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Design And Build Project Risk Analysis at Tugu Pal 0 Stage II Project Construction

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ABSTRACT

The implementation of the design and build method in the Phase II Pal Nol Monument construction project, managed by the Public Works and Spatial Planning Agency (PUPR) of South Kalimantan Province, aims to analyze the risks associated with the design and construction processes. This project, which utilizes an integrated design and build construction method (multi-year), is located on Jl. Dharma Praja within the South Kalimantan Provincial Office Area and executed by the contractor KSO ADHI-PUTRA. A comprehensive risk mitigation strategy for the project includes detailed work planning, effective coordination, periodic evaluation, a thorough understanding of design specifications, continuous risk analysis, flexible contingency plans, and strong communication with government entities and stakeholders.

Keywords: *Risk Analysis, Design and Build, Construction, Tugu PAL 0 Stage II*

INTRODUCTION

A construction project is a series of activities utilizing various resources to achieve specific goals, such as development or construction, within constraints of time, cost, and quality (Kerzner, 2006). Essential resources include labor, materials, equipment, methods, money, information, and time. In this context, the design and build method is gaining popularity in the construction industry for its integration of design and construction under a single entity (Praboyo, 1999). Unlike traditional methods, which separate these stages, the design and build approach offers time and cost efficiencies while fostering better collaboration among stakeholders.

The shift in construction practices highlights the importance of integrating design and construction processes. The design and build method addresses potential conflicts between design and construction teams, which often lead to delays and disagreements in traditional models (Mora and Li, 2001). By consolidating both functions, the method reduces errors and enhances overall project efficiency, making it a preferred choice for complex projects requiring swift and effective management. Financially, it reduces costs and risks related to separate project management, as one entity oversees the entire process, providing cost savings and improved project timelines (Presidential Decree No. 80/2003).

In addition to cost and time efficiency, practical experience demonstrates that design and build projects often foster greater innovation. The close collaboration between the design and construction teams from the project's inception allows for the exploration and implementation of creative ideas (Mora and Li, 2001). This synergy leads to improved construction solutions that align with the needs and expectations of project stakeholders. Consequently, it is crucial for the construction industry to continue developing and adopting this approach to effectively address the challenges posed by modern projects.

The design and build method have been applied in the Phase II construction project of the Pal Nol Monument, overseen by the Public Works and Spatial Planning Agency (PUPR) of South Kalimantan Province. This phased project, budgeted for implementation in the 2023 fiscal year, has faced several challenges, including two changes in construction management and Budget User Authority (KPA), along with three significant design modifications. The objective of this study is to analyze the design and construction risk factors associated with the Phase II Pal Nol Monument project, as managed by the Public Works and Spatial Planning Agency of South Kalimantan Province.

MATERIALS & METHODS

The Phase II Pal Nol Monument Construction Project is executed using the integrated design and build construction method (multi-year) and is managed by the Public Works and Spatial Planning Agency (PUPR) of South Kalimantan Province. The project is situated on Jl. Dharma Praja within the South Kalimantan Provincial Office Area, with KSO ADHI-PUTRA serving as the implementing contractor, and the construction site located in Banjarmasin.

Data Analysis

Data analysis was conducted using the risk analysis method with a risk matrix. Assessment of risk factors needs to be carried out to obtain the desired results. The assessment can be carried out by capturing responses from parties related to the design and build of Tugu Zero Phase II. There are two variables in the assessment, namely independent variables and dependent variables.

Independent variables are free variables that cause dependent variables. In this study, the dependent variables are the frequency of occurrence and the impact on time.

Dependent variables are bound variables that arise from independent variables.

RESULT

Based on the guidelines for frequency and consequences belonging to Godfrey et al., (1996) as stated in Section 2.4.3 regarding risk acceptability, the results of risk acceptability estimates in this study can be shown in Table 1.

Table 1. Risk Identification of Monument Pal 0

No	Risk Identity	Frequency	Impact	Risk Value	Risk Acceptability
a	b	c	d	e (c x d)	f
X1	Very tight project schedule determination by Owner	1	3	3	negligible
X2	Improperly structured work sequence plan	**4**	**4**	**16**	**unacceptable**
X3	Owner's planning experience in creating TOR for design and build work	5	2	10	undesirable
X4	Owner's understanding in determining the duration of design and build work	5	2	10	undesirable
X5	Owner's understanding in calculating the design and build work budget according to TOR	5	2	10	undesirable
X6	Owner's involvement in every meeting with the design team during design development	2	3	6	undesirable
X7	Limited authority of Owner personnel in decision making	3	3	9	undesirable
X8	Availability of Owner representatives (Assisting experts, MK Consultants,	2	4	8	undesirable

	etc.) to assist Owner during design and build work				
X9	Agreement of both parties to the design team's work results during design development	3	3	9	undesirable
X10	Delays in the auction process and even failed tenders	3	1	3	negligible
X11	Availability of experienced design and builder companies	1	2	2	negligible
X12	Incomplete technical assessment criteria in assessing the qualifications of auction participants	2	5	10	undesirable
X13	Time available for auction participants to prepare auction bids	3	4	12	undesirable
X14	Communication between personnel involved in the design and build work, both between design team personnel themselves and with the physical work implementation team	2	2	4	acceptable
X15	Delays in reaching design agreements during design development caused by differences in perception between Owner and team design	2	3	6	undesirable
X16	Contractor's experience in carrying out design and build work	2	2	4	acceptable
X17	Contractor's competence in carrying out design and build work	2	5	10	undesirable
X18	Contractor's cash flow capability in completing design and build projects	3	2	6	undesirable
X19	Suitability of design specification standards received by the contractor with the implementation	**5**	**4**	**20**	**unacceptable**
X20	Availability of special Owner personnel to handle design and build work	3	2	6	undesirable
X21	No standard standards in the auction process for work with a design and build system	4	2	8	undesirable
X22	Contractor's capability in project management (HR, financial, K3, etc.)	5	2	10	undesirable
X23	Contractor's capability in terms of management capacity and quality control of design and build work	3	3	9	undesirable
X24	Coordination and communication between sections in the contractor's work organization	2	3	6	undesirable
X25	Suitability of the number of HR with existing work activities	4	2	8	undesirable
X26	Design team's understanding in estimating the duration of each activity in design and build work	2	4	8	undesirable
X27	Design team's experience in making designs for design and build work	1	3	3	negligible
X28	Design team's understanding of the design needs requested by the Owner in accordance with the TOR	4	2	8	undesirable
X29	The occurrence of riots, unrest, labor strikes, etc.	2	1	2	negligible
X30	Availability of equipment and machinery for contractors to carry out	5	3	15	undesirable

	design and build work				
X31	Clarity in defining the scope of the project in the TOR	2	3	6	undesirable
X32	Conditions and environment of the site location do not comply with initial assumption	4	3	12	undesirable
X33	The occurrence of unexpected events such as fires, floods, natural disasters, etc.	2	2	4	acceptable
X34	Changes in the situation or government political and economic policies	**5**	**5**	**25**	**unacceptable**
X35	Local regulations	2	2	4	acceptable
X36	Workplace accidents caused by equipment operations	1	3	3	negligible
X37	Poor occupational health and safety (K3) procedures	4	1	4	acceptable
X38	Workers are not equipped with personal protective equipment (PPE)	1	2	2	negligible
X39	Work environment conditions do not meet health requirements	1	4	4	acceptable

Based on the risk analysis conducted, three high-impact risk factors were identified for the Phase II Pal Nol Monument project: an inadequately structured work sequence plan, discrepancies between the design specifications received by the contractor and the actual implementation, and changes in the government's political and economic landscape or policies. Ideally, design and build projects should have a fixed design from the outset, allowing owners to minimize field supervision; however, this project experienced modifications in design specifications and construction management. This indicates that the resources allocated for the Phase II Pal Nol project may not be fully qualified for the effective use of the design and build method. Following the identification of these three primary risks, a simulation will be conducted to assess the potential cost implications, providing a clearer understanding of the financial consequences associated with each identified risk, as detailed in Table 2.

Table 2. Event scenarios

Scenario	Probability	Consequence	Risk Function
Poorly structured work sequence plan	0.058	70,366,400,975.00	4,059,600,056.25
Suitability of design specification standards received by contractors with implementation	0.096	70,366,400,975.00	6,766,000,093.75
Changes in government political and economic situations or policies	0.019	124,945,888,888.89	2,402,805,555.56
		R =	13,228,405,705.56

In the context of risk management, Table 2 presents a quantitative risk analysis for three distinct risk scenarios associated with the project. Each scenario outlines potential risks or events that may arise during project execution. The identified risk scenarios include a poorly structured work sequence plan, issues with conformity to design specification standards, and changes in the government's political and economic situation or policies.

For the first two scenarios—poorly structured work sequence and conformity to design specification standards—the consequences of bid costs have been evaluated, focusing on the work most affected, which is the construction of the Tugu Statue, with an associated bid cost of Rp 70,366,400,975.00. In contrast, the third scenario, which pertains to changes in the political and economic climate, considers the total bid value of Rp

124,945,888,888.89, as such changes could potentially halt the entire project.

Probability indicates the likelihood of each risk scenario occurring. For instance, a probability of 0.058 for the first scenario suggests a 5.8% chance that the work sequence plan will not be well organized. This probability is derived from the frequency of the occurrence of a poorly structured planning sequence throughout the Tugu Zero Phase II project, which is noted to happen three times in a year. To calculate the weekly probability, this figure is divided into weeks and working days, resulting in a value of 3/(52).

In the second scenario, the project experienced five design changes within a year, resulting in a probability of occurrence of 5/52 or approximately 0.096. The third scenario, related to potential changes in regional leadership, has a probability of occurrence estimated at 1/52, reflecting the likelihood of such changes happening once a year and not being a consistent risk during working days.

Consequences represent the estimated financial impact associated with each risk scenario, expressed in local currency units such as Rupiah. For instance, the consequence for the second scenario is noted as Rp 70,366,400,975.00, which corresponds to the highest cost anticipated from this risk. In both the first and second scenarios, this probability can lead to significant losses in the Tugu Pal 0 Building work, amounting to 56.17% of the total work value, or Rp 70,366,400,975.00.

The Risk Function, which results from multiplying the probability by the consequence, yields an estimate of the relative risk value for each scenario and is crucial for prioritizing risks within the project. For example, the risk function for the third scenario amounts to Rp 2,402,805,555.56. The total risk (R) for all identified scenarios in the project is calculated to be Rp 13,228,405,705.56. This Expected Monetary Value (EMV) analysis aids project managers in identifying, assessing, and managing risks in a measurable and objective manner. By evaluating the probability and consequences of each risk scenario, the project team can allocate resources more effectively to mitigate the impacts of the most significant risks to the project's success.

Several risks can affect the project, each with varying degrees of probability and impact. The risk associated with a poorly structured work sequence plan has a low probability of occurrence (0.058), yet its impact is substantial, rated at 0.563, indicating that it could affect more than half of the related aspects. Although deemed low probability, irregularities in the work plan could result in significant cost variations, with a potential maximum cost of Rp 74,176,843,077.80 and a minimum cost of Rp 70,366,400,975.00.

The second risk, concerning conformity to design specification standards, shows a higher probability of occurrence (0.096) while maintaining the same impact level (0.563) as the first risk. Although this risk is still considered low, it has the potential to cause similar cost variations, demonstrating that even with a slightly elevated probability, the overall project costs could still be significantly affected.

Lastly, the risk stemming from changes in the government's political and economic situation or policies has a comparable probability of occurrence to the second risk (0.019). However, the impact of this risk is considerably greater, rated at 1.00, indicating a complete effect on the related aspects of the project. This scenario is classified as high risk due to its substantial potential impact on project outcomes.

Overall, although some risks have a low probability of occurrence, their impact is quite significant and can cause large cost variations. The risk of changes in the government's political and economic situation or policies is a risk with the highest level of impact costs, so it requires more attention in mitigating it to avoid a major negative impact on the project. Meanwhile, the conformity of the design accepted by the contractor with the implementation has the highest risk level of 5.42%, which means it is in accordance with the initial concerns that design changes affect the design and build system.

The variety of types of probability distributions (TRIANGLE, PERT, UNIFORM) used reflects the varying levels of uncertainty and nature of each risk. Triangular and PERT distributions show estimates that are more centered on the most likely values, while uniform distributions indicate greater uncertainty.

Variance estimates provide insight into the stability of cost predictions. Risks with larger deviations indicate the potential for higher cost variability, which requires more attention in project planning and management. Given the risks, there are more details regarding cost expectations, average costs, and variance estimates for each risk. The following is a detailed explanation of each risk:

First, for a risk with an R value of 3.25%, the possible cost is Rp 72,652,666,236.68. The minimum possible cost is Rp 70,366,400,975.00, which is the bid cost. While the maximum anticipated cost is Rp 74,176,843,077.80. The average (mean) expected cost of this risk is Rp 72,398,636,763.16, with an estimated variance of Rp 2,032,235,788.16, which shows a fairly small cost fluctuation with a variance percentage of 2.80%. This means that even though this risk has a not too large impact, the associated costs still show consistency with minimal fluctuations.

Second, the risk with an R value of 5.42% has a possible cost of Rp 74,176,843,077.80. The minimum cost remains at Rp 70,366,400,975.00, while the maximum possible cost is Rp 74,176,843,077.80. Expected cost The average (mean) expected cost is Rp 72,906,695,710.20, with an estimated variance of Rp 2,540,294,735.20. The percentage variance of this risk is 3.42%, indicating that the second risk has the greatest influence of the three risks. Third, the risk with an R value of 1.92% has a possible cost of Rp 127,348,694,444.45. The minimum possible cost remains at Rp 124,945,888,888.89, while the maximum anticipated cost is Rp 131,711,888,982.64. The average (mean) expected cost is Rp 128,002,157,438.66, with an estimated variance of Rp 3,056,268,549.77. The percentage variance of this risk is 2.40%, indicating a smaller cost fluctuation compared to the previous two risks.

First, for a risk with an R value of 3.25%, the possible cost is Rp 72,652,666,236.68. The minimum possible cost is Rp 70,366,400,975.00, which is the bid cost. While the maximum anticipated cost is Rp 74,176,843,077.80. The average (mean) expected cost of this risk is Rp 72,525,651,499.92, with an estimated variance of Rp 2,159,250,524.92, indicating a fairly small cost fluctuation with a variance percentage of 2.97%. This means that even though this risk has a not too large impact, the associated costs still show consistency with minimal fluctuations. Second, the risk with an R value of 5.42% has a possible cost of Rp 74,176,843,077.80. The minimum cost remains at Rp 70,366,400,975.00, while the maximum possible cost is Rp 74,176,843,077.80. Expected Cost The average (mean) expected cost is Rp 73,541,769,394.00, with an estimated variance of Rp 3,175,368,419.00. The percentage variance of this risk is 4.28%, indicating that the second risk has the greatest influence of the three risks.

Third, the risk with an R value of 1.92% has a possible cost of Rp 127,348,694,444.45. The minimum possible cost remains at Rp 124,945,888,888.89, while the maximum anticipated cost is Rp 131,711,888,982.64. The average (mean) expected cost is Rp 127,675,425,941.55, with an estimated variance of Rp 2,729,537,052.66.

The increase in the risk value (R) and estimated variance from the first row to the second row indicates an increase in uncertainty and a greater potential financial impact. The first risk has a small variation and a fairly stable prediction, the second risk shows an increase in uncertainty, and the third risk shows lower uncertainty with a greater potential impact on project costs.

Overall, it shows that although some risks have a low probability of occurrence, their impact on project costs can be quite significant with varying variances. In addition to PERT, it is also necessary to test through a uniform distribution.

Given the risks, there are further details regarding the expected cost, average cost, and estimated variance for each risk that may occur in the project. First, for a risk with an R value of 3.25%, the possible cost is Rp 72,652,666,236.68. The minimum possible cost is Rp 70,366,400,975.00, which is the bid cost. While the maximum anticipated cost is Rp 74,176,843,077.80. The average (mean) expected cost of this risk is Rp 71,509,533,605.84, with an estimated variance of Rp 1,143,132,630.84, which shows a fairly small cost fluctuation with a variance percentage of 1.57%. This means that even though this risk has a not too big impact, the associated costs still show consistency with minimal fluctuations.

Second, the risk with an R value of 5.42% has a possible cost of Rp 74,176,843,077.80. The minimum cost remains at Rp 70,366,400,975.00, while the maximum possible cost is Rp 74,176,843,077.80. Expected cost The average (mean) expected cost is Rp 72,271,622,026.40, with an estimated variance of Rp 1,905,221,051.40. The percentage variance of this risk is 2.67%, indicating that the second risk has the greatest influence of the three risks.

Third, the risk with an R value of 1.92% has a possible cost of Rp 127,348,694,444.45. The minimum possible cost remains at Rp 124,945,888,888.89, while the maximum anticipated cost is Rp 131,711,888,982.64. The average (mean) expected cost is Rp 126,147,291,666.67, with an estimated variance of Rp 1,201,402,777.78. The increase in risk value (R) and estimated variance from the first row to the second row indicates an increase in uncertainty and a greater potential financial impact. The first risk has little variation and a fairly stable prediction, the second risk shows an increase in uncertainty, and the third risk shows lower uncertainty with a greater potential impact on project costs.

Thus, although some risks have a low probability of occurrence, their impact on project costs can be quite significant with relatively stable variance. The risk of changes in the government's political and economic situation or policy has a slightly lower variance, but still requires attention in risk planning and mitigation to maintain project cost stability.

The risk of conformity of the design received by the contractor with the implementation has the greatest impact and variance, so it requires more attention in risk planning and mitigation. For the risk of changes in the government's political and economic situation or policy, it is necessary to prepare a strong mitigation strategy, such as conducting periodic political and economic analysis, and designing a contingency plan. Continuous monitoring is needed to ensure that the situation does not change and the risk remains under control. Improving the planning work sequence plan and ensuring compliance with design specification standards can help reduce the possibility of future risks. By understanding and managing these risks well, the project can run more smoothly and avoid the potential for significant additional costs.

Implementing a comprehensive and proactive risk mitigation strategy, the "design and build" project can be better prepared for challenges that may arise and achieve the desired results in terms of time, cost, and quality. This study provides important guidance for stakeholders in the construction industry to manage risks effectively and ensure project success. A summary of applicable risk mitigations is shown in Table 3.

Table 3. Summary of Risk Mitigation

Risk Scenario	Solution
Poorly structured work sequence plan	1. Preparation of Detailed and Structured Work Plan 2. Effective Coordination and Communication

	3. Periodic Monitoring and Evaluation
Compliance with design specification standards	1. Deep Understanding of Specifications 2. Strict Quality Control 3. Effective Communication between Design and Implementation Teams
Changes in government political and economic situations or policies	1. Continuous Risk Analysis 2. Flexible Contingency Plan 3. Communication with stakeholders 4. Use of Project Management Technology

Based on the results of the analysis of risk factors and mitigation interviews with experts, a risk modeling table can be created which can be shown in Table 4.

Table 4. Risk Mitigation Model

Risks	Score	Risk Acceptability	Mitigation Strategy
Poorly structured work sequence plan	16	unacceptable	1. Preparation of a Detailed and Structured Work Plan 2. Effective Coordination and Communication 3. Periodic Supervision and Evaluation
Suitability of design specification standards	20	unacceptable	1. Deep Understanding of Specifications 2. Strict Quality Control 3. Effective Communication between Design Team and Executor
Changes in government political and economic situations or policies	25	unacceptable	1. Continuous Risk Analysis 2. Flexible Contingency Plans 3. Communication with stakeholders 4. Use of Project Management Technology

The biggest risks affecting the Tugu Pal 0 Phase II project are poorly structured work sequence plans, inconsistencies in design specification standards, and changes in political and economic situations. These results are in line with previous studies showing that uncertainty in planning and managing political risk can lead to project delays and significant cost increases (Alazzaz & Whyte, 2015). Another study by Hastak and Shaked (2000) also confirmed that construction projects with a design and build system often face challenges related to changes in technical specifications that affect project implementation. In this context, risk mitigation that includes improving communication and early planning is essential to reduce the impact of identified risks. This study also found that ineffective risk management in design and build projects causes significant risks to the overall cost of the project. This is consistent with the findings of Tang et al. (2007), which states that coordination between owners and contractors in the design and build system is often a major challenge that causes cost variations and decreases in project quality. In a study conducted by Le-Hoai et al. (2008), inadequate planning and political changes are also mentioned as major factors affecting the success of construction projects in developing countries. Therefore, improving competency in planning and risk management through cost and risk probability simulations, as conducted in this study, is a recommended strategy to minimize negative impacts on the project.

CONCLUSION

Addressing risks necessitates the implementation of comprehensive and proactive mitigation strategies. Key steps include the preparation of detailed and structured work plans, effective coordination and communication, periodic monitoring and evaluation, and a thorough understanding of design specifications. Furthermore, continuous risk analysis, the development of flexible contingency plans, and maintaining open lines of communication with the government and stakeholders are essential for effectively managing external risks.

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