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RISK ANALYSIS IN THE IMPLEMENTATION OF THE GUNUNG PAMATON – GUNUNG COKLAT ROAD CONSTRUCTION PROJECT, BANJAR REGENCY, SOUTH KALIMANTAN

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ABSTRACT

Road infrastructure construction projects in mountainous areas have high complexity and risk that can hinder the achievement of project objectives. This study aims to analyze the risks in the Pamaton Mountain – Brown Mountain Road Construction Project, Banjar Regency, South Kalimantan. The method used for this risk analysis is quantitative research with purposive sampling of 17 respondents. The data is analyzed using the Severity Index (SI) calculation. The risk level is then mapped using the Probability and Impact Matrix to determine the dominant risk category based on the risk acceptance scale. The results of the study identified 21 valid risk variables, consisting of 15 medium-category risks and 6 high-category risks. As a mitigation measure, risk responses were carried out, including: risk reduction in 16 variables, risk transfer in 3 variables, and risk avoidance in 2 variables.

Keywords: risk analysis, severity index, probability and impact matrix, dominant risk variables.

1. INTRODUCTION

The construction sector is an important pillar in infrastructure development and economic growth of a country. The success of a construction project is determined not only by the technical aspects and quality of the results, but also by the effectiveness of the management of resources, time, and costs. The complexity of construction projects involving many stakeholders makes the project vulnerable to various uncertainties or risks that can hinder the achievement of project objectives.

In construction projects in Indonesia, risks can come from natural, technical, economic, regulatory, and social and environmental factors. Imoptimal risk management has the potential to cause cost overruns, delays in completion, and project failure. Therefore, risk management is a crucial aspect in the implementation of modern construction projects.

Various previous studies have examined the risks of alan development projects, but generally focus on lowland areas with relatively simpler risk characteristics. Research related to road construction in mountainous areas is still limited, even though areas with

steep topography, extreme weather, and limited transportation access have higher risk complexity. Mount Pamaton, although it has an altitude of about 450 meters above sea level, has topographic characteristics and risks similar to mountainous areas.

The Mount Pamaton – Gunung Chocolate Road Construction Project in Banjar Regency, South Kalimantan, faces various challenges in the form of high rainfall, thick fog, difficult terrain conditions, and limited mobilization of tools and materials. These conditions increase the potential for technical risks, time, cost, and occupational safety.

Therefore, this study aims to conduct a comprehensive risk analysis on road construction in mountainous areas. The results of the research are expected to be a reference in decision-making and risk mitigation planning for stakeholders, so that the project can be implemented effectively, efficiently, and sustainably.

2. THEORETICAL STUDY

2.1 Risk Management

Risk management is the systematic process of planning, identifying, analyzing, responding, and monitoring project risks. So in highway construction projects, risks on a small or large scale will never be avoided. The smaller the potential risks caused, the more beneficial the project will be both in terms of cost and in terms of the implementation of its construction.

2.2 Identify Risks

Risk identification is an analysis that is carried out to systematically and continuously find risks that may arise when carrying out an activity or activity. The risk identification stage is the earliest stage of a risk management process with the aim of describing and detailing the types of risks that may occur when we carry out activities or activities.

2.3 Risk Analysis

Risk analysis is a process of identification and assessment. Systematic risk analysis can help to clearly identify, assess and rank risks, focus on the main risks, clarify the limits on the limitation of losses, minimize the potential for damage in the event of the worst circumstances, control uncertainty in the project, clarify and affirm the role of each person/entity involved in risk management.

2.4 Risk Assessment

Risk assessment in road projects requires special consideration of weather factors, soil conditions, and local government regulations. The risk assessment process should be carried out objectively using established criteria and involving expert assessment from experienced practitioners to ensure the accuracy of the assessment.

2.5 Measurement of Potential Risk

Risk measurement is an attempt to find out the magnitude or small of a risk that will occur. This is done to see the high and low risks faced, and then prioritize which risks are the most important. Risk measurement is an advanced stage after risk identification.

3. METHODS

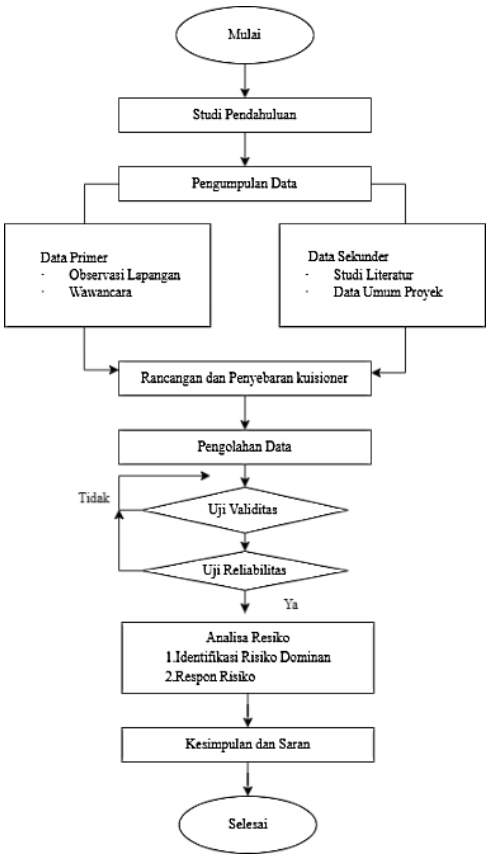

Figure 3. 1 Research Plan

4. RESULTS AND DISCUSSION

4.1 Data Analysis

4.1.1 Recapitulation of Frequency and Impact Data on Projects Based on Questionnaire Results

The recapitulation of the questionnaire from 17 respondents regarding frequency and impact can be seen in Table 4. 1 below.

Table 4. 1 Questionnaire Data Recapitulation

No	Variable Code	Risk Variables	Risk Frequency					Total	Risk Impact					Total
			1	2	3	4	5		1	2	3	4	5	
A		**Labor Factor**												
1	P1	Poor labor productivity	3	10	4	0	0	17	2	5	5	5	0	17
2	P2	Lack of communication/coordination	4	9	4	0	0	17	2	6	5	1	3	17
3	P3	Work safety is not implemented properly	1	6	9	1	0	17	0	4	3	6	4	17
4	P4	Occurrence of labor accidents at the project site	7	10	0	0	0	17	4	0	5	4	4	17
5	P5	Lack of teamwork	7	10	0	0	0	17	3	7	4	2	1	17
6	P6	Lack of competent workforce in construction implementation	1	11	5	0	0	17	0	6	8	2	1	17
7	P7	Lack of precision in working	2	8	7	0	0	17	1	4	8	3	1	17
8	P8	Lack of experience working in mountainous terrain	1	8	8	0	0	17	1	3	9	2	2	17
B		**Equipment Factor**												
1	P9	Equipment is not available	5	8	4	0	0	17	5	4	8	0	0	17
2	P10	Inadequate equipment	3	9	5	0	0	17	3	4	9	1	0	17
3	P11	Construction equipment breakdown	2	5	7	3	0	17	1	3	9	4	0	17
4	P12	Delay in equipment mobilization	3	5	8	1	0	17	3	4	6	4	0	17
5	P13	Difficulty in transporting heavy equipment to mountainous locations	0	3	8	5	1	17	0	3	5	7	2	17
C		**Material Factor**												
1	P14	Specification materials not available	4	7	5	1	0	17	3	3	9	2	0	17
2	P15	Materials received are of poor quality	2	8	6	0	1	17	2	3	7	5	0	17
3	P16	Misuse of materials	7	10	0	0	0	17	2	6	5	3	1	17
4	P17	Long delivery of materials	1	5	7	4	0	17	1	3	9	4	0	17
5	P18	Insufficient material inventory	3	6	8	0	0	17	1	4	8	4	0	17
D		**Cost Factor**												
1	P19	Increase in fuel prices, materials and labour wages	1	7	5	4	0	17	2	3	7	3	2	17
2	P20	Cost estimation errors	0	11	6	0	0	17	0	4	8	3	2	17
E		**Implementation Risks**												
1	P21	Insufficient material inventory	1	10	5	1	0	17	1	3	7	5	1	17
2	P22	Cost Factor	1	15	1	0	0	17	0	5	10	2	0	17
3	P23	Licensing requirements, social and economic impact	2	8	5	2	0	17	2	4	8	3	0	17
4	P24	Work quality that does not meet standards	1	10	4	2	0	17	0	4	6	5	2	17
F		**Environmental Factors**												
1	P25	Damage to the surrounding environment	2	5	9	1	0	17	1	2	6	5	3	17
2	P26	Impact on tourist destinations	3	11	3	0	0	17	2	6	9	0	0	17
3	P27	Pollution of water sources in mountain areas	5	2	6	4	0	17	2	6	3	6	0	17
4	P28	Disturbance of forest areas and ecosystems	5	1	7	4	0	17	3	2	7	5	0	17
G		**Nature Factors**												
1	P29	Prolonged rainy season that hinders construction	0	2	5	5	5	17	0	2	2	6	7	17
2	P30	Potential for landslides on steep slopes	0	4	5	7	1	17	0	1	3	5	8	17
H		**Political Factors**												
1	P31	Cross-sectoral licensing issues (forestry, environment, tourism)	2	9	5	1	0	17	1	6	5	4	0	17

4.1.2 Validity Test

The results of the validity test of the risk analysis of the Mount Pamaton-Gunung Brown Road Development Project were influenced by the quality of the questionnaire instruments relevant to the project conditions, the characteristics of 17 competent respondents, and the use of SPSS statistical analysis with the criterion (Sig. 2-tailed) < 0.05 which was carried out in stages. Project conditions in mountainous areas with steep topography, limited access, and high rainfall also affect the relevance of risk variables. In

addition, the interconnectedness between variables causes several variables to be eliminated to avoid redundancy, so that from the initial 31 variables, 21 valid, unique, and representative risk variables are obtained for project risk analysis.

4.1.3 Reliability Test

Reliability testing using Cronbach's Alpha method. This method shows how the risk factors of the questionnaire correlate or interact. In this analysis, the results of the validity test are used with 21 statements that have been declared valid in the validity test.Based on the results of the reliability test analysis, Cronbach's Alpha value = 0.956 for frequency and 0.970 for impact greater than 0.6. If Cronbach's Alpha value is greater than 0.6 then the questionnaire has a trustworthy level of reliability. So it can be concluded that this questionnaire has proven to be reliable.

4.2 Risk Analysis

This analysis is used to process data from the results of filling out the questionnaire in Table 4.1 to determine the probability of occurrence and to identify relevant risk factors. The method used is the Severity Index (SI) method which is the first step of risk analysis, then continued by categorizing it based on the level of probability and impact.

4.2.1 Risk Probability Assessment with the Severity Index (SI) Method

The results of the calculation of risk probability using the severity index method can be seen in Table 4. Sec. 2.

Table 4. 2 Results of Probability Data Processing with the Severity Index Method

Variable Code	Risk Variables	Frequency					Total	IF	Remarks
		1	2	3	4	5			
A	**Labor Factor**								
P1	Poor labor productivity	3	10	4	0	0	17	41%	Enough
P4	Occurrence of labor accidents at the project site	7	10	0	0	0	17	32%	Rare
P6	Lack of competent workforce in construction implementation	1	11	5	0	0	17	45%	Enough
P8	Lack of experience working in mountainous terrain	1	8	8	0	0	17	48%	Enough
B	Equipment Factor								
P9	Equipment is not available	5	8	4	0	0	17	39%	Enough
P10	Inadequate equipment	3	9	5	0	0	17	42%	Enough
P11	Construction equipment breakdown	2	5	7	3	0	17	53%	Enough
P12	Delay in equipment mobilization	3	5	8	1	0	17	48%	Enough
P13	Difficulty in transporting heavy equipment to mountainous locations	0	3	8	5	1	17	65%	Frequent
C	Material Factor								
P14	Specification materials not available	4	7	5	1	0	17	44%	Enough
P15	Materials received are of poor quality	2	8	6	0	1	17	48%	Enough
P17	Long delivery of materials	1	5	7	4	0	17	56%	Enough
P18	Insufficient material inventory	3	6	8	0	0	17	46%	Enough
D	Cost Factor								
P19	Increase in fuel prices, materials and labour wages	1	7	5	4	0	17	54%	Enough
E	Implementation Risks								
P23	Licensing requirements, social and economic impact	2	8	5	2	0	17	48%	Enough
P24	Work quality that does not meet standards	1	10	4	2	0	17	48%	Enough
F	Environmental Factors								
P25	Damage to the surrounding environment	2	5	9	1	0	17	51%	Enough
P27	Pollution of water sources in mountain areas	5	2	6	4	0	17	51%	Enough

P28	Disturbance of forest areas and ecosystems	5	1	7	4	0	17	52%	Enough
G	Nature Factors								
P29	Prolonged rainy season that hinders construction	0	2	5	5	5	17	75%	Frequent
P30	Potential for landslides on steep slopes	0	4	5	7	1	17	66%	Frequent
H	Political Factors								

From the table above, it can be concluded by calculating the Severity Index (SI) of each questionnaire statement according to the information that the scale of the probability of risk occurrence is from the category of rare.

4.2.2 Risk Impact Assessment using the Severity Index (SI) Method

The results of the calculation of the risk impact using the severity index method can be seen in Table 4. Sec. 3.

Table 4. 3 Results of Impact Data Processing with the Severity Index Method

Variable Code	Risk Variables	Frequency					Total	IF	Remarks
		1	2	3	4	5			
A	**Labor Factor**								
P1	Poor labor productivity	2	5	5	5	0	17	55%	Medium
P4	Occurrence of labor accidents at the project site	4	0	5	4	4	17	65%	Height
P6	Lack of precision in working	0	6	8	2	1	17	58%	Medium
P8	Lack of experience working in mountainous terrain	1	3	9	2	2	17	61%	Medium
B	**Equipment Factor**								
P9	Equipment is not available	5	4	8	0	0	17	44%	Medium
P10	Inadequate equipment	3	4	9	1	0	17	49%	Medium
P11	Construction equipment breakdown	1	3	9	4	0	17	59%	Medium
P12	Delay in equipment mobilization	3	4	6	4	0	17	53%	Medium
P13	Difficulty in transporting heavy equipment to mountainous locations	0	3	5	7	2	17	69%	Height
C	**Material Factor**								
P14	Specification materials not available	3	3	9	2	0	17	52%	Medium
P15	Materials received are of poor quality	2	3	7	5	0	17	58%	Medium
P17	Long delivery of materials	1	3	9	4	0	17	53%	Medium
P18	Insufficient material inventory	1	4	8	4	0	17	58%	Medium
D	**Cost Factor**								
P19	Increase in fuel prices, materials and labour wages	2	3	7	3	2	17	60%	Medium
E	**Implementation Risks**								
P23	Licensing requirements, social and economic impact	2	4	8	3	0	17	54%	Medium
P24	Work quality that does not meet standards	0	4	6	5	2	17	66%	Height
F	**Environmental Factors**								
P25	Damage to the surrounding environment	1	2	6	5	3	17	80%	Height
P27	Pollution of water sources in mountain areas	2	6	3	6	0	17	55%	Medium
P28	Disturbance of forest areas and ecosystems	3	2	7	5	0	17	56%	Medium
G	**Nature Factors**								
P29	Prolonged rainy season that hinders construction	0	2	2	6	7	17	81%	Height
P30	Potential for landslides on steep slopes	0	1	3	5	8	17	84%	Height
H	**Political Factors**								

From the table above, it can be concluded by calculating the Severity Index (SI) of each questionnaire statement according to the information that the scale of probability of risk occurrence is in the medium to high category.

4.2.3 Recapitulation of Data Management Results with Severity Index (SI)

The recapitulation of the results of data processing using the Severity Index (SI) Method can be seen in Table 4.4 below:

Table 4. 4 Recapitulation of Data Processing Results with the Severity Index Method

Variable Code	Risk Variables	Risk Frequency		Risk Impact	
		Categories	P value	Categories	Value I
A	**Labor Factor**				
P1	Poor labor productivity	Enough	3	Medium	3
P4	Occurrence of labor accidents at the project site	Rare	2	Height	4
P6	Lack of competent workforce in construction implementation	Enough	3	Medium	3
P8	Lack of experience working in mountainous terrain	Enough	3	Medium	3
B	**Equipment Factor**				
P9	Equipment is not available	Enough	3	Medium	3
P10	Inadequate equipment	Enough	3	Medium	3
P11	Construction equipment breakdown	Enough	3	Medium	3
P12	Delay in equipment mobilization	Enough	3	Medium	3
P13	Difficulty in transporting heavy equipment to mountainous locations	Frequent	4	Height	4
C	**Material Factor**				
P14	Specification materials not available	Enough	3	Medium	3
P15	Materials received are of poor quality	Enough	3	Medium	3
P17	Long delivery of materials	Enough	3	Medium	3
P18	Insufficient material inventory	Enough	3	Medium	3
D	**Cost Factor**				
P19	Increase in fuel prices, materials and labour wages	Enough	3	Medium	3
E	**Implementation Risks**				
P23	Licensing requirements, social and economic impact	Enough	3	Medium	3
P24	Work quality that does not meet standards	Enough	3	Height	4
F	**Environmental Factors**				
P25	Damage to the surrounding environment	Enough	3	Height	4
P27	Pollution of water sources in mountain areas	Enough	3	Medium	3
P28	Disturbance of forest areas and ecosystems	Enough	3	Medium	3
G	**Nature Factors**				
P29	Prolonged rainy season that hinders construction	Frequent	4	Height	4
P30	Potential for landslides on steep slopes	Frequent	4	Height	4
H	**Political Factors**				

4.2.4 Risk Response to the Dominant Risk Occurring in the Project

From the results of the above analysis, the risk categorized as Medium or High in the Probability Impact Matrix shows that all 21 risk factors identified are significant risks. Therefore, an interview will be conducted to find out the cause of the risk. Then a solution to the cause of the risk will be determined. The respondent who will be interviewed is Mr. Hilman Setyawan, S.T. as the Team Leader from CV. Arsa Dewapan.

A recapitulation of causes, risk responses, and types of risk management can be seen in Table 4. 5.

Tabel 4. 5 A Recapitulation of Causes, Risk Responses, and Types of Risk Management

No	Sources of Risk	Variable	Causes	Risk Response	Types of Risk Handling
			Hilman Setyawan	Hilman Setyawan	
1	Workforce	Poor labor productivity	Harsh mountainous terrain conditions and limited access lead to faster physical fatigue of workers, plus long distances from settlements to project sites reduce effective working time.	work scheduling that adjusts to field conditions as well as the implementation of the shift and rotation system of the workforce	Risk Reduction
		Occurrence of labor accidents at the project site	The lack of implementation of Occupational Safety and Health (K3) standards at high-risk project sites (slopes/ravines) and steep	Enforce strict supervision of K3, provide standard PPE, and insure all workers with comprehensive Labor Insurance.	Risk Transfer

			and slippery slope areas due to rain increases the potential for work accidents.		
		Lack of competent workforce in construction implementation	The qualifications or experience of the workforce do not correspond to the specific needs of road construction in mountainous areas.	Conduct a strict selection and recruit local workers who are experienced in mountainous terrain.	Risk Reduction
		Lack of experience working in mountainous terrain	The majority of the workforce is familiar with low-lying projects so they are unfamiliar with mountainous terrain challenges such as steep slopes, extreme weather, and limited access	Recruit experienced supervisors and foremen in mountain projects, conduct field orientations and simulations of terrain conditions.	Risk Reduction
2	Equipment	Equipment is not available	Delays in the procurement process of specific heavy equipment are needed for road structure work.	Make a detailed procurement schedule and have a backup contract with several trusted rental equipment providers.	Risk Reduction
		Inadequate equipment	Technical specifications or the age of the equipment used are not optimal, causing inefficient and problem-prone work	Conduct a feasibility audit (features and condition) of equipment prior to mobilization	Risk Reduction
		Construction equipment breakdown	Lack of preventive maintenance on heavy equipment and use that exceeds operational limits.	Setting up a team of mechanics at the project site and executing a rigorous scheduled maintenance program.	Risk Reduction
		Delay in equipment mobilization	The condition of the access road to the location is damaged and narrow, as well as the dependence on the weather for the transportation of equipment	Prepare a mobilization schedule with sufficient buffer time	Risk Reduction
		Difficulty in transporting heavy equipment to mountainous locations	The access road to Mount Pamaton-Mount Brown has a limited width, high slope and not all segments can be passed by the tool at the beginning of the work	Conducting route surveys and making temporary work roads	Avoiding Risks (Risk Avoidance)
3	Ingredients	Specification materials not available	Weak source monitoring and damaged materials during transportation	Increased inspection of materials at source and in the field	Risk Reduction
		Materials received are of poor quality	Shipping of materials from suppliers that are not closely supervised and materials exposed to rain during transfer from AMP to dump trucks	Implement strict quality control procedures at the receiving point and minimize exposure to rain with material protection using tarpaulins.	Risk Reduction
		Long delivery of materials	The distance of transporting materials from the supplier's warehouse to the project site is very far, plus operational constraints on the Asphalt Mixing Plant (AMP)	Make the stock of raw materials (aggregate) at the project site larger in anticipation of delays. In addition, develop a strict preventive maintenance schedule for all key components of the AMP	Risk Reduction
		Insufficient material inventory	Inaccurate planning of material requirements, delivery delays, and difficulty making additional deliveries in a short period of time due to limited access	Create a daily material stock monitoring system, intensive coordination with suppliers for quick response	Risk Reduction

4	Cost	Increase in fuel prices, materials and labour wages	Changes in economic policy that triggered a price surge beyond initial estimates.	Filing a price adjustment claim as per the terms of the contract and making a long-term contract with the supplier to lock in the price.	Risk Transfer
5	Implementation	Licensing requirements, social and economic impact	The licensing process involving various agencies takes a long time, the existence of community land affected by road construction, and community concerns about socio-economic changes	The risk is transferred to the Provincial Government as the project owner for licensing and land acquisition management. The contractor coordinates and supports socialization to the community and involves local workers	Risk Transfer
		Work quality that does not meet standards	The lack of strict field supervision, as well as the workmanship in extreme terrain, makes it difficult to maintain layer thickness and compaction according to technical standards	Periodic supervision by consultants & rigorous field quality testing	Risk Reduction
6	Environment	Damage to the surrounding environment	Land clearing, excavation, and landfill activities can cause vegetation damage, soil erosion, and changes in natural contours in mountainous areas	Reclamation, revegetation & creation of permanent drainage channels	Risk Reduction
		Pollution of water sources in mountain areas	Work waste carried away by mountain water flow	Treat wastewater before disposal and not dispose of waste carelessly	Risk Reduction
		Disturbance of forest areas and ecosystems	Clearing land for roads can interfere with wildlife habitats	Clearly mark project boundaries with permanent pegs and create custom paths to the project.	Avoiding Risks (Risk Avoidance)
7	Nature	Prolonged rainy season that hinders construction	Rainfall is so high that work is often halted	Prepare an implementation schedule by prioritizing critical work in the dry season and have an alternative work schedule during extreme rainy conditions.	Risk Reduction
		Potential for landslides on steep slopes	Very high rainfall triggers the movement of soil masses on the already existing slopes.	make slope designs with safe slopes, periodic soil stability monitoring, and temporarily stop work during critical conditions.	Risk Reduction

5. CONCLUSION

Based on the analysis that has been carried out on 17 competent respondents, the following conclusions can be drawn:

1. Based on the results of the validity and reliability testing of the questionnaire, 21 valid risk variables were identified in the implementation of the Mount Pamaton-Gunung Chocolate Road Construction Project. The risk variables are distributed in 7 categories of risk factors, namely: labor factors (4 variables), equipment factors (5 variables), material/material factors (4 variables), cost factors (1 variable), implementation risks

(2 variables), environmental factors (3 variables), and natural factors (2 variables). The identified risk variables reflect the complexity of the implementation of road construction projects in mountainous terrain, where each risk category has specific characteristics and impacts on the success of the project.

2. The risk variables/factors included in the dominant category are in the medium (medium) and high (high) categories in accordance with Ministerial Circular No. 4 of 2021, based on the results of the research there are 15 risk factors in the dominant category with a medium category risk level and 6 dominant category risk factors with a high category risk level
3. Risk responses were carried out to 21 dominant risk variables through Risk Reduction for 16 risk variables, Risk Transfer for 3 risk variables, and Risk Avoidance 2 risk variables.

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