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Original research article

Application of the house of risk matrix methodology for supply chain management risk mitigation

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A B S T R A C T

For a company, efficient operations hinge on a robust supply chain system. Consequently, it is crucial to manage a well-structured supply chain system effectively. This research examines a manufacturing firm that specializes in producing heavy equipment for industrial applications. The firm adopts a make-to-order (MTO) production strategy, requiring it to order raw materials from suppliers in advance. However, this approach poses multiple risks, including delays or mistakes in raw material deliveries, which directly lead to setbacks in production. In response to these issues, this study seeks to pinpoint potential risks and formulate risk mitigation strategies using the House of Risk (HOR) method. The HOR method is a sophisticated tool tailored for risk mitigation analysis. Through this research, 21 risk events and 15 risk agents were identified, leading to the development of 25 prioritized mitigation strategies to tackle the risks in the company's supply chain system. These strategies are anticipated to assist the company in reducing supply chain risks, thereby promoting more seamless and effective operational performance.

1. Introduction

Indonesia's economic growth is significantly driven by the industrial sector, particularly the manufacturing industry. This sector plays a pivotal role in transforming raw materials into semi-finished and finished goods through various processing activities [1]. As manufacturing companies grow and expand, they inevitably face an increase in business risks that can disrupt operational efficiency. These risks, ranging from supply chain disruptions to production delays, highlight the critical need for effective risk management and mitigation strategies. Such strategies are essential to address uncertainties and ensure the smooth execution of the production process [2]. In this context, understanding and managing risks within the supply chain system becomes a priority for manufacturing firms aiming to maintain competitiveness and operational stability.

For a company, efficient operations hinge on a robust supply chain system. Consequently, it is crucial to manage a well-structured supply chain system effectively. This research examines a manufacturing firm that

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specializes in producing heavy equipment for industrial applications such as batching plants, stone crusher plants, and asphalt mixing plants. The firm adopts a make-to-order (MTO) production strategy, meaning the production process begins only after receiving product orders from customers. This approach involves specific agreements, including product processing timelines and customer-desired specifications [3]. While the MTO system offers flexibility in meeting customer demands, it also introduces challenges in the supply chain, particularly in the procurement of raw materials. The company pre-orders both primary and supporting materials from suppliers, but this process is often hindered by issues such as suppliers lacking sufficient raw material inventory, difficulties in obtaining materials with the required specifications, and delivery delays. Notably, raw material delivery delays occur with a frequency of 50%, significantly impacting the production schedule.

In addition, errors in raw material deliveries further complicate the production process, often requiring the company to return incorrect materials to suppliers, which adds to operational delays. These challenges underscore the importance of identifying and mitigating risks within the supply chain to ensure seamless operations. Previous studies have addressed similar issues in different industries. For instance, Dias et al. [4] utilized the SCRM and AHP methods to mitigate risks in the automotive industry, while Hamdani & Ernawati [5] applied the SCOR, FMEA, and AHP methods in the sugar industry. Building on these scientific references and the specific problems faced by the manufacturing firm, this research employs the House of Risk (HOR) method—a novel approach in risk mitigation management. The HOR method offers a comprehensive framework for analyzing risks, from identification to the design of mitigation strategies, making it well-suited for addressing the complexities of supply chain risks [2].

Furthermore, this study encompasses all aspects of the company's supply chain by mapping the system using the Supply Chain Operation Reference (SCOR) concept. The SCOR framework evaluates five key aspects—plan, source, make, deliver, and return—providing a detailed analysis of the supply chain system. This concept was selected because it facilitates a thorough examination of supply chain processes, thereby supporting the HOR method in identifying risk events and agents effectively [6]. By integrating the SCOR and HOR methods, this research aims to develop actionable risk mitigation strategies tailored to the company's operations. The study seeks to enable the company to establish a structured risk management system, which will enhance the efficiency of its operational performance and contribute to long-term sustainability [7].

This research offers significant contributions both academically and practically. Academically, it advances the application of the HOR method in the context of MTO-based manufacturing firms, providing a detailed methodology for risk identification and mitigation that can be adapted to other industries. By combining the SCOR framework with the HOR method, the study also contributes to the literature on supply chain risk management by offering a systematic approach to mapping and addressing risks in a structured manner. Practically, the research delivers a set of prioritized mitigation strategies that the manufacturing firm can implement to minimize supply chain disruptions, particularly those related to raw material procurement and delivery delays. These strategies are expected to improve operational efficiency, reduce production delays, and enhance customer satisfaction by ensuring timely delivery of customized heavy equipment. Ultimately, this study provides a blueprint for manufacturing companies in Indonesia to strengthen their supply chain resilience amid growing industrial demands.

2. Material and method

2.1. Research data

This research focuses on analyzing the mitigation of supply chain system management in a company that manufactures heavy equipment for industrial use, a critical aspect that supports the seamless operation of the company's operational system [8]. Supply chain system management encompasses highly complex elements, including the upstream to downstream flow of the company's operations [9]. These elements are interconnected and inseparable from one another [10]. Therefore, achieving a smooth and successful supply chain system management is a key goal for all companies, necessitating the implementation of risk mitigation strategies [11]. Risk mitigation is a discipline that involves organizations identifying, mapping, and managing challenges through a comprehensive approach [4].

This study is a quantitative descriptive research project conducted from July to December 2024. The research process began with observations, followed by brainstorming sessions, interviews, and the distribution of questionnaires to three experts: the Head of the Supply Chain Management Division, the Head of the Production Division, and a Supply Chain Management staff member from the company. The selection of these three respondents was deliberate, as they are directly involved in the supply chain system and possess a clear understanding of the company's supply chain dynamics and conditions.

2.2. Research method

The first step in this study involves mapping the supply chain of a company that manufactures heavy equipment for industrial use, using the Supply Chain Operations Reference (SCOR) concept, which offers the advantage of systematically mapping the company's supply chain system [12]. The SCOR concept integrates several aspects of the supply chain, including business elements, comparisons, and practices [13]. Through the SCOR framework, the entire supply chain system is mapped, covering five key aspects: planning (plan), procurement (source), production (make), delivery (deliver), and returns (return) [12].

After mapping the supply chain using the SCOR model, the process continues with the application of the House of Risk (HOR) method as the primary approach for identifying and mitigating risks within the company. This method was selected because it is a modern approach designed for comprehensive risk mitigation analysis. The HOR method builds upon the Failure Mode and Effect Analysis (FMEA) and House of Quality (HOQ) methods, offering an innovative framework for risk management [14]. The initial step in applying this method involves assessing the severity and occurrence of risks based on a predefined parameter scale [15]. This step reveals that a single risk agent can trigger multiple risk events [7]. Given the challenges faced by the company and supported by a literature review, the House of Risk (HOR) method was chosen for its standalone capability. This method provides a complete framework for risk mitigation management, enabling a thorough analysis from risk identification to the design of mitigation strategies.

3. Results and discussion

3.1. Relevant supply chain system

Field observations, interviews, brainstorming sessions, and questionnaires completed by experts—namely the Head of the Supply Chain Management Division, the Head of the Production Division, and a Supply Chain Management staff member—yielded relevant data to support the data processing in the following section. The supply chain of a company that manufactures heavy equipment for industrial use flows from upstream to downstream, encompassing three aspects: financial flow in the form of money, material flow in the form of raw materials and finished products, and information flow in the form of necessary data. Fig 1 show the supply chain of the relevant system being studing. As shown in Fig. 1, the supply chain system of a company that manufactures heavy equipment for industrial use comprises five parts. The "Plan" section includes 4 sub-processes with 4 detailed activities. The "Source" section consists of 4 sub-processes with 4 detailed activities. The "Make" section encompasses 4 sub-processes with 6 detailed activities. The "Delivery" section involves 1 sub-process with 1 detailed activity. Lastly, the "Return" section includes 1 sub-process with 1 detailed activity.

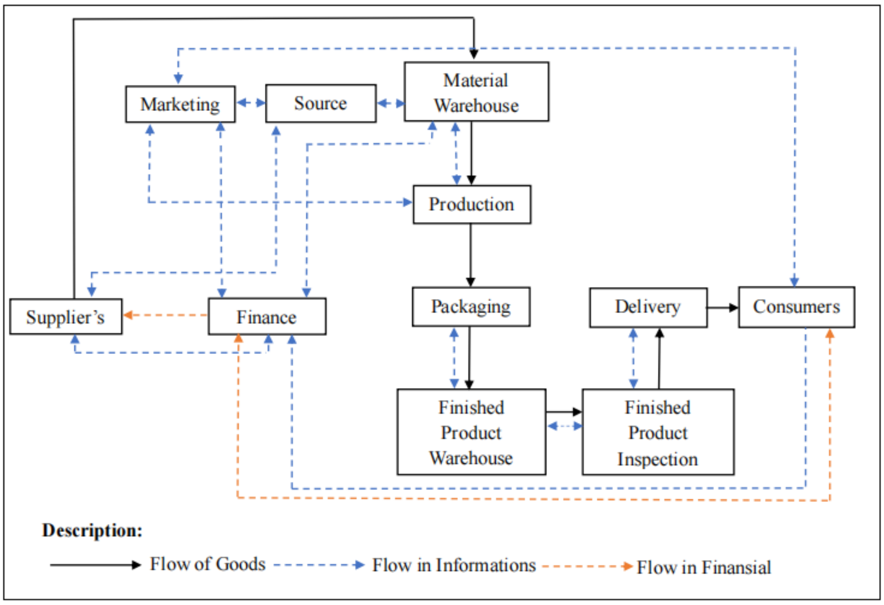

Fig 1. Supply chain of relevant system

Table 1
Risk event and severity

Code	Risk event	Severity
E1	Changes product design from consumers	7
E2	Orders from consumers at the same time	5,6
E3	Amount of raw material stock inventory in the warehouse is not in accordance with production planning	4
E4	Mismatch between production plan and cost budget plan	7
E5	Calculation errors in preparing raw materials	5
E6	Increase in raw material prices	7
E7	Miscommunication with suppliers	4
E8	Workers error in mapping raw materials	5
E9	Unreliability of raw material delivery from suppliers	5,6
E10	Sudden purchase of raw materials	2,6
E11	The purchase number of raw materials does not match the order details	3
E12	Change in production schedule	3
E13	Delay in production implementation	6
E14	Errors measurement of raw materials to be processed	7
E15	Iron or steel cutting process is not appropriate	7
E16	Insufficient number of human resources	6
E17	Less raw materials	5,6
E18	Limited finished product warehouse capacity	1
E19	Delay in consumers picking up the product	3
E20	Consumer error in product handling	6,6
E21	Return of raw materials that are not in accordance with the company's orders to suppliers	1

Table 2
Risk event and occurence

Code	Risk agent	Occurrence
A1	Lack of consumer understanding of the product design drawn by the company's drafter	3,6
A2	Orders placed by customers at the same time	6
A3	Limited inventory of raw materials in the warehouse	2
A4	Workers' inaccurate raw material counts due to the warehouse being scattered across multiple locations.	3,6
A5	Increase in production support costs	5,3
A6	Workers' inaccuracy in calculating raw material requirements	2
A7	Raw material prices from suppliers that have increased	7
A8	Suppliers sourcing raw materials from their branch offices without the company's knowledge	2
A9	Suppliers find raw materials from other suppliers without the knowledge of the company	2
A10	Inaccuracy of workers in checking or inspecting raw materials	2
A11	Suppliers must prepare a raw material delivery fleet that matches the company's demand	9,3
A12	Raw materials are lacking or run out so the company must purchase raw materials again	4
A13	Inaccuracy from suppliers in preparing raw materials ordered by the company	2
A14	Consumer delays in making payments or payments to the company	6
A15	Raw materials that are not yet available due to delays in delivery from suppliers	3
A16	Workers who are less careful in the process of measuring raw materials	2,6
A17	Workers who are not careful in cutting iron or steel	2,3
A18	Workers who are absent from work due to illness or leave	2
A19	Cutting errors that cause the company to have to buy raw materials again	1,6
A20	Limited warehouse capacity	5,3
A21	Unpreparedness of consumers in preparing a fleet to take finished products from the company	5,3
A22	Consumers' lack of readiness in providing resources to collect finished products.	6
A23	Human data source errors from the consumer side in handling finished products in the shipping process	6,6
A24	Supplier errors in delivering raw materials that the company should not have ordered	3,3
A25	Supplier error in delivering raw materials exceeding the order made by the company	3

3.2. House of Risk (HOR) Phase 1

After mapping the supply chain system, the next step involves identifying risk events. To conduct this identification, observations, brainstorming sessions, and interviews were carried out with the three experts mentioned previously, resulting in the identification of 21 risk events within the supply chain system of a company that manufactures heavy equipment for industrial use. Subsequently, a severity assessment was conducted by distributing questionnaires to the same three respondents. These 21 risk events are symbolized as E1 to E21. Table 1 shows the risk agent and severity.

Next, the identification of risk agents, along with their occurrence, was performed to determine the frequency of each risk agent within the company's supply chain system. This assessment was also conducted by distributing questionnaires to the three respondents mentioned earlier. The results of the risk agent occurrence assessment are summarized as follows: there are 25 risk agents, symbolized as A1 to A25. Table 2 shows the risk agent and its occurrence. Furthermore, a correlation assessment was conducted using a parameter scale: 9 for strong correlation, 3 for moderate correlation, 1 for weak correlation, and 0 for no correlation [12].

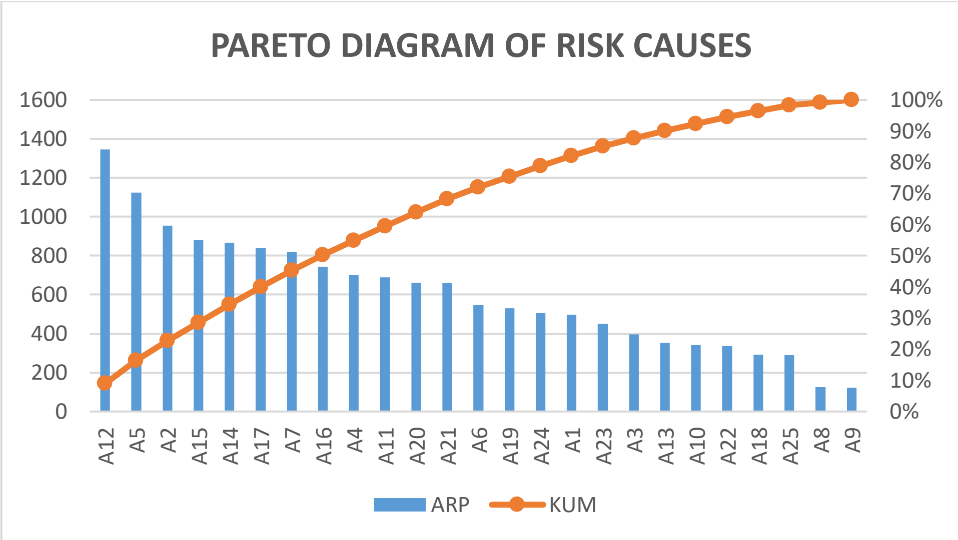

Fig 2. Pareto Diagram HOR phase 1

Table 3
Risk event and occurence

Code	Risk Mitigation Strategies	Rank	ETDk Value	ETDk %	ETDk Cum.
PA1	Training to improve workers abilities and skills	1	8.265,64	12,84%	12,84%
PA2	Creating a detailed, clear, and easy-to-understand Standard Operating Procedure for workers.	2	8.233,16	12,79%	25,63%
PA5	Accurate forecasting and planning of raw material purchases based on historical data	3	6.558,6	10,24%	35,87%
PA11	Proactive communication with customers	4	5.487,76	8,53%	43,39%
PA4	Regular recording of raw materials in the warehouse	5	4.649,24	7,22%	51,61%
PA16	Conduct regular supervision and inspection of each production activity	6	3.753,72	5,83%	57,44%
PA9	Strengthen the memorandum of understanding with suppliers	7	3.091,12	4,80%	62,25%
PA10	Dynamic control and management of budget management	8	2.658,48	4,13%	66,38%
PA12	Using company vehicles in case of force majaeure	9	2.656,48		70,50%
PA13	Staged payment determination (Installment Payment)	10	2.602,8	4,04%	74,55%
PA14	Conduct regular payment alerts				
PA19	Adjustment of product selling price and RAB based on raw material price increase	11	2.461,2	3,82%	78,37%
PA8	Utilization of leftover materials	12	1.674,42	2,60%	80,97%
PA29	Conduct inspections or checks when raw materials arrive at the company	13	1.516,68	2,36%	83,33%
PA30	Process returns to suppliers				
PA24	Additional warehouse capacity	14	1.490,63	2,32%	85,64%
PA28	Implement location labeling and coding system	15	1.407,78	2,19%	87,83%
PA27	Clear division of job lists for workers, especially in the warehouse	16	1.172,48	1,82%	89,65%
PA25	Warehouse layout improvement	17	966.135	1,50%	91,15%
PA7	Management and development of human resources (HR)	18	886,16	1,38%	92,53%
PA15	Segmenting and monitoring at risk customers	19	867,6	1,35%	93,88%
PA20	Prioritize product workmanship based on the memorandum of understanding with customers	20	685,2	1,06%	94,94%
PA21	Optimizing production capacity				
PA6	Recording company inventory and creating a regular maintenance schedule	21	664,62	1,03%	95,97%
PA23	Perform job prioritization	22	662,5		97,00%
PA17	Conduct a price agreement discussion	23	615,3	0,96%	97,96%
PA18	Expand the regional supplier network for quality and price comparison.				
PA26	Implement a temporary storage policy (Buffer Storage)	24	493,695	0,77%	98,72%
PA22	Collaborate with third parties or outsourcing to maximize orders made by consumers	25	411,12	0,64%	99,36%
PA30	Value Stream Mapping creation	26	410,1		100%

The questionnaire for this assessment was completed by one respondent, the Head of the Supply Chain Management Division, who is considered to have comprehensive knowledge of all aspects of the supply chain system. This was followed by the determination of the Aggregate Risk Priority (ARP) value [3]. From this, prioritized risk agents were identified, which will be used to design mitigation strategies in the HOR Phase 2 method [3]. The order of the priority risk agents is presented as follows. This research adopts the Pareto 80:20 concept, meaning that risk mitigation strategies addressing 80% of priority and secondary risk agents are also expected to resolve 20% of tertiary risk agents, as detailed below [16]. It can be observed that 15 priority risk agents meet the standard 80% threshold of the Pareto diagram: A12, A5, A2, A15, A14, A17, A7, A16, A4, A11, A20, A21, A6, A19, and A24. These priority risk agents are then processed in the HOR Phase 2 method.

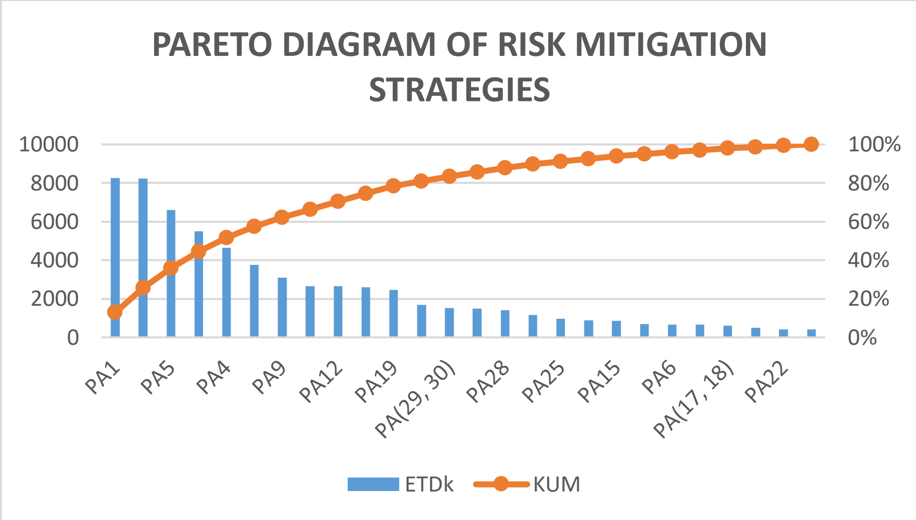

Fig 3. Pareto Diagram HOR phase 2

3.3. House of Risk (HOR) Phase 2

The HOR Phase 2 method focuses on addressing issues, also known as risk mitigation, based on the data processing results from the HOR Phase 1 method, specifically the priority risk agents [3]. The design of these risk mitigation strategies was developed through brainstorming with the Head of the Supply Chain Management Division to ensure the strategies are appropriate, accurate, and relevant to the company's specific situation and conditions. The goal is to implement risk mitigation strategies that can minimize potential risks in the supply chain system of a company that manufactures heavy equipment for industrial use, thereby preventing disruptions to the company's operational system. It was found that one risk agent can be addressed by multiple risk mitigation strategies, and conversely, a single risk mitigation strategy can be applied to several risk agents [14]. The following risk mitigation strategies were derived from brainstorming with experts: 30 strategies, symbolized as PA1 to PA30 (see Table 3).

Next, a relationship assessment was conducted between the risk agents and the risk mitigation strategies. According to Andriyanto & Mustamin [11], after this relationship assessment, the next step involves data processing to calculate the Effectiveness of Action (TEk) value. This is done by multiplying the Aggregate Risk Priority (ARP) value by the relationship value between each risk agent and the corresponding risk mitigation strategy. Following this, a questionnaire was distributed to determine the degree of saturation value, completed by one expert—the Head of the Supply Chain Management Division. The degree of saturation value assesses the level of difficulty the company may face in implementing the risk mitigation strategies. When completing the degree of saturation questionnaire, the expert considers various factors, including the company's financial capacity, human resource capabilities, operational capabilities, and other factors that support smooth operations. The parameter scale for the degree of saturation assessment is as follows: 3 for easy to implement, 4 for moderate implementation, and 5 for difficult to implement [8].

If there are at least 20 draft risk mitigation strategies, a priority scale must be established [2]. This priority scale can be determined using a Pareto diagram (see Fig 3). Similar to the HOR Phase 1 method, Phase 2 employs the Pareto 80:20 concept to identify prioritized risk mitigation strategies. This means that strategies addressing 80% of primary and secondary risk agents are also expected to resolve 20% of tertiary risk agents. The total overall ETDk value is 64,373, and using a Pareto diagram, 15 prioritized risk mitigation strategies were identified out of the 30 draft strategies, as detailed below.

4. Conclusions

The supply chain analysis identified 21 risk events associated with 25 distinct risk agents. Data processing involved calculating the Aggregate Risk Priority (ARP) value, with the results presented in an 80/20 Pareto diagram. This identified 15 priority risk agents. Subsequently, risk mitigation strategies for these priority agents were designed through brainstorming sessions with the Head of the Supply Chain Management Division to ensure the strategies were accurate and relevant to the company's specific situation. To prioritize these mitigation strategies, a Pareto diagram was created based on the Effectiveness to Difficulty (ETDk) ratio. This analysis yielded 15 priority risk mitigation strategies.

It is hoped that these research findings can serve as a reference for addressing similar risk mitigation challenges. Furthermore, future research on related problems is encouraged to explore and develop alternative methods, thereby expanding the range of methodologies and contributing to research advancement.

Declaration statement

Gita Wahyu Ningsih: Conceptualization, Methodology, Writing-Original Draft. **Dira Ernawati**: Collecting data. **Isna Nugraha**: Writing-Review & Editing. *, ,

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The authors report there are no competing interests to declare.

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article or its supplementary materials.

AI Usage Statement

Generative AI and AI-assisted tools were used to enhance the language and readability of this manuscript. The authors have reviewed and revised all AI-generated content to ensure its accuracy and alignment with the research. The authors remain fully responsible for the work's scientific content, conclusions, and integrity, and disclose the use of AI to ensure transparency and adherence to publisher guidelines.

References

[1] Bappenas and ERIA, *Indonesian Manufacturing Sector Review 2021*. Jakarta: National Development Planning Agency (Bappenas) and Economic Research Institute for ASEAN and East Asia (ERIA), 2021.

[2] G. P. Kaban and P. A. Wicaksono, "Supply chain risk analysis and mitigation using the House of Risk (HOR) model in the furniture industry (Case study: PT. XYZ)," *J. Tek. Ind.*, 2021.

[3] R. Hermawan, "Production optimization for CV. Sandy Persada in Banjar City using the Largest Candidate Rule method," *J. Media Teknol.*, vol. 6, no. 1, pp. 37–52, 2019.

[4] G. C. Dias, C. T. H., and U. R. de O., "Supply chain risk management and risk ranking in the automotive industry," *Gest. Prod.*, vol. 27, no. 1, pp. 1–21, 2020, doi: 10.1590/0104-530X3800-20.

[5] M. I. S. Hamdani and D. Ernawati, "Supply chain risk analysis and mitigation using Failure Mode and Effect Analysis (FMEA) at PG. Wringin Anom Situbondo," *J. Manaj. Ind. dan Teknol.*, vol. 4, no. 1, pp. 49–60, 2023.

[6] A. Siswanto et al., "Risk mitigation design using House of Risk in the processed salt supply chain (Case study: PT. Garam Unit Camplong)," *Agroindustrial Technol. J.*, vol. 6, no. 2, pp. 46–57, 2022.

[7] S. G. Partiwi, V. N. Islami, and H. Firmanto, "House of Risk (HOR) approach to manage risk involving multi-stakeholders: A case study of the automotive industry cluster of Multifunctional Rural Mechanized Tool (MRMT)," *Oper. Supply Chain Manag.*, vol. 16, no. 1, pp. 133–139, 2023, doi: 10.31387/oscm0520378.

[8] A. Ridwan, P. F. Ferdinant, and W. Ekasari, "Supply chain risk mitigation design for pallet and dunnage products using the House of Risk method," *Tek. J. Sains dan Teknol.*, vol. 16, no. 1, p. 35, 2020, doi: 10.36055/tjst.v16i1.8028.

[9] H. Sofyan et al., "Supply chain risk analysis and mitigation using the House of Risk model at Company XYZ," *J. Tek. Log. Inform.*, vol. 12, no. 2, pp. 193–204, 2022.

[10] R. Paputungan et al., "Identification of nutmeg supply chain network design in Sangihe Islands Regency," *J. EMBA*, vol. 10, no. 2, pp. 379–388, 2022.

[11] A. Andriyanto and N. K. Mustamin, "Risk management analysis and mitigation strategies at PT Agility International using the House of Risk (HOR) method," *J. Logistik Bisnis*, vol. 10, no. 2, pp. 4–11, 2020, doi: 10.46369/logistik.v10i02.949.

[12] A. Syamil et al., *Supply Chain Management Textbook*, vol. 1, Aug. 2023. [Online]. Available: Google Books.

[13] D. S. Prasetyo, A. Emaputra, and C. I. Parwati, "Supply chain performance measurement using the Supply Chain Operations Reference (SCOR) model for Subur Crackers SME," *J. PASTI*, vol. 15, no. 1, p. 80, 2021, doi: 10.22441/pasti.2021.v15i1.008.

[14] A. A. Ramadan and A. Arvianto, "Production material risk mitigation using the House of Risk method (Case study: PT ITCI Hutani Manunggal)," *Tek. Ind.*, vol. 1, 2023.

[15] A. Alijoyo, Q. B. Wijaya, and I. Jacob, *Failure Mode Effect Analysis: Failure Mode and Impact Analysis*. [Online]. Available: www.lspmks.co.id, 2020.

[16] P. S. Quaralia, "Regional cooperation in agricultural supply chains for sustainable food security: A case study of ASEAN," *Padjadjaran J. Int. Relat.*, vol. 4, no. 1, p. 56, 2022, doi: 10.24198/padjir.v4i1.37614.

[17] R. Ekawati, A. T. Prawira, A. Saptiyadi, A. W. Hapsari, G. Prihasetya, and M. Sayputra, “Business model canvas of auto detailing and car wash home service,” *Journal Industrial Servicess*, vol. 10, no. 1, pp. 25–38, 2024, doi: 10.62870/jiss.v10i1.24440.

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