Proposed supply chain risk mitigation strategy of chicken slaughter house PT X by house of risk method

Maria Ulfah[1]*, *Dyah Lintang* Trenggonowati[1], and *Fadila Zahra* Yasmin[1]

[1]Departement of Industrial Engineering, Faculty of Engineering, University of Sultan Ageng Tirtayasa, Banten, Indonesia

Abstract. Slaughter House PT X is a company engaged in the production, trade, and distribution of chicken meat that having a role to provide the needs of raw material in a form of fresh chicken meat in the chicken meat processing industry. However, this company has the potential to experience a variety of supply chain risk that can disrupt the company's business processes. The purposes of this study are to identify risk events that have been potentially occurred, identify priority risk agent based on Aggregate Risk Potential (ARP) value, and determine the priority sequence of a risk mitigation strategy in Slaughter House PT X. This study uses the Supply Chain Operation Reference (SCOR) to mapping the company's supply chain activity. Thereafter House of Risk (HOR) method is used to identify, analyze, evaluate, and designing mitigation strategy to minimize potential occurrence of risk agent. The results of the study showed that there are 33 risk events and 32 risk agents identified. Then, based on the result of risk evaluation, there are 15 priority risk agents for mitigation action. There are 11 proposed mitigation strategies to be implemented in Slaughter House PT X.

1 Introduction

Supply chain management is not a new thing for the company nowadays. The company should have to manage and run the supply chain to fulfill customer needs [1]. The complexity of multiple stakeholder within the supply chain structure and the number of uncertainties poses challenge in supply chain management.

The emergence of risks in supply chain activity becomes unavoidable. To reduce and overcome the various risks that occurred within the supply chain, it will be required to undertake a continuous improvement of supply chain performance by overcoming and preventing various risks which potentially occurred [2]. Supply chain risk management becomes an effort to manage the risks that have been occurring along the supply chain flow.

Chicken slaughter house PT X is a company engaged in production, trade, and distribution of chicken meat to fulfill the needs of raw materials in the form of fresh

---

[1] Corresponding author: maria67_ulfah@yahoo.com

chicken meat for chicken meat processed industry or sold directly to customers through the retailer. The complexity within agro industry supply chain can caused some problem on its supply chain flow. The problems that occurred in chicken slaughter house PT X are based on the monthly report data of production result in 2016 and 2017, showed unstable production results for every month in a year also there are several months that cannot fulfill the production target. Furthermore, there was a decreased value of the yield percentage of the total net weight of life bird as a raw material to the total net weight of finished product in the form of chicken meat where the yield value of 2016 is 75,19% decreased to 74,37% in 2017. The causes of these problems are variable, it is not only came from the company, but also from the farm in the form of life bird as the supplier. If there is a risk in the supplier as an upstream supply chain, it will affect the customer as a downstream in the supply chain. Therefore, supply chain risk management in PT X is required to reduce or even eliminate potential risks in the company's supply chain activity.

The goals of the research are to identify risk events that potentially occurred within the business process in chicken slaughter house PT X, identify priority risk agents based on Aggregate Risk Potential (ARP) value that causes the risk to occur within a business process in chicken slaughter house PT X and determine the priority sequence of applying proposed risk mitigation based on Effectiveness to Difficulty Ratio (ETD) value on chicken slaughter house PT X.

2 Research method

House of Risk (HOR) is formed from modification of FMEA (Failure Modes and Effect Analysis) and House of Quality (HOQ) model to prioritize which risk agent that selected first to take the most effective action in order to reduce the risk potential of risk agent.

There are two phases used in House of Risk (HOR) approach that is HOR 1 which is used to determine the priority level of risk agent that supposed to give a preventive action and HOR 2 that used to determine priority in taking effective action [3].

The steps of House of Risk (HOR) first phase are [2]:
1. Identify the risk event that may occur in every business process.
2. Estimate the impact of some risk events (if they have occurred).
3. Identify the risk agent and asses the probability of risk occurrence for each risk agent.
4. Develop the linkage matrix relationship between each risk agent and risk event.
5. Calculate the Aggregate Risk Potential of agent j (ARP_j) value.

$$ARP_j = O_j \, \Sigma \, S_i \, R_{ij} \tag{1}$$

ARP_j= Aggregate Risk Potential of Risk agent j
O_j = Occurrence value
S_i = Severity value
R_{ij} = Correlation value between risk event i
           and risk agent j
$R_{ij} \in \{0,1,3,9\}$
6. Rank the risk agent based on aggregate risk potential value in decreasing order (from highest to lowest).

The steps of House of Risk (HOR) second phase are [2]:
1. Select a number of risk agents with highest priority rank using Pareto analysis of ARP_j value, declare in the second phase of House of Risk (HOR).
2. Identify relevant action that considered to prevent the risk agent or Proactive Action (PA).
3. Determine the relationship between each risk agent and proactive action, E_{jk}.

4. Calculate the Total Effectiveness value for each action as follows [2]:

$$TE_k = \Sigma_j \, ARP_j \, E_{jk} f \qquad\qquad (2)$$

TEk = Total Effectiveness
ARPj = ARP value
Ejkf = correlation value of risk agent and
mitigation action

5. Estimate the degree of difficulty in performing each action, Dk. Calculate the effectiveness to difficulty ratio.

$$ETD_k = \frac{TE_k}{D_k} \qquad\qquad (3)$$

ETD = Effectiveness to Difficulty
Dk   = degree of difficulty

6. Rank the priority of each action (Rk) which means first rank is the action with highest ETD value.
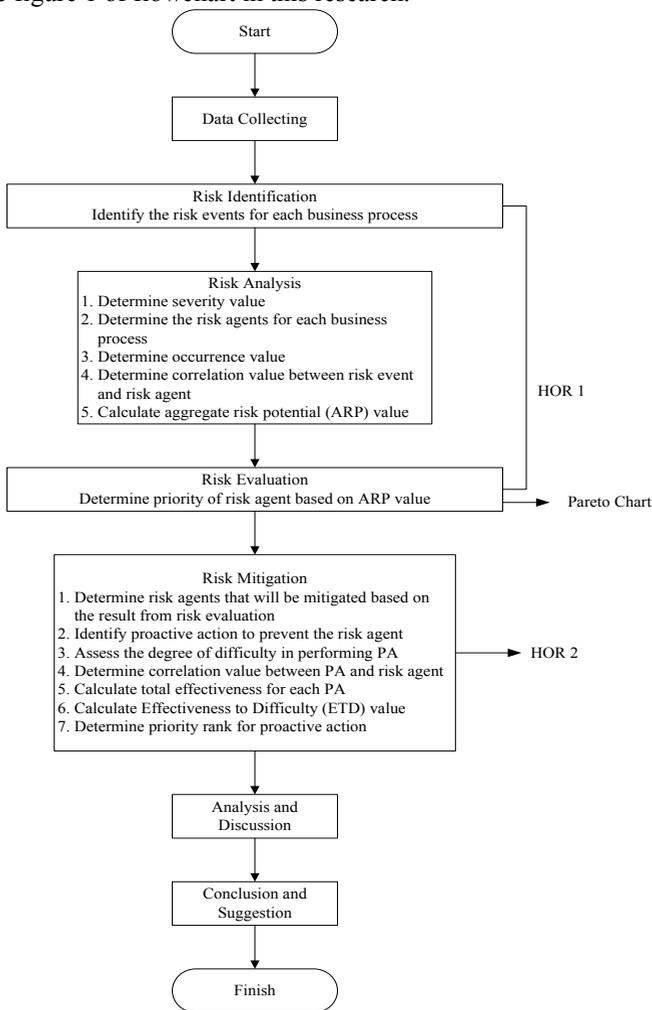
This is the figure 1 of flowchart in this research.

Fig 1 Research flowchart

3 Result and discussion

Data processing in this study consist of risk identification, risk analysis, and risk evaluation that belong to House of Risk first phase, and risk mitigation that belongs to House of Risk second phase.

3.1 Risk identification

Risk identification is an early stage for the study using House of Risk (HOR) method in the first phase. In this stage, the risk identification performed by the mapping of supply chain activity that has been identified previously using the Supply Chain Operation Reference (SCOR) method. The risk that has been identified either unprecedented or have a probability to occur in the supply chain activity of chicken slaughter house PT X. There are 33 risk events identified in the supply chain on chicken slaughter house PT X.

3.2 Risk analysis

The next stage is risk analysis.

Table 1 Risk agent assessment

Code	Risk Agent	Occurrence (O)
A1	Inappropriate product demand planning	5
A2	Fluctuating market condition	9
A3	Lack of raw materials needed	7
A4	Unexpectedly product demand from customer	9
A5	Inappropriate raw material planning	5
A6	The farm does not provide the required chicken size	6
A7	Insufficient ordering of live chicken's quantity that comply the specification	5
A8	External factors (currency exchange rate, government policy)	3
A9	Delay in support material procurement from packaging warehouse	6
A10	Nature disaster	6
A11	Inaccurate inspection of raw material receipts	3
A12	Variation size of live chicken weight	7
A13	Delay of raw material	7
A14	Disrupted power supply	2
A15	Machine downtime	8
A16	Lack of machine maintenance	7
A17	Inaccurate operator	7
A18	Error during packing pressing process	4
A19	Error during final weighing of finished product	4
A20	Error printing on the packaging	4
A21	Imperfect defeathering process	3
A22	Bacterial contamination	2
A23	Unhygenic production process	1
A24	Inaccurate physical checking of finished product	2
A25	Inappropriate water temperature on drum chiller process	1
A26	Lack of coordination between shipping departement and warehouse departement	5
A27	Error while order recording	3
A28	No transport truck	5
A29	Lack of communication with sales departement	5
A30	Inappropriate coolant temperature in the truck	2
A31	Lack of coordination with warehouse departement	5
A32	Delay of the transporter to take retur product	3

Based on table 1 above, the process of risk agent identification has been obtained 32 risk agent in the supply chain of chicken slaughter house PT X. Risk agent with rating 8 (high) or frequent is a machine downtime (A15), this is caused by frequent component replacement. Risk agent with rating 9 and 10 (very high) or hard to avoid, first is fluctuating market condition (A2), this is often occurring because of the increasing or decreasing the need of chicken meat in some certain period in a year. The second is unexpectedly product demand from customers (A4), this is often occurring because of the customer wants to increase their production result, so that they need to add the order beyond initial order.

3.3 Risk evaluation

Risk evaluation is the stage to determine priority sequence of risk agent that will be mitigated based on Aggregate Risk Potential (ARP) value. ARP value is used as a reference and input to determine the priority of which risk agent that should be handled first by sorting the ARP value from the largest to the smallest to analyze using Pareto chart [4].

Aggregate Risk Potential (ARP) is the result of multiplication of occurrence value with sigma of the result of multiplication of severity value with correlation value. ARP value is determinant of how much the risk affects chicken slaughter house PT X. The greater ARP value in a risk agent, the more harmful and dangerous the risk is, it means supposed to take the action immediately [5].

Based on the result of risk agent prioritization, there are 15 risk agents that have been obtained belong to priority risk agent and 17 risk agents belong to non-priority risk agent.

The risk agents belong to a priority risk agents are A4, A15, A16, A17, A2, A6, A7, A12, A9, A28, A19, A3, A13, A27, and A5, whereas the risk agents belong to non-priority risk agents are A26, A10, A29, A1, A31, A18, A20, A11, A21, A22, A32, A23, A14, A30, A8, A25, and A24. This in table 2 of the result of Aggregate Risk Potential (ARP) value.

Table 2 Aggregate Risk Potential (ARP) calculation

Code	Risk Agent	ARP	%ARP	*%Cum ARP*	*Rank*	Category
A4	Unexpectedly product demand from customer	2133	11,818	11,818	1	
A15	Machine downtime	1656	9,176	20,994	2	
A16	Lack of machine maintenance	1575	8,727	29,721	3	
A17	Inaccurate operator	1554	8,610	38,331	4	
A2	Fluctuating market condition	1458	8,078	46,410	5	
A6	The farm does not provide the required chicken size	1188	6,582	52,992	6	
A7	Insufficient ordering of life bird's quantity that comply the specification	720	3,989	56,981	7	Priority Risk Agent (A)
A12	Variation size of life bird weight	672	3,723	60,705	8	
A9	Delay in support material procurement from packaging warehouse	648	3,590	64,295	9	
A28	No transport truck	630	3,491	67,786	10	
A19	Error during final weighing of finished product	504	2,793	70,578	11	
A3	Lack of raw materials needed	441	2,443	73,022	12	
A13	Delay of raw material	441	2,443	75,465	13	
A27	Delay of raw material	432	2,394	77,859	14	
A5	Inappropriate raw material planning	360	1,995	79,854	15	

The following is fig 2 of the Pareto chart to determine the priority risk agent to be mitigated.
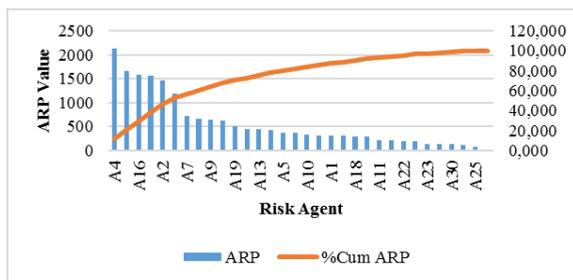

Fig 2 Pareto chart of risk agent

The priority risk agent is obtained from 79,854% (80%) total of cumulative ARP, while the non-priority risk agent is derived from remaining 20% of cumulative ARP. Intake of 80% from total cumulative ARP based on 80:20 Pareto chart principle, which is 20% of total risk agent contribute about 80% of total cumulative ARP [4].

3.4 Risk mitigation

Risk mitigation includes the activity to manage and monitor risk, create mitigation measures, reduce risk impact, and reduce the likelihood of occurrence. The proposed mitigation strategy was proposed by researcher then discussed with expert judgement in chicken slaughter house PT X. Based on 15 priority risk agent as the result of House of Risk (HOR) first phase, there are 11 mitigation strategy to prevent risk occurring in the supply chain.

Then performed the assessment for degree of difficulty to implementing each proposed mitigation strategy for the company. The next step is calculating Total Effectiveness (TEk) value for each mitigation strategy. TEk value that has calculated can not represent how proper these precautions can effectively fix some risk. Therefore, it is necessary to calculate Effectiveness to Difficulty Ratio (ETD) value for each mitigation strategy. ETD value can represent the level of effectiveness of mitigation strategy to be realized and fixed the risk. ETD value is needed to determine the priority sequence of mitigation strategy by sorting the value from the highest to the lowest [6].

Prioritizing the implementation of mitigation strategy is to determine alternative risk mitigation assessment that can be implemented by concerned the limitation of cost, human resources, and other aspects of the company [6].

Table 3 Priority of Risk Mitigation Strategy

Code	Proactive Action	Rank
PA2	Performing reliability maintenance	1
PA3	Conduct regular training for workers	2
PA8	Promotes implementation of work instruction	3
PA4	Intensive market research	4
PA11	Forecasting and collaborative planning	5
PA9	Perform evaluation supplier performance of live chicken suppliers	6
PA10	Improve communication and coordination with customers	7
PA6	Looking for alternative suppliers for live chicken	8
PA1	Set up buffer stock	9
PA5	Selective supplier of live chicken selection	10
PA7	Improve coordination with the shipping company	11

4 Conclusion

Based on the research result and analysis, it can be concluded that:

1. There are 33 risk events that potentially arise in the business process chicken slaughter house PT X among others are error in determining the needs of live chicken, required size of live chicken is unavailable, the farm cannot fulfill the order, live chicken size that has been received is inappropriate, and shackle rail plummeted.
2. There are 15 priority risk agents based on Aggregate Risk Potential (ARP) value belong to risk agent A category. Risk agent sequence based on Aggregate Risk Potential (ARP) value is unexpectedly product demand from customer (A4) with ARP value is 2133, machine downtime (A15) with ARP value is 1656, lack of machine maintenance (A16) with ARP value is 1575, inaccurate operator (A17) with ARP value is 1554, and fluctuating market condition (A2) with ARP value is 1458.
3. The sequence of priority of proposed mitigation strategy to be implemented based on Effectiveness to Difficulty Ratio (ETD) value in chicken slaughter house PT X are performing reliability maintenance (PA2), conduct regular training for workers (PA3), promotes implementation of work instruction (PA8), intensive market research (PA4), forecasting and collaborative planning (PA11), perform evaluation supplier performance of live chicken suppliers (PA9), improve communication and coordination with customers (PA10), looking for alternative suppliers for live chicken (PA6), set up buffer stock (PA1), selective supplier of live chicken selection (PA5), and improve coordination with the shipping company (PA7).

Reference

1. Utari, R. dan Baihaqi, I. *Perancangan Strategi Mitigasi Resiko Supply Chain di PT Atlas Copco Nusantara dengan Metoda House of Risk*. B-19-2. (2015)
2. Ulfah, M. Maarif, M. S. Sukardi. Raharja, S. Analisis dan Perbaikan Manajemen Risiko Rantai Pasok Gula Rafinasi dengan Pendekatan House of Risk. **26 (1)**, 87-103. (2016)
3. Pertiwi, Y. E. Susanty, A. Analisis Strategi Mitigasi Resiko pada Supply Chain V Surya CIP dengan House of Risk Model. **Vol 6 No 1**, 2. (2017)
4. Nugraheni, S. A. Yuniarti, R. Sari, R. A. The Analysis of Supply Chain Risk on Ready To Drink (RTD) Product using House of Risk Method. **Vol 5 No 1**, 49. (2017)
5. Arafiany, N. M. *Usulan Aksi Mitigasi Risiko Rantai Pasok Pabrik Baja Lembaran Dingin PT XYZ Menggunakan Metode House of Risk (HOR)*. 144. (2017)
6. Elvandra, A. R. Maarif, M. S. Sukardi. Management of Supply Chain Risk in Cattle Slice Fattening at PT Catur Mitra Taruma.. **Vol 4 No 1**, 97. (2018)