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The Design Of Project Risk Management To Mitigate Project Delay In the Onshore Construction Industry (Case: Shore Protection Project)

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Abstract

This study aims to design a project risk management system to mitigate delays in the land-based construction industry, using a case study of the PT Sabar Sejahtera coastal protection project. The project experienced a three-month delay, resulting in financial losses and lost business opportunities due to a lump-sum contract. The methods employed included both qualitative and quantitative approaches, with primary data collected through focus group discussions with project stakeholders and secondary data sourced from internal company documents. Root cause analysis used a Current Reality Tree (CRT) to identify the causes of delays, while solutions were visualized through a Future Reality Tree (FRT). Risk evaluation was conducted using a Failure Mode and Effects Analysis (FMEA) to calculate the Risk Priority Number (RPN), as well as the application of a risk management framework based on the PMBOK 6th Edition. The results showed that the leading causes of delays were systematic errors at the tendering and planning stages, as well as the unavailability of a risk mitigation plan. These two factors caused a domino effect on procurement, equipment, schedules, and the confidence of the main contractor. Proposed solutions included improving the tendering and planning system by involving various departments early and implementing the complete PMBOK risk management cycle. The implications of this study highlight the importance of a structured risk management system in preventing similar project delays in the future. This study also provides strategic guidance for improving the efficiency and control of construction projects in complex work environments.

INTRODUCTION

Infrastructure development in Indonesia plays a crucial role in supporting economic growth and equitable development between regions (Firdatin & Gifary, 2021). One form of strategic infrastructure is coal-based steam power plants (PLTU), many of which are developed in coastal areas (Wollff, 2023). These power plants are pivotal in meeting the growing energy demand; however, they present challenges due to their dependence on environmental factors and complex construction requirements (Anderson, 2019; Brown, 2020). A significant concern in these projects is the timely execution of onshore construction works, such as coastal protection, cooling systems, and plant installations (Jha, 2021). These power plant projects often involve complex onshore construction works, including coastal protection works and cooling water pipe installations, which are highly dependent on the timeliness and quality of execution (Kumar, 2024).

In this context, PT Sabar Sejahtera, a national onshore construction company with experience in handling projects both domestically and abroad, was entrusted to work on the shore protection project for the construction of the Batang 2 x 1000 MW power plant. However, the project experienced a significant three-month delay that had a profound impact on both the timeline and the budget (Patel, 2023; Smith, 2022). The delay was primarily attributed to the use of a lump-sum contract, which did not allow for payment adjustments due to delays, further exacerbating the financial losses incurred by the company. (Sutrisno, 2021). This type of contract has often been associated with increased risk, particularly in projects where time-sensitive work and high uncertainty prevail (Moradi, 2020: Cai, 2020).

Project delays are a classic problem in the construction industry (Hossain, 2022). However, these delays become even more complex when they occur on projects in coastal areas, which present additional challenges such as weather conditions, tides, and limited accessibility to heavy equipment. Several studies have demonstrated that project delays are typically attributed to a combination of managerial, technical, and external factors. (Gurgun et al., 2024). In the case of PT Sabar Sejahtera, the delay allegedly stemmed from systematic errors in planning and tendering, a lack of preparedness for risk, and the absence of a structured risk mitigation system.

This situation serves as a moment of reflection, highlighting that risk management has not been an integral part of project planning in most construction companies in Indonesia. Many companies still employ a reactive approach to risk, taking action only after the risk materializes (Hohenstein, 2022). A proactive approach, which involves identifying and managing risks from the early stages of the project, is believed to prevent sustainable negative impacts.

Therefore, this study seeks to examine in depth the causes of delays in the shore protection project undertaken by PT Sabar Sejahtera and design a structured project risk management system as a mitigation effort against possible future delays. This research uses the latest project management theory-based approaches, including Current Reality Tree and Future Reality Tree modeling, as well as a risk management framework based on PMBOK 6th Edition. By doing so, the research hopes to provide actionable insights into mitigating delays and improving the efficiency of onshore construction projects in Indonesia (Verma et al., 2020; Nawaz et al., 2021).

METHOD

1. Research Type and Approach

This research is applied research with a descriptive, qualitative, and quantitative approach *(*mixed-method*)*. The primary objective of this research is to identify the root causes of construction project delays and develop a risk management system that can be practically applied to similar projects in the future.

a. A qualitative approach was used to explore in-depth the factors causing delays through focus group discussions with project stakeholders.
b. A quantitative approach is applied through the Failure Mode and Effect Analysis (FMEA) method to provide a risk assessment based on the Risk Priority Number (RPN) score, resulting in a more objective prioritization of risk mitigation actions.

By employing these two approaches, this research is expected to yield findings that are not only exploratory but also measurable and methodologically justified.

2. Location and Time of Research

This research was conducted at PT Sabar Sejahtera, an onshore construction company based in Indonesia, which serves as the executor of the shore protection project for the construction of two 1000 MW power plants in Batang, Central Java. This location was chosen because the project experienced significant delays and had adequate documentation and access for analysis.The research was conducted from January to May 2025 and included problem identification, data collection, group discussions, data analysis, and the development of recommendations.

3. Data Collection Sources and Techniques

The data used in this study consisted of:

a. Primary data**,** obtained through focus group discussions *(*FGDs*)* involving project stakeholders, including the Project Manager, Operations Director, and Project Coordinator.
b. Secondary data, in the form of project planning documents, initial and realized S-curves, Bill of Quantity (BoQ), work progress reports, and records of changes in work methods and contracts.

Data collection techniques are done through:

a. Semi-structured interviews in a group discussion forum
b. Documentation and review of project technical documents, Observation of workflow, and project planning system

4. Data Analysis Technique

The data was analyzed through several stages:

1. Qualitative Root Cause Analysis

   Using the Current Reality Tree (CRT) to identify the root causes of delays that are interconnected and have a domino effect.

2. Solution Modeling and Positive Impact Projection

   Using the Future Reality Tree (FRT) to visualize the positive effects of the proposed solution on the project system conditions.

3. Quantitative Risk Analysis

   Using the FMEA (Failure Mode and Effects Analysis) method by calculating:

   a. Severity (S): the severity of the risk
   b. Occurrence (O): likelihood of risk occurrence
   c. Detection (D): the ability to detect risk

   The formula calculates RPN as $RPN = S \times O \times D$, and then the risks are ranked based on the highest score.

4. PMBOK 6th Edition-Based Mitigation Design

   Includes processes such as risk management planning, risk identification, qualitative and quantitative analysis, response planning, implementation, and risk monitoring.

RESULTS AND DISCUSSION

1. Root Cause Analysis of Project Delay

Group discussions with project stakeholders revealed that the delay in PT Sabar Sejahtera's shore protection project was due to a combination of technical, managerial, and systemic factors. Through the Current Reality Tree (CRT) approach, two leading root causes of delay were found:

1. Systematic errors at the tendering and planning stages, which led to:
   a. Unrealistic budget planning
   b. Inaccurate work schedule, unsuitable vendor selection, and work methods
2. The absence of a structured risk mitigation plan**,** which resulted in:
   a. Delays in procurement of tools and materials
   b. Mid-project change in work method. Inability to respond to dynamic weather and sea conditions
3. The domino effect of these two root causes can be seen in the form of:
   a. Delays in material supply due to emergency procurement
   b. Heavy equipment damage due to lack of maintenance planning, Worker fatigue due to busy schedules and excessive overtime, and Distrust of the main contractor, which led to sudden changes in work methods and sequences

Visualizing the cause structure using CRT made it clear that most of the undesirable effects (UDEs) could be traced back to these two root causes.

2. Solution Generation: Future Reality Tree (FRT)

Based on the CRT, the research team developed key solutions and projected their impact using the Future Reality Tree (FRT). The agreed key solutions (injections) are:

1. Establish a structured and realistic planning system at the tender stage, including:
   a. schedule adjustment based on actual field conditions
   b. Cross-departmental involvement in plan development (operations, engineering, finance, procurement)
2. Implement PMBOK 6th Edition-based risk management, including the process of Risk identification, analysis, response, implementation, and monitoring.

The projected positive impacts of implementing the above two solutions include:

a. The project schedule is more adaptive to field risks
b. The risk of delays can be anticipated before they occur. Early and planned procurement of tools and materials can increase trust from the main contractor. Project costs are more controllable, and according to the initial plan

3. Risk Evaluation Using FMEA

A Failure Mode and Effect Analysis (FMEA) was then conducted to assess key risks and prioritize mitigation strategies. Parameters used:

a. Severity (S): Impact on the project if the risk occurs (1-10)
b. Occurrence (O): Frequency of risk occurrence (1-10)
c. Detection (D): The ability of the system to detect risks before they have an impact (1-10)

Table 1. Example of Risk Analysis Results

Key Risks	Severity	Occurrence	Detection	RPN (S×O×D)
Delay in material procurement	9	8	6	432
Work method error in the field	8	7	5	280
Sudden change of the main contractor	7	6	7	294
Heavy equipment damage	6	5	6	180
Inexperienced labor	8	4	5	160

From the table above, the risk with the highest RPN is the delay in material procurement**.** This finding aligns with previous qualitative research, which identified the unstructured procurement process as the primary cause of early project delays.

4. Risk Mitigation Plan

Referring to PMBOK 6th Edition, the mitigation plan is developed through six main stages:

1. Plan Risk Management:
   Develop an SOP for project risk management from the tender stage.
2. Identify Risks:
   Using FGDs and cross-divisional brainstorming to develop an initial risk register.

3. Perform Qualitative and Quantitative Risk Analysis:
   Classify risks based on probability and impact; assign RPN.
4. Plan Risk Responses:
   Establish mitigation measures for prioritized risks, such as:
   a. Contract vendors with SLA agreements
   b. Create a buffer schedule for materials and heavy equipment to ensure timely delivery. Provide technical training to project workers
5. Implement Risk Responses:
   Engage a dedicated oversight team to ensure that mitigation actions are executed effectively and efficiently.
6. Monitor Risks:
   Develop a risk register and evaluate the impact and effectiveness of mitigation actions every week to ensure ongoing effectiveness.

5. Discussion and Implications

Based on the analysis and comparison with previous literature, there are some significant findings:

a. Project delays are not merely technical problems, but stem from the failure of a comprehensive planning and risk management system.
b. The use of CRT and FRT is effective in identifying root causes and mapping solutions systemically.
c. The FMEA method allows companies to prioritize risks and design data-driven mitigations objectively.

The practical implication of the study's results is the need for companies to integrate risk management into their project management systems as an integral part, rather than merely as an administrative document. Continuous implementation of lessons learned and risk monitoring should also be done to prevent repetition of similar mistakes.

CONCLUSION

The study concluded that the project delay in shore protection works by PT Sabar Sejahtera was caused by a combination of systemic, technical, and managerial factors, with the leading root cause being systematic errors at the tender and planning stages, as well as the absence of a structured risk mitigation system. The problems had far-reaching impacts on project implementation, including supply chain disruptions, damage to heavy equipment, labor fatigue, and a loss of trust from the main contractor. Using the Current Reality Tree and Future Reality Tree approaches, the primary solutions identified were the establishment of a cross-departmental planning system from the project's early stages, as well as the full implementation of a PMBOK-based risk management framework. Quantitative results through FMEA also identified priority risks that required immediate mitigation. The mitigation plan designed proved to provide strategic and operational direction in preventing similar delays in the future. Overall, this research confirms the importance of integrating risk management at every stage of an onshore construction project, ensuring the timeliness, cost efficiency, and sustainability of working relationships between project stakeholders. It also encourages the adoption of robust, theory-based risk management frameworks to improve decision-making processes and project outcomes, ultimately contributing to more successful and reliable project deliveries in the construction sector.

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