Analysis of Risk Management Implementation in Paliwara Landslide Mitigation Project in Hulu Sungai Utara Regency of South Kalimantan Province, Indonesia

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ABSTRACT

The Paliwara Landslide Mitigation Project in Hulu Sungai Utara Regency of South Kalimantan Province is dealing with many risks that potentially able to delay project objectives achievement. The analysis in this study aims to identify key risks in the project and to evaluate these risks management using a standard of AS/NZS 4360:2004 as the management framework. Research methodology applied in this study was descriptive qualitative method, by reviewing secondary project data such as progress report, Show Cause Meeting (SCM) documentation, and implementation timeline. Result of risk identification are able to identify ten key risks including weak project management, extreme weather (heavy rainfall), remote project locations that delayed the material supply to worksite, and potential for subsequent landslides. According to the probability and impact assessment, there were two risks were classified as very high level (poor project management and disruption due to extreme weather), while one risk was classified as high level (the geotechnical risk of subsequent landslide). Meanwhile, the remaining risks were classified as moderate to low level. Mitigation strategies directed to have focus on risks with high level including strengthening project management and coordination, adapting schedule to the weather condition and implementing technical measures to stabilize slopes. This study demonstrates the importance of proactively implementing risk management for road infrastructure construction project, in particular for those projects with challenging natural and site condition to prevent future project failures.

Keywords: Risk Management, Standard of AS/NZS 4360:2004, Landslide, Slope Construction Project.

INTRODUCTION

Paliwara Landslide Mitigation Project located in Amuntai Tengah District, Hulu Sungai Utara Regency of South Kalimantan is a strategic project to make a stabilization of slopes and to repair national roads damaged by landslides. Landslides in Paliwara area have disrupted the flow of road traffic and damaged the roadways also put serious risk to the safety of road users on this Trans-Kalimantan route. As a part of restoration effort to this vital infrastructure, a plan for construction project is underway to strengthen the road structure and to prevent further landslides in the future.

During the project implementation, Paliwara project faced complex challenges where there were significant delays in work execution when compared to the work schedule and work quality deviations since the work results did not fully meet technical specifications, along with administrative issues in project management. Accumulation of these problems make the service user of project owner must take decisive action by holding a Show Cause Meeting (SCM) to evaluate the contractor's wok performance. SCM is an official forum to acquire explanation from the contractor about the causes of work delays and deviations. If the work performance doesnot show improvement after SCM forum took place, the project owner has the right to terminate the contract in accordance with applicable provisions. In the case of Paliwara Project, the work contract was ultimately terminated before the project was completed reflecting the failure of target achievement due to poorly managed risks.

Risk management is crucial to identify, analyse, and give respond to any risk faced from the beginning of the project to its completion (Thompson & Perry, 1991). Implementation of effective risk management is expected to minimize potential losses and increases chances of achieving the project objectives (Yuliana & Hidayat, 2017). As a guidance, the International Standard AS/NZS 4360:2004 provides comprehensive framework guidelines for risk management comprises of context definition, risk identification, risk analysis, risk evaluation, and risk treatment (ISO, 2018). The entire process is iterative and integrated with ongoing monitoring and communication. According to these principles, this study evaluates the implementation of risk management in Paliwara Landslide Mitigation Project with objective of the study to provide an overview to the extent of risk that can be identified and addressed in Paliwara project also to formulate recommendations for risk management improvement effort for similar projects in the future.

LITERATURE REVIEW

Risk Management in a Construction Project

A construction project, in particular for road infrastructure and slope management project inherent high risk level since there are numerous uncertainties within the project implementation such as unpredictable field geology, unpredictable weather, multi-stakeholders' involvement, also time and resource constraints (Thompson & Perry, 1991). According to standard of AS/NZS 4360 (2004), risk management is a systematic process comprises of context establishment, risk identification, risk analysis, risk evaluation and ways in addressing risks in a coordinated manner (ISO, 2018). Application of structured risk management in construction project can increase the likelihood of project success through appropriate mitigation planning and proactive responses to uncertainty (Yuliana & Hidayat, 2017). As suggested by empirical research by Afiq (2021) on a dormitory building project, and by Putri et al. (2015) reported on a hospital construction project confirming the early identification and mitigation of construction risks able to prevent delay and cost overrun to a project.

Risks on Road and Slope Construction Project

For a road infrastructure project that involving slope stabilization, there are several dominant common risks as suggested by Rahman & Tjendani (2022) about geotechnical risks such as ground movement and subsequent landslides among of the most crucial events. As well as the remote project locations that lead to delays in material distribution and equipment mobilization, while extreme weather conditions such as heavy rainfall can prolong the field work. Other cause such as sudden design changes or unexpected decisions by project owner are also source of risks which potentially triggers conflict and additional delays. Setyawan et al. (2022) also added with a weak coordination between parties, lack of quality control and regulatory changes during project also contribute to significant risks in construction projects. Therefore, identifying and mapping risks from since the planning stage is crucial act especially for projects with high technical and environmental challenges which must involve landslide mitigation.

A Role of Supervising Consultant in Risk Control

A supervision consultant holds a key role for assuring project implementation adheres to technical specifications, schedules, and budgets (Wally et al., 2022) through certain activities such as daily monitoring, quality inspection, and regular reporting. Moreover, supervision consultant can serve as early warning system for potential of deviation or problems in the work field. Effective supervision also involves identification of causal delay and technical problems, allowing prompt corrective action to take place (Sumajouw & Sompie, 2014). Supervision consultant also qualified to act as neutral mediator between project owner and contractor in resolving technical disputes and ensuring the contractor compliance to the applicable procedures and regulations.

Show Cause Meeting (SCM) as Mitigation Mechanism

A Show Cause Meeting (SCM) is a formal forum used by the project owner to request explanation related to significant delays or deviations of project implementation from the contractor. SCM is part of an administrative risk management strategy, in which, through SCM, contractors are given the opportunity to explain the encountered work problems and to develop corrective plans (Putra et al., 2021). If the explanation and corrective efforts are inadequate, the SCM results can serve as a basis for the project owner to take decisive action such as a contract termination. As suggested by Suparno (2015) that a proper implementation of SCM able to subdue conflict escalation and promote a peaceful resolution of issues before these negative impacts escalate to legal action. Thus, SCM serves as a project risk mitigation mechanism in particular related to aspects of time performance and contract compliance.

Regulation and Technical Standard

In national road projects, technical standards are essential to guarantee the quality and safety of the work. Moreover, 2018 General Highways Specification or *Spesifikasi Umum Bina Marga 2018* (Second Revision) is served as the guideline for work methods, material requirements, and quality benchmarks for road and bridge projects in Indonesia. Along with the technical standards, there are procurement and contract aspects which also regulated through regulations like the Presidential Regulation No 12 of 2021 regarding Government Procurement of Goods/Services. Compliance with technical specifications and contract regulations becomes influential element of project risk management (Ervianto, 2005). Failure to comply with these requirements can lead to administrative sanction, claims, or worse, lawsuits which will bring negative impact to project continuity. Therefore, a project team must have a thorough understanding about applicable standards and regulations to be integrated into project planning and project control.

Construction Project

Ervianto (2005) explains a construction project is a series of activities which carried out once and over a period of time. These activities include certain processes that organize project resources into final activity result as a building. These processes within certain activities involve related parties both from direct parties or indirect parties, and the existing relationships between parties involved in the project are further clarified by working relationship and functional relationship. When a lot of parties are involved in a construction project, potential conflicts are greater, thus, it can be said that a construction project carries potentiality of high conflicts (Setyawan et al., 2022)

According to Ervianto (2005), the parties involved in a construction project are as shown in the following figure (Figure1)

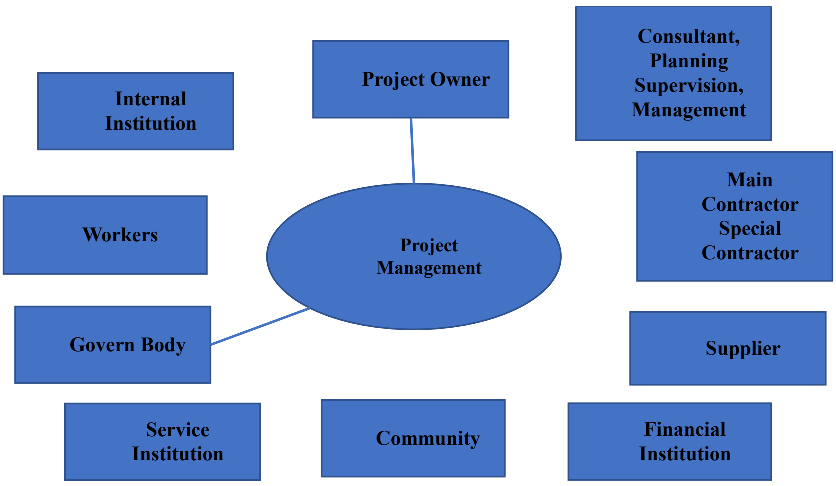

Figure 1. Existing parties within a construction project

Source: Ervianto (2005)

Risk Management on a Project

According to Putra et al. in Aldesra (2021), risk is an uncertainty matter which occurs due to information lackness or the absence of information about what will happen. This uncertainty brings impacts both in negative and positive impacts, where the positive outcome represents an opportunity and a negative outcome represents a risk. Suparno (2015) gave more explanations about the possible risks that may occur in construction project such as:

1. Unpredictable external risks such as natural disasters, government regulations, vandalism activities, along with other unforeseen effects.
2. Predictable external risks such as financial situation, interest rate, material availability, environmental impacts, taxation, inflation and others.
3. Internal or non-technical risks such as cash flow, safety issues, profit plans, schedule delays, strikes and cash flow bottlenecks.
4. Technical risks such as technology, design changes, implementation changes, and maintenance issues which arise from technology usage in project (for example BIM, changes also adjustment).
5. Legal risk such as licencing, patent, litigation, subcontractor’s workperformance, contract failure, lawsuits, and force majeure.

Methods in Risk Management

1. Risk breakdown structure (RBS) method

   RBS method is used to make categorization of each risk. It is a way for grouping risks into a logical, systematic and structured risks hierarcy in accordance with applicable standards. RBS application can improve understanding of the risks within a project (Putri et al., 2015).

2. Analythical hierarchy process (AHP) method

   AHP method is a method used for decision-making plan that developed Saaty (2012) which describes many multi-criteria problems into a hieararchy. The hierarchy is able to break down complex problems into specific criterias which then will be organized and analyzed so then decisions can be made (Efrizon, 2014).

Risk Management Process

According to the standard of AS/NZS 4360 (2004) there are four steps within the risk management procedure as listed below:

Establish the context

In establishing the problem, it involves internal and external parameters which put into consideration for risk management activity. Next, a determination of the workscope is set and a risk analysis is conducted.

Identify risk

Risk identification is a stage for acquiring suitable risk problem variables. Risk identification also involves activity to obtain a list of risk sources and events that able to impact project target achievement. 3. Analyse risk

Risk analysis involves several considerations about the risk source, consequences, and the probability of that risk. The risk will be analyzed by combining the likelihood (frequency/probability) and consequences (effect/impact). Likelihood and consequences of each risk will determine the risk level.

Evaluate risk

Risk evaluation involves and compares risks identified during the analysis process with the established risk

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criteria. Then, the result is a prioritized list of risks to be taken into further action in the next step.

Treat risk

Risk treatment is a method for minimizing risk as described to be risk mitigation. The risk is analyzed which sometimes cannot be completely eliminated but can only be minimized resulting in residual risk.

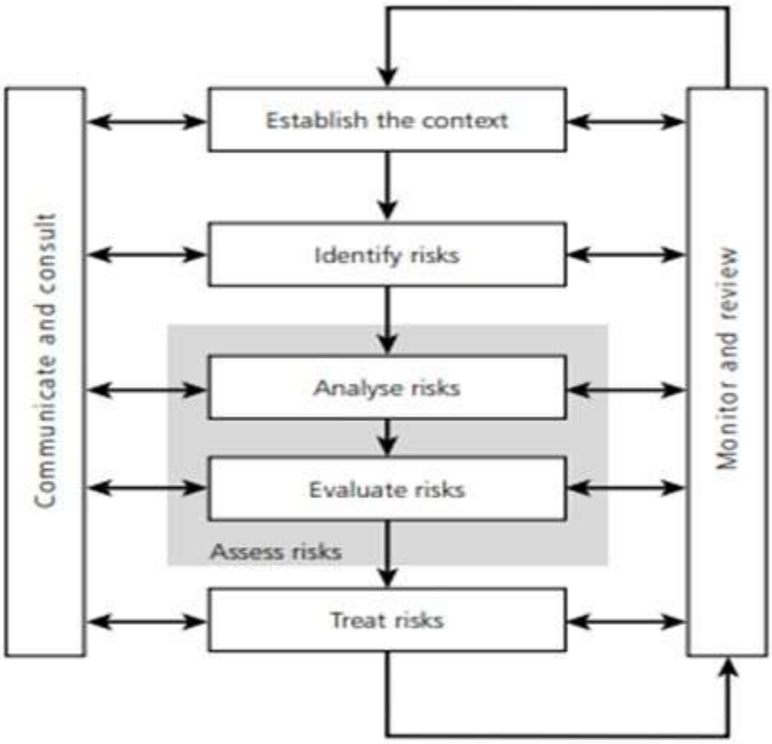

Figure 2. Flow chart of risk management

Source: AS/NZS 4360 (2004)

Risk Identification

According to Sumajouw & Sompie (2014) a risk identification process is identification of the type of risk that are likely and usually will occur. Risk identification is a systematic and continuous process for identifying potential risks that could impact project objectives. Whereas PMBOK GUIDE Sixth Edition, (2017) added with several data collection techniques that can be used to acquire problem information as listed below:

1. Brainstorming technique

   Brainstorming technique conducts by collecting ideas or thoughts to find solutions to problems, such as creating several frameworks and ideas in managing the risk of project accidents or to minimize work accidents.

2. Checklist technique

   Checklist technique is carried out by checking work items list and the possibility of the risks will occur so it can be developed to obtain information on how to prevent these risks.

3. Interview technique

   Interview technique is conducted by interviewing important people in the project such as the project manager, site manager, quality health safety and environment (QHSE) officials, experts to obtain information on work accident risks.

4. Root cause analysis

   Root cause analysis technique is carried out by looking for root causes of the problem by identifying the specific main causes of the problem for follow-up.

5. Assumption and constraint analysis

   Assumption and constraint analysis is carried out by identification of inaccuracy, instability, inconsistency, also assumption to minimize the risk occurrence.

6. Strength, weaknesses, opportunity, threat (SWOT) analysis

   The SWOT analysis technique is carried out by evaluating strengths, weaknesses, opportunities and any threats posed by the project.

7. Document analysis technique

   Document analysis technique is held by identifying project documents such as agreement documents, technical documents, contract documents, problems/constraints in the project also other archive documents related to the project.

Risk Analysis

Thompson & Perry (1991) stated the risk management from qualitative perspective has two directions of purpose: identifying risks and assesing the risks. In qualitative analysis, risk value can be found by multiplying likelihood by risk impact. If the result of likelihood is high and the risk impact also high, it resulted a high level of risk. On the contrary, if the likelihood is low and the impact is also low, it resulted a low level of risk. Then, main risks will be handled by a method called as risk mitigation. Furthermore, standard of AS/ NZS 4360 (2004), will asses each risk through qualitative ways by dividing the risks into five categories. The assessment of each likelihood and consequences is presented in the following tables (Table 1 and Table 2).

Table 1. The assessment of risk likelihood

Score	**Definition**	**Description**
1	Rare	Likelihood to happen is a very small
2	Unlikely	Likelihood to happen is sometimes
3	Moderate	Likelihood to happen is several times
4	Likely	Likelihood to happen is frequent
5	Almost Certain	Likelihood to happen in very frequent times

Source: AS/NZS 4360 (2004)

Table 2. The assessment of impact/risk consequences

Score	**Definition**	**Description**
1	Insignificant	No wounds or injuries, low level of loss, impact scope is small
2	Minor	Requires first aid, impact scope is small

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3	Moderate	Requires medical help, financial loss is quite high
4	Major	High level of loss, production ability decline, impact scope is wide
5	Catastrophic	Resulted in loss of life (death), major damage, very high financial losses

Source: AS/NZS 4360 (2004)

Risk Evaluation

The purpose of risk evaluation is facilitating decision-making based on the analysis results. This evaluation will determine which risks that have the highest priority to be handled as it is done by categorizing likelihood and impact values into a risk matrix. Once the likelihood and impact values are identified, these can be entered into the risk matrix. The following table (Table 3) is an example of a risk matrix in compliance to AS/NZS 4360 (2004) standard.

Table 3. The risk matrix

L/C		**Consequences**				
Likelihood		**1**	**2**	**3**	**4**	**5**
		Insignificant	**Minor**	**Moderate**	**Major**	**Catastropic**
5	Very often	5	10	15	20	25
4	Often	4	8	12	16	20
3	Moderate	3	6	9	12	15
2	Seldom	2	4	6	8	10
1	Rare	1	2	3	4	5

Source: AZ/NZS 4360 (2004)

Description:

- Very High : Intolerable and requires immediate treatment
- High : Unwanted and requires special attention
- Moderate : Accepted with high approval and high responsibility
- Low : Accepted with approval by the management
- Very Low : Can be ignored, but must be checked regularly

The result of risk evaluation is a risk ranking that requires further research on basis of residual risks and effective risk control.

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Risk Management

According to Planagan & Norman in Putra, et al., (2021) there are four points for handling risks as stated below:

1. Risk retention

   Accepting or restrain the risk impact that has low or acceptable level of loss.

2. Risk reduction

   Studying these risks further then implementing risk prevention efforts by combining efforts to prevent risk accumulation. This activity often resulted in residual risk therefore necessitates an assesment to it.

3. Risk transfer

   A transfer act of some or the entire risk to another party. Such high level of risk activities will be transferred to another party with better ability to handle and control the risks.

4. Risk avoidance

   The act of avoiding work that poses very significant weakness by refusing to undertake high-risk project, such as a project with the possibility of contract breaching.

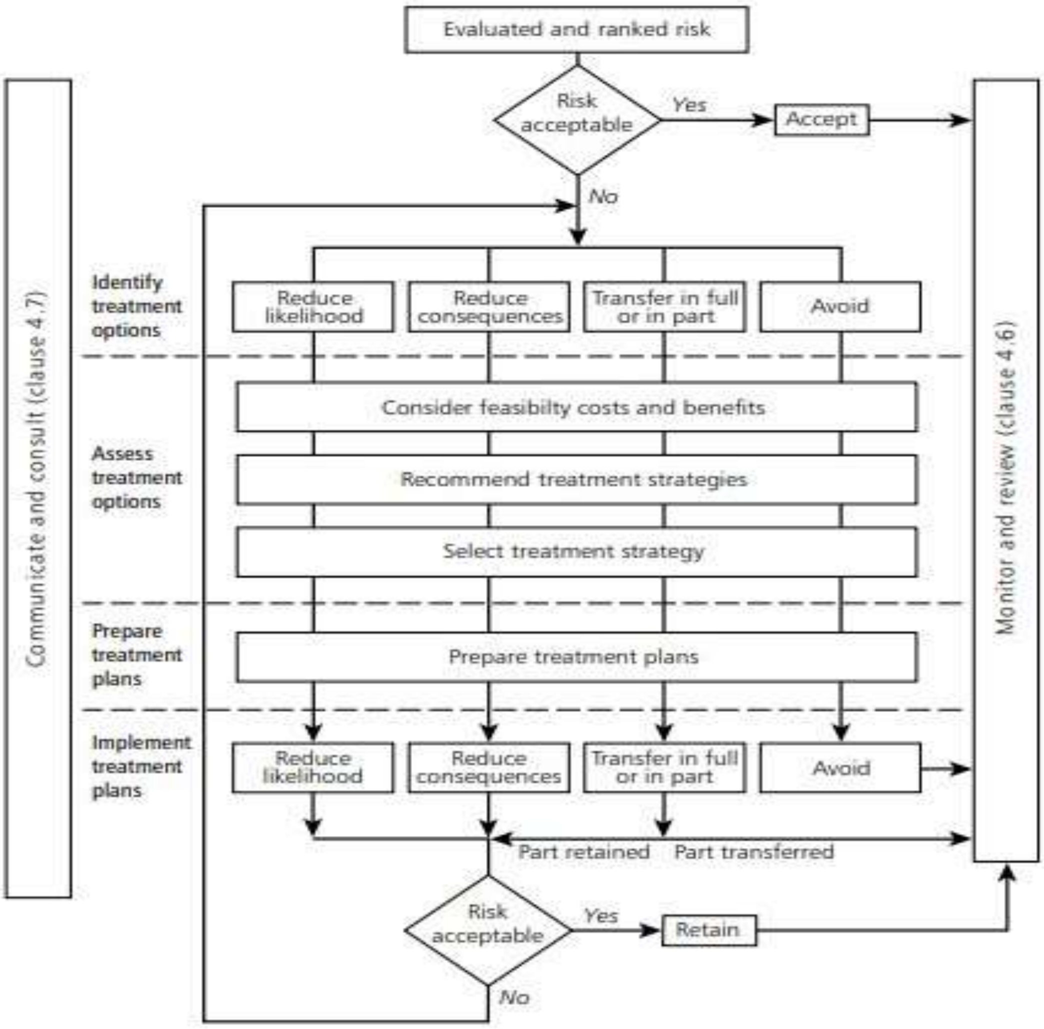

Figure 3. The Risk Management Process

Source: AS/NZS 4360 (2004)

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RESEARCH METHOD

This study uses a qualitative descriptive approach aimed to give a systematical description of implementing risk management process within a construction project based on the standard of AS/NZS 4360 (2004). This approach was chosen since the study focus is on analysing risk management process and strategies within real project, rather than focusing on statistical hypothesis testing.

Type of Data

The type of data used in this research was secondary data in the forms of project documents which were obtained from:

1. Contract documents and addendum for Paliwara Landslide Mitigation Project
2. Weekly and monthly project implementation reports
3. Work implementation chronology documents
4. Show cause meeting (SCM) documents and technical meeting reports
5. Documents of visual project progress and technical drawings

These data reflect the actual project implementation which are used as a basis for identifying problems and risk occurrence throughout the project cycle.

Analysis Stages in Compliance to Standard of AS/NZS 4360:2004

This research is following five main stages of risk management in compliance to standard of AS/NZS 4360 (2004):

1. Context establisment

This stage is conducted to have an understanding of the project scope, internal and external movements also the project objectives. Meanwhile, the elements of consideration are:

- Project location and geographical challenges (steep slopes or has potential of landslide)
- The work scope (road structure management and slope stabilization)
- The project stakeholders (service users, contractors, and supervising consultant)
- Time of project implementation also the weater or season conditions

The context establishment also includes an understanding to the applicable technical standards (such as the 2018 General Highways Specification) and the procurement regulations (such as Presidential Regulation No 12 of 2021).

2. Risk identification

Risk identification process involves reviewing all project implementation documents to identify events that could lead to deviation from project objectives (time, quality and cost). Whereas the risks are identified based on the following categories:

- Geotechnical risks (example: subsequent landslide, slope instability)
- Administrative risks (incomplete documentation)
- Managerial risks (weak project control)
- External risks (extreme weather, logistic supply)

Output from this stage is a risk list with descriptions, causes, and risk source categories.

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3. Risk analysis

Each risk will be analysed based on two main dimensions:

- Probability (P): likelihood of risk occurrence (scale 1–5)
- Impact (D): consequences of project risk if it occurs (scale 1–5)

The risk score is calculated by the formula of: Risk Value = P x D\text {Risk Value} = P\times D Risk Value = P x D

Then, the analysis results will be classified based on the score and grouped into three main categories:

low, medium and high categories.

4. Risk evaluation

The analysed risks will be entered into a risk matrix table to decide the treatment priority. This matrix helps visualize the relationship between likelihood and impact.

Risks with highest risk scores become the main priority for mitigation, in particular for those risks that included into high and very high-risk categories.

5. Risk treatment

For every risk priority, the mitigation strategy is developed based on four approaches:

- Avoid: stopping high-risk activities
- Reduce: lowering the probability/impact level
- Transfer: through contracts/subcontracts or insurance
- Accept: taking risks that considered to be acceptable

Meanwhile, the mitigation strategy is developed according to risk context and the nature of the project, for example:

- Make an adaptation of the implementation schedule to the rainy season
- Providing backup equipment and alternative suppliers
- Strengthening communication between stakeholders through SCM and weekly meetings.

Validation and Data Triangulation

For increasing validity of the findings, a triangulation method was conducted through:

1. A comparison of contract documents to field implementation
2. A confirmation of supervision reports and SCM documentation
3. Consistency analysis between data types (administrative, technical and visual)

Instruments of Analysis

The supporting instruments used in the analysis process are:

1. Risk identification template: contains of a table of risk descriptions, codes and categories
2. 5 x 5 risk matrix: for mapping and to prioritize risks
3. Risk control form: contains mitigation and monitoring actions

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RESULT AND DISCUSSION

Research Object

This research was held on a Project of National Road Landslide Mitigation in Paliwara Village, district of Amuntai Tengah, Hulu Sungai Utara Regency of South Kalimantan. The work project was implemented by National Road Implementation Work Unit Region I of South Kalimantan Province as an effort to restore national road access that affected by landslide disaster.

Project general data:

1. Name of the project: Landslide Mitigation of National Road in Paliwara Village, district of Amuntai Tengah, Hulu Sungai Utara Regency.
2. Project location: Paliwara Village, Amuntai Tengah District, Hulu Sungai Utara Regency, South Kalimantan Province.
3. Contract value: IDR. 13.174.337.200 (Thirteen billion one hundred seventy-four million three hundred thirty-seven thousand two hundred rupiah).
4. Time implementation : 150 (a hundred and fifty) of calendar days.
5. Constr. service provider: CV. Cahaya Purna Nusaraya
6. Supervising consultant: CV. Amri Archteam Consultant
7. Planning consultant : CV. Triwarsa Engineering Consultant
8. Work scope: Slope and landslide management, gabion structure construction, excavation and embankment work, drainage construction and road security and road equipment.

Risk Identification

According to document review and field condition of the study site, there are many risks identified which cold impact the success of Paliwara Landslide Mitigation Project. The following table (Table 1) lists the identified main risks altogether with the risk codes, the estimated probability of occurrence, and the magnitude of the impact if the risks were to occur. Risk code is numbered according to the risk source category, including:

1. A for human resource aspect (labor and safety)
2. B for planning or technical design aspect
3. C for resources aspect (material and equipment)
4. D for implementation/administration management aspect
5. E for external aspects (environment and natural conditions)

Each risk is assessed through qualitative way on a scale of 1 (very low) to 5 (very high) for its probability and impact.

Table 4. Risk identification of Paliwara Road Landslide Mitigation Project

No	Work Item	Type of Risk	Risk Code	Probability (P)					Impact (D)				
				1	2	3	4	5	1	2	3	4	5
1	Steel piling work	Worker's safety	A.1		x							x	
		Deep and fast flowing river condition	T.1					x			x		
		Construction material from outside Kalimantan	M.1					x	x				
		Extreme weather	C.1	x					x				

2	Formwork (*Bekisting)*	Worker's safety	A.1		**x**							**x**	
		Deep and fast flowing river condition	T.1					**x**			**x**		
		High level complexity	M.1					**x**	**x**				
		Extreme weather	C.1	**x**					**x**				
3	Reinforcement work	Unprofessional workers	P.1		**x**					**x**			
		Reinforcement has big diameter size which requires special equipment	P.2	**x**					**x**				
		Deep and fast flowing river condition	T.1					**x**			**x**		
		Construction material from outside the regency	M.1					**x**	**x**				
		Extreme weather	C.1	**x**					**x**				
4	Cast work	Construction material from outside the regency	M.1					**x**	**x**				
		Extreme weather	C.1	**x**					**x**				
		Material quality	M.2	**x**							**x**		

Source: Analysis (2025)

Risk Evaluation

After obtaining data identification through the implemented work items then researchers will examine the specific work item with its associated risks. The work items as mentioned in Table 4 can be divided into four categories:

1. Steel piling work with time duration of 10 weeks has four types of risks
2. Formwork (*bekisting)* with time duration of 6 weeks has four types of risks
3. Reinforcement work with time duration of 10 weeks has five types of risks
4. Casting work with time duration of 4 weeks has three types of risks

These data will be inputted into a risk evaluation table as displayed in the following table (Table 5).

Table 4. Risk evaluation on Paliwara Road Landslide Mitigation Project

No	**Work Item**	**Risk**	**P**	**I**	**P x I**	**Average**
1	Steel piling work	A.1	2	4	8	**7.25**
		T.1	5	3	15	
		M.1	5	1	5	
		C.1	1	1	1	
2	Formwork (*Bekisting)*	A.1	2	4	8	**7.25**
		T.1	5	3	15	
		M.1	5	1	5	
		C.1	1	1	1	

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3	Reinforcement work	P.1	2	2	4	**5.2**
		P.2	1	1	1	
		T.1	5	3	15	
		M.1	5	1	5	
		C.1	1	1	1	
4	Cast work	M.1	5	1	5	**4.33**
		C.1	1	1	2	
		M.2	2	3	6	

Source: Analysis (2025)

Table 5. Risk distribution matrix on Paliwara Road Landslide Mitigation Project

L/C		**Consequences**				
Likelihood		**1**	**2**	**3**	**4**	**5**
		Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
5	Very often	M.1		T.1		
4	Often					
3	Moderate					
2	Seldom		P.1	M.2	A.1	
1	Rare	C.1, P.2				

Source: Analysis (2025)

The explanation of risk value on Paliwara Road Landslide Mitigation Project is:

1. High risk level ( )
   - T.1 : Deep and fast flowing river condition
2. Moderate Risk Level ( ) • A.1 : Worker's safety
   - M.2: Material quality
3. Low Risk Level ( )
   - P.1 : Unprofessional workers
   - M.1: Construction material from outside the regency
4. Very Low Risk Level ( )
   - C.1 : Extreme weather
   - P.2 : Reinforcement has big diameter size, requires measuring equipment

Risk Treatment/Risk Control

As a result of risk level evaluation, priority of risk management is focused on the high and the very high risks since these risks bring most critical impact on the project. However, the mitigation plans were also prepared for all identified risks to ensure a comprehensive control also present in this project. Table 7 summarizes mitigation plans for each risk where mitigation strategies are briefly described (including the actions or procedures necessary to reduce the likelihood or impact of each risk).

In general, the risk control for Paliwara Road Landslide Mitigation Project is presented in the following table (Table 7):

Table 7. Risk Control on Paliwara Road Landslide Mitigation Project

Code	Type of Risks	Risk Score	Risk Category	Control
T.1	Deep and fast flowing river condition	15	High	(1) Work scheduling is made during the dry season; (2) Monitoring water level elevation and soil stability.
A.1	Workers Safety	8	High	(1) Routine inspection of heavy equipment; (2) Training on the use of equipment; (3) Placement of heavy equipment in a stable location.
M.2	Material quality	6	Moderate	(1) Laboratory testing before use; (2) Strict selection of suppliers; (3) Incoming material documentation.
P.1	Unprofessional workers	4	Moderate	(1) Job training before work implementation; (2) Direct supervision by experts; (3) Skills certification for certain workers.
M.1	Construction material from outside the regency	5	Moderate	(1) Delivery time schedule planning; (2) Timely vendor selection; (3) Storage of spare materials at the project site.
C.1	Extreme weather	1	Moderate	(1) Adjustment of implementation schedule; (2) Monitoring of daily weather forecasts; (3) Protection of work areas with tents/tarpaulins during rain.

Source: Analysis (2025)

CONCLUSION

1. The result from risk evaluation analysis can be put into conclusion of: the steel piling work with average value of 7.25 and formwork with average value of 7.25 are classified to have medium risk level, whereas the reinforcement work with average value of 5.2 and casting work with average value of 4.33 are classified to have low risk level.
2. The result of risk identification in Paliwara Road Landslide Mitigation Project is: (a) unstable or submerged soil condition (T.1) classified as high risk level, (b) Worker Safety (A.1) and Material Quality (M.2) are classified as medium risk level, (c) Unprofessional workers (P.1) and Material from outside the district (M.1) are classified as low risk level, and (d) Extreme weather (C.1) is classified as very low risk.
3. The result of risk treatment or risk control conducted in this study carried out by identifying risks that have high risk content as found out to be deep and fast flowing river condition or T.1. Therefore, the control to solve the risk are:

- Work schedule is made during the dry season, and
- Monitoring the water level elevation and soil stability.

As recommendation for future similar projects, the researchers recommended to implement a disciplined risk management framework in compliance with standard of AS/NZS 4360:2004 from early on (the planning stage). Then, risk identification should be conducted in comprehensive act; involving experts such as geotechnical engineers and planners to make any technical risks (innapropriate design to the field condition for example) can be identified early. Also, the project owner must establish certain criterias that consider management capacity and risk control track records when selecting the project contractor. During work implementation, role of supervising consultant should be optimized not only to monitor the work quality but also able to supervise or guide the implementation of risk management in the work field. Communication and coordination between stakeholders must be improved to avoid misinformation and delays in decision-making process. Furthermore, the project scheduling should be designed to adapt to condition where there are potentials of bad weather and complemented by contingency plan for worst-case scenario (such as natural disaster happenings). With these steps, the future landslide mitigation project is expected to run more smoothly, can be completed on time and able to achieve their objectives without significant constraints.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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