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Risk Mitigation Analysis with the House of Risk (HOR) Method Approach in the Service Procurement Process

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ABSTRACT

Service procurement is a crucial part of supply chain operations, often susceptible to various risks that can disrupt business continuity. PT. Pupuk Iskandar Muda, a major fertilizer company in Indonesia, faces multiple risk events in its service procurement processes. This study aims to identify these risks and propose effective mitigation strategies using the House of Risk (HOR) method. The HOR model comprises two phases: risk identification and prioritization using Aggregate Risk Potential (ARP), followed by the development of mitigation strategies based on risk agent rankings. The results reveal 20 risk events and 19 associated risk agents, from which 10 were prioritized through Pareto analysis. Consequently, 11 mitigation strategies were formulated to address the root causes of these high-impact risks. The novelty of this research lies in its specific focus on risk mitigation in service procurement—an area often overlooked in supply chain literature, which typically emphasizes goods procurement. This study contributes to the development of more targeted and proactive risk management approaches, particularly for state-owned enterprises operating in complex, high-stakes industries.

Keywords: *supply chain; House of Risk; Aggregate Risk Potential; mitigation actions*

INTRODUCTION

PT. Pupuk Iskandar Muda plays an important role in supporting Indonesia's agricultural sector. Over time, PT. Pupuk Iskandar Muda has undergone significant development, continuously expanding its production capacity and diversifying fertilizer products to support agriculture in Indonesia (Gusti, 2021; Hatane et al., 2022; Itang et al., 2022; Schreer & Padmanabhan, 2020). Every company requires goods and services to support its activities. To obtain these goods and services, the company conducts procurement activities. Procurement of Goods and Services is essentially an effort by the user to obtain or realize the desired goods/services, by using certain methods and processes to achieve agreements on price, time, and other terms (Ardiana et al., 2023; Hardenta et al., 2023; Ramadhan & Adhim, 2021).

The government regulation that governs the procurement of goods and services is the Regulation of the Minister of SOEs No. 15 of 2012, concerning General Guidelines for the Implementation of Procurement of Goods and Services of State-Owned Enterprises (Hanisah, 2021; Wahyuningsih et al., 2023). According to the regulation, goods procurement activities can be carried out through auctions, either by direct appointment or through selection. The procurement of goods and services often carries the potential to generate risks that can impact procurement results. Risks may arise for both the user and service provider, and these can have either negative or positive impacts.

Therefore, the procurement department is responsible for managing these risks and their causes (Klee & Janson, 2023; Lebete & Maramura, 2023; Maepa et al., 2023; Riswandi & Yudoko, 2023). The approach to managing risk is known as risk management. However, nowadays, risk management has become increasingly complex due to the emergence of various problems, not only related to the increasing variety of risks but also the relationships between risks, the causes of risks, and the relationship between risk and the cause. With the use of risk management, the expected project goals such as being cost-effective, timely, and ensuring quality in the procurement outcomes can be realized.

Some of the risk events in the procurement process experienced by the Procurement of Goods and Services work unit include sudden changes in the work schedule, errors in creating the TOR (Terms of Reference), service specifications that do not meet user requirements, an insufficient deadline for service work, inconsistency between the offer price and the available budget, and delays in completing service work (Devitt & Porter, 2021). The sources of risk in the procurement process can arise from various factors, including user requests that involve incomplete work specifications, the inability of partners to meet demanding job requirements, and other similar issues. These risks can undoubtedly disrupt and hinder the company's optimal performance.

Therefore, it is necessary to take action to minimize the risks by identifying, analyzing, and designing risk mitigation strategies. Currently, the company as a whole has risk management in place; however, for the Procurement work unit, it has not been deemed entirely appropriate, as risk management is only applied to issues that are perceived to occur at certain times (Gurtu & Johny, 2021; Kurniawan et al., 2021; Prakash et al., 2017). Determining mitigation strategies is crucial in managing these risks. By identifying these risks in detail, the company can develop effective mitigation plans to avoid unwanted losses.

Currently, common problems include delays in service work completion by the service provider, which can disrupt factory operations and even halt the production process for a long time due to disruptions in factory equipment that cannot be completed quickly.

Previous research on Risk Analysis and Mitigation using the House of Risk (HOR) method has been conducted by M. Genta Pertiby Kaban and Dr. Purnawan Adiwicaksono (2022), in their study on the Analysis and Mitigation of Supply Chain Risks in the Procurement of Production Materials in the Furniture Industry using the HOR model. The study identified 12 risk events and 26 risk causes, and 23 mitigation strategies were proposed. A similar study by Muhammad Gesha Lantana, Resista Vikaliana, and Gita Kurnia (2024) at PT Inalum also used the HOR method, which identified 35 risk events and 21 risk causes and proposed 7 mitigation actions.

Based on the above, this study will analyze risk events and risk agents that trigger risks in the service procurement process using the House of Risk (HOR) method approach. The aim is to propose a risk mitigation strategy to help minimize risks in the service procurement process within the company.

Several studies have applied the House of Risk (HOR) method in various industries, such as the furniture industry and aluminum manufacturing (Kaban & Wicaksono, 2022; Lantana et al., 2024). These studies identified various risk events and proposed mitigation strategies, yet their contexts and operational characteristics differ significantly from those in state-owned enterprises, particularly in the fertilizer sector.

There remains a gap in the literature regarding how procurement risks manifest and are managed in capital-intensive, government-regulated industries like PT Pupuk Iskandar Muda. This study aims to fill that gap by providing a focused analysis of service procurement risks and mitigation strategies using the HOR approach in a real-world setting.

The novelty of this research lies in its application of the HOR method specifically within the service procurement unit of PT Pupuk Iskandar Muda, emphasizing how tailored risk management can enhance operational reliability and minimize production disruptions.

The urgency of this research is underscored by recent cases of delayed service completion that have halted factory operations, affecting productivity and financial performance. Therefore, this study has significant practical implications. It will guide the company in developing targeted risk mitigation strategies to ensure timely and efficient procurement processes, ultimately supporting the stability of fertilizer production operations.

METHOD

This research was conducted at a fertilizer company in Indonesia, namely PT. Pupuk Iskandar Muda. The selection of the research location was carried out in a deliberate (purposive) manner. This research was conducted from December 2023 to June 2024 within the Procurement of Goods and Services work unit.

The study used both primary and secondary data. Primary data were collected through structured interviews, direct observations, and questionnaires. Secondary data were obtained from internal reports, procurement documentation, and previous studies on the House of Risk (HOR) method.

To ensure data quality, interviews were conducted with multiple experts for triangulation. Questionnaire instruments were validated through expert judgment to assess the clarity and relevance of each item. Reliability was maintained by testing consistency across similar respondents.

Research Stage Framework

The framework of the research stages on the application of the House of Risk (HOR) method for risk mitigation in the service procurement process (Case Study at PT Pupuk Iskandar Muda).

Stages of Data Collection

The data used in this study are primary and secondary data, both of which are quantitative and qualitative.

1. Primary Data

   Secondary data were obtained through Work Unit Reports and journals, as well as related articles that explain the procurement of goods and services and procurement risk management, with analysis using the *House of Risk* (HOR) method to identify priority risk agents and risk mitigation strategies.
2. Secondary Data

   Primary data were obtained through questionnaires and interviews. The process of interviewing, discussing, and filling out questionnaires involved experts, staff, and officials who are competent and have been involved in the service procurement process for an extended period. This primary data includes the flow of the work process, the procurement policies used, the risk management currently in place, and the risk events

that have arisen.

Data Collection Techniques

The data collection techniques for this study include observation, interviews, and questionnaires. The respondents for this study include experts in the field of Procurement of Goods and Services, the Assistant Vice President (AVP) of the Procurement of Goods and Services work unit, and special staff involved in the procurement of services process. Observation was carried out by directly recording at the research site, identifying procurement business process activities, risk events that arise, and uncertainties faced. Interviews, discussions, and questionnaire distribution were conducted to obtain data on the level/scale of impact of a risk event, identification of risk causative agents, measurement of the level of correlation between a risk agent and risk management, and assessment of the level of difficulty in implementing mitigation actions.

Data Analysis Methods

The data used in this study include both primary and secondary data. The data obtained will be used as a measure in this study. The analysis methods used to obtain the research objectives are presented in Table 1.

Table 1. Data Analysis Methods

No.	Research Objectives	Data Type	Data Source	Analysis Method
1	Obtaining the activities of the procurement process of goods and services, the risks that arise and the uncertainties faced.	Qualitative	Interview Discussion	Descriptive Analysis
2	Obtain data on; the level of impact of a risk event, identification of the causative agent, measurement of the level of correlation between a risk agent and risk management, measuring the level of difficulty in implementing mitigation actions	Quantitative	Questionnaire	*House of Risk* (HOR)
3	Determine alternative strategies to be applied to overcome risks arising in the service procurement process	Qualitative	Interview Discussion	Descriptive Analysis

Descriptive Analysis

This type of research is a descriptive analysis that aims to make a systematic, factual and accurate description, description or painting of the facts, properties and relationships between phenomena. Descriptive analysis is used to analyze the activities of the service procurement process, the risk events that arise and the uncertainties faced. As well as see what risk management methods are currently applied.

1. **Analysis Using *the House of Risk* (HOR) Phase 1 Method**

   The next Risk Assessment was carried out using *the House of Risk* (HOR) method. The result of data processing at this stage is *the Aggregate Risk Potential* (ARP) value which will then be mapped with a *Pareto Diagram*.

   This stage is the initial stage that aims to identify what the risk event is and how or the risk agent is causing it. In the process of work, HOR phase 1 has several stages of work (Pujawan, 2009), namely;

Identify the company's business processes such as *Plan*, *Source*, *Make*, *Deliver*, *Return*. And identify what risk events arise that result in losses to the company. Identify risk events (Ei) for each of the business processes that have been identified at an early stage, as illustrated in Table 2.

Table 2. HOR Phase 1

Business Processes	***Risk Event (E_i)***	***Risk Agent (A_i)***				***Severity of risk event i (S_i)***
		A1	**A2**	**A3**	**A4**	
Plan	E1	R11	R12	R13		S1
	E2	R21	R22			S2
Source	E3	R31				S3
Death	E4	R41				S4
Deliver	E5	R51				S5
Return	E6	R61				S6
Occurrence of agent j		O1	O2	O3	O4	
Aggregate risk potential j		ARP1	ARP2	ARP3	ARP4	
Priority rank of agent j						

Source (Pujawan, 2009)

Measurement of the extent of the impact of a risk event (Si) on the company's business processes (if applicable). The scale of values used is 1-10 where the value of 1 indicates that the impact that arises has a small influence on the sustainability of the supply chain, the value of 5 indicates that the impact that arises has a moderate category influence, the value of 10 indicates that the impact that arises results in a serious impact. The meaning of the impact level value can be seen in Table 3.

Table 3. Meaning of Impact Level Value

Impact Level Scale	***Severity***	**Information**
1	*Yes*	No Risk
2	*Very Slight*	Risk resulting in very little disruption
3	*Slight*	Risk of resulting in minimal disruption
4	*Minor*	Risk resulting in minor disruption
5	*Moderate*	Risk resulting in ongoing disruption
6	*Significant*	Risk resulting in significant disruption
7	*Major*	Risk resulting in significant disruption
8	*Extreme*	Risk resulting in very severe disruption
9	*Serious*	Risk of causing serious disruption
10	*Hazardous*	Risk of resulting in dangerous interference

Identification of risk agents (A_j), this describes what factors can cause risk events that have been identified at the previous stage and measure the value of the opportunity of the emergence of a risk agent (O_j). The scale of the value used is 1-10 where the value of 1 indicates that it almost never happens, the value of 10 indicates that it always happens. The meaning of the value of the level of occurrence of risk agents can be seen in Table 4.

Table 3. Meaning of Value of Opportunity Level

Emergence Rate	Event (*Occurrence*)	Information
1	*Almost Never.*	The appearance of risk agents almost does not occur
2	*Remote*	The appearance of risk agents is very rare
3	*Very Slight*	The appearance of risk agents is very few
4	*Slight*	The appearance of a slight risk agent
5	*Low*	Emergence of low-risk agents
6	*Medium*	Emergence of medium-risk agents
7	*Moderately High*	The emergence of risk agents is quite high
8	*High*	Emergence of high-risk agents
9	*Very High*	The emergence of a very high risk agent
10	*Almost Curtain*	The appearance of risk agents always occurs

Develop a relationship matrix or measurement of the correlation value between a risk event and the causative agent of the risk. If a risk agent causes the onset of a risk, then it is said that there is a correlation. The correlation value (Rij) consists of 0, 1, 3, 9. The meaning of the relationship level value can be seen in Table 3.5.

Table 5. Meaning of Relationship Level Value

Value	Description	Criterion
0	Unrelated	There is no association between risk agents and risk events
1	Low Linkage	There was little association between risk agents and risk events
3	Moderate Linkage	There is a growing association between risk agents and risk events
9	High Linkage	There is a very close relationship between risk agents and risk events

Calculation of the value of the risk priority index/*Aggregate Risk Potential* (ARP). Where the accumulated level of impact of risk events (Si) is multiplied by the correlation value (Rij) and multiplied by the probability value of the emergence of risk agents (Oj). This index value will be used as a consideration to determine the priority of risk management which will later be an input in HOR phase 2. The calculation of the ARP value uses the formulation 2.1 in Chapter II.

Determine the *priority rank of agent* based on the value of the *Aggregate Risk Potential* (ARP) index from the largest to the smallest, where the largest ARP value becomes the 1st rank and the smallest ARP value becomes the last rank.

2. Analysis Using *the House of Risk* (HOR) Phase 2 Method

House of Risk (HOR) phase 2 method is a step to determine which action should be taken first, given the differences in effectiveness and the resources involved and the

level of difficulty in doing so. Design of mitigation strategies to carry out risk management/*risk treatment* of risk agents that have been identified and some at priority risk levels. The implementation of HOR phase 2 has several stages of work (Pujawan, 2009), which are as follows:

Selecting risk agents ranging from the highest to the lowest ARP values using *pareto* analysis. Risk agents that fall into the high-priority category will be inputs in the HOR phase 2, as depicted in Table 3.4 above. The determination of priority risk agent categories is carried out using *Pareto*'s law or known as the 80:20 law. The application of Pareto's law on risk is that 80% of a company's losses are due to 20% of crucial risk. By focusing on 20% of crucial risks, the impact of company risk of 80% can be resolved.

Identify relevant mitigation actions (PAk) to prevent emerging risk agents. Risk handling may apply to one or more risk agents. One risk agent can be addressed with more than one action and one action simultaneously can reduce the likelihood of more than one risk agent occurring.

Measurement of the correlation value between a risk agent and risk management. The correlation relationship (Ejk) will be a consideration in determining the degree of effectiveness in reducing the emergence of risk agents. If a risk mitigation is able to handle/reduce a risk agent, then it is said that there is a correlation. The correlation values consist of 0, 1, 3, 9. The meaning of the relationship level value can be seen in Table 6.

Table 4. Meaning of Relationship Level Value

Value	Description	Criterion
0	Unrelated	There is no link between risk agents and risk mitigation actions
1	Low Linkage	There is a low association between risk agents and risk mitigation actions
3	Moderate Linkage	There is a moderate link between risk agents and risk mitigation actions
9	High Linkage	The appearance of a slight risk agent

a. Calculate the total effectiveness (TE_k) on each risk agent using the formula 2.2 as described in Chapter II.
b. Measure the level of difficulty in implementing mitigation actions (D_j) in an effort to reduce the emergence of risk agents. The scale of the value used is a value of 3 to 5. The meaning of the difficulty level value can be seen in Table 7.

Table 7. Meaning of Difficulty Value

Value	Description	Criterion
3	Low difficulty	Indicates that the difficulty level in implementing a category mitigation action is low
4	Moderate difficulty	Indicates that the level of difficulty in implementing the category mitigation action is moderate
5	High difficulty	Indicates that the level of difficulty in implementing mitigation actions is high and very difficult to implement

a. Calculating the total ratio of *effectiveness to difficulty of ratio* (ETDk) implementation of mitigation actions
b. Determine the priority rating for each action (Rk), which ranges from the highest to the lowest ETD value. The main rating is given to the mitigation actions that have the highest ETDk value.

Table 8. HOR Phase 2

To be treated risk agent (Aj)	*Preventive Action (PA_k)*					*Aggregate Risk Potentials (ARP_j)*
	PA1	**PA2**	**PA3**	**PA4**	**PA5**	
A1	E11					ARP1
A2						ARP2
A3						ARP3
A4						ARP4
Total Effectiveness of action k	TE1	TE2	TE3	TE4	TE5	
Degree of difficulty performing action k	D1	D2	D3	D4	D4	
Effectiveness to difficulty ratio	ETD1	ETD2	ETD3	ETD4	ETD5	
Rank of Priority	R1	R2	R3	R4	R5	

Pareto Diagram

The last analysis method used is using *a pareto* chart. The use of this diagram is to help prioritize the causes of delays in the procurement process of goods and services, so that the main causes can be identified based on the amount of percentage obtained from the RPN calculation. The principle of *the pareto chart* is made based on statistical data with the principle that 20% of the causes of a problem are responsible for 80% of the problems that arise or vice versa. 20% of the cause of delay is 80% of the accumulated percentage of RPN value which is the main cause of delay, so that it can be a reference to provide recommendations for improvement for the procurement process of goods and services of PT. Pupuk Iskandar Muda.

RESULTS AND DISCUSSION

Risk Occurrence

Risk *events* can be interpreted as specific special events, which have a negative impact on decisions, plans, companies, or organizations (Schlagel and Trent, 2015), while Risk *Agents* are sources or causes that can result in risk *events*.

At this stage, it is intended to find out the risk *events* that occur in the supply chain of the service procurement process. This stage begins with determining supply chain activities, identifying risk events and measuring the scale of the impact of risk events on the supply chain of the service procurement process. The data was obtained through observation, interviews and direct discussions with *experts* and *buyer staff* in the procurement work unit, questionnaire distribution and literature study.

Supply Chain Activity

At this stage, activities are determined for each component of the supply chain network based on the business processes carried out, namely *Plan, Source, Make, Deliver, Return*. In

the business *plan process* there are 3 sub-activities carried out, in the source business process there are 2 sub-activities, in the make business process there are 6 sub-activities, in the *business process deliver* there are 2 sub-activities and in the return business process there are 1 sub-activities. Data was obtained through observation, interviews and direct discussions with several expert personnel in the procurement work unit. The complete supply chain activities of the service procurement process can be seen in Table 9.

Table 9. Supply Chain Activities Service Procurement Process

No.	Business Process	Sub Activities
1	*Plan*	Planning a schedule for factory equipment repair work Identify the time requirements of the service work and the specifications of the materials that will be used during the factory equipment repair service work Determining the budget/estimated price of work for factory equipment repair services
2	*Source*	Procurement methods used to determine the source of partners *History* and documents of service procurement that have been carried out previously
3	*Death*	Approval of the partner's proposal Timing for bid entry Request for quotation information to partners Evaluation and coordination with partners regarding the submitted offers Negotiation with partners Determination of the completeness of specifications and documents for the procurement of service works
4	*Deliver*	Delivery of Materials, Work Equipment and Manpower from partners Control and supervision of service work results
5	***Return***	**Conveying dissatisfaction and discomfort with the results of service work is not in accordance with the needs of the scope of work**

Source : Researcher

Identify Risk Events

Risk Events are an event that arises in companies, especially in the process of procuring services that have the potential to interfere, delay, hinder or not optimally in the implementation of service work, so it is necessary to identify risk events/*event risks*. At this stage, the aim is to identify risk *events* that occur in the service procurement process. This stage begins by determining the components of the service procurement supply chain network, determining the activities of the service procurement supply chain, determining risk events and measuring the level of impact of risk events on the service procurement process. Data was obtained through observation, direct interviews with *experts*, which will then be carried out impact assessments related to risk *events* using questionnaires.

From each sub-activity in Table 4.1 above, it can be determined the risk *events* that arise in the process of procuring service work. In total, there are 20 risk *events* divided into 5 risk *events* in the business *plan* process, 3 risk *events in* the source *business process*, 9 risk *events in the* make *business process*, 2 risk *events in the* delivery business process and 1 risk *event* in the return business process. In the appendix, the relationship between business processes, sub-activities and risk events will be conveyed. Risk *events* are coded with the letter Ei (where i is the number of risk events) which aims to facilitate the next reading process. The occurrence of risk *events* can be seen in Table 10.

Table 10. Risk Occurrence

No.	Business Process	Risk Occurrence	Code
1	*Plan*	Sudden Change in Work Schedule	E1
		Addition of Scope of Work	E2
		Errors in making TOR *(Term of Reference)* and service work specifications are not in accordance with what *the user needs*	E3
		The Deadline for Service Work Needs is Too Short	E4
		Budget mismatch	E5
2	*Source*	Incompatibility in the selection of procurement methods	E6
		Errors in determining partners	E7
		Previous procurement documents are invalid	E8
3	*Death*	Rejection of partner proposals	E9
		Changes to partner proposals	E10
		Bid submission deadline is too short	E11
		Uninformed Request for Quotation Letter	E12
		Offer documents not accepted	E13
		Incomplete offer documents	E14
		Inconsistencies in offer documents	E15
		Inconsistency of the offer price with the available spending budget	E16
		Job request specifications and incomplete scope of work	E17
4	*Deliver*	Material incompatibility that will be carried out by the service work	E18
		Delay in completion of service work by partners	E19
5	*Return*	Delay in filing a complaint with the partner	E20

Source : Researcher

Measurement of Risk Event Impact Scale

The next step is to measure the scale of the impact of risk events, where in this measurement to determine the magnitude of the disruption or the level/scale of impact caused by a risk *event* on the supply chain of service procurement. The severity scale used is 1 – 10 where the results of the measurement of the impact scale of risk events can be seen in Table 11.

Table 11. Impact Scale Measurement

Business Process	No.	Risk Event	Code (Laughs)	Impact Scale (*Severity*)
Plan	1	Sudden change in work schedule	E1	**6**
	2	Increased scope of work	E2	**5**
	3	Errors in making *TOR (Term of Reference),* service specifications are not in accordance with what *the user needs*	E3	**7**
	4	The deadline for service work needs is too short	E4	**4**
	5	Budget mismatch	E5	**4**
Source	6	Incompatibility in the selection of procurement methods	E6	**6**
	7	Error in determining partners	E7	**7**
	8	Previous procurement documents are invalid	E8	**4**
Death	9	Rejection of partner proposals	E9	**4**
	10	Changes to partner proposals	E10	**4**
	11	Bid submission deadline is too short	E11	**3**
	12	Uninformed Request for Quotation Letter	E12	**6**
	13	Offer documents not accepted	E13	**5**
	14	Incomplete offer documents	E14	**4**
	15	Inconsistencies in offer documents	E15	**5**
	16	Mismatch Offer price with Available Budget	E16	**4**
	17	Job request specifications and incomplete scope of work	E17	**5**
Deliver	18	Material incompatibility that will be carried out by the service work	E18	**6**
	19	Delay in completion of service work	E19	**6**
Return	**20**	**Delay in filing a complaint with a partner**	**E20**	**5**

Source : Researcher

Of the 20 risk *events*, 2 risk *events* were obtained that provided an impact level with a value of 7 where the risk resulted in a very large disturbance, 5 risk events that provided an impact level with a value of 6 where the risk resulted in a large disturbance, 5 risk *events* which provides an impact level with a value of 5 where the risk results in moderate disruption, 7 risk events that provide an impact level with a value of 4 where the risk results in small disruption and 1 risk *event* that provides an impact level with a value of 3 where the risk results in a small disruption.

Draft Risk Mitigation Strategy

This stage begins with determining risk mitigation actions, measuring the level of relationship between risk agents and risk mitigation actions, calculating the level of risk mitigation effectiveness and the difficulty level of implementation, calculating the difficulty effectiveness ratio and ranking the priority of actions, and details of mitigation actions to be carried out.

Risk Mitigation Actions

Some mitigation actions were obtained from direct interviews with *experts* by considering the level of difficulty and effectiveness when applied. In determining risk mitigation actions for 1 risk agent, 1 or more risk mitigation actions are obtained and vice versa. Risk mitigation actions will be delivered in the form of tabulation.

Of the 10 priority risk agents in Table 4.9, 11 risk mitigation actions are obtained that can eliminate or reduce the emergence of risk agents. Risk mitigation actions are encoded with the letter PAi (where i is the number of risk mitigation actions) which aims to make it easier to read later. Risk mitigation actions can be seen in Table 12.

Table 12. Risk Mitigation Actions

No.	Code	Risk Agent	Risk Mitigation Actions	Code
1	A17	Information about the value of work results that have been previously carried out by partners is not obtained	Creating standardization/*checklist* of information/data that must be completed by company partners	PA1
2	A9	Sudden need for service work	Perform calculations, planning, to *users* related to equipment that is in poor condition	PA2
3	A8	Error in assigning associate criteria	Benchmarking similar companies	PA3
4	A2	Planning for the procurement of service work is not right	Conducting routine training related to the planning of the procurement of service work	PA4
5	A3	Requests from *users* regarding incomplete or unclear job specifications	Creating standardization / *checklist* for the issuance of requests for the procurement of service works	PA5
6	A16	Partner performance is not evaluated regularly and well	Creating SOPs/Procedures for partner performance evaluation	PA6
			Assign evaluation criteria to partners	PA7
7	A15	Partners are less thorough in understanding the needs of service work	Make commitments/work agreements to all partners registered in the company	PA8
8	A18	Mistakes in supervising service work	Make standardization / procedures for supervision of service work with work supervisors in the field.	PA9
9	A6	Associate ability to meet low job demand	To make a more careful and selective selection of partners	PA10
10	A10	Lack of Proper Procurement Staff	Providing *rewards* and *punishments* as well as self-development/motivation to all staff	PA11

Source : Researcher

Measurement of the Degree of Relationship between Risk Agents and Actions

Table 13. Measurement of the Relationship Level of Risk Agents with Mitigation Actions

Risk Agent	Risk Mitigation										
	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	PA10	**PA11**
A17	**3**		**1**			**3**	**1**	**1**			

A9		**3**							**1**			
A8	**1**			**1**		**3**	**3**	**1**		**3**		
A2				**1**	**1**		**1**		**1**		**1**	
A3					**3**							
A16	**3**		**1**	**1**		**9**	**3**			**1**		
A15								**9**	**3**			
A18		**1**	**1**		**1**				**3**			
A6						**1**	**1**		**1**	**1**		
A10				**1**						**3**		

Source : Researcher

This measurement is carried out to obtain the level of relationship between risk agents and risk mitigation actions. Measurements were made with discussion and gave a value of the level of relationship from unrelated to high correlation. Measurements of the level of relationship between risk agents and risk mitigation actions can be seen in Table 13.

Calculation of Risk Mitigation Effectiveness Level (TEk) and Determination of Implementation Difficulty Level

This measurement is carried out to find out how effective the risk mitigation actions have been and how difficult it is to implement. For each level of effectiveness of risk mitigation actions, it is coded with the letter TEk and the level of difficulty of implementation is coded with the letter D_k (where k is the sum of TE or D) which aims to make it easier to read later. The calculation of TEk is calculated by the formula in formulation 2.2.

$$TEk = \sum j \; ARPjEjk$$

For all the results of the TEk calculation, you can see Table 4.12. Here's an example of $TE_{\text{calculation 1}}$.

$$TE1 = \sum 1 \; ARP1E11$$

$$TE1 = \sum 1 \mathbf{(672 \times 3) + (360 \times 1) + (252 \times 3)}$$

$$TE1 = \sum 1 \mathbf{(2016) + (360) + (756)}$$

$$TE1 = \mathbf{3132}$$

Next is to determine the level of difficulty in implementing risk mitigation actions. Measurements are carried out by conducting discussions and assigning a value of low difficulty to high difficulty. The results of the calculation of the TEk for each risk mitigation action and the results of determining the level of difficulty of implementation can be seen in Table 14.

Table 14. Effectiveness Level & Implementation Difficulty Level

No.	Risk Mitigation Actions	Code	Total Effectiveness (TE_k)	Difficulty (Dk)
1	Creating standardization/*checklist* of information/data that must be completed by company partners	PA1	3132	3
2	Perform calculations, planning, to *users* related to equipment that is in poor condition	PA2	1335	5
3	Benchmarking similar companies	PA3	1119	5
4	Conducting routine training related to the planning of the procurement of service work	PA4	1059	4
5	Creating standardization / *checklist* for the issuance of requests for the procurement of service works	PA5	1263	3
6	Creating SOPs/Procedures for partner performance evaluation	PA6	5556	3
7	Assign evaluation criteria to partners	PA7	2985	4
8	Make commitments/work agreements to all partners registered in the company	PA8	2940	3
9	Make standardization / procedures for supervision of service work with work supervisors in the field.	PA9	2078	4
10	To make a more careful and selective selection of partners	PA10	2010	5
11	Providing *rewards* and *punishments* as well as self-development/motivation to all staff	PA11	285	4

From Table 14 above, it is obtained that the highest total effectiveness of the implementation of risk mitigation actions is 5556 for the risk mitigation actions of PA_6 and the total value of the effectiveness of the implementation of risk mitigation actions is 285 for the risk mitigation actions of PA_{11}. For the level of implementation difficulty, 3 risk mitigation actions were obtained, namely PA2, PA3, PA10 which had a difficulty level value of implementation of 5 which showed the level of difficulty in the implementation of mitigation actions in the high category and very difficult to implement, there were 4 risk mitigation actions that had a value of difficulty level of implementation 4 which showed a level of difficulty in the implementation of mitigation actions in the medium category and 4 risk mitigation actions that had a value of level Implementation difficulty 3 which indicates a low level of difficulty in implementing mitigation actions.

Calculation of *Effectiveness to Difficulty Ratio*
(ETD) and Risk Mitigation Action Priority Rating

In determining the priority ranking of risk mitigation actions based on the *Effectiveness to Difficulty Ratio* value. For each *Effectiveness to Difficulty Ratio* is encoded with the letter ETDk (where k is the number of ETD) to make it easier to read later. The calculation of ETDk uses the formula in Formulation 2.3.

$$\boldsymbol{ETD_k = \frac{TE_k}{D_k}}$$

The results of the ETDk calculation and ranking can be seen in Table 4.13. The following is an example of the calculation of ETD_1.

$$\boldsymbol{ETD_1 = \frac{TE_1}{D_1}}$$

$$\boldsymbol{ETD_1 = \frac{TE_1}{D_1}}$$

$$\boldsymbol{ETD_1 = \frac{3132}{3} \qquad ETD_1 = 1044}$$

The results of the *Effectiveness to Difficulty* (ETDk) calculation are then ranked based on the largest to smallest values, then the order of mitigation actions shown in table 4.13 is obtained.

Table 15. *Effectiveness to Difficulty Ratio* and Priority Rating

No.	Risk Mitigation Actions	Code	ETD_k	Priority Rating
1	Creating SOPs/Procedures for partner performance evaluation	PA6	1852	1
2	Creating standardization/*checklist* of information/data that must be completed by company partners	PA1	1044	2
3	Make commitments/work agreements to all partners registered in the company	PA8	980	3
4	Assign evaluation criteria to partners	PA7	746.2	4
5	Make standardization / procedures for supervision of service work with work supervisors in the field.	PA9	519.5	5
6	Creating standardization / *checklist* for the issuance of requests for the procurement of service works	PA5	421	6
7	To make a more careful and selective selection of partners	PA10	402	7
8	Perform calculations, planning, to *users* related to equipment that is in poor condition	PA2	267	8
9	Conducting routine training related to the planning of the procurement of service work	PA4	264.75	9
10	Benchmarking similar companies	PA3	223.8	10
11	Providing *rewards* and *punishments* as well as self-development/motivation to all staff	PA11	71.25	11

Source : Researcher

CONCLUSION

Based on the research and analysis of risk data in the company's service procurement process, several key conclusions were drawn. First, the identification process revealed 20 risk events associated with 19 different risk agents. Second, through the use of a Pareto chart analysis, 10 priority risk agents were identified, which accounted for 77.42% of the total

potential risk impact—making them the primary focus for mitigation efforts. Lastly, from these 10 high-priority risk agents, 11 risk mitigation actions were formulated (as shown in Table 4.14) to effectively reduce or prevent the occurrence of the identified risk agents.

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