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House of Risk (HOR) Approach to Manage Risk involving Multi-stakeholders: The Case of Automotive Industry Cluster of Multifunctional Rural Mechanized Tool (MRMT)

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ABSTRACT

The agricultural sector is one of the potential sectors for the economic development of the Indonesian nation and the improvement of rural community welfare. Therefore, it needs to be well-managed, including through the provision of adequate supporting facilities such as transportation equipment that is suitable for the characteristics of the agricultural sector. PT KMWI is one of the companies that produces specialized transportation equipment designed to support agricultural activities in rural areas, known as the Multifunctional Rural Mechanized Tool (MRMT). The production involves several businesses and industries that are established within an MRMT automotive industry cluster. Effective cooperation and collaboration among the stakeholders in the industry cluster significantly determine the efficiency and effectiveness of the products produced. Therefore, it needs to be well-managed, and risk management needs to be implemented to maintain its functional stability using the House of Risk (HOR) method. From the application of HOR 1, the multistakeholder approach yielded the Combined Aggregate Risk Potential (CARP), and 6 priority risk potentials were selected based on a Pareto chart, which resulted in the determination of 13 mitigation actions. The risk potential with the highest CARP value among the priority risks is risk factor (A4) inaccurate demand forecasting. Then, the 13 mitigation actions were assessed using HOR 2, the multistakeholder approach, to obtain the Effectiveness to Difficulty (ETD) value of each mitigation action for every stakeholder.

Keywords: *CARP, house of risk, industrial cluster, multistakeholder, risk management*

1. INTRODUCTION

The agricultural sector is one of the potential sectors for the economic development of the Indonesian nation and the improvement of rural community welfare. Therefore, it needs to be well-managed, including through the provision of adequate supporting facilities such as transportation equipment that is suitable for the characteristics of the agricultural sector. PT KMWI is one of the companies that produces specialized transportation equipment designed to support agricultural activities in rural areas, known as the Multifunctional Rural Mechanized Tool (MRMT).

The MRMT project is not the first automotive project initiated by the government. There have been many automotive projects by the government that were previously planned up to the testing phase but were stopped before entering mass production. This was influenced by several factors such as weak competitiveness with products that already exist in the market, government regulations that were less supportive, and others. However, compared to previous projects, MRMT has a greater chance of success up to the after-market stage. To strengthen competitiveness, an MRMT automotive industry cluster was formed.

With the increased competitiveness, local products will have a greater opportunity to have a wider market. Therefore, local products can be optimally utilized in the production of MRMT by the Ministry of Industry. The success in producing MRMT is also influenced by several factors such as managing uncertainty or potential risks that may become obstacles.

Risk is the uncertainty that may occur in the future (Verwire & Berghe, 2004). According to Monahan (2004), risk is the loss caused by an event or multiple events that hinder the achievement of a company's goal. Risk is also the possibility of an event occurring that will impact the achievement of a goal and can be measured by likelihood and consequences (AS/NZS 4360, 2004). In an industrial cluster, one of the processes that determines the effectiveness of the cluster is the quality of its supply chain management. Therefore, it is necessary to analyze and mitigate the risks that may occur.

Risk analysis in the supply chain needs to be conducted to develop a framework that can identify, assess, and mitigate supply chain risks not only within the company but comprehensively within a supply chain (Parenreng *et al*., 2016). Supply chain risk management is the process of identifying and managing risks across the supply chain map both internally and externally, using a coordinated approach among supply chain stakeholders to reduce overall supply chain liabilities.

According to Pujawan and Geraldin (2009), the HOR is a method that suggests that proactive supply chain risk management should pay attention to preventive measures by reducing the chances of a risk occurring. The HOR method is a combination of the FMEA (Failure Modes and Effect Analysis) method with the HOQ (House of Quality) model. The FMEA method in the HOR model is in the stage of analyzing the level of risk obtained from the calculation of the Risk Potential Number (RPN), which is the result of multiplying the chances of risk occurrence (occurrence), the impact of a risk (severity), and the chance of risk detection.

The House of Risk method is divided into two processes, namely HOR 1 and HOR 2. In the HOR 1 stage, the prioritization of the causes of risks that need to be prevented is conducted, while in HOR 2, the prioritization of actions that are considered the most effective from the cost factor and general resources is carried out (Pujawan & Geraldine, 2009).

The automotive industry has a complex flow of information and materials, making it quite susceptible to errors in the process. An automotive industry cluster with stakeholders who have different interests has a higher operational complexity and therefore carries higher risks. Therefore, the MRMT industry cluster needs to perform risk management on each activity that will be mapped based on the stakeholders involved in MRMT. This will determine how risk mitigation strategies will be applied to the stakeholders involved to prevent them from affecting other stakeholders and disrupting the performance of the industry cluster. This study aims to identify and map potential risks and formulate risk mitigation strategies for the MRMT automotive industry cluster.

2. LITERATURE REVIEW

Risks in the context of supply chain mat emerge from both globalization and rapid development of technology (Lin *et al*., 2006). Risk in supply chain could be a result of severe macroeconomic situation, problems in social systems, and political issues. In a micro context, risk could be also due to problems with the suppliers, internal processes, as well as problems from the demand side. Juttner *et al*. (2003) suggest that risk sources fall into one of three categories: 1) environmental risk sources, 2) network-related risk sources or 3) organizational risk sources. Ivanov and Dolgui (2021) distinguish between three levels of disruption propagation in the context of a supply chain, namely: network, process and control. Risk in supply chains, however, can also be the results of poor design of the supply chain itself (Wagner & Bode, 2006). This requires supply chain managers to always include risk factors when making supply chain decisions, be it for strategic, tactical, as well as operational decisions. In response, researchers are now revisiting the concept of supply chain vulnerability (Juttner, 2005; Papadakis, 2006; Wagner & Neshat, 2012).

A supply chain is a complex network involving multiple stakeholders operating within an organizational environment. It encompasses various parties, such as suppliers, manufacturing companies, logistics companies, distribution and sales agents, as well as other stakeholders like infrastructure operators, regulators, banks, and insurance companies. Risks and uncertainties are present at every stage of the activities involved in acquiring goods and services and delivering the final output to the customer (Harland *et al*., 2003), including support activities. Gheorghe & Mock (1999) propose that stakeholder analysis is an effective approach to studying risk management. The stakeholder approach recognizes diverse risk perceptions, which can impact how supply chain risks are managed. It is important to note that risks occurring within a specific supply chain member can be a consequence of problems in other members of the supply chain. For instance, a delay in material supply at a manufacturing company may be the result of production issues within the supply chain. This delay could also be triggered by a problem on the road, which falls under the responsibility of the government, as one of the stakeholders in the supply chain. Unfortunately, there is limited research addressing how risks are managed concerning different stakeholders within a supply chain system.

3. RESEARCH METHODOLOGY

Brainstorming with the MRMT industrial cluster stakeholders was conducted to determine the existing condition. Subsequently, identification of stakeholders in the MRMT automotive industry cluster, identification of value chain activities, classification of stakeholders, identification of potential risk events and risk agents, and mapping of the relationship between risk events and risk agents were carried out.

The risk analysis with HOR 1 Multistakeholder begins with assessing the impact of each risk event (severity) on each stakeholder and evaluating the likelihood of each risk event (occurrence) for each risk agent, as well as the relationship between the risk agent and the risk event.

The risk evaluation phase is conducted to determine which risk agents need to be mitigated first. Prioritization is based on the results of the Combine Aggregate Risk Potential (CARP) score for each risk agent. The risk agents that receive priority are those with high CARP scores, and this is also determined using Pareto Chart analysis.

The determination of risk mitigation actions for each classified risk agent based on priorities is done using the HOR 2 Multistakeholder method, where the relationship value of the action and the difficulty level of performing the mitigation are determined for each stakeholder. The prioritization of the mitigation actions is based on the ratio value of the difficulty level of the mitigation actions for each stakeholder (ETDs), starting from the highest to the lowest value (Asrol, 2017; Djunaedi, 2005; Gillbert, 2007).

4. DATA ANALYSIS

4.1 Data Collection – MRMT Automotive Industry Cluster

1. Stakeholders of the MRMT Automotive Industry Cluster

The stakeholders of the MRMT Automotive Industry Cluster were identified using the general stakeholder model by Partiwi and Hanoum (2009). The government institutions involved are the Ministry of Industry, Coordinating Ministry for Economic Affairs, Ministry of Agriculture, Ministry of Cooperatives and Small and Medium Enterprises (SMEs), Ministry of Village, Disadvantaged Regions Development, and Transmigration. The financing institutions include Astra Modal Ventura, Financial Services Authority, and revolving fund management agency (LPDB). The research and testing institutions consist of the Ministry of Research, Technology, and Higher Education, National Development Planning Agency (Bappenas), and Agency for the Assessment and Application of Technology (BPPT). The logistics company used is PT Kreasi Mahesa Distributor (PT KMD). There are several associated organizations, namely the Indonesian Automotive Industry Association (IOI), Association of Small and Medium Enterprises Automotive Component (PIKKO), and the Indonesian Karoseri Association (Askarindo). The MRMT suppliers consist of three major groups, namely the main component suppliers, supporting component suppliers, and supporting component suppliers (SMEs). For the production process of MRMT, the Ministry of Industry selected PT KMWI (PT Kreasi Mahesa Wintor Indonesia) located in Citereup, Bogor.

The next stakeholders identified for this research are the Ministry of Industry, IOI, and representatives from universities or academics. The selection of these stakeholders is based on the results of brainstorming and the assessment of the stakeholder attribute matrix, namely the level of interest and power of influence.

2. Value Chain of The Automotive Industry Cluster MRMT

In the process of mapping the value chain, there are several core processes, including input provision, production process, ordering and delivery, and consumption. Value chain of The MRMT Automotive Industry Cluster is shown in **Figure 1**.

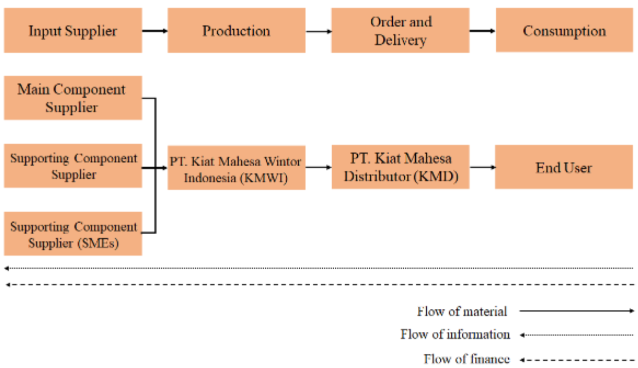

Figure 1 Value Chain of the MRMT Automotive Industry Cluster

3. Flow Process of the MRMT

The flow process for producing MRMT starts with input by managing inbound logistics, where most of the MRMT suppliers are local products, especially from small and medium enterprises (IKM). Meanwhile, machines and technology are obtained from the management of PT KMD, a subsidiary of Astra Otoparts. Then, the core activities include part sequencing, which is done to ensure that the required parts arrive in the production line correctly. Scheduling is used to adjust production volume with the demand forecasting schedule. MRMT will be delivered by PT KMD as a distributor to end consumers. The overview of the MRMT flow process is given in **Figure 2**.

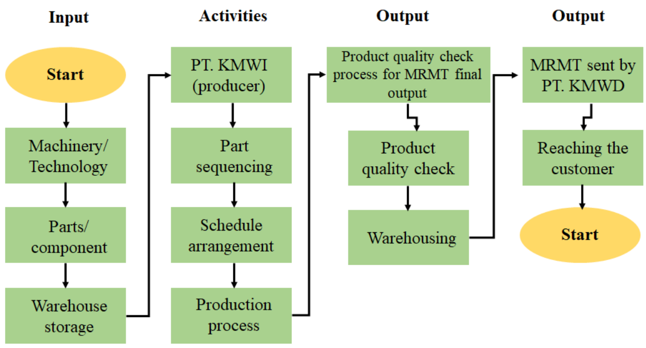

Figure 2. Flow Process of the MRMT

4.2 Identifying Risks in MRMT Industry Cluster

In the initial stage of risk identification, several potential risks were collected from previous research references as the initial input for respondents to determine potential risks in the supply chain of the MRMT automotive cluster industry. After the initial potential risks have been collected, they are then grouped into risk agents and risk events. List of the risk agents and the risk events are shown in **Table 1** and **Table 2**, respectively.

After grouping the risk agents and risk events, an initial mapping is then conducted to connect a risk agent with a risk event. **Figure 3** illustrates the relations between risk agents and risk events The initial mapping of relationships will be confirmed through discussions with stakeholders.

4.3 Risk Assessment Using HOR 1 Multistakeholder

The severity and occurrence assessment are carried out using a rating scale based on Anityasari and Wessiani (2011). The rating scales for severity and occurrence are given in **Table 3** dan **Table 4**, respectively.

In HOR 1 multistakeholder, there are three severity values obtained from each stakeholder, therefore, three ARP (Aggregate Risk Potential) values and a CARP (Combined Aggregate Risk Potential) value are obtained by summing each ARP value. The CARP value is used to indicate which risk factors should be prioritized for mitigation action because they have the potential to disrupt the performance of the MRMT automotive industry cluster.

Figure 4 shows the CARP (Combined Aggregate Risk Potential) values from the three stakeholders, namely the Ministry of Industry, Academia, and PT KMWI. In this study, 6 priority risk factors will be taken based on the previous Pareto diagram, namely (A4) inaccurate demand forecasting, customer complaints about the product, and (A14) delayed delivery of products to customers.

Table 1. Risk Agents

Codes of Risk Agents	Risk Agents
A1	The material specifications provided by the supplier do not meet the standards.
A2	Delayed delivery from supplier
A3	The distributor is experiencing delays in picking up the finished goods.
A4	The demand forecast is not accurate enough
A5	There is a buildup of inventory in the form of finished goods
A6	There is a disturbance in the transportation of products at the distributor
A7	There is a damage in the production machine
A8	There is a communication error in interpreting information
A9	There is a labor strike that has resulted in the cessation of production
A10	There is a shortage of skilled labor
A11	Human error
A12	There is a less-supportive regulation
A13	There are limitations of credit service companies for consumers
A14	There is a delay in delivering the products to the customers
A15	Complaint from customers regarding the product
A16	Media factor
A17	There is an increase in inflation
A18	There is a fire incident
A19	There is a natural disaster

Table 2. Risk Events Table

Codes of Risk Agents	Risk Events
E1	Dependency on the certain supplier
E2	The production process is hindered
E3	There is a buildup of inventory in the form of finished goods
E4	There has been a sudden change in production demand
E5	The decrease of customer's satisfaction
E6	Additional cost for calling the distributor
E7	The distributor is experiencing delays in picking up or delivering products to customers
E8	Additional costs have emerged.
E9	There is a difference in the standard interpretation between the core actor and the supplier
E10	Contractual violation against an institution has occurred
E11	Workplace accident
E12	The impression regarding the existence of hazards in marketed products.
E13	Uncertainty in production costs
E14	Sudden price increases (materials, transportation, etc.)
E15	The factory is unable to operate or is undergoing a forced shutdown
E16	There is an overstock in the storage warehouse
E17	Errors in production planning
E18	Complaints regarding the addition of the MRMT application

4.4 *Selection of Risk Mitigation using HOR 2 Multistakeholder*

Based on the identified priority risk causes, the next step is to determine the mitigation actions or preventive actions for the selected risk causes. The determination of risk mitigation actions is obtained from the results of brainstorming sessions with stakeholders who will execute those mitigation actions. The risk mitigation actions refer to the risk agents are presented in **Table 7**.

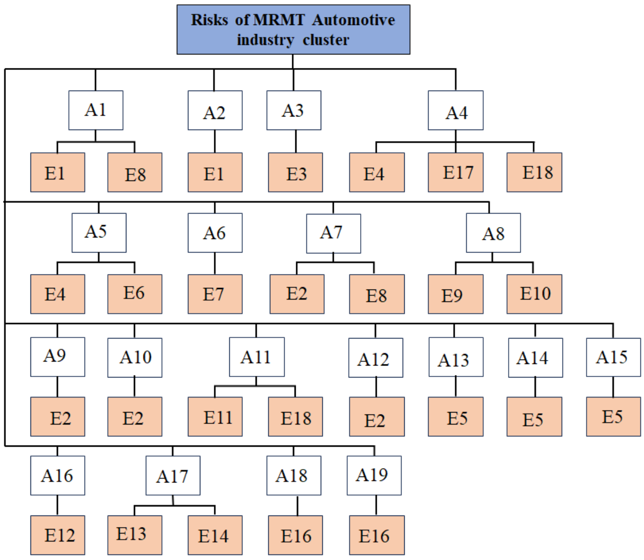

Figure 3. Diagram of Risk Agents and Risk Events Relationships

Table 3. Severity Assessment Scale

Scale	Severity	Description
1	Insignificant	No injuries, low financial loss
2	Minor	First aid, medium financial loss
3	Moderate	Medical treatment, high financial loss
4	Major	Extensive injuries, loss of production capability, major financial loss
5	Catastrophic	Death, huge financial loss

Table 4. Occurrence Assessment Scale

Scale	Occurrence	Possibility of occurence
1	Rare	<5%
2	Unlikely	5%-25%
3	Possible	25%-50%
4	Likely	50%-75%
5	Almost certain	>75%

Table 5. Assessment Scale of Correlation between Cause and Event

Level	Description
0	No correlation
1	Low correlation
3	Moderate correlation
9	High correlation

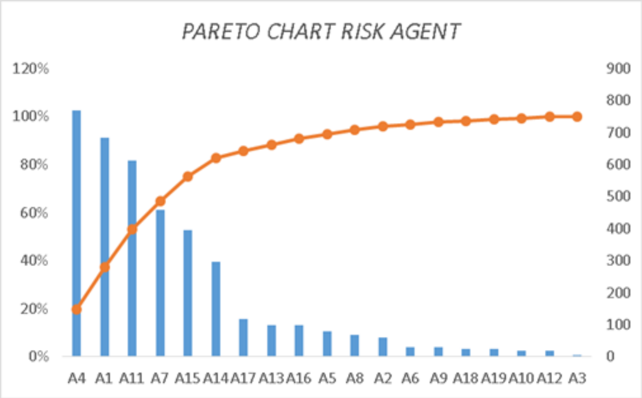

Figure 4. Pareto Chart of CARP

To facilitate the assessment of mitigation actions, a bar chart is needed for each stakeholder. The implementation of risk mitigation actions starts with the highest ETD value to the lowest. This is because high ETD values are easier to implement than low ETD values. Based on **Figure 5**, mitigation action can begin with (PA9) imposing punishment on suppliers who have the highest ETD value.

Table 6. Scale of Difficulty Level for Mitigation Assessment

Scale	Description	Indicator of implementation
1	Very easy	Requires low cost and short time
2	Easy	Requires low cost and long time
3	Neutral	Netral
4	Difficult	Requires high cost and short time
5	Very difficult	Reuires high cost and long time

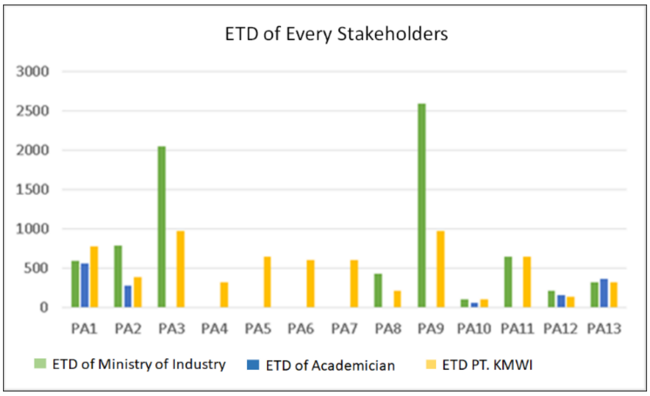

Figure 5. ETD Diagram for Each Stakeholders

Table 7. Action of Risk Mitigation

Codes of Risk Agents	Risk Agents	Mitigation Action	Codes of Mitigation Action
A4	Less accurate demand forecast	The demand forecasting is done collaboratively. Building good communication with distributors	PA1 PA2
A11	Human Error	Conducting training to enhance capabilities and reduce the likelihood of human error. Providing a clean and comfortable working environment for employees Providing rewards and punishments to motivate employees	PA3 PA4 PA5

Table 7. Action of Risk Mitigation (*con't*)

Codes of Risk Agents	Risk Agents	Mitigation Action	Codes of Mitigation Action
A7	Machine breakdown or production machinery failure	Performing regular maintenance for production machinery Implementing control measures for the condition of production machinery	PA6 PA7
A1	The materials sent by the supplier do not meet the standards	Performing supplier audit Applying punishment to the supplier	PA8 PA9
A15	Customer complaints regarding the product	Improving product design and quality control systems Evaluating historical data of customer complaints Applying warranty system	PA10 PA11 PA12
A14	Late delivery of products to customers	Reviewing the method of product delivery	PA13

5. RESULTS AND DISCUSSION

The selection of stakeholders can be determined by assessing them using a stakeholder attribute matrix. The attributes used are the level of interest and power of influence. The level of interest refers to how strongly the stakeholder is interested in the activities and other stakeholders within the industry cluster, while the power of influence reflects the stakeholder's strength in influencing the activities of the industry cluster (Fujita and Thisse, 1996; Djamhari, 2006; Ho, *et al*, 2015).

Mismatches in material specifications sent by suppliers, inaccurate demand forecasts and the occurrence of production machine breakdowns are the highest ranked risks that cause production quality not to meet expectations and or delays in completion. The different interests between MRMT cluster stakeholders need to be synchronized so that an effective risk mitigation can be developed. Based on the risk impact analysis generated through multistakeholder HOR 1, the CARP value is obtained which is an aggregate of the ARP values of each stakeholder and for further risk mitigation.

Accuracy in forecasting the need or demand for products will determine the planning and procurement of materials that form them; therefore, it must be done using the right method with accurate data. If the actual demand is greater than the forecast and the company cannot meet the existing demand, and vice versa, if the actual demand is greater than the forecast, there will be a buildup of finished goods in the warehouse. With the decline in customer satisfaction or the buildup of finished goods in the warehouse, the government will have to help solve the problem with various policies.

The causes of the risk of material specifications sent by suppliers not meeting standards include the fact that most local suppliers (70%) are SMEs (Small and Medium Industries), which generally have a low-quality control system. The material specifications in question can be in the form of quantity or quality that does not meet the standards. This can cause the production process to be hampered and cause losses for the company. Therefore, the development of SMEs needs to be the focus of development programs carried out by the government in collaboration with universities and related institutions, as well as by PT KMWI so that quality and consistency can continue to be improved and guaranteed in the future.

PT KMWI is an MRMT manufacturer selected by the Ministry of Industry (MoI) with an important function of carrying out the production process with a better understanding of the direct conditions regarding MRMT manufacturing processes. The success of MRMT production process is largely determined by PT KMWI. The next stakeholder is the Ministry of Industry, which is a stakeholder of the government agency. MoI has high interest and power as the business owner and has significant authority in making decisions. The Ministry of Industry is a government agency that starts planning the establishment of MRMT supported by several other associations. Starting from product planning to mass production and after-sales of MRMT, all are done under the supervision of MoI. The last stakeholder with high interest and power is the University or academia, which plays a role as one of the processes in the development and research of the formation of MRMT. The role of universities is important in the research and testing process, where the success of the feasibility of producing MRMT is determined, in part, by universities.

6. CONCLUSIONS

This paper is an attempt to analyse supply chain risks in the context of an enterprise that connects with other stakeholders, in particular the Government and Academics. We identified 36 risk potentials which were grouped into 19 risk causes and 18 risk events. From the assessment of severity and occurrence, as well as the correlation between risk causes and risk events, 6 priority risk causes were identified with a total cumulative CARP of 75%. Mitigation actions were carried out on priority risks through a brainstorming process with stakeholders in the automotive cluster industry. This paper enriches the literature in the involvement of other stakeholders in managing supply chain risks. The future research is expected to be more specifically involve different stakeholders in handling risks within a supply chain network.

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