Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

Managing Supply Chain Risk of Perishable Goods: Perspective from Small to Medium-sized Tofu Firm in a Developing Country

Nina Aini Mahbubah
Industrial Engineering Study Program, Faculty of Engineering, Universitas Muhammadiyah Gresik
Jl. Sumatera 101 GKB Randuagung, Gresik, Indonesia 61121
Email: n.mahbubah@umg.ac.id

ABSTRAK

Tahu merupakan makanan berbasis protein nabati yang menjadi makanan sehari hari bagi masyarakat Indonesia. Produsen Tahu mayoritas memiliki skala usaha kecil menengah dan tersebar di berbagai Kota, termasuk di propinsi Jawa Timur. Bahan Baku utama tahu yaitu kedelai yang didapatkan dari ekspor keterlambatan pengiriman bahan Baku kedelai, pemilik usaha kesulitan dalam perencanaan bahan Baku, terganggunya proses produksi dikarenakan mesin mengalami kerusakan dan berbagai potensi risiko lainnya. Penelitian ini bertujuan untuk mengidentifikasi risiko, mengkalkulasi, dan menetapkan strategi mitigasi di sepanjang rantai pasokan industri tahu skala kecil-menengah. Metode House of Risk dan Supply Chain Operation Refrences digunakan sebagai pendekatan peneltian. Hasil penelitian yaitu pemetaan konfigurasi rantai pasok usaha skala kecil - menengah tahu, dan memetakan risiko, dan menghitung nilai risiko. ditemukan Sembilan belas factor penyumbang kejadian risiko dan dua puluh sumber risiko . Pada perhitungan HOR 1 ditemukan risiko dengan nilai aggregate Risk Potential tertinggi adalah kurangnya manajemen perawatan pada mesin produksi. Pada perhitungan HOR tahap kedua didapatkan Sembilan perioritas tindakan mitigasi dan perhitungan tindakan mitigasi prioritas guna meminimalisir risiko sepanjang aliran rantai pasok.

Keywords: HOR, Risiko, UKM, Rantai Pasok, Tahu

ABSTRACT

Tofu is a vegetable-based protein food condiment that is a daily food for the Indonesian people. Most tofu producers have small and medium-sized businesses across various cities, including East Java Province. The primary raw material for tofu is soybeans, which are obtained from exports. Due to the delay in the delivery time of raw soybean materials, business owners have difficulty planning raw materials, and the production process is disrupted due to machine damage and various other potential risks. This study aims to identify risks and calculate and determine mitigation strategies along the supply chain. The House of Risk method is a comprehensive risk management framework that helps identify, assess, and manage risks. The supply Chain Operation References method provides a structured approach to understanding supply chain operations. The result of this study includes mapping risk based on the configuration of the tofu industry supply chain and calculating risk scores. Nineteen contributing factors to risk events and twenty sources of risk were found. In the HOR 1 calculation, the risk with the highest aggregate Risk Potential score was the lack of maintenance management on production machines. In the second stage of the HOR calculation, nine priority mitigation actions were obtained, and the calculation of priority mitigation actions was carried out to minimize risks along the supply chain.

Keywords: HOR, SME, Risk, Supply Chain, tofu

1. INTRODUCTION

Tofu is known as vegan food and is served daily in Indonesian households. In addition, tofu has been found in food stall sellers in Indonesia. The production process of tofu has at least seven stages. The preliminary stage includes selecting high-quality soybean raw materials. The soybeans' raw materials have been purchased from resellers and distributors. Once the soybeans

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

are available, the production process starts in the following orders: soaking–grinding-boiling-filtering-extraction-casting-slicing-packaging.
The second stage is soaking the soybeans, which softens to the next stage. The third stage is the grinding process, which involves mixing water until it becomes liquid. Once the grinding is completed, the ground soybeans are boiled at a high temperature until the liquid soybeans are formed. After the soybean liquidation, the soybean juice was filtered to detach it from the tofu wastes. After the filtering process, vinegar is added to coagulate the soybean juice. Once the coagulate soybean juice is formed, it is cast on a wooden pattern and kept until it solidifies into tofu. The final stage is tofu cut into pieces according to consumer requests, packaged in drum containers, and distributed to customers.

The tofu products were distributed to Lamongan City, Babat City, Gresik City, and Tuban. The tofu waste is sold to local cattle farmers and used as cattle food. Figure 1 shows the tofu production process configuration from the upstream, midstream, and downstream supply chain.

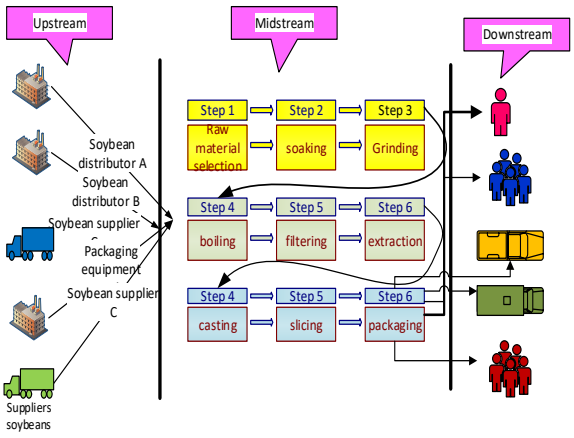

Figure 1. Tofu supply chain configuration

Figure 1. Shows the supply chain map from upstream to downstream tofu supply chain. Upstream includes a list of raw material suppliers, namely soybeans, woods, gas-liquid, and packaging materials, which can be seen from suppliers from distributors, and secondary raw materials, such as firewood, which are supplied from several wood yards. The soybeans are then processed into tofu products. After the production process is done, the goods are distributed to customers. Local cattle breeders bought tofu waste and used it as an additional ingredient for cattle breeders.

At the stages of the production process from the distribution of tofu to consumers, there are many potential disruptions, including planning risks, namely sudden changes in production plans; supplier risks, namely delays in raw materials from suppliers; risks in the production process, namely damage to machines; and risks related to delays in delivery.

Industrial supply chains can be configured through comprehensive mapping of upstream, downstream, and midstream supply chains [1]. Quantifying supply chain risk through streams of supply chain configuration is considered a valuable action in managing business continuity [2]. Process mapping is beneficial for identifying and determining processes throughout a supply chain stream [3].

In line with supply chain management, risk management can be used to confirm a robust operation system and examine uncertainty. Therefore, combining risk and supply chain management is significant in predicting and managing potential disruptions. By effectively managing risks, companies can ensure the continuity of their operations and maintain customer satisfaction, making risk management an integral part of supply chain operations [4]. Supply Chain Operation References (SCOR) have been used as a comprehensive approach in grouping risk based on operational activities from upstream to downstream. SCOR has five dimensions: plan, source, make, delivery, and return [5].

Supply chain risk management can be formed into five stages: supply chain configuration, classification of risk using SCOR's five dimensions, identification of risk, calculation of risk, and finally, the provision of scenario action based on risk calculation results. Each stage is crucial in the overall risk management process [6]. Empirical studies have been done in terms of managing supply chain risk. In addition, risk quantification has been developed by several researchers and validated in manufacturing and service enterprises through empirical findings. House of Risk (HOR) is one of the robust theories in quantifying risk and managing risk supply

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

chains [7]. HOR was also empirically adopted to manage manufacturing or service industry risk.

This research aims to mitigate the risk of the Tofu supply chain using the integration method of HOR and SCOR. By identifying the risk agents that have the potential to cause risk events, we can calculate and analyze each risk agent's priority order for carrying out mitigation action activities. The practical mitigation actions proposed as a result of this research will significantly improve the resilience of the tofu supply chain, thereby enhancing the industry's ability to manage risk effectively.

2. LITERATURE REVIEW

2.1 Supply Chain Risk Management

Supply Chain Risk management (SCRM) is a collaborative activity involving all stakeholders to manage risk within the supply chain stream [4]. This cooperative determination aims to identify, minimize, evaluate, and observe processes that can potentially cause risks at the macro and micro levels [8]. These risks can impact the sustainability of the company's business, underscoring the prominence of an integrated approach to risk management [9].

In addition, SCRM is based on a combination of two theories, namely Supply chain management and risk management, where the two collaborate to implement risk management in manufacturing and service enterprises. SCRM is related to suppliers' failure to distribute products, resulting in unfulfilled customer demand [5]. It can be ascertained that supply chain risk management is a risk that occurs in the product flow process from suppliers to end customers, as well as in information flow and raw materials [10].

2.2. Supply Chain Operation References Model

The SCOR method determines the performance of a company's supply chain. The SCOR model is a reference for processes in the supply chain. Applying the Supply chain operation references method includes measurements and observations of the supply chain process [11]. This model has three process levels. The top level contains five company management processes: Plan, Source, Make, delivery, and return. Configuration level 1 includes planning activities and implementing the material flow process in a company. Finally, Process Element Level 3 contains business processes such as forecasting, product sales, product order processes, transactions with suppliers or other stakeholders, and the right to return and add products [5].

2.3. House of Risk

House of Risk was developed by [7]; the House of Risk is a development of the FMEA (Failure Mode and Effect Analysis) and HOQ (House of Quality) methods. The FMEA method is used to identify and analyze the level of risk obtained from the results of processing and calculating RPN (Risk Potential Number). The HOQ method is used to design a strategy to eliminate identified risk agents. House of Risk has 2 phases: HOR phase 1, to determine the priority of risk sources for corrective action. In HOR phase 2, research uses the SCOR to set priorities for risk minimization actions [7], [12].

3. METHODOLOGY

3.1. Materials and Methods

This research used the SCOR approach to categorize supply chain risk with five core processes: plan, source, make, deliver, and return. In addition, the stage for identifying risk events and agents by distributing questionnaires to businesses and employees. The questionnaire results then proceed to the next stage by calculating the potential risks and causes of risks using the HOR method, which consists of 2 stages, namely, stage HOR 1 and HOR 2, and continued with mitigating determining actions to minimize risks.

3.2. Procedure

This research began by identifying five core processes: plan, source, make, deliver, and return, to identify risk causes. Then, the potential risks and causes of risks were calculated using the House of Risk method, which consists of two stages: HOR 1 and HOR 2. The research continued by determining the number of mitigation strategies to minimize the risk of the tofu supply chain.

3.2.1. House of Risk Phase 1 [7]

$$ARPj = Oj \sum Si\ Rj \quad (1)$$

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

Information:
ARP= Aggregate Risk Potentials
Si= Severity of the risk event
Oj= Occurrence of the cause of the risk
Rj= correlation between j risk causes and i risk events

3.2.2. House of Risk Phase 2 [7]

1. Correlation

The first stage assessed the correlation between mitigation strategies and risk agents. The scale range is 0, 1, 3, and 9. The number O indicates no correlation, 1 indicates low correlation, 3 indicates medium correlation, and 9 indicates high correlation.

2. Determining ranking priorities

The priority ranking was determined by calculating Total Effectiveness (Tech) and Effectiveness to Hard (ETD). The priority ranking was determined by identifying the ETD Value, which can be seen in formula 2. as follows [7]:

$$TEk = ARPj\ Ejk \quad (2)$$

Information:
Tech = Ratio of Total Effectiveness
ARPj = Aggregate Risk Potential
Ejk = correlation between risk causes and mitigation actions

Meanwhile, calculating the total effectiveness to Difficulty Ratio of Action can be seen in Formula 3 [7]:

$$ETDK = \frac{TEk}{DEk} \quad (3)$$

Information:
ETDk = Effectiveness to Difficulty
Tech = Total Effectiveness
Deck = Degree of Difficulty

3. RESULTS AND DISCUSSION

The results of this study consist of business activity, assessment stage of risk event and risk agent, quantified HOR 1 and HOR 2. Finally, this discussion based on research results is used to compare and contrast the results with the empirical study results.

4.1. Business Activity

The business activity process at Tofu UKM had three entities: suppliers, Tofu UKM, and customers. Based on the SCOR method, supply chain activities were divided into plan, source, make, deliver, and return. Table 1 depicts SME Tofu's business activities.

Table 1. Business activities

Plans	1. Production planning
	2. Control of raw material inventory
	3. Demand forecasting
Source	1. Scheduling delivery of raw materials from suppliers
	2. Receipt of delivery of raw materials
	3. Checking delivery of raw materials
	4. Procurement process
Make	1. Execution and production control
	2. Production scheduling
	3. Carrying out production activities
Deli very	1. Delivery selection
	2. Product warehouse

Table 1 shows the results of business activities in Tofu SMEs based on the SCOR model. There are 12 business activities taking place. The plan has three business activities: production planning, raw material inventory control, and demand forecasting. There are four business activities in source activities: scheduling deliveries, receiving raw materials, checking deliveries, and the procurement process. The make has three activities: production control, scheduling, and production activities. Deliver has two activities, namely delivery selection and product warehouse.

4.2. Risk Event and Risk Agent Assessment

Risk assessments and risk sources were carried out based on the results of direct observations and interviews with related parties. A severity assessment shows the intensity and severity level of the risk that affects operational processes. The following is a risk event assessment table 2.

Table 2 shows that 19 identified risk events could impact the disruption of supply chain activities in Tofu SMEs. These risk events are divided into four categories: plan, make, source, and delivery. Furthermore, three risk events were distinguished from the plan, four from the source, eight from the make, and four from the delivery category. Once the risk events were identified, the next step was to generate risk agents based on the previous stage.

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

In assessing risk agents, an occurrence rank was formed with a scale from 1 to 10. Furthermore, occurrence assessment indicates that the risk occurs along the supply chain. Table 2 shows the assessment of the occurrence rating of risk sources in Tofu SMEs. The assessment calculation of risk agents uses a scale level of 1, the lowest, up to 10, the highest rank, meaning that a value of 1 rarely happens, which is the same as a value of 10, the highest occurrence [13].

Table 2. Risk event and risk agent assessment

Major process	Sub-process	Risk events	Severity	Code	Risk Agent	Occurrence	Code
Plans	Production planning	Sudden changes in production plans	4	E1	Increase in demand	5	A1
	Raw material inventory control	The difference between recorded stock and available stock	8	E2	Seasonal factors	6	A2
	Demand forecasting	Errors in forecasting calculations	7	E3	Incorrect price reference	4	A3
Source	Scheduling delivery of raw materials from suppliers	Delays in raw materials from suppliers	3	E4	Urgent purchase request	4	A4
	Receipt of delivery of raw materials	Errors in raw materials received	2	E5	Lack of coordination	5	A5
	Checking the delivery of raw materials	The warehouse staff did not inspect the receiving raw materials	2	E6	Trouble occurs	6	A6
	Procurement process	Error in items sent by the supplier	2	E7	Transportation disruption	3	A7
Make	Production control	Defect tofu product	2	E8	External factors	3	A8
		Available raw material supplies cannot be used	4	E9	Irregular inspection of the receiving raw material	3	A9
		Inefficient process	5	E10	Unorganized delivery procedures	4	A10
		Machine downtime	6	E11	Lack of communication	2	A11
		Lack of machine maintenance	8	E12	It depends on one supplier	6	A12
	Production scheduling	Production schedule delays	3	E13	Limited human resources	4	A13
		Machine breakdown	6	E14	Inefficiency production process	5	A14

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

	Carry out production activities	Unable to meet demand	5	E15	Exceed demand for raw materials	4	A15
Delivery	Delivery selection	Lack of product delivery capacity	4	E16	Machine breakdown	7	A16
		Lack of transportation	2	E17	Irregular maintenance	8	A17
		Inaccuracy of delivery place	1	E18	Defect of materials while in storage	4	A18
	Product warehouse	Delay in delivery time	3	E19	Disruption during transport	2	A19
					Inadequate warehouse space	3	A20

4.3. HOR Matrix Stage 1

Stage 1 HOR was the initial stage of identifying risk events and the agents. The correlation value (Rij) was measured at this stage, and the priority index value (ARP) was calculated. This correlation value was used to calculate the Value of the relationship between risk events and risk agents. The correlation values were given with 0, 1, 3, and 9 scores. Where zero means there was no correlation, one means there was a low correlation, 3 means a medium correlation, and nine means a high correlation [5].

Once the correlation value was finalized, an ARP calculation was carried out to determine the priority of risk agents given as preventive action. The following is an example of the ARP calculation:

$$ARPi = Oj \sum (Si\ Rij)$$

$$ARP1 = 5 \sum (9x4)$$

$$ARP1 = 180$$

Appendix 1 presents the ARP calculation results. Risk agents were included in the high level of risk, with a cumulative aggregate risk potential ARP value of 80% of the total cumulative ARP value of all risk agents, as shown in Figure 2.

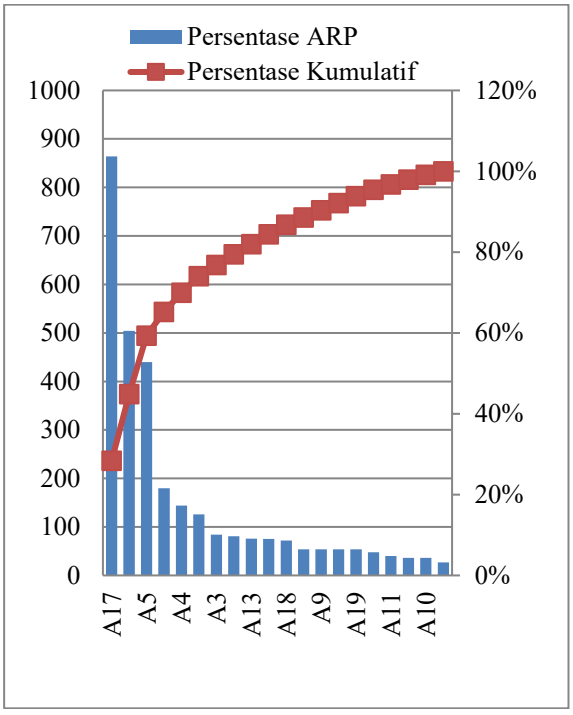

Figure 2. Pareto diagram

The Pareto result was presented in a risk matrix based on the rank of likelihood and consequence, as presented in Table 3.

Table 3. Risk matrix calculation

Probability	Consequences				
	Very hight 1	Light 2	Medium 3	Big 4	Extreme 5
Very big (5)					A17, a16
Big (4)					

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

Medium (3)		A7	A5,A1, A4,A2,A3		
Small (2)					
Very small (1)					

Low
Medium
High
Very High

Table 3. shows that risk agents with codes A17 and A16 are considered very high risk, with codes A5, A1, A4, A2, and A3 as high risk, while code A7 is a moderate risk. The risk matrix assessment was obtained through a questionnaire based on the set scale value and criteria.

4.4. Risk Matrix Stage 2

Appendix 2. Shows the HOR 2 matrix. This stage continues the priority risk agents obtained by determining mitigation actions to minimize the impact. The first step was identifying mitigation actions as a solution for priority risk agents. For this reason, ideal mitigation actions are carried out to overcome priority risk agents, and the company will carry out mitigation efforts by maximizing practical efforts with the resources received and supporting finance.

4.5. Discussion

This research's method aligns with the following empirical findings: business activity identification based on the SCOR phase, quantifying risk using the HOR approach, and conducting mitigation action to minimize risk through perishable goods supply chain streams [8], [9], [14], [15]. However, the research results can be differentiated regarding the number and occurrence of risk agents, thus causing differences in data processing and research results.

In the research conducted [16], [17] used the 2-phase HOR model and, for determining risk agents, used the Pareto 80/20 principle. The findings were excessive working hours, inappropriate planning, significant product variations, supplier's inability to fulfill orders, and disruption of electricity supply. Meanwhile, the research conducted [9], [18] used the same model, namely 2-phase HOR, and the difference with the research conducted was that in this research, there was no risk matrix for the results obtained, namely planning and implementing routine maintenance, improving coordination of each line, establishing suitable planning.

In addition, the HOR approach is used in empirical research with the object of study in food and perishable goods [9], [19], [20]. The production process has many risk agents, which is the main priority for risk mitigation. Meanwhile, the research uses the same HOR 2 model as this research and determines the risk agent using the 80/20 Pareto principle; the research object in the research (Ridwan et al., 2019) is the same as this research object. In contrast, the empirical research is the focus on product quality. For research (Aldimas et al., 2021), it is the same as this research, namely using a 2-phase HOR model. However, there are differences in determining priority risk agents with this research (Aldimas et al., 2021) using 70% contribution of risk sources from total ARP. A calculation of HOR 2 also needs to be made in the research.

Appendix 3. Presenting the why-why analysis method as a scenario proposed for mitigating risk through the supply chain stream. The research results are adequate for companies because they have never conducted evaluations and disrupted supply chain streams. Thus, the results of this research can be used as a reference for company owners and employees to make improvements that researchers have proposed to streamline business processes.

5. CONCLUSION AND FUTURE RESEARCH RECOMMENDATION

The results of this study can be described as follows. The tofu product supply chain configuration starts with tier-one suppliers, the production process, and ultimate customers and waste buyers. Furthermore, the results of the supply chain business process identified three business activities in the plan category, four business processes in the source category, and three and two in the make and delivery of the later activities.

Furthermore, the finding on risk identification obtained the results of nineteen potential risk events caused by twenty risk cases.

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

Furthermore, the results of the first stage of the HOR calculation showed that two risk agents, Irregular maintenance and Defect of materials while in storage, are considered very high risk. In addition, there are five high-category risks, namely Increase in demand, Seasonal factors, Incorrect price reference, Urgent purchase request, lack of coordination with codes A5, A1, A4, A2, and A3, and finally, code A7 as transportation delay is a moderate risk.

Finally, it concluded that the Tofu SME supply chain finds potential risks: equipment maintenance, coordination, demand fluctuations, procurement, seasonal changes, price referencing, and transportation disruptions. Mitigating scenario strategies, namely prioritizing predictive maintenance, conducting daily briefings, preparing stock buffers, and coordinating with relevant entities, can be helpful as short-term strategies for Tofu SMEs in maintaining business continuity.

Research limitations can be outlined as follows. The first limitation pertains to the study's object of study, which focuses on one type of perishable product. However, this limitation also presents an opportunity for future research. For example, an object of study that includes perishable goods from various manufacturers should be added. Future research will represent a broader range of products and perspectives on risk mitigation among different perishable goods manufacturers and their supply chains.

The second limitation is that the study solely considers economic risk factors within the supply chain. Future research should broaden its scope to include social and environmental risk factors and halal risks throughout the food supply chain. This expanded focus will significantly enhance the understanding of supply chain risk management from SME enterprises in developing countries.

REFERENCES

[1] N. A. Mahbubah and Suhartini, "Mapping risk of jewelry manufacturing supply chain: Perspective from jewelry SMEs industrial cluster in a developing country," in *Proceedings of the International Conference on Green Engineering & Technology*, 2022, p. 6. doi: https://doi.org/10.1063/5.0198963.

[2] D. Atmajaya, D. Gustopo, and E. Adriantantri, "Rekomendasi Implementasi Manajemen Risiko Supply Chain Keripik Pisang Menggunakan Metode House Of Risk (HOR) (Studi Kasus : Usaha Mikro Kecil Menengah (UMKM) Indochips Alesha Trimulya)," *J. Valtech (Jurnal Mhs. Tek. Ind.*, vol. 3, no. 1, pp. 22–29, 2020.

[3] N. A. Mahbubah *et al.*, "Mapping Sustainability Risk of Sarong Supply Chain: Evidence from SMEs Industrial Cluster in Indonesia," in *Industry Forward and Technology Transformation in Business and Entrepreneurship*, 2023, pp. 403–414. doi: 10.1007/978-981-99-2337-3_35.

[4] G. Karakaya and S. Ghorbani, "Prioritizing Risk Components in the perishable goods supply chain and Supplier selection in supply chain risk management," *Int. J. Adv. Sci. Technol.*, vol. 29, no. 6s, pp. 21–30, 2020, [Online]. Available: https://hdl.handle.net/11467/4638

[5] N. Chairany, A. Padhil, A. Mail, and N. Rauf, "Risk Analysis of Supply Chain Food Loss on Fishery Products Using Failure Mode Effect and Supply Chain Operation Reference Model," *Ind. Eng. Manag. Syst.*, vol. 22, no. 1, pp. 31–42, 2023, doi: 10.7232/iems.2023.22.1.031.

[6] R. Kuara, D. T. Cahyaningrum, D. Kuniawati, and W. Dhamayanthi, "Risk Management in New Product Development of Kombucha Cascara : A Coffee Waste-Based Local Product Case Study in Karangpring Village Jember," *J. Bus. Manag.*, vol. 2, no. 3, pp. 100–106, 2025, doi: https://doi.org/10.47134/jobm.v2i3.32.

[7] I. N. Pujawan and L. H. Geraldin, "House of risk: A model for proactive supply chain risk management," *Bus. Process Manag. J.*, vol. 15, no. 6, pp. 953–967,

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

2009, doi: 10.1108/14637150911003801.

[8] D. Fitriandini, W. Roessali, and S. Wulandari, "Risk Management Analysis in Snake Fruit Supply Chain through House of Risk Approaches (Case study in CV ' MT ')," *Agro Bali Agric. J.*, vol. 7, no. 3, pp. 865–877, 2024, doi: https://doi.org/10.37637/ab.v7i3.1855.

[9] M. Ulfah, "Mitigasi Risiko Rantai Pasok Produk Donat Menggunakan Metode House of Risk di UMKM Nicesy," *J. Ind. Serv.*, vol. 6, no. 1, p. 49, 2020, doi: 10.36055/jiss.v6i1.9474.

[10] A. S. Albana, R. D. Prihadianto, and H. Mardhiana, "Framework Development for The Assessment of The Supply Chain Resilience Using The House of Risk," *Indones. J. Bus. Entrep.*, vol. 8, no. 2, pp. 304–312, 2022, doi: 10.17358/ijbe.8.2.304.

[11] M. H. Aldimas, N. Mahbubah, and E. Dhartikasari, "Mitigasi Risiko Rantai Pasokan Pemeliharaan Ikan Hias Koi Menggunakan Metode House of Risk," *RADIAL J. Perad. Sains, Rekayasa dan Teknol.*, vol. 9, no. 1, pp. 53–65, 2021, doi: 10.37971/radial.v9i1.220.

[12] E. Kusrini, B. Wahyudi, P. P. S. Negara, and S. Hidayatuloh, "Supply Chain Risk Analysis for Organic Vegetable Farm in Indonesia," *J. Adv. Agric. Technol.*, vol. 10, no. 2, pp. 36–41, 2023, doi: 10.18178/joaat.10.2.36-41.

[13] D. C. Putri, Y. Nadya, and H. Irawan, "Usulan Perbaikan Manajemen Risiko Rati Pasok UKM Kerupuk Ikan dengan Metode House of Risk (Studi Kasus: Ukm Kerupuk Ikan Ibu Hasnah, Desa Bukit Pala, Ranto Peureulak-Aceh Timur)," *J. Ind. Samudra*, vol. 1, no. 1, pp. 30–38, 2020, doi: https://doi.org/10.55377/jis.v1i1.2885.

[14] F. O. Yunus, T. Lasalewo, and H. Uloli, "Analisis Mitigasi Risiko Penjualan Kopi Roasted Pada UKM Puntang Coffee Menggunakan Metode House of Risk," *Jambura*, vol. 6, no. 1, pp. 257–268, 2023, doi: https://doi.org/10.37479/jimb.v6i1.19359.

[15] S. A. Mustaniroh, and D. A. Ndadari, "Mitigation strategies for supply chain risks in cassava chip SME using house of risk method (A case study in Langgeng Jaya Abadi SME, Malang Regency)," *Adv. Food Sci. Sustain. Agric. Agroindustrial Eng.*, vol. 1, no. 1, pp. 25–32, 2018, doi: 10.21776/ub.afssaae.2018.001.01.5.

[16] R. P. Destiarni, S. Widodo, and T. Sugiarti, "Mitigasi Risiko Operasional UMKM Pengelolaan Talas Desa Lenteng Timur Kabupaten Sumenep Pendekatan House of Risk," *Benefit J. Manaj. dan Bisnis*, vol. 9, no. 2, pp. 150–167, 2024, doi: https://doi.org/10.23917/benefit.vi.4137.

[17] A. A. Puji and A. Mansur, "Analisis Dan Perbaikan Manajemen Risiko Rantai Pasok Safirah Collection Dengan Pendekatan House of Risk," *Angew. Chemie Int. Ed. 6(11), 951–952.*, vol. 6, no. 11, pp. 449–456, 2018.

[18] J. E. Pertanian, "Mitigasi risiko usaha kerupuk ikan (studi kasus: umkm lamora di desa socah kecamatan socah bangkalan)," *J. Ekon. Pertan. dan Agribisnis*, vol. 9, no. 1, pp. 296–316, 2025, doi: https://doi.org/10.21776/ub.jepa.2025.009.01.25.

[19] M. Ulfah, "Mitigasi risiko rantai pasok industri kue menggunakan house of risk," *J. Ind. Serv.*, vol. 8, no. 1, p. 63, 2022, doi: 10.36055/jiss.v8i1.14315.

[20] A. Mansur and M. Z. Arasti, "Risk mitigation strategy in perishable product supply chains," in *Proceedings of the International Conference on Industrial Engineering and Operations Management*, 2021, pp. 6512–6520. doi: 10.46254/an11.20211118.

[21] A. Ridwan, D. L. Trenggonowati, and V. Parida, "Usulan Aksi Mitigasi Risiko Rantai Pasok Halal Pada Ikm Tahu Bandung Sutra Menggunakan Metode House of Risk," *J. Ind. Serv.*, vol. 5, no. 1, pp. 112–120, 2019, doi: 10.36055/jiss.v5i1.6512.

[22] M. H. Aldimas, N. A. Mahbubah, E. Dhartikasari, and R. Pasok, "Mitigasi Risiko Rantai Pasokan Pemeliharaan

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

Ikan," vol. 9, no. 1, pp. 53–65, 2021.

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

Appendix 1. HOR matrix 1

Risk event	Risk Agent																				Severity
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	
E1	9			9																	4
E2					3																8
E3		3	3		9																7
E4							9					3							9		3
E5											9										2
E6									9				1								2
E7											1										2
E8																		3			2
E9															3			3			4
E10														3							5
E11																	9				6
E12																9					8
E13						3															3
E14																	9				6
E15													3								5
E16																				3	4
E17													1								2
E18					1																1
E19								3		3											3
Occurrence	5	6	4	4	5	6	3	3	3	4	2	6	4	5	4	7	8	4	2	3	
ARP	180	126	84	144	440	54	81	27	54	36	40	54	76	75	48	504	864	72	54	36	
Priority rank	4	6	7	5	3	12	8	20	12	18	17	12	9	10	16	2	1	11	12	18	

Sigma Teknika, Vol. 8 No.1: 001-012
Juni 2025
E-ISSN 2599-0616
P-ISSN 2614-5979

Appendix 2. HOR 2 Matrix

Risk agent (Ai)	Mitigation action (Pai)									ARP
	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	
A17	3	9								864
A16			9							504
A5				9						440
A1					3					180
A4						3				144
A2							3			126
A3								3		84
A7									1	81
Tech	2592	7776	4536	3960	540	432	378	252	81	
Dk	3	4	3	3	5	4	4	3	3	
ETDk	864	1944	1512	1320	108	108	94.5	84	27	
Rank	4	1	2	3	5	5	7	8	9	

Appendix 3. Why-why analysis

code	Risk Agent	3 Why is phase			code	Mitigation scenario
		Why 1	Why 2	Why 3		
A17	lack of machine maintenance management	There is no machine maintenance schedule at the company	Machine maintenance is only carried out when damage occurs	There are no maintenance experts at the company	P1	preventive maintenance
					P2	predictive maintenance
A16	Engine failure occurs	lack of machine maintenance	irregular maintenance schedule	old age of the machine	P3	regular maintenance
A5	lack of coordination	no briefing	lack of communication	no work SOP	P4	daily briefing
A1	increased demand	lack of preparation	depend on one supplier	no contract agreement with the supplier	P5	contract with a customer for 1 year
A4	urgent purchase request	lack of auxiliary raw materials	market influence	unintegrated planning	P6	prepare stock buffer
A2	Seasonal factors	short-term purchase demand	seasonal factors	environmental influences	P7	production stock planning
A3	Price reference is not accurate	inadequate market research	lack of coordination	price update delay	P8	coordination with relevant parties
A7	Transport disruption	natural factors	lack of coordination with the transporter	There is no definite schedule for the delivery of goods	P9	transporter telephone number socialization