS employees in the management system and post-harvest product handling (PA7), recruiting more skilled employees (PA8), evaluating the supplier (PA9), finding new suppliers (PA10), evaluating the agreement with other actors in the chain (PA11), and considering a new collaboration with a fairer agreement (PA12). The result of HOR 2 (Table 3) showed that the mitigation strategy with the highest value of Total Effectiveness was PA7. This strategy has the highest Total Effectiveness value because this strategy has high correlations with both risk agents which caused the highest ARP in the supply chain of organic rice.

TABLE 3. HOR 2

	PA1	**PA2**	**PA3**	**PA4**	**PA5**	**PA6**	**PA7**	**PA8**	**PA9**	**PA10**	**PA11**	**PA12**	**ARP**
A4	9	9	3	3	9	3	9	3	3	3	3	9	1092
A17				9		9	9	9					864
TEk	9828	9828	3276	11052	9828	11052	17604	11052	3276	3276	3276	9828	
Dk	4	4	4	4	4	3	4	5	4	4	4	4	
ETDk	2457	2457	819	2763	2457	3684	4401	2210,4	819	819	819	2457	
Rank	4	4	6	3	4	2	1	5	6	6	6	4	

PAj = mitigation strategy
Correlation between Ai and PAj
Empty: no correlation
1: low
3: medium

Level of Dk
3: easy
4: medium
5: difficult
9: high

The training of MUTHOS employees in the management system and post-harvest product handling

were also not difficult to be applied by considering the financial and human sources in MUTHOS. This mitigation strategy will eliminate the error of management planning of MUTHOS and their unskilled employees as risk agents with the highest ARP. According to Adzido *et al.* (2015), training and development promote efficiency, improved quality, skills, behaviour, employee loyalty, and corporate performance.

The training can be carried out regularly by collaboration with government institutions or universities around MUTHOS. This training and development can eliminate some risks events in the organic rice supply chain of MUTHOS, such as planning errors of seeds supply, machinery maintenance, determining of the number of employees, determination of grain inventory, bad drying, rice damage during milling, and shipping of organic rice to the end customers.

V. CONCLUSION

The supply chain of organic rice is more complex than other commodities because of several sources of uncertainty from the characteristics of agricultural organic commodities and the complex relationships between stakeholders in the supply chain. The supply chain management of organic rice will face a lot of risk events in delivering the commodities from the supplier's supplier to the end consumers. Unskilled human resources in this chain can cause some errors in management planning and product handling. Training and development of human resources in this chain promote efficiency, improved quality, skills, behaviour, and supply chain performance so some risk events in this chain can be minimized. Further research can be carried out in the supply chain of organic rice by measuring the performance of the chain before and after the training and development of its human resource.

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