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Risk Analysis of Time and Cost Factors in the Renovation Project at Vimala Hills Residential Area

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Abstract: Construction projects always have uncertainties even in small projects, especially in terms of time and cost. This study aims to identify and analyze the dominant risks in home renovation projects in Vimala Hills Bogor and design mitigation strategies. Data collection was carried out by distributing questionnaires to all project implementers. Data analysis used the severity index method to measure frequency and severity combined with biserial point tests and KR-20 to measure the validity and reliability of 15 risk variables with 30 respondents directly involved in the project. The results showed that there were two dominant risks in the high category, namely bad weather conditions (frequency of 80.00%, impact of 77.50%, and risk value of 16) and change of work (frequency of 56.67%, impact of 64.17%, and risk value of 12). Other risks are in the medium to low category. The mitigation strategies implemented include adjusting work schedules based on weather forecasts, protecting work areas, finalizing the design before construction begins, and implementing formal procedures for work changes. After mitigation, the risk value of the two dominant variables dropped to the low category. These findings confirm the importance of implementing risk management even on small scale projects to prevent delays and cost overruns and increase efficiency so that contractors can achieve optimal project goals in the future.

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1. Introduction

Home renovation is becoming a growing trend as the need for space increases due to the increasing number of family members and soaring property prices. Many people prefer to renovate their homes rather than buy new properties to keep them in line with modern needs [1,2]. Renovation projects even if small scale still involve complex risks, especially in terms of time and cost. These risks can cause delays or cost overruns if not managed effectively.

In every construction process there is always a risk that comes from an uncertain event. If these risks are not anticipated appropriately, they will hinder the implementation of the project or even cause losses. A risk management system is needed to reduce the negative impact on the functional objectives of the project, including identification, analysis, and response to possible risks that arise [3–8].

Risk management includes risk management from the beginning to the end of a project carried out by identifying, determining risk assessments, and establishing mitigations [9]. The implementation of risk management aims to provide confidence in facing uncertainty so that it can support the achievement of development goals [10]. This study analyzed the risk to time and cost in a home renovation project in Vimala Hills Bogor using the severity index method. The purpose of this research is to identify risks, look for dominant risks, and design appropriate mitigation. The study is carried out through a risk level value analysis approach and then designing preventive measures to minimize risks [11]. Through the application of the severity index, the results of the research can be used as a basis for decision making for stakeholders in the project to minimize delays and cost overruns that are often a problem.

The severity index method has been carried out in previous studies to analyze the risks used as a reference in this study. Research conducted by Fitriah Mas'ud discussing the risk management of construction projects, especially the time and cost of hospital construction projects using the severity index method, showed that there were 4 dominant risks, namely low availability of workers, lack of control, schedule changes, and low labor productivity [3]. This is further strengthened by Erlangga who analyzed risks with a severity index in parking buildings in Semarang and produced 4 environmental risk variables and 1 natural risk variable that have a high risk category [4]. Likewise, with Pamungkas, analyzing the risk to costs in housing projects using a severity index. The results of the study found 2 dominant risks, namely the increase in material prices and the existence of unexpected costs [12]. Meanwhile, Nugroho analyzed the risks that affected the implementation time of the Haryono Data Center construction project and found 11 dominant risks that had the potential to cause delays [13].

A review of the existing literature shows that there are still research gaps, especially related to risks in small-scale projects such as residential renovations that generally only have a working value of less than IDR 2,500,000,000, short work durations, limited scope of work, low levels of complexity, and often involve direct owners in the field. Previous research has focused on medium to large-scale projects. For example, in the construction of hospitals and office buildings that are broader in scope than they have not highlighted in depth, the typical risk characteristics of small projects, such as direct involvement of owners, budget constraints, and reliance on informal labor. This condition often makes the risk management aspect overlooked by contractors. Therefore, the reason for choosing a location in Vimala Hills, Bogor is that this research is focused on filling the gap by exploring specific risks in small scale project.

The project studied is a house renovation. Vimala Hills Bogor housing is an area with fluctuating weather characteristics that often interfere with the smooth running of construction work, has high building quality standards, and applies strict area management rules so that it can provide a more diverse and contextual picture of risks in small-scale projects. This study shows that the implementation of risk management remains crucial and cannot be ignored even in small-scale projects to prevent potential delays and cost increases while improving the efficiency of implementation to achieve more optimal project goals in the future.

2. Method

The research was carried out for 40 working days from February to March 2025 on a house renovation project carried out by a contractor in Vimala Hills, Gadog, Megamendung, Bogor Regency, with a coordinate point of 6º40'25'S 106º52'27 '' E. The Location map is presented in **Figure 1**.

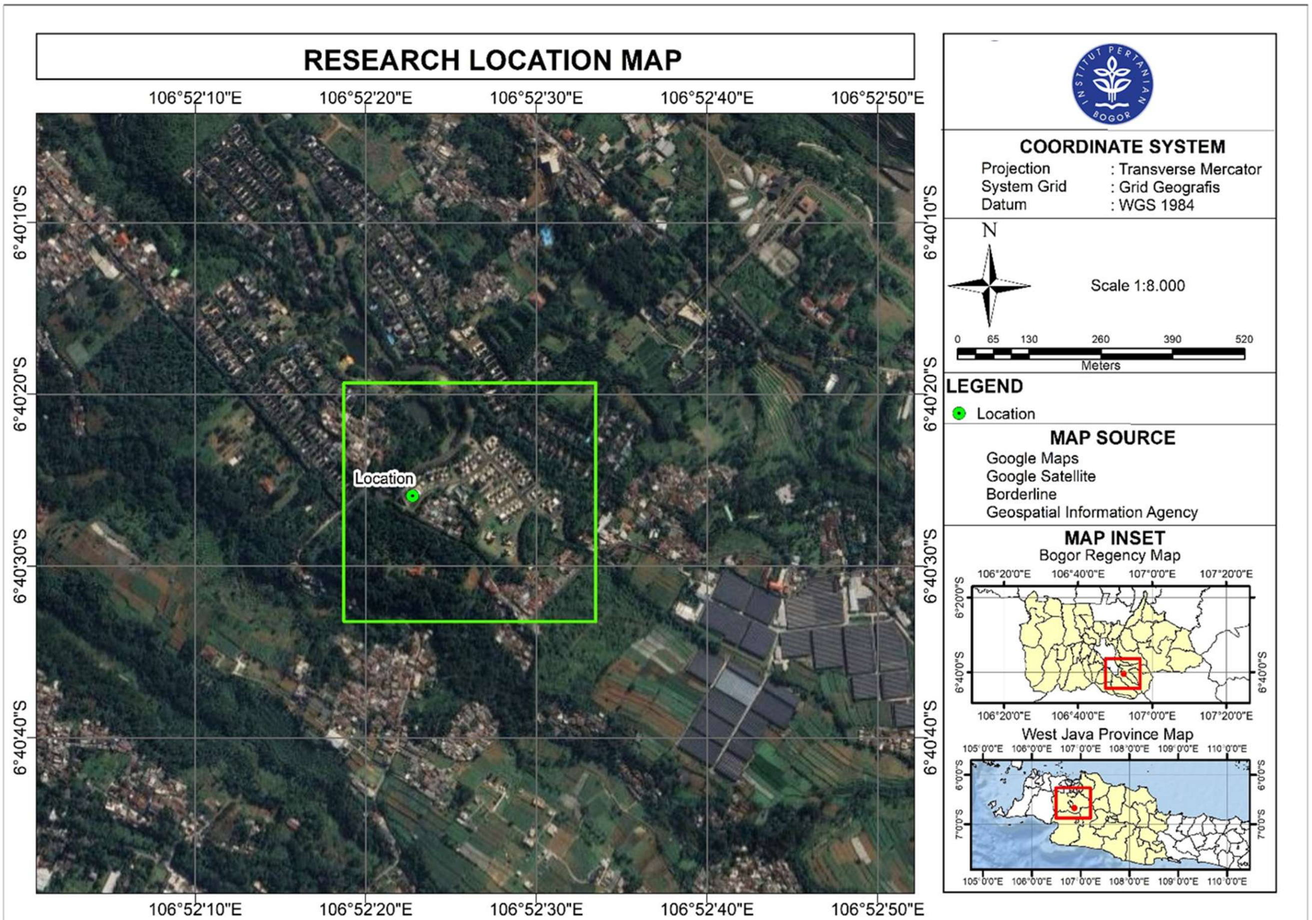

Figure 1. The maps of the research location are in Vimala Hills, Bogor housing

2.1. Data Collection Method

Data collection includes primary and secondary data. Primary data includes field notes, documentation, questionnaires, and interview results. Primary data was obtained by distributing 2 stages of questionnaires to respondents, then conducting risk analysis and planning appropriate handling responses. Meanwhile, the secondary data collected included project documents from contractors as well as literature studies from scientific journals and previous research reports. The population of this study is all project implementers who are directly involved in the renovation of houses in Vimala Hills. In order for the data obtained to be accurate and representative of the entire population, this study uses a total sampling technique. Where all members of the population are used as research samples. This technique was chosen because the population is relatively small, so it is possible to involve all individuals without having to make a selection. In addition, all members of the population are directly related to the object of study, so their existence is considered relevant and contributes to a comprehensive understanding of project risks. This technique was carried out with the aim of avoiding bias in sample selection and ensuring that the study truly reflected real conditions in the field. Based on these criteria, the sample in this study amounted to 30 respondents.

2.2. Data Processing

2.2.1. Step I

This stage aims to identify factors that are considered potentially risky for the project. The first step of the questionnaire was tested for validity using biserial point correlation because the form of questionnaire data was dichotomous or had two possible answers, namely "At Risk" and "Not at Risk" with the help of IBM SPSS software version 24. This test aims to assess the extent to which each item has a significant relationship with the overall total risk score. The results are declared valid if the r value is calculated > r of the table at a significance level of 5% (α= 0.05) because the data is obtained directly through observation in the field. The biserial point validity test is sought with the **Equation (1)** [14].

$$r_{bis} = \frac{\underline{x}i - \underline{x}t}{St}\sqrt{\frac{pi}{qi}} \quad (1)$$

description:
r_{bis} = correlation coefficient of score of item 1 with total score
$\underline{x}i$ = mean total score of respondents who answered "At Risk"
$\underline{x}t$ = mean total score of all respondents
St = standard deviation
pi = proportion of respondent who scored 1
qi = proportion of respondent who scored 0 (qi = 1-pi)

Furthermore, a reliability test was carried out from the risk variables asked to the respondents in the first questionnaire using the Kuder Richardson test (KR-20) because the data was dichotomous. The KR-20 test is very appropriate for evaluating binary scale instruments and providing an idea of the extent to which the questionnaire items work uniformly in measuring the same concept. If the KR-20 value > 0.70 then the questionnaire is declared reliable and suitable for further research. In this study, the KR-20 test was calculated with Ms. Excel because in IBM SPSS there are no tools to calculate KR-20. The reliability test of the KR-20 can be searched by **Equation (2)** [15].

$$ri = \frac{k}{(k-1)}\left[\frac{St^2 - \Sigma\, piqi}{St^2}\right] \text{ where } St^2 = \frac{\Sigma\, \underline{x}t - \frac{(\Sigma \underline{x}t)^2}{n}}{n} \quad (2)$$

description:
ri = reliability coefficient
k = number of valid question
pi = mean total score of all respondents
qi = standard deviation
pi = proportion of respondent who scored 1
qi = proportion of respondent who scored 0 (qi = 1-pi)
St^2 = total variance
$\underline{x}t$ = mean total score of all respondents
n = number of respondent

2.2.2. Step II

The second step of the questionnaire was analyzed using the Severity Index (SI) method. The assessment was carried out based on two main aspects, namely the frequency and the magnitude of the impact caused to the smooth running of the house renovation project in the Vimala Hills area. The results of the second phase of the questionnaire were used to measure the level of each risk. The severity index method is calculated using **Equation (3)** [12,16].

$$SI = \frac{\Sigma_{i=0}^{4} \alpha_i x_i}{4 \ \Sigma_{i=0}^{4} x_i} \times 100\% \quad (3)$$

description:
αi = rating a signed to item i
xi = frequency of responses from the respondent
i = 0,1,2,3,4,............ n
$\alpha_0 = 0$, $\alpha_1=1$, $\alpha_2=2$, $\alpha_3=3$, $\alpha_4=4$
x_0, x_1, x_2, x_3, x_4 represent the frequency of respondent answer
x_0 = frequency of respondent answering “Very Rare” so $\alpha_0 = 0$
x_1 = frequency of respondent answering “Rare” so $\alpha_1 = 1$
x_2 = frequency of respondent answering “Moderate” so $\alpha_2 = 2$
x_3 = frequency of respondent answering “Often” so $\alpha_3 = 3$
x_4 = frequency of respondent answering “Very Often” so $\alpha_4 = 4$

Then the results are used to convert the Severity Index (SI) value into the assessment scale category presented in **Table 1** [4].

Table 1. *Severity Index* rating scale classification

Frequency/Impact	Severity Index Value	Value
Very Rare (VR) or Very Low (VL)	0% < SI < 12.50%	1
Rare (R) or Low (L)	12.50% < SI < 37.50%	2
Normal (N) or Moderate (M)	37.50% < SI < 62.50%	3
Often (O) or High (H)	62.50% < SI < 87.50%	4
Very Often (VO) or Very High (VH)	87.50% < SI < 100%	5

Source: Erlangga (2019)

The next step is to find the dominant risk through the calculation of the risk level using **Equation (4)**.

$$R = P \times I \quad (4)$$

where:
R = risk level
P = probability
I = impact

2.2.3. Step III

After obtaining a risk value, in the end it plans mitigation against the dominant risks in the home renovation project in Vimala Hills.

3. Result and Discussion

3.1. Respondent Profile

A total of 30 respondents were involved in this study with characteristics classified based on position position, level of last education, and work experience. The respondents came from various levels of positions ranging from managerial positions such as directors, project managers, purchasing, and administrative staff to field technical workers including drafters, implementers, foremen, and field workers. The background of the respondents shows a fairly high diversity. Respondents with a S1 level of education occupied managerial and administrative positions while respondents with an education level below them were found in a group of technical workers in the field. In terms of work experience, the range is very varied. Starting from the work experience of the respondents also varies. Starting from respondents with one year of experience to respondents who have 25 years of experience. The diversity of respondents' characteristics reflects the real condition of project actors in the field involving various backgrounds, competencies, and work experiences in an implementation team.

3.2. Identify Risks

The questionnaire consisted of 15 risk variables. Each answer is at risk of being given a score of 1, while for non-risk answers are given a score of 0 and then tested using **Equation (1)** whose results can be seen in **Table 2**. The risk variables in this study were identified through discussions and interviews with project leaders by considering empirical experiences and events experienced in the project. The identification process focuses on risks that have the potential to cause delays in implementation time and cost overruns so that the variables chosen reflect the real conditions that often occur in the project. One of the most common risks encountered in home renovation projects is the change of work after the contract is signed. This risk has the potential to have a significant impact on project schedules and costs because it requires adjustments to planning, material procurement, and labor allocation. Job changes often arise as a result of design changes, additional needs from the project owner, or unforeseen field conditions. This risk is also exacerbated by a lack of detailed planning and limited communication between the owner and the contractor, thus triggering inefficiencies and deviations from the original plan.

Table 2. Results of the validity test of the first stage of the questionnaire

Code	Risk Identification Variable	Validity	
		R Count	R Table
X1	Delays in material procurement	0.411	0.361
X2	Advers natural condition/weather	0.464	0.361
X3	Change order (design, specifications, additions, and subtractions)	0.449	0.361
X4	Developer regulations or policies	0.513	0.361
X5	Scarcity of material	0.563	0.361
X6	Slow project progress due to lack skills	0.513	0.361
X7	Decreased productivity due to a lot of idle time (chatting, smoking, playing mobile phones)	0.457	0.361
X8	Limited work tools so they have to wait for each other to take turns	0.462	0.361
X9	Access to mobilization in projects	0.510	0.361
X10	Rising material prices	0.538	0.361
X11	Damaged to materials in storage	0.446	0.361

Code	Risk Identification Variable	Validity	
		R Count	R Table
X12	Loss/theft of materials in the project	0.540	0.361
X13	Incorrect in estimating costs	0.395	0.361
X14	Unexpected cost	0.505	0.361
X15	Late payment from clients	0.543	0.361

Source: SPSS analysis result, 2025

Furthermore, to perform the reliability test, it is calculated using **Equation (2**) Based on the results of the calculation using the KR-20 formula, a reliability value of 0.766 > 0.70 was obtained. This value shows that the research instrument has a fairly good level of reliability, so it is suitable for continuing research.

3.3. Risk analysis with Severity Index (SI)

Risk analysis is calculated using a severity index with **Equation (3)** based on the level of frequency and impact to measure the severity of each of the identified risk variables. The reason for choosing the severity index method is because it is easy to implement, fast in its implementation, focuses on impact, and can be used to assess risks from technical aspects, cost, quality, and safety. The results of this analysis will be used to determine the risk priorities that need further attention and treatment, so that risk mitigation strategies can be developed in a more targeted d effective manner in the context of home renovation projects in Vimala Hills.

Table 3. Results of the assessment of frequency and impact

Risk Variable	Frequency					SI (%)	Category		Impact					SI (%)	Category	
	VR	R	N	O	VO		Code	Value	VL	L	M	H	VH		Code	Value
Delays in material procurement	7	15	7	1	0	26.67	R	2	4	17	8	0	1	30.83	VL	2
Advers natural condition/weather	1	1	3	11	14	80.00	O	4	1	0	7	9	13	77.50	H	4
Change order (design, specifications, additions, and subtractions)	6	4	3	10	7	56.67	N	3	4	6	1	7	12	64.17	H	4
Developer regulations or policies	8	17	1	0	4	29.17	R	2	10	16	1	1	2	24.17	L	2
Scarcity of material	10	8	8	4	0	30.00	R	2	8	9	12	0	1	30.83	L	2
Slow project progress due to lack skills	10	15	5	0	0	20.83	R	2	13	9	6	1	1	23.33	L	2
Decreased productivity due to a lot of idle time	2	6	4	10	8	63.33	O	4	4	6	15	4	1	43.33	M	3

Risk Variable	Frequency					SI (%)	Category		Impact					SI (%)	Category	
	VR	R	N	O	VO		Code	Value	VL	L	M	H	VH		Code	Value
(chatting, smoking, playing mobile phones)																
Limited work tools so they have to wait for each other to take turns	8	15	4	3	0	26.67	R	2	14	9	6	0	1	20.83	L	2
Access to mobilization in projects	17	11	2	0	0	12.50	VR	1	23	6	0	1	0	7.50	VL	1
Rising material prices	6	3	8	11	2	50.00	N	3	6	6	5	11	2	47.50	M	3
Damaged to materials in storage	7	22	1	0	0	20.00	R	2	10	15	4	0	1	22.50	L	2
Loss/theft of materials in the project	20	7	2	1	0	11.67	VR	1	23	5	2	0	0	7.50	VL	1
Incorrect in estimating costs	21	6	3	0	0	10.00	VR	1	18	8	3	0	1	15.00	L	2
Unexpected cost	8	5	11	5	1	38.33	N	3	8	7	9	4	2	37.50	M	3
Late payment from clients	13	11	6	0	0	19.17	R	2	15	12	1	1	1	17.50	L	2

Source: Data analysis, 2025

Table 4. Results of level analysis and risk assessment on home renovation project in Vimala Hills

No	Risk Variable	P	I	Risk Value	Risk Level
X1	Delays in material procurement	2	2	4	Low
X2	Advers natural condition/weather	4	4	16	High
X3	Change order (design, specifications, additions, and subtractions)	3	4	12	High
X4	Developer regulations or policies	2	2	4	Low
X5	Scarcity of material	2	2	4	Low
X6	Slow project progress due to lack skills	2	2	4	Low
X7	Decreased productivity due to a lot of idle time (chatting, smoking, playing mobile phones)	4	3	12	Moderate
X8	Limited work tools so they have to wait for each other to take turns	2	2	4	Low
X9	Access to mobilization in projects	1	1	1	Low

No	Risk Variable	P	I	Risk Value	Risk Level
X10	Rising material prices	3	3	9	Moderate
X11	Damaged to materials in storage	2	2	4	Low
X12	Loss/theft of materials in the project	1	1	1	Low
X13	Incorrect in estimating costs	1	2	2	Low
X14	Unexpected cost	3	3	9	Moderate
X15	Late payment from clients	2	2	4	Low

Source: Data analysis, 2025

Based on **Table 4**, the results of the calculation of the risk value show that there are two risk variables that are classified as high risk. The two variables are risks related to poor weather conditions and risks due to job changes. In the risk variable X2, the probability value is 4 and the impact value is 4, so it is included in the category of high risk. While the variable in the risk variable X3 has a probability value of 3 and an impact value of 4, it is included in the category of high risk level.

3.4. Risk Mitigation

3.4.1. Adverse natural condition/weather

Extreme weather is a major risk in renovation projects in the Vimala Hills due to the geographical location in the mountains and the rainy season that triggers sudden weather changes. The lack of daily weather anticipation and slippery field conditions also hampered the implementation of construction. To mitigate the impact of bad weather, a number of strategies are implemented, including monitoring daily weather forecasts, rescheduling sensitive work when the weather is sunny, and increasing working hours when necessary. Protection of work areas and materials is carried out through the installation of tarpaulins and temporary drainage. The procurement of critical materials is accelerated, and the project schedule is arranged flexibly with alternative plans. In addition, routine briefings and the provision of Personal Protective Equipment (PPE) are needed to ensure the readiness of the team in the field. This strategy is effective in reducing the risk to project time and cost.

3.4.2. Change order (design, specifications, additions, and subtractions)

The risk of changes in design, specifications, and work adjustments is one of the main challenges in renovation projects in Vimala Hills. This was triggered by the immaturity of the initial design, additional requests from the owner, and the condition of the existing building that was different from the plan. This risk mitigation includes thorough design completion before construction begins, the application of a change of work clause in the contract, as well as an analysis of the impact of any changes on time and cost. Any proposed changes need to be submitted in writing and formally approved. A diplomatic approach is needed when discussing with the owner, a more detailed survey of existing buildings, the provision of time and cost buffers, and regular coordination between the owner and the contractor are important strategies to keep the project on schedule and budget.

Table 5. Risk assessment after mitigation

No	Risk Variable	P	I	Initial Risk Value	Initial Risk Level	Residual Risk		Final Risk Value	Final Risk Level
						P	I		
X2	Adverse Natural/Weather Conditions	4	4	16	High	3	2	6	Low
X3	Change Order (design, specifications, additions, subtractions)	3	4	12	High	2	2	4	Low

Source: Data analysis, 2025

Risk assessment was carried out by considering the effectiveness of the mitigation strategy on the frequency (P) x impact (I) of each risk. Initially, the risk of extreme weather had a value of 16 out of the frequency (P) = 4 and impact (I) = 4 because the project location was in a mountainous area and indeed often experienced sudden weather changes that hampered the work. The potential for cost overruns and delays to be reduced after mitigation includes monitoring daily weather forecasts, prioritizing sensitive work during sunny weather, protecting work areas and materials by installing tarpaulins, creating temporary drainage, and accelerating the procurement of critical materials. The risk values are reduced not because they are subjective but based on empirical experience in the field and reinforced from the S curve graph. Probability (P) is lowered from 4 to 3 because with an adaptive monitoring and scheduling system, the possibility of weather-disrupted work can be suppressed even if it cannot be completely eliminated. Meanwhile, the impact value (I) was lowered from 4 to 2 because when weather disturbances occur, the impact on schedules and costs is no longer as large as before. Value I is not set to 3 because based on similar project experience and scheduling simulations, the residual impact of weather disturbances after mitigation is carried out no longer causes significant deviations in time and cost. This assessment is also carried out through project team discussions and expert judgement.

Likewise with the risk of change order. Before mitigation, the work change had a value of 12 with a frequency (P) = 3 and an impact (I) = 4. This condition reflects frequent changes in work due to mismatch of the image with the existing location and the existence of additional requests from project owners. The probability value (P) decreased from 3 to 2 because the initial design coordination and verification mechanism was able to reduce the possibility of job changes. The post-mitigation valuation is based on the results of field evaluations and contractors' experience on similar projects which show that the impact of the remaining minor changes does not result in a time deviation of more than 10% and significant additional costs. Thus, this assessment remains objective because it goes through a validation process with project actors and empirical comparators.

4. Conclusion

Based on the results of a study on a home renovation project in Vimala Hills, it was found that there are 15 risk variables that have the potential to affect the success of the project, especially in terms of time and cost. Of all the variables, two risks were identified as the most dominant with high risk levels, namely poor weather conditions and change order. Weather risks arise due to the location of the project in a mountainous area with rapidly changing weather characteristics and the implementation of the project that coincides with the rainy season. Meanwhile, the risk of change order is caused by the infinality of the design at the beginning of the project and the absence of a structured change management system.

Weather risk mitigation strategies are carried out through regular weather forecast monitoring, scheduling outdoor work when the weather is sunny, installing temporary protection in the work area, and preparing flexible project schedules. The mitigation of the risk of change order includes finalizing the design before construction, strengthening contract clauses related to job changes, and implementing clear and formal job change procedures. The implementation of these mitigations proved effective, as shown by the reduction in the level of risk in both dominant variables from the "High" to "Low" category.

These findings have significant practical implications, especially for projects located in areas with fluctuating natural characteristics. An active role of contractors in designing risk mitigation strategies is required from the initial planning stage even if it is only a small scale project. The final design determination and the implementation of a structured work change mechanism need to be the main focus in project management to minimize the impact on time and cost. The integration of mitigation measures into the planning and implementation process of construction can improve project reliability and reduce potential deviations from planned objectives.

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