

# **IMPACT AND RISK MANAGEMENT STRATEGIES ON EAST SURABAYA HOSPITAL CONSTRUCTION PROJECTS: A TECHNICAL, TIME, COST, AND ENVIRONMENTAL APPROACH**

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## **Abstract**

Urban hospital construction faces multifaceted risks, yet integrated strategies addressing environmental, technical, temporal, and financial interdependencies remain underexplored. This study analyzes risk management in the East Surabaya Hospital project, aiming to develop an adaptive framework for sustainable infrastructure development. A mixed-method approach combined SWOT analysis, FMEA, and AMDAL documentation, supplemented by stakeholder interviews, questionnaires, and field observations. Data were analyzed using Risk Priority Numbers (RPN) and statistical validation ( $p=0.02$ ). Environmental risks (45%)—air/noise pollution and drainage disruptions—were most critical, followed by technical risks (35%). Mitigation strategies (preventive maintenance, contingency funds, flexible scheduling) reduced technical risks by 25% and environmental impacts by 30%. Financial risks (10-15% budget overruns) were managed via strategic negotiations. The study underscores the need for integrated risk management, recommending real-time monitoring, stakeholder engagement, and AI-driven predictive tools. It contributes a replicable model for healthcare infrastructure projects, aligning with sustainable development goals and ISO 31000 standards.

**Keywords:** Risk Management, Hospital Construction, Environmental Impact, Project Management, FMEA.

## **INTRODUCTION**

Health infrastructure development plays a vital role in improving the quality of public health services. This is in line with the mandate of Law Number 17 of 2023 concerning Health article 4 paragraph (3) which guarantees the right of every citizen to obtain safe, quality and affordable health services. In the context of sustainable development, Herlina & Supriyatin (2021) emphasize the importance of balance between infrastructure development and environmental impact control. Sukananda & Nugraha (2020) also underlined the urgency of implementing AMDAL as an environmental impact control instrument in every development project in Indonesia.

The hospital construction project, which started in 2023 and is planned for completion in 2024, faces various challenges and risks that need to be managed effectively. Data from the National Development Planning Agency shows that around 35% of infrastructure projects in Indonesia experience delays or cost overruns due to weak risk management. The Journal of Construction Engineering and Management (2022) revealed that infrastructure projects in Indonesia's urban areas face significant

challenges in terms of compliance with Environmental Impact Assessment (AMDAL). Bahamid et al. (2022) in their research identified that effective risk management practices are key to the success of modern construction projects.

The complexity of project risk management is increasing as construction technology and standards evolve. Musostova et al. (2022) highlighted the importance of a systematic approach to project risk management, especially in the face of uncertainty and complexity of large-scale construction projects. Setyawan et al. (2022) in their study on risk management of high-rise building construction found that technical, financial, and environmental factors are critical aspects that require special attention in the construction implementation stage.

In the context of environmental impacts, Khaerulyansyah et al. (2018) emphasized the importance of a comprehensive study of the impacts of development in urban areas. This is reinforced by the findings of Patriadi et al. (2021) which show that infrastructure development can significantly affect the condition of the surrounding environment. Rahman & Tjendani (2022) identified various risks in the construction of high-rise buildings that require an integrated risk management approach.

Siahaan & Simanjuntak (2022) underline the importance of risk identification at the implementation stage of construction projects, especially in the context of multi-project management. Soeryodarundio et al. (2022) added that the use of appropriate risk analysis methods can assist in the prioritization and effective handling of project risks. Fatimah et al. (2021) in their study in Aceh Province found various risk factors that need to be anticipated in building construction projects.

Syahputra et al. (2022) emphasized the importance of following standardized project management guidelines in managing risk. This is in line with the research of Vargas et al. (2022) who compared the ISO 31000 (2018) standard with the PMBOK Guide in the context of project risk management. Rodli et al. (2019) added that the development of an organizational learning culture can accelerate progress in construction project management.

This research aims to deeply analyze the impacts of various risks identified in the East Surabaya Hospital construction project, as well as formulate effective risk management strategies to minimize these impacts. By understanding the relationship between technical, time, cost and environmental aspects, this research is expected to contribute significantly to the development of a more comprehensive and adaptive risk management approach for hospital construction projects in urban areas.

This study advances existing research by integrating SWOT analysis, FMEA, and Environmental Impact Assessment (AMDAL) into a unified risk management framework for urban hospital construction a gap identified in prior works like Bahamid et al. (2022) and Setyawan et al. (2022), which focused on generic construction risks. Unlike Musostova et al. (2022) and Rahman & Tjendani (2022), this research quantifies the dominance of environmental risks (45%) and their cascading effects on technical (35%), temporal, and financial dimensions, offering a novel, data-driven perspective. It also introduces real-time environmental monitoring and AI-driven predictive modeling as

future directions, bridging the reactive strategies noted in Fatimah et al. (2021) and Soeryodarundio et al. (2022).

## **METHOD**

Problem identification is a crucial stage that begins with comprehensively defining the impact of risks on a construction project, covering various important aspects such as technical, time, cost, and environment. This study focuses on the construction of East Surabaya Hospital, a strategic project that faces a variety of potentially significant risks during its implementation. An in-depth understanding of the impact of risks becomes a fundamental foundation for formulating effective and measurable mitigation strategies. In this context, the main focus was on the detailed identification of how each risk could affect the project's success rate and the concrete measures that could be implemented to minimize its negative impact. This in-depth analysis of various risk factors includes an evaluation of potential technical obstacles, schedule deviations, cost overruns, as well as impacts on the surrounding environment that may arise during the construction process.

The literature review was conducted systematically with the aim of providing an in-depth and comprehensive understanding of theories and approaches in construction risk management. This research adopts SWOT and FMEA methods integrated with EIA documents, an approach that has been proven relevant and effective for large-scale construction projects. The scope of literature analyzed includes the latest environmental regulations, comprehensive project management guidelines, as well as various previous studies addressing risk mitigation strategies in similar infrastructure projects. The review also included an analysis of best practices in the construction industry, occupational safety and health standards, and technical guidelines related to the construction of healthcare facilities. The results of this literature review provide a solid theoretical framework to comprehensively analyze and manage project risks, taking into account relevant technical, managerial, and regulatory aspects.

The data collection process was conducted through a mixed-method approach that combines qualitative and quantitative methods in an integrated manner. The method included a series of in-depth interviews with key stakeholders, the distribution of structured questionnaires, intensive field observations, and a thorough document study. Research respondents included various parties directly involved in the project, including experienced project managers, technical consultants, and implementing contractors. Secondary data collected included comprehensive EIA documents, detailed project progress reports, accurate geotechnical maps, as well as various other supporting documents. The use of multiple data collection methods ensured that all identified risks were thoroughly covered and their impact on the project could be accurately and objectively assessed.

Data analysis was conducted using a multi-method approach that integrated SWOT analysis to deeply evaluate the project's internal and external factors, combined with the FMEA method to prioritize risks based on three key parameters: severity, probability of occurrence, and detectability. A qualitative analysis approach was implemented to

explore in detail the characteristics and implications of each identified key risk, while a quantitative approach was used to give each risk a measurable weighting and prioritization. The analysis process also included an evaluation of the interrelationships between risks, potential cascading impacts, as well as the effectiveness of the various mitigation options available. The results of this comprehensive analysis were then used as the basis for designing effective, scalable and implementable risk mitigation strategies.

The research subjects included all stakeholders directly involved in project implementation, including a team of experienced project managers, implementing contractors with various specializations, and technical consultants from various fields of expertise. In addition, the research also involved related parties such as material suppliers, sub-contractors, and representatives from relevant government agencies. The object of the research is the East Surabaya Hospital construction project, a strategic project with a high level of complexity that has a contract value of Rp 494 billion and is planned to be completed within 12 months. The focus of the research was directed at identifying and analyzing risks that could potentially affect four key aspects of the project: technical, time, cost, and environmental, taking into account the special characteristics of the project as a healthcare facility.

The research was conducted at the construction site of the East Surabaya Hospital located at Jl. Penjaringan Asri, Surabaya, a strategic area that has its own characteristics and challenges. The duration of the research covered the entire 12-month project implementation period, with data collection activities conducted intensively and continuously throughout the project implementation period. This approach was applied to ensure that the data collected could accurately reflect the actual conditions in the field, including seasonal variations and changes in conditions that may occur during the construction period.



**Figure 1.** Location of Works/Public Health Service Facilities of East Surabaya Regional General Hospital (RSUD) in Wonorejo-Rungkut Canal Area

**Source:** BAPPEKO Surabaya City/Technical Proposal for Flood Control/SDMP

The research instruments used included a comprehensive set of tools, including structured interview guidelines, validated questionnaires and detailed observation sheets. The research also utilized advanced modeling software such as HEC-RAS for detailed drainage system analysis, and SWMM for comprehensive environmental impact simulation. In addition, project documents such as EIAs, periodic progress reports, and other technical documentation were key data sources that provided important information for the risk analysis.

Data analysis was conducted through a series of systematic and structured stages. The first stage utilized SWOT analysis to comprehensively identify the strengths, weaknesses, opportunities, and threats associated with various aspects of project risks. Next, the FMEA method was implemented to calculate the Risk Priority Number (RPN) of each identified risk, providing clear guidance for mitigation prioritization. The process of analyzing the results was carried out by integrating the findings from both methods, combined with sensitivity analysis and scenario simulation, to produce effective, applicable, and measurable risk management recommendations. The results of this analysis were then validated through discussions with experts and key stakeholders to ensure their relevance and applicability in the project context.

## **RESULT AND DISCUSSION**

### **Results**

#### **Technical Impact**

The results revealed that the technical aspect became one of the significant sources of risk in the implementation of the East Surabaya Hospital construction project, with a contribution of 35% of the total risks identified. The dominant technical issues include frequent heavy equipment breakdowns, delays in the procurement process of construction materials, as well as various technical specification discrepancies found during implementation. The research showed that these issues directly hindered the smooth flow of work in the field, led to the temporary suspension of construction activities, and had a significant impact on reducing the productivity of the project team. Further analysis revealed that the root of these technical issues stemmed from weak coordination between the planning and implementation teams, as well as inaccuracies in predicting field conditions. The impact of these technical risks not only implied cost overruns for repairs and replacements, but also required substantial additional time allocation to complete the delayed tasks.

#### **Time Impact**

Investigations into the time impact revealed alarming findings, with each risk that was not successfully mitigated potentially resulting in an average delay of up to 15 working days. These delays were not only caused by technical factors such as machine breakdowns, but were also affected by a range of significant non-technical obstacles, including protracted permitting processes and problems in the availability of construction raw materials. The research found that the impact of these delays had a cascading effect that affected the entire project schedule, from preparation to completion. Furthermore, these delays proved to have serious implications for the cooperative relationship between various stakeholders, including the relationship between the contractor and the project funder, potentially worsening the overall project management situation.

#### **Cost Impact**

An analysis of the cost impact resulted in findings indicating the potential for significant budget overruns, reaching a range of 10%-15% of the initial total budget set. The study identified that these cost overruns were mainly due to various unforeseen

expenses, such as the cost of repairing and maintaining damaged machines, as well as additional costs required to accelerate work to catch up with the schedule. The study also found that this cost risk has a double impact, in that in addition to increasing direct expenditure, it also reduces the flexibility of the project budget in dealing with other urgent needs that may arise during the construction period.

### Environmental Impact

The results of the environmental impact study showed that this aspect accounted for the largest portion of the total project risk, at 45%. These findings cover a range of significant impacts on the surrounding environment, including increased air pollution from construction activities, disruptive noise levels, and disruption to existing drainage systems. The research revealed that these environmental risks were not only ecologically impactful, but also had far-reaching social implications, reflected in the declining support of the surrounding community for the project's sustainability. The analysis shows that inefficiencies in environmental impact management have the potential to cause various social problems, such as increased complaints from surrounding communities, which can ultimately become a serious obstacle in the development process.



**Figure 2.** Existing Drainage System of the Work Site  
**Source:** Field Survey Results, 2023

**Table 1. Table of Area Elevation in Each Village in Rungkut Sub-district in 2022**

No.	Village	Area Height (above sea level)
1	Rungkut Kidul	4,6
2	Medokan Ayu	4,6
3	Wonorejo	4,6
4	Penjaringan Sari	4,6
5	Kedung Baruk	4,6
6	Kalirungkut	4,6

**Source:** Rungkut Sub-district in numbers 2023

## Discussion

### Risk Identification and Assessment

The discussion of the risk identification and assessment process demonstrates the effectiveness of the comprehensive approach adopted, involving an in-depth analysis of

the AMDAL document, the conduct of extensive field surveys, and a series of in-depth interviews with relevant parties. This process resulted in a thorough risk mapping, covering technical, environmental, time and cost aspects. The risk baseline data obtained through this process proved to be a strong foundation in determining the priorities and mitigation strategies that needed to be implemented. This systematic approach to risk identification and assessment enabled the project team to develop a better understanding of the characteristics and potential impacts of each identified risk.

### **Technical Risk Mitigation**

The technical risk mitigation strategy implemented showed promising results through the implementation of a comprehensive preventive maintenance system for heavy equipment, supported by a strict routine inspection schedule and the use of high-quality spare parts. The discussion revealed that a proactive approach to material procurement, characterized by the establishment of long-term contracts with trusted suppliers, successfully minimized the risk of delays and specification discrepancies. This strategy proved effective in ensuring the availability and readiness of heavy equipment and materials in accordance with project needs, while minimizing potential disruptions to the construction schedule.

### **Time Risk Mitigation**

The discussion related to time risk mitigation illustrates the successful implementation of a flexible scheduling system equipped with adequate time buffers to anticipate various unexpected obstacles. The implementation of digital-based project management technology proved to make a significant contribution in improving coordination and work efficiency among the implementation team. This system allows real-time monitoring of project progress and facilitates faster and more accurate decision-making in the face of various challenges that arise during construction implementation.

### **Cost Risk Mitigation**

Analysis of the cost risk mitigation strategy shows the effectiveness of the policy of providing a contingency budget of 10%-15% of the total project budget. The discussion reveals that the availability of this reserve fund plays an important role in accommodating various unexpected costs that arise during project implementation. The strategy of renegotiating contracts with service providers also proved effective in optimizing expenditure efficiency without sacrificing the quality of work, creating a good balance between cost control and achieving established quality standards.

### **Environmental Risk Mitigation**

The discussion of environmental risk mitigation strategies shows the successful implementation of various impact control measures, including the installation of effective dust control devices and strategic scheduling of high noise work. The construction of temporary drainage systems designed with local hydrological conditions in mind proved effective in preventing waterlogging during the rainy season. A proactive approach to communication with neighboring communities, supported by transparency in the delivery

of information related to risks and mitigation measures, successfully built trust and maintained community support for the project.

### **Analysis of Results and Implications**

Discussion of the results of the statistical analysis confirmed the effectiveness of the mitigation strategies implemented, with significant reductions in the likelihood of technical risks by 25% and environmental impacts by 30%. The results of the linear regression conducted indicate a strong positive correlation between risk mitigation efforts and project success rates, evidenced by a p-value of 0.02 which is statistically significant. This finding confirms that the EIA-based risk management approach has a substantial contribution to project success, not only in the aspects of budget and schedule control, but also in maintaining harmonization with the environment and surrounding communities.

### **CONCLUSION**

A study on risk management in the East Surabaya Hospital construction project found that an integrated approach addressing environmental (45%), technical (35%), financial, and scheduling risks is crucial for success. Environmental risks—such as air pollution, noise, and drainage disruptions—had cascading effects on timelines and costs, while technical risks were mitigated through preventive maintenance and supplier contracts, reducing incidents by 25%. Financial risks, including 10-15% potential budget overruns, were managed via contingency funds and strategic negotiations. Key recommendations include real-time environmental monitoring, preventive technical measures, flexible scheduling, stakeholder engagement, and a dedicated risk management team. Future research should explore AI-driven predictive modeling, combining IoT, BIM, and machine learning to automate risk mitigation, optimize stakeholder communication, and analyze cross-risk interdependencies, advancing from reactive to proactive risk management in healthcare construction.

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