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Risk Management In The Implementation of The Probolinggo - Banyuwangi Toll Road Construction Project Package

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KEYWORDS
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ABSTRACT
The construction of the Probolinggo-Banyuwangi Toll Road Package 2 is a strategic project that plays a critical role in enhancing infrastructure connectivity in East Java. However, it faces significant risks arising from both internal and external factors. Internal challenges include limited availability of skilled manpower, inadequate heavy equipment, and poor project coordination, which hinder project efficiency. External challenges, such as fluctuating raw material prices, regulatory changes, and adverse weather conditions, further complicate the implementation of the project. These risks, if unmanaged, could result in delays, cost overruns, and compromised project quality. This study focuses on identifying key risk factors and developing effective mitigation strategies through qualitative and quantitative risk analysis. Priority risks, including material delivery delays, frequent design changes, and financial instability, were identified as critical to the project's success. The findings underline the importance of proactive and structured risk management approaches, as guided by frameworks like ISO 31000 and AS/NZS 4360, which emphasize early risk identification, assessment, and mitigation during the planning phase. Furthermore, the research highlights the necessity of strong coordination among stakeholders, from government agencies to contractors and subcontractors, to mitigate risks collaboratively. Developing a risk-conscious organizational culture is crucial to ensuring project efficiency, not only in terms of cost but also in time and quality management. By implementing a systematic and integrated risk management framework, the Probolinggo-Banyuwangi Toll Road Package 2 project can serve as a model for managing risks effectively in large-scale construction projects. This study provides valuable insights for future infrastructure developments in Indonesia, emphasizing the importance of robust risk management practices for achieving project sustainability and success.

INTRODUCTION

Construction projects are complex and challenging activities, especially in the construction implementation services sector which faces high uncertainty in project implementation (Sugiyanto, 2020). The Probolinggo - Banyuwangi Package 2 toll road construction project is one of the strategic projects that requires comprehensive risk management. Risks can arise from internal factors, such as ineffective management, to external factors, such as regulatory changes or uncertain weather conditions (Labombang, 2011).

Risk management in construction projects is an important process that aims to identify, analyze, and control risks that have the potential to interfere with the achievement of project

objectives (Hanafi, 2006). Based on the AS/NZS 4360 standard, risk management is conducted through a systematic approach that includes risk identification, analysis, evaluation, and mitigation (Australian/New Zealand, 2004). This approach helps construction companies to minimize the impact of risks on project cost, time, and quality.

In the context of the Probolinggo - Banyuwangi Package 2 toll road project, risks can arise from various aspects. Technical factors, such as limited human resources and heavy equipment, often become obstacles in project implementation. In addition, changes in government regulations related to the procurement of goods and services are also a challenge for construction implementation service companies (Flanagan & Norman, 1993). These uncertainties require a well-thought-out mitigation strategy to ensure the smooth running of the project.

As a project that involves many parties, ranging from the government, main contractor, to subcontractors, the success of the project is highly dependent on inter-stakeholder coordination. Barriers in communication or lack of synchronization between parties can increase the risk of project delays (Bu-Qammaz et al., 2009). Therefore, risk management focuses not only on technical aspects, but also on managerial and coordination aspects. In recent years, the risk management approach has undergone a paradigm shift. Construction companies now prioritize the implementation of proactive risk strategies, where risks are identified and anticipated from the planning stage (Ardian, 2021). This approach allows companies to reduce the likelihood of major risks occurring that can hinder the smooth running of the project.

One of the key challenges in construction project risk management is prioritizing the risks that should be addressed first. Risks that have a high impact on project success, such as material supply delays or extreme weather changes, should be the main focus of mitigation strategies (Rumimper et al., 2015). In this case, qualitative and quantitative risk analysis can help prioritize risks based on their severity and chance of occurrence. In the Probolinggo - Banyuwangi Package 2 toll road project, the main risk factors include material supply delays, technical errors, and government policy changes. These factors can significantly impact the project schedule and cost. Therefore, a mitigation strategy involving all relevant parties is required to reduce the impact of these risks (Duffield & Trigunarsyah, 1999).

The risk mitigation process should also consider previous experience in managing similar projects. Previous studies have shown that the use of standards-based approaches, such as ISO 31000 and AS/NZS 4360, can assist construction companies in identifying and managing risks effectively (Lisananda, 2021). These approaches ensure that each risk is properly analyzed and mitigation strategies are designed to minimize its impact. In addition, effective risk management requires commitment from all levels of the organization, from project managers to field workers. Without a strong commitment, risk management implementation can be ineffective (Lokobal, 2014). Therefore, construction service companies need to develop an organizational culture that supports the consistent implementation of risk management.

The risks faced in construction projects also include external factors, such as fluctuations in raw material prices and changes in currency exchange rates (Patriadi, 2021). These factors affect the project budget and can cause cost overruns if not properly anticipated (Flanagan & Norman, 1993). In this case, flexible and adaptive mitigation strategies are necessary to deal with such uncertainties. Risk management also plays a role in improving project efficiency (Rodli, 2019). By identifying risks early on, companies can allocate resources more efficiently and reduce waste. This helps the project to achieve the set targets in terms of cost, time, and quality (Sugiyanto, 2020).

This study makes an important contribution in understanding how risk management can be applied in the Probolinggo - Banyuwangi Package 2 toll road project. By identifying key

risk factors and corresponding mitigation strategies, construction companies can increase the chances of project success. This research also provides insight into the importance of a structured and systematic risk management approach in dealing with challenges in construction projects.

Literature Review

Definition of Risk and Risk Management

Risk in construction projects refers to the potential occurrence of events that can result in losses, either in terms of cost, time, or project quality. In this context, Flanagan and Norman (1993) define risk as factors that cause undesirable conditions that can result in loss or damage. Risk can be speculative, i.e. having both profit and loss opportunities, or pure, i.e. offering only loss opportunities (Hanafi, 2006). Risk is a very important aspect to consider in construction projects due to the unique, temporary, and complex nature of projects, and often involves many parties and activities. In addition, construction as an activity that is not routine and only lasts for a certain period also adds uncertainty, which can make risks more difficult to predict. Therefore, systematic risk management is key to project success.

Risk management is a systematic approach to identifying, evaluating, and managing risks aimed at minimizing losses and maximizing opportunities for success. Based on the Australian/New Zealand standard AS/NZS 4360:2004, the risk management process includes several stages. The first stage is defining the context, which is understanding the scope and parameters of the project that allows for more precise risk identification. The second stage is risk identification, where potential risks that could affect the project are recognized through techniques such as brainstorming, interviews or historical analysis. After that, the risk analysis stage is conducted to evaluate the impact and likelihood of the risk occurring. This analysis is followed by risk evaluation to prioritize which risks require more attention. The fifth stage is risk control, which involves developing specific mitigation strategies to reduce the impact or likelihood of the risk. Finally, the monitoring and review stage is conducted on an ongoing basis to ensure the effectiveness of the measures that have been taken. By implementing these stages, construction projects can mitigate the impact of uncertainty more effectively, thereby increasing the probability of project success.

Sources of Risk in Construction Projects

Construction projects face various sources of risk that can arise from both internal and external factors. According to Duffield and Trigunarsyah (1999), risks in construction can be classified into several main categories. Physical risks include natural threats such as earthquakes, floods, landslides or fires. These risks can directly affect project sustainability, especially in geologically vulnerable locations. Environmental risks relate to ecological impacts such as pollution or poor waste management. Ecological imbalances not only impact the project but can also lead to conflicts with local communities or the government. Design risk is the risk that arises from technical errors, the use of new technology, or design specifications that do not match field conditions. Design errors can affect construction efficiency, increasing costs and time to completion.

In addition, logistics risk is a challenge in construction projects, mainly related to delays in material delivery, equipment damage during transportation, or limited availability of resources. Financial risks also play a significant role, especially in large projects with complex budgets. These risks may include currency exchange rate fluctuations, inflation, interest rate changes, or the inability of the contractor to provide adequate cash flow. Legal or regulatory risks are often overlooked but can have a major impact, especially if there are changes in government policies that affect construction or land use regulations. Political risk is also a major concern in large-scale projects, especially those involving project owners or contractors from different countries. Political instability, changes in government, or war can disrupt the project. Operational risks, such as the availability of skilled human resources, are also

challenges that project managers need to address. All these types of risks indicate that construction projects require a comprehensive risk mitigation approach to minimize the adverse impacts that can occur.

Previous Research

Various studies have been conducted to understand risk in construction projects. Lokobal (2014) examined risk management in construction service companies in Sarmi Regency, Papua. This research identified the supervision aspect as the highest risk based on the consequences that could occur. Other significant risks include aspects of location, human resources, socio-culture, and planning. This research used quantitative methods by distributing questionnaires to 30 contractors. The results showed that the price and cost budget aspects were the risks with the greatest level of influence on project success. Ardian (2021) conducted research on the Golf Residence 3 housing construction project, which showed that material risk was the top priority. The extreme risk indicators found include delays in material delivery, rising raw material prices, monetary instability, and poor material quality.

Lisananda's research (2021) on a wastewater piping project in Pekanbaru used the ISO 31000:2018 approach to evaluate the implementation of risk management. The results showed that only the contractor fully implemented risk analysis, while other stakeholders did not. There were 53 risk variables identified, with 23 categories falling into risk avoidance, 27 categories of risk transfer, and 3 categories of risk reduction. These three studies show that although various risk management methods have been implemented, there is room for improvement, especially in engaging all stakeholders to collaborate in risk mitigation. In addition, these studies also emphasize the importance of early risk identification, comprehensive evaluation, and development of effective mitigation strategies to reduce the impact of risks on construction projects.

Risk Mitigation

Risk mitigation strategies are an important step in construction project management to reduce the impact of uncertainties. According to AS/NZS 4360, there are several commonly used risk mitigation methods. The first is risk avoidance. This approach involves deciding not to proceed with the risky activity or replacing it with a safer method. For example, in the case of construction projects, avoiding the use of untested technology can be one way of reducing the risk of failure. Second, reducing the likelihood of risk by technical, administrative, or human approaches. Technical approaches involve replacing materials, using safer tools, or changing construction methods. Hazard isolation is also a common technical strategy, for example by installing guards to prevent work accidents. Administrative approaches include implementing stricter work policies, while human approaches involve training employees on work safety.

In addition, reducing the consequences of risk can be done through an effective emergency response system. Providing personal protective equipment (PPE), such as helmets and gloves, not only protects workers but also reduces the severity of injuries in the event of an accident. Another method is risk transfer, for example by using contracts that divide responsibility to subcontractors or third parties. Insurance is also one of the risk mitigation tools often used to protect projects from financial losses due to unforeseen events. The final step in risk mitigation is to conduct regular consultation, monitoring and review to ensure the strategies implemented remain relevant. This is important because project conditions can change over time, and mitigation strategies that were previously effective may require adjustments to meet new challenges. By applying this approach, construction projects can run more efficiently and risks can be significantly minimized.

RESEARCH METHOD

The research focuses on risk management in the Probolinggo - Banyuwangi Package 2 toll road construction project, aiming to identify significant risk factors that could affect project success and formulate effective mitigation strategies. Through a comprehensive approach that includes literature reviews, direct observations, and interviews with stakeholders, the study addresses various risks arising from technical, financial, and operational aspects. It emphasizes not only technical uncertainties but also challenges in inter-team coordination and external impacts, such as policy changes and environmental conditions. By utilizing a quantitative data analysis approach, the research seeks to contribute meaningfully to risk management practices in Indonesian toll road construction projects.

Data collection involved both primary and secondary sources to ensure a thorough understanding of the risks associated with the project. Primary data was gathered through questionnaires and structured interviews with project stakeholders, while secondary data included official project documents and relevant literature. The data analysis utilized a risk matrix to evaluate the likelihood and impact of identified risks, further validating the findings through stakeholder interviews. The research subjects included project managers, field implementers, and experts specializing in various fields. Conducted on-site, the research aimed to provide accurate and practical mitigation recommendations tailored to the specific needs of the Probolinggo - Banyuwangi Package 2 toll road construction project.

RESULTS AND DISCUSSION

Research Results

Material Risk Analysis

The results show that material risks have a significant contribution to potential project delays. The main risk factors include material price increases, material scarcity, delivery delays, and poor material quality. The increase in material prices has a direct impact on increasing project costs. Meanwhile, material shortages can cause delays in the work schedule, especially in meeting specific material needs. Low material quality can reduce the quality of the building structure, requiring replacement or repair. Based on the assessment results, the dominant material risk indicator is material theft with a significant impact on project costs.

Table 1. Risk Indicators and Descriptions

No.		Risk	Description
1	Materials	Increase in material prices	Impact on project cost increase
2		Scarcity of materials	Impact on time delays and increased costs for appropriate raw materials
3		Delay in material delivery	Impact on time delays and increased costs for appropriate raw materials
4		Poor material quality	Impact on low building quality
5		Inappropriate material volume and type	Impact on building costs
6		Excess material usage (waste material)	Impact on wasted material costs
7		Changes in material specifications	Impact on work time.
8		Material theft	Impact on job cost, material purchase again
9	Equipment	Incomplete equipment	Delayed work time and cost to purchase or rent equipment
10		Equipment that is no longer suitable	Impact on job costs to provide new equipment
11		Equipment delivery delays	Impact on work time delay

12		Equipment misplacement	Impact on work time delays and costs in terms of less productive labor.
13	Labor	Loss of Equipment	Impact on work time and cost to provide support equipment
14		Lack of labor availability	Impact on the time of work is delayed because of the lack of labor be slow progress
15		Lack of labor capability/skills	Impact on work time delays and costs incurred as labor becomes less productive.
16		Arriving/starting work late, leaving early	Impacts on low labor productivity, resulting in delayed work time and costs borne from lost work hours.
17	Contract	Job change *(Change order)*	Impact on work time delay
18		Contract Clauses	Impact on large job costs to cover unlisted contract clauses
19	Financial	Payment method that is not on time	Resulting in a lot of delayed work
20		Cost estimation inaccuracy	Impact on the cost of work because the estimated cost does not match the implementation cost
21		Fluctuations (uncertainty) in bank lending rates	Uncertainty of interest rates on bank loans due to certain exchange rates
22		Cash flow bottlenecks	Impact on work time is delayed due to delays in work as a result of costs that should have been incurred experiencing congestion
23		Not paying attention to unexpected costs	Impacts the cost of the work because it does not take into account the possibility of unforeseen costs
24	Physical Conditions on site	Hard-to-reach location conditions	Impacts on the cost of having to provide to reach the project site
25		Poor *site* and location conditions	resulting in more time and money spent on work in poor locations
26		Difficult land acquisition conditions	Impact on work stoppage because land acquisition is not the domain of the implementing contractor
27	Natural Conditions	Poor weather conditions	Impact on work time delay, and costs incurred for work stoppage due to bad weather.
28		Natural disasters	Impact on work time is delayed and building quality is reduced if work is still being done.
29	Social Conditions	Demonstration, project site picketing	Impact on implementation costs due to insecurity from external intrusion
30		Riots	Impact on work time due to work being stopped or delayed
31		Cultural conditions and customs of the communities around the site that hinder the project	Impact on costs that must be provided to adjust to the conditions of the surrounding community
32	Contractor Management	Work Strike	Impact on work time is delayed because the work process is halted due

			to the strike.
33		Lack of project manager experience	Impacts on time, cost, and can affect the quality of work
34		Lack of communication and coordination between parties involved in the project	Impact on time and cost that makes working conditions unfavorable
35		Lack of supervision of contractors and suppliers	Impact on time and costs that must be borne, because there is a risk that the specifications of the goods do not match
36		Lack of control over work implementation schedule	Impact on work time delay
37	Government Policy/Legali sation	Changes in government political policies that complicate project completion	Impact on job cost and time
38		Monetary instability	Impact on work costs due to high forex exchange rates resulting in a fall in the value of the currency, which results in all goods and services prices rising
39		Bureaucratic bottleneck in licensing process	Impact on work time
40		Change in construction method	Impact on work time and cost due to changed construction methods
41	Construction Methods and Technology	Incorrect or incomplete design	Impact on work time delayed due to having to wait for design corrections, and design completeness
42		Inappropriate selection of construction method	Impact on work time delay, and costs incurred from inappropriate construction methods.
43		Difficulty applying new/specialized technology	Impacts on work time delays because it takes time to learn new/specialized technology methods, and impacts on costs because it takes new workers who can understand new/specialized technology.
44	Occupational Health and Safety	Accidents occur due to human error	Impact on costs due to accident treatment
45		Accidents occur due to equipment failure	Impact on costs due to accident-related maintenance and work time due to equipment repairs
46		Poor Occupational Health and Safety (OHS) procedures	Impact on time and cost of work due to non-implementation of OHS

Labor Risk

Labor-related risks also have a considerable impact on project implementation. Insufficient labor availability and labor capabilities that are not up to standard are major issues. Work delays often occur due to low labor productivity due to late arrival at the project site or lack of technical skills. This leads to additional costs for training or re-recruitment. In addition, unforeseen strikes can also stop project activities at unplanned times, increasing the risk of significant delays in project completion.

Equipment Risks and Site Conditions

Equipment management is one of the critical factors in the success of construction projects. Research shows that incomplete equipment, late delivery, and misplacement are major sources of risk. The physical condition of the project site also adds to the complexity of the work, especially if access to the site is difficult or there are constraints on land acquisition. Equipment mismanagement can affect work schedules, while poor site conditions require additional costs for operational adjustments.

Discussion

The analysis results confirm that material, labor, and equipment risks are the primary factors impacting the success of the Probolinggo-Banyuwangi toll road construction project Package: 2 STA 9+000 - 20+200. Material risks, such as price fluctuations, scarcity, and delivery delays, pose significant challenges that can disrupt project timelines and inflate costs. To address these issues, a robust procurement strategy is essential to ensure the availability of high-quality raw materials at competitive prices. Additionally, the implementation of a technology-based inventory management system can help mitigate risks related to theft and late delivery by providing real-time tracking and accurate forecasting of material needs. Establishing long-term contracts with reliable suppliers can further stabilize material availability and pricing, reducing dependency on market fluctuations.

Labor risks also play a pivotal role in project success, with issues such as insufficient skilled workers and low productivity requiring immediate attention. Regular technical training programs designed to meet project-specific needs can improve workforce capabilities, minimizing errors and inefficiencies. An incentive system that rewards productivity can enhance worker motivation, ensuring better performance and adherence to deadlines. Employment insurance is also critical to provide financial security in case of strikes or accidents, fostering a sense of stability and commitment among the workforce. Furthermore, collaborating with vocational training institutions can create a sustainable pipeline of skilled labor, ensuring the availability of competent workers for ongoing and future projects.

Equipment risks, including incomplete equipment, delayed deliveries, or breakdowns, can severely hinder project progress. To mitigate these risks, a scheduled maintenance system is vital to ensure that machinery remains operational and breakdowns are minimized. Effective site management, supported by comprehensive baseline surveys, can help identify and address physical and logistical constraints, including those posed by difficult site access or challenging terrain. Additionally, the government plays a strategic role in facilitating licensing and land acquisition processes, which are critical for the smooth execution of the project. Planned and integrated risk mitigation strategies, encompassing these key aspects, can significantly enhance the efficiency and sustainability of project implementation while ensuring that the project meets its time, cost, and quality objectives.

CONCLUSION

This research identified 45 risk indicators and 12 main risks that could affect the implementation of the Probolinggo - Banyuwangi Package 2 toll road construction project. Some of the significant risks include material price increases, material delivery delays, lack of labor skills, and natural conditions such as bad weather or natural disasters. The main risks found include aspects of materials, equipment, labor, physical site conditions, finance, policies, and work methods. Priority risks categorized as extreme risks are recurring design changes, delays in material delivery, financial issues, and difficult site access during the rainy season. Risk control for this category includes measures such as intensive coordination with relevant parties, setting detailed material delivery schedules, and preparing alternative access routes to the project site.

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