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ANALYSIS RISK MANAGEMENT FOR PROCUREMENT OF GOODS AND SERVICES IN DAM PROJECTS

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Abstract

Dam projects are construction projects with a high level of complexity and uncertainty, particularly during the procurement of goods and services. A poorly managed procurement process has the potential to pose significant risks to project performance in terms of cost, time, quality, and safety. This study aims to identify risk indicators for procurement of goods and services during the vendor selection stage of a dam project, determine priority risks based on the Severity Index (SI) and Risk Index (RI), and formulate appropriate risk responses. The research method used is a quantitative approach with data collection through literature studies, observations, interviews, and questionnaires distributed to respondents experienced in the field of procurement and dam project management. Risk analysis was conducted referring to the ISO 31000:2018 risk management framework. The results show that procurement risks are spread across aspects of administration and compliance, vendor technical and capability, financial and price, time and performance, occupational safety and health, and the supply chain. Some risks are categorized as high to very high and require priority control. This study provides a practical contribution in the form of risk mapping and risk response recommendations that can be used as a basis for procurement decisions in dam projects.

Keywords: Risk Management, Procurement Of Goods and Services, Dam Projects, Iso 31000:2018, Severity Index, Risk Index.

INTRODUCTION

Every construction project always faces the possibility of project risk issues. The higher the complexity of a project, the greater the project risk. Project risk is a condition inherent in a project due to uncertainty and the probability of certain events occurring, which, if they occur, will have physical and financial consequences. Construction projects are a type of project with a relatively high level of risk compared to other sectors. This is due to the complexity of the work, the involvement of multiple stakeholders, the large-scale use of resources, and dependence on dynamic external conditions. According to Fakhratov M. et al., 2020, the construction industry is characterized by greater complexity and is difficult to manage due to the requirement for specialized technical skills and intensive coordination. Construction project performance is generally constrained by three main constraints: cost, time, and quality, known as the project management triangle. The success of a construction project is largely determined by the company's ability to achieve these three objectives in a balanced manner. One crucial aspect that directly influences the success of a construction project is the procurement of goods and services. Risk in a construction project is defined as an uncertain event or condition that can have a positive or negative impact on the achievement of project objectives (Junaidi et al., 2024). The procurement process for goods and services involves a series of stages, from planning and supplier selection to bid evaluation and contract signing. Each stage carries potential risks that can impact project performance if not managed properly (Cunha et al., 2022).

PT Nindya Karya, a State-Owned Enterprise (SOE) engaged in general contracting, EPC, and investment, has implemented various strategic infrastructure projects in Indonesia, including dam projects. Dam projects are large-scale construction projects with a high level of complexity and significant impacts on social, economic, and environmental aspects. Procurement of goods and services for dam projects is generally high-value and requires intensive use of natural resources, potentially posing risks not only to project performance but also to environmental sustainability and development sustainability. The implementation of goods and services procurement, whether manual or electronic, is inherently subject to various risks, such as procurement delays, specification discrepancies, supplier failures, and administrative and environmental risks (Prawira, 2020; Hermawan & Arumsari, 2021).

Therefore, procurement risk management is a crucial element in ensuring the effectiveness and efficiency of construction project implementation. The construction sector itself accounts for a significant portion of total goods and services procurement, thus potentially having a significant impact on society and the environment (Mungiu-Pippidi, 2015). However, research specifically addressing the criteria, indicators, and risks of goods and services procurement in the construction sector remains limited, particularly in water resource development such as dams. Previous studies have focused primarily on the building and general construction sectors, while studies on goods and services procurement in dam projects are rare. Based on these conditions, this study focuses on identifying goods and services procurement risks in the PT Nindya Karya dam project to fill this research gap and contribute to improving procurement risk management in water resource construction projects.

LITERATURE REVIEW

Procurement

Every business or organization engages in procurement as part of its operations to meet customer demand for goods or services (Erlangga, 2017). The procurement process involves several processes, including planning, supplier selection, negotiation, supplier assessment, contract signing, and selection of the winning bidder. Procurement encompasses a wide range of products and services, including tangible commodities, consulting services, construction services, and others (Brammer & Walker, 2011). The basic objective of procurement is to ensure timely delivery by ordering goods or services at the best price, at the right time, and in the right quantity. Furthermore, businesses must ensure that the goods they purchase comply with standards and requirements (Darma, 2017).

Risk Management

Risk is an uncertain situation that has the potential to cause a difference between expected and actual results, which may have a negative impact (Pramana, 2011; Tang, 2006). Through measurement selection, risk transfer, risk management, and risk recovery, the primary goal of risk management is to maximize organizational performance. This strategy emphasizes the benefits that can be gained from risk management, such as improved performance and decision-making (Wang et al., 2020). According to Flanagan, R & Norman (1995), risk management involves making decisions regarding how to manage those risks. Risk management consists of five stages, as shown in Figure 1: risk identification, risk classification, risk analysis, risk response, and risk response.

Severity Index

The severity index method is the result of a combination of probability assessments and risk impacts on time and cost. The Severity Index (SI) is calculated using the following formula:

$$SI = \frac{\sum_{i=0}^{4} a_i . x_i}{4 \sum_{i=0}^{4} x_i}$$

With,
ai = assessment constant
xi = respondent frequency
i = 0, 1, 2, 3, 4,..., n
x_0, x_1, x_2, x_3, x_4 are the respondent frequency responses
$a_0 = 0$, $a_1 = 1$, $a_2 = 2$, $a_3 = 3$, $a_4 = 4$
x_0 = respondent frequency "very low," then a0 = 0
x_1 = respondent frequency "low," then $a_1 = 1$ x 2 = respondent frequency "quite high," then $a_2 = 2$
x_3 = respondent frequency "high," then $a_3 = 3$ x 4 = respondent frequency "very high," then $a_4 = 4$

METHOD

Case Study

This research was conducted at PT Nindya Karya, located at Jalan Letjend MT. Haryono Kav 22 Jakarta, with the object of this research covering 7 development procurement processes in the 2021-2025 period spread across 38 provinces in Indonesia carried out by PT Nindya Karya.

Figure 1. Studi Location

Research stages

This research was conducted through structured and systematic stages. The initial stage began with problem formulation to identify the main issues that would be the focus of the research. A literature review was then conducted to obtain a theoretical foundation, understand the development of previous research, and identify research gaps. Based on the results of this review, the most appropriate research strategy was selected to achieve the research objectives. The next stage involved developing the research instruments used for data collection. Data were then systematically collected and analyzed using the severity index method to determine the importance or severity of the factors studied. The results of the analysis were then critically discussed in the discussion section, before conclusions were drawn that summarize the main findings and implications of the research.

Primary Data

Primary data was obtained from interviews and questionnaires with several project staff. These interviews were conducted to obtain information about what might have happened in the project under review.

Secondary Data

The secondary data used was secondary data derived from reviewing literature studies and previous similar research.

RESULTS AND DISCUSSION

The respondents in this study were 30 individuals involved in the procurement of goods/services for the dam construction project at PT Nindya Karya. Respondent profiles were categorized by education and work experience.

Table 1. Respondent profile based on last education

Education	Respondent
S1	19
S2	9
S3	2

Table 2. Respondent profile based on length of experience

Length of experience	Respondent
<5	7
5-9	2
10-15	5
>15	16

Severity Index Analysis

Table 3. Severity index analysis based on probability and impact

Risk Code	Probability		Time Impact		Cost Impact		Quality Impact	
	SI (%)	Weight	SI (%)	Weight	SI (%)	Weight	SI (%)	Weight
X1	63,3	M	66,2	M	60,2	M	63,3	M
X2	83,3	H	83,3	H	80,7	H	80,0	T
X3	66,7	M	67,0	M	65,2	M	71,2	M
X4	70,0	M	76,7	M	75,1	M	76,7	M
X5	71,3	M	80,0	M	75,2	M	70,0	M
X6	68,0	M	73,1	M	70,1	M	71,2	M
X7	80,7	H	86,7	H	84,0	H	83,3	T
X8	65,3	M	70,0	M	66,1	M	70,0	M
X9	62,7	M	73,3	M	70,1	M	75,1	M
X10	64,0	M	70,6	M	66,7	M	70,7	M
X11	66,0	M	73,3	M	70,5	M	76,2	M
X12	60,7	M	66,7	M	63,3	M	72,1	M
X13	52,0	L	56,7	L	53,1	L	57,5	L
X14	56,7	L	60,0	M	56,7	L	60,0	M
X15	72,0	M	73,7	H	76,7	H	70,3	H
X16	69,3	M	75,1	M	80,0	M	76,3	M
X17	70,7	M	77,0	M	72,2	H	76,4	M
X18	66,0	M	71,2	M	70,2	M	76,5	M
X19	67,3	M	73,1	M	73,3	M	76,9	M
X20	58,0	R	60,1	M	60,1	M	64,5	M
X21	64,7	M	43,2	M	70,1	M	73,3	M
X22	82,0	H	83,4	H	83,3	H	83,0	T
X23	57,3	L	63,3	M	60,3	M	60,2	M
X24	50,0	L	56,7	L	53,3	L	56,7	L
X25	48,7	L	53,3	L	50,0	L	53,3	L

Based on the Severity Index (SI) probability analysis, risks related to fairness, transparency, ethics, and financial aspects demonstrate a high probability (≥75%). This indicates that these risks are highly likely to occur in the procurement of goods and services. The most dominant indicators in this risk group include conflicts of interest, collusive practices or unfair competition, and pricing irregularities relative to the Own Estimated Price (HPS). Conversely, risks related to environmental and occupational health and safety (OHS) aspects have a lower SI probability, around 45–55%, because these aspects are generally regulated as standard requirements and are mandatory in project implementation. From an impact SI perspective, the risks of conflicts of interest, collusion, and pricing irregularities relative to the HPS fall into the very high impact category with SI values exceeding 85%. These risks have the potential to cause serious consequences, including failure in vendor selection, legal disputes, significant financial losses, and a decline in the company's reputation. Meanwhile, risks in the administrative, technical, time, and logistics aspects have a high impact level with an SI range of 70–80%, which can affect the smooth and effective implementation of the project. Risks in the environmental and OHS aspects are in the moderate to high impact category, depending on the level of compliance and controls implemented.

Risk Index Analysis and Risk Level

Table 4. Ranking of frequency and impact values of risk factors

No	Probability (P)	Impact (I)	Risk P x I	Risk Ranking
X1	0,63	0,40	0,25	19
X2	0,81	0,51	0,42	3
X3	0,67	0,43	0,29	14
X4	0,70	0,48	0,34	6
X5	0,71	0,48	0,34	4
X6	0,68	0,45	0,31	10
X7	0,83	0,54	0,45	1
X8	0,65	0,43	0,28	15
X9	0,63	0,46	0,29	13
X10	0,64	0,44	0,28	16
X11	0,66	0,46	0,31	11
X12	0,61	0,43	0,26	17
X13	0,52	0,35	0,18	23
X14	0,57	0,37	0,21	22
X15	0,72	0,47	0,34	8
X16	0,69	0,49	0,34	5
X17	0,71	0,48	0,34	7
X18	0,66	0,46	0,30	12
X19	0,67	0,47	0,32	9
X20	0,58	0,39	0,23	20
X21	0,65	0,39	0,25	18
X22	0,82	0,53	0,43	2
X23	0,57	0,39	0,22	21
X24	0,50	0,35	0,18	24
X25	0,49	0,33	0,16	25

Table 5. level of risk

Risk Code	Probability		Dampak Waktu		Dampak Biaya		Dampak Mutu	
	Risk Index	Level	Risk Index	Level	Risk Index	Level	Risk Index	Level
X1	63,3	M	0,06	VL	0,05	L	0,06	VL
X2	83,3	H	**0,20**	**VH**	**0,18**	**H**	**0,19**	**ST**
X3	66,7	M	0,06	VL	0,05	L	0,06	VL
X4	70,0	M	0,08	VL	0,07	VL	0,08	VL
X5	71,3	M	0,09	M	0,08	VL	0,09	M
X6	68,0	M	0,06	VL	0,06	VL	0,06	VL
X7	80,7	H	**0,18**	**H**	**0,20**	**VH**	**0,18**	**H**
X8	65,3	M	0,06	VL	0,05	L	0,06	VL
X9	62,7	M	0,07	VL	0,06	VL	0,07	VL
X10	64,0	M	0,06	VL	0,05	L	0,06	VL
X11	66,0	M	0,07	VL	0,06	VL	0,07	VL
X12	60,7	M	0,06	VL	0,05	L	0,06	VL
X13	52,0	L	0,03	L	0,03	L	0,03	L
X14	56,7	L	0,04	L	0,04	L	0,04	L
X15	72,0	M	0,15	M	0,18	H	0,18	H
X16	69,3	M	0,08	VL	0,10	M	0,08	VL
X17	70,7	M	0,09	M	0,15	M	0,09	M
X18	66,0	M	0,08	VL	0,06	VL	0,07	VL

Risk Code	Probability		Dampak Waktu		Dampak Biaya		Dampak Mutu	
	Risk Index	Level	Risk Index	Level	Risk Index	Level	Risk Index	Level
X19	67,3	M	0,09	M	0,07	VL	0,08	VL
X20	58,0	L	0,05	L	0,05	L	0,05	L
X21	64,7	M	0,07	VL	0,06	VL	0,07	VL
X22	82,0	H	**0,19**	**ST**	**0,18**	**H**	**0,17**	**H**
X23	57,3	L	0,05	L	0,05	L	0,05	L
X24	50,0	L	0,04	L	0,04	L	0,04	L
X25	48,7	L	0,04	L	0,04	L	0,04	L

Based on the risk level analysis, the highest risk is found in variable X7, with a risk value of 0.45, ranking first. This risk is followed by variable X22, with a value of 0.43, ranking second, and variable X2, with a value of 0.42, ranking third. The high risk values for these three variables indicate that these risks have a significant combination of probability and impact, thus having the potential to significantly impact the performance of goods and services procurement projects. In terms of probability, risks X7, X22, and X2 have the highest probability levels at 83.3%, 82.0%, and 83.3%, respectively, all of which fall into the High (T) category. This indicates that these risks are highly likely to occur in the procurement process if adequate controls are not implemented. Meanwhile, in terms of time impact, risks X2 and X22 fall into the Very High (ST) category, indicating a significant potential for project delays if these risks materialize. From a cost perspective, risks X7 and X2 have a very high cost impact, potentially causing significant project cost overruns. Furthermore, the three main risks, X7, X2, and X22, also have a high to very high impact on quality. This confirms that these priority risks not only impact one aspect of project performance but can simultaneously impact time, cost, and quality, necessitating a comprehensive and sustainable mitigation and control strategy.

Table 6. Very high risk factors

Ranking	Code	Risk factor	Risk
1	X7	Non-compliance with procurement regulations and procedures	Very high
2	X22	Delays in the supply of goods/services	Very high
3	X2	Unequal opportunities for vendors in the tender process	Very high

X2 (unequal vendor opportunity) is categorized as very high risk due to its high Risk Index for time and quality, while remaining high for cost. This risk has the potential to lead to delays, procurement disputes, and suboptimal vendor selection, thus directly impacting project quality. X7 (non-compliance with procurement regulations and procedures) is considered a very high risk, particularly in terms of cost. This risk has the potential to trigger legal consequences, cancellation of the tender process, re-evaluation, and cost overruns. It is systemic in nature because it impacts the legitimacy and accountability of the procurement. X22 (delay in the supply of goods/services) is designated as a very high risk with the highest Risk Index for time. Its impacts include delays in follow-up work, increased costs due to idle time, and potential quality degradation. X15 (price fairness relative to the Cost of Goods Sold) and several financial and ethical indicators are in the high-medium category and can still be controlled through strengthened evaluation, bid clarification, and procurement oversight.

Table 7. Very high risk factors based on category

Ranking	code	Risk Factor	Category			
			SOM	SEM	SQM	PM
1	X7	Non-compliance with procurement regulations and procedures				√
2	X22	Delays in the supply of goods/services			√	
3	X2	Unequal opportunities for vendors in the tender process	√			
4	X15	Reasonability of bid prices relative to the Cost of Goods Sold				√

Table 8. Risk Response

Risk code	Indicator	Category	Risk	Risk Response	Response Action
X2	Unequal opportunities for vendors in the tender process	SOM	Very high	Avoidance & Control	Tender document transparency, evaluation process audits, and complaint mechanisms
X7	Non-compliance with procurement regulations and procedures	PM	Very high	Control	Standardization of SOPs, committee training, and compliance monitoring
X22	Delays in the supply of goods/services	SQM	Very high	Mitigation	Supply chain evaluation, penalty clauses, and alternative suppliers
X15	Reasonability of bid prices relative to the HPS	PM	High	Mitigation	Price fairness analysis, bid clarification, and financial verification
X5	Indications of collusion or unfair business competition	SOM	Moderate	Mitigation	Strengthening independent evaluations and reviewing bidding patterns
X16	Vendor financial stability	PM	Moderate	Mitigation	Financial statement and cash flow audits
X19	Track record of timely work	PM	Moderate	Monitoring	Evaluating vendor historical performance

Vendor selection risk responses demonstrate that risk management approaches must be tailored to the risk severity and risk management category. Very high risks require primary attention because they have the potential to directly derail the procurement process and significantly impact project performance. The risk of vendor inequality in the tender process (A2), which falls under the Social and Organizational Management (SOM) category, requires strict avoidance and control strategies. Unfairness in the tender process can undermine healthy competition and reduce the chances of selecting a competent vendor. Therefore, transparency in procurement documents, independent audits of the evaluation process, and the implementation of a grievance mechanism are essential response steps.

The risk of non-compliance with procurement regulations and procedures (B2), under the Project Management (PM) category, is systemic and strategic. Risk responses focus on control through standardization of procurement procedures, enhancement of committee competency, and multi-layered compliance monitoring. Failure to control this risk has the potential to result in legal consequences and cancellation of the vendor selection process. Furthermore, the risk of delays in the supply of goods/services (G2), which falls under the Supply and Quality Management (SQM) category, is addressed through mitigation strategies. Evaluating supply chain reliability, implementing penalty clauses, and providing alternative suppliers are important steps to reduce the probability and impact of risks on project schedules and quality. High and moderate risks, such as the reasonableness of bid prices relative to the Cost of Goods Sold (HPS) and vendor financial stability, still require mitigation and control measures through more in-depth and systematic evaluation. Risks related to Occupational Health and Safety (OSH) and the environment are generally low and acceptable with routine monitoring.

CONCLUSION

Based on the research findings on procurement risk management for goods and services in the PT Nindya Karya Dam project, the following conclusions can be drawn:

1. Procurement risk indicators for goods and services in vendor selection for the PT Nindya Karya Dam project include aspects of fairness and transparency, administration and compliance, technical capability, financial capability, time and performance, supply chain, and environment and Occupational Safety and Health (OHS). The indicators with the highest SI scores primarily relate to procurement fairness and ethics, such as unequal vendor opportunities, conflicts of interest, and indications of collusion, followed by financial aspects, specifically the fairness of bid prices relative to the Cost of Goods Sold (HPS).

2. Priority risks in vendor selection for the PT Nindya Karya Dam project, based on the risk index, are unequal vendor opportunities in the tender process (X2), non-compliance with procurement regulations and procedures (X7), and delays in the supply of goods and services (X22).
3. Risk control measures are tailored to the risk category, including very high categories (X2, X7, and X22) requiring strict avoidance, control, and mitigation measures, including through increasing transparency of the tender process, standardization and supervision of compliance with procurement procedures, and strengthening supply chain management. Risks in the high to moderate categories are controlled through mitigation and monitoring strategies, such as more in-depth evaluation of vendor offers and historical performance. Meanwhile, risks in the low category are acceptable with routine monitoring and compliance with applicable administrative and regulatory requirements.

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