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Research Paper

Risk Management Analysis of The Maliana II Irrigation Network Development Project in Bobonaro District, Timor Leste

Gregorius Emanuel Konda[1], Lalu Mulyadi[2], Lies Kurniawati Wulandari[3*].
[1]*Postgraduate Civil Engineering Student, National Institute of Technology Malang – Indonesia*
[23]*Postgraduate Civil Engineering Lecturer, National Institute of Technology Malang – Indonesia*
**Corresponding Author*

Abstract: *In this study, methods relevant to field conditions are combined with the PESTLE method that identifies political, economic, social, technological, environmental, and legal factors that affect the organization. Then continued with Qualitative Risk Analysis for subjective assessments to measure risks, such as high, medium, low. The initial stage was conducted interviews with contractors involved in the project, as well as conducting field surveys to directly observe the activities taking place at the project site after which they were analyzed according to the source of risk and conducted the distribution of questionnaires. This research aims to collect broader and deeper data related to the identification of problems that have been carried out through interviews. After that, Secondary Data Collection was carried out through literature studies, journals, media and related books.*

The dominant risks are in the very high category, namely differences in the price of basic materials, difficulties in obtaining spare parts for construction equipment, local community pros and cons regarding work involvement, and local traditional rituals. High-category risks include unstable weather conditions and damage to the coverdam, while other risks are spread across the medium and low categories according to the results of the mode value recapitulation. Mapping of risk levels resulted in a grouping of very high, high, medium, and low, indicating priority for gradual handling. The most dominant risk impacts are related to cost and time, particularly in the financial and socio-cultural clusters, while technical risks related to weather and the coverdam have the potential to reduce productivity and trigger the need for recovery work.

The monthly report for the December 2025 period is used as empirical reinforcement supporting the link between respondents' perceptions and the dynamics of project implementation as recorded in the progress, obstacles, and follow-up work in the field. Risk response and control need to be implemented based on priority levels. Very high risks require strategic control through strengthening procurement governance, cost and supply chain control, spare parts management and equipment reliability, and strengthening stakeholder management including adapting work plans to local socio-cultural dynamics. High risks require adaptive technical controls focused on weather preparedness and strengthening inspections and maintenance of coverdams. Medium and low risks are controlled through standard operating procedures, strengthening field coordination, monitoring equipment and workforce performance, consistent implementation of occupational safety, and regular monitoring through periodic project evaluations.

Keywords: *Risk management; Maliana 2 irrigation network; Timor Leste*

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I. INTRODUCTION

Risk management is a crucial aspect in project implementation, especially in the construction sector. The Maliana II irrigation canal construction project in Bobonaro Regency, Timor Leste, with a contract budget of US$ 9,886,820.81, is highly relevant to analyze in the context of risk management implementation. In this project, PT. MinartaDutahutama acts as the contractor, while PT. Caturbina Guna Persada and PT. Multimera Harapan act as consultants. The project is scheduled to last for 30 months, starting on December 4, 2024. The implementation of effective risk management can help minimize potential losses and increase project success.

Infrastructure development in Timor-Leste requires identifying and analyzing potential risks during project implementation. This aligns with the Timor-Leste government's goal of improving food security and supporting economic growth through sustainable infrastructure development. Therefore, this project risk management analysis is expected to provide useful insights for decision-makers and other stakeholders.

Timor Leste adheres to a semi-presidential system of government with a division of power between the President as head of state and the Prime Minister as head of government. In managing dam and irrigation construction projects, the government follows planning, procurement, implementation, and evaluation procedures involving technical ministries such as the Ministry of Agriculture and Public Works, as well as agencies such as the National Development Agency (NDA). The legal basis used includes the Timor Leste Constitution, Decree-Law No. 10/2005 on public procurement, No. 14/2008 on NDA, No. 41/2012 on water resources management, and No. 24/2009 on public infrastructure, which overall guarantee transparency, accountability, and efficiency in project implementation.

II. LITERATURE REVIEW

2.1.Risk Management

Risk management is a process involving the assessment or measurement of risk and the development of strategic steps to manage it. This process includes risk identification, risk assessment, and the formulation of appropriate management methods (Darmawi, 2000). Several approaches can be used in risk management, such as transferring the risk to another party, avoiding the risk entirely, reducing the negative impact of the risk, or assuming some or all of the risk.

The consequences of these risks. Traditional risk management focuses more on physical and legal threats, such as natural disasters, fires, death, or lawsuits. Meanwhile, financial risk management focuses more on managing risk through the use of financial instruments.According to AS/NZS 4360:2004, implementing risk management offers various benefits to a company.

2.2. Construction Projects

In everyday life, we often use the term "project" to describe a specific activity or project. However, according to A Guide to the Project Management Body of Knowledge (PMBOK), a project is defined as a temporary undertaking undertaken to produce a unique product or service.

A project is considered unique because its end result, whether a product or service, has unique characteristics or features that set it apart from others. Therefore, fundamentally, a project is an activity carried out over a specific period of time with the goal of creating a product or service with unique characteristics.

1. Project Activity Cycle

Due to its temporary nature, every project has a cycle known as the Project Life Cycle. This cycle encompasses stages from pre-project to post-project. Generally, this cycle consists of three main phases: the initial phase, the middle phase, and the final phase. What differentiates one project cycle from another is the details of the project's implementation.

The Project Life Cycle is a project activity cycle used to describe the stages from project inception to completion. This cycle provides an overview of the technical work that must be done in each phase and who needs to be involved in each stage. Descriptions of activities within the project life cycle can vary from very simple to very detailed.

a. Cost and Labor Patterns

• In the initial phase, costs and labor volume are typically low.
• Both factors increase significantly during the middle phase, peaking near the end.
• Once the project is completed, costs and labor volume will decrease dramatically.

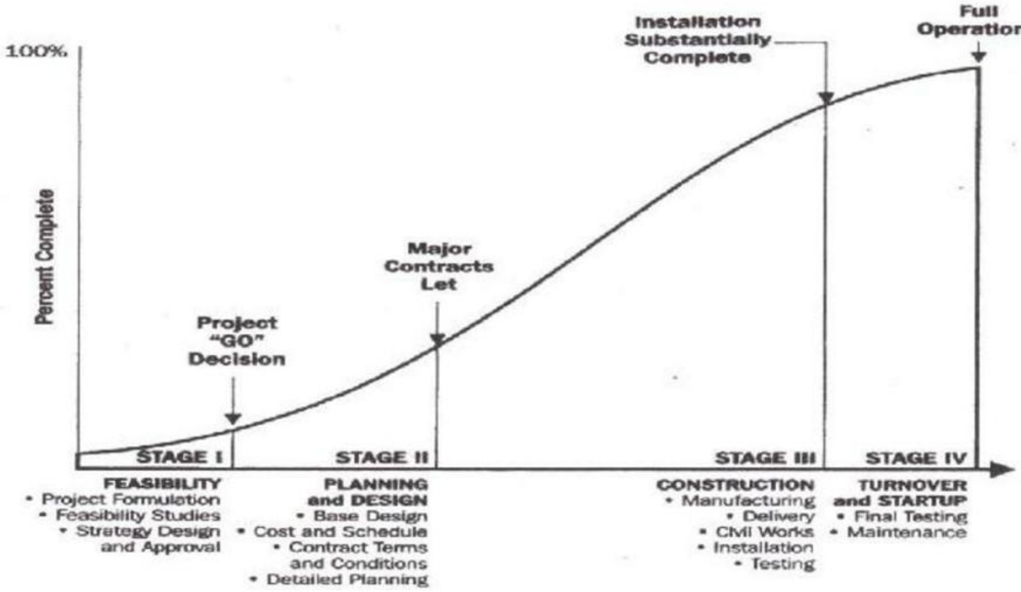
b. Probability of Completion and Risk Level

• In the early stages of a project, the probability of completion is at its lowest. This is due to the numerous potential obstacles and risks that may occur.
• Risk and uncertainty are highest in the early stages of a project, but decrease as the project progresses.
• Conversely, the probability of project success increases as the project progresses.

c. Stakeholder Influence

• In the initial phase, shareholders' ability to influence the final outcome of a project is very high.
• Over time, this influence decreases. This is due to the increasing costs of making changes or correcting errors in the final stages of the project.

Citing Morris's opinion in the PMBOK book, the construction project life cycle is as depicted in the figure below.



III. RESEARCHMETHOD

3.1.Research Variables

A variable is a condition or characteristic that can be manipulated, controlled, or observed by researchers. In general, variables are divided into two types:

• Independent Variable: A variable that influences another variable.

• Dependent Variable: A variable that is influenced by the independent variable.

In this study, the independent variable is the risk level for each identified risk factor. Meanwhile, the dependent variable is the action or steps taken to address the risk.

3.2.Data Collection

Data collection in this study involved two main approaches:

a. Primary Data Collection Method

This method involved collecting data directly from primary sources in the field. The researcher conducted:

- Interviews

Conducted interviews with contractors involved in the project, as well as field surveys to directly observe activities taking place at the project site.

- Questionnaires

The purpose of distributing this research questionnaire was to collect broader and more in-depth data related to the problem identification conducted through interviews. This questionnaire will help understand respondents' perspectives and experiences related to the research topic, thus providing a more comprehensive picture of the problems faced.

- Respondents

The respondents were parties involved in the irrigation project, namely project managers, engineers, and staff associated with the Maliana II irrigation network scheme construction project.

b. Secondary Data Collection Method

This method involves collecting data through literature studies, journals, media, and related books.

3.3. Data Analysis Method

1. Hazard and Risk Identification

The risk management process for the Maliana II irrigation network scheme project involves hazard identification. This process includes identifying potential risks and their consequences. Identification is conducted by reviewing each activity within the construction project. Information gathering through direct field observations and interviews with relevant parties serves as an important foundation for the initial hazard identification process.

2. Data Creation and Processing Stage

This research was conducted by collecting data and information, both primary and secondary. Primary data collection was conducted through a survey using a questionnaire as the primary tool to obtain information from respondents.

a. Questionnaire Creation
To increase the effectiveness of data collection, a questionnaire is required that is appropriate for the research instrument and easy for respondents to understand (Waisnawa, 2010). The questionnaire consists of several sections as follows:
• Section One: Contains respondent identification, including respondent name, division or position, respondent gender, and respondent nationality.
• Section Two: Provides an explanation of how to complete the questionnaire and how to answer the questions according to the answer fields provided.
• Section Three: Contains a list of questions and a checklist that respondents must answer. The questions asked must be clear and easy to understand. The items in this checklist relate to the sources and types of risks relevant to dam and irrigation canal construction projects. In addition, there is a column for respondents' opinions regarding the risks, opportunities, and consequences of the incident.
This is to assess the likelihood of potential disruptions or activities.

3. Risk Mapping
In the risk mapping process, the results of both qualitative and quantitative data analysis are presented along with the potential impacts that may arise if a decision is made. Each alternative is analyzed considering various perspectives and potential consequences. This risk mapping uses a rating scale, where R indicates low risk, M indicates medium risk, and T indicates high risk (Aji, 2013).
4. Risk Assessment
Once a risk has been successfully identified, the next step is to conduct a risk assessment to determine its severity. This assessment considers two main aspects: the likelihood of the risk occurring (probability) and the magnitude of the impact (severity). Based on this analysis, risks are then classified to distinguish between those with a significant impact on the company and those with a low or insignificant impact. Through a combination of probability and severity values, risk levels can be categorized into four levels: extreme, high, medium, and low.

IV. RESULTANDDISCUSSION

4.1. General description


Figure 4.1 Building Construction Work


Figure 4.2 Irrigation Channel Excavation Work

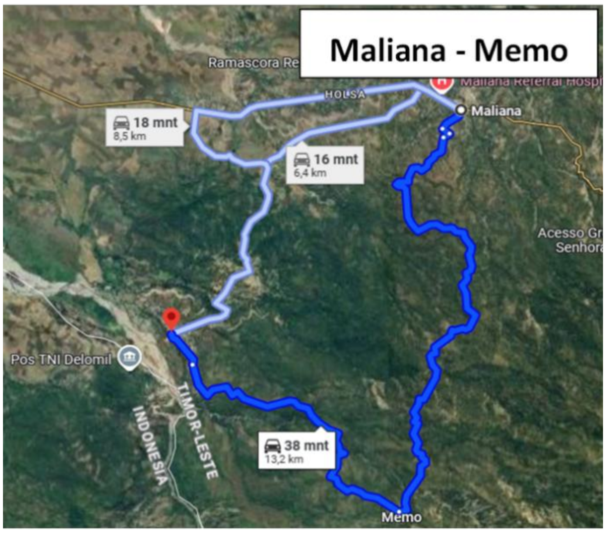


Figure 4.3 Project Location Map

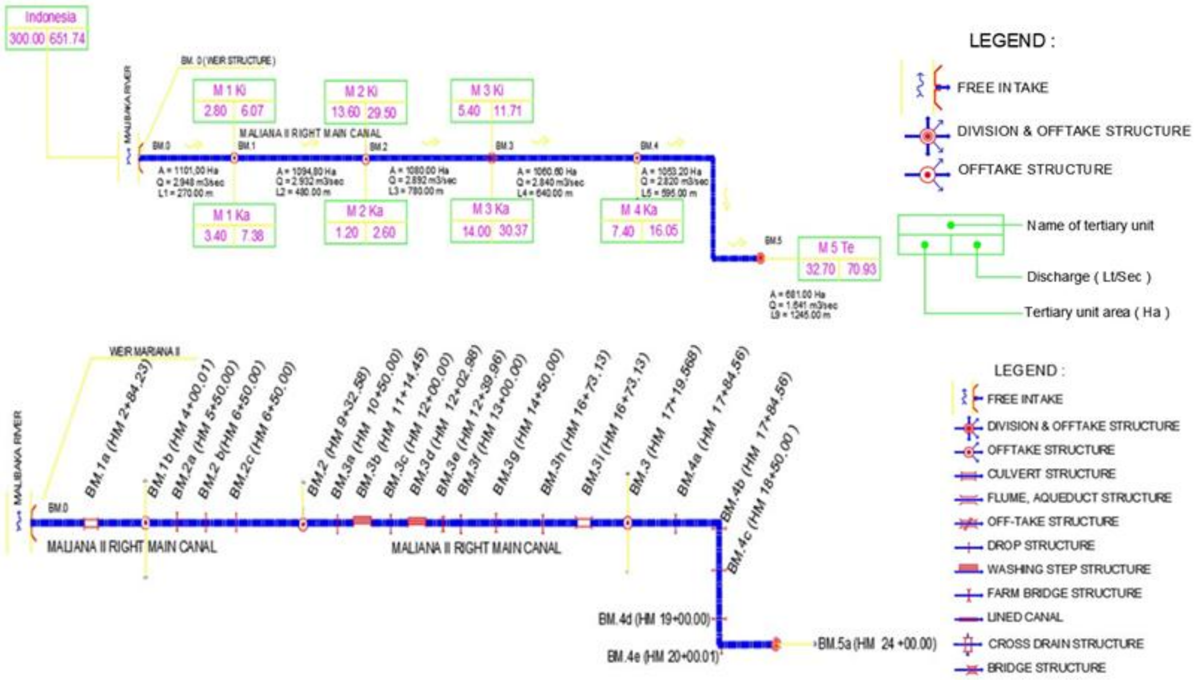


Figure 4.4 Irrigation Network Scheme

4.2. Managerial Implications

The validity test of the questionnaire instrument was conducted to determine the ability of each question item to measure the construct under study. Validity testing was conducted using Pearson Product Moment correlation, which involves correlating the scores of each question item with the total score of the variable. Data were processed using statistical software, and the test results were presented in a correlation matrix.

The decision-making criteria for the validity test were based on the correlation coefficient of the item to the total. An item was declared valid if the Pearson correlation coefficient value was greater than the table's r value or met the minimum required correlation threshold. In this study, the threshold of $r \geq 0.30$ was used with a significance level of 0.05, which is commonly used in social research and project management.

Based on the validity test results presented in the Correlations table, the majority of questions P1 through P20 showed positive Pearson correlations and were above the minimum required threshold. Furthermore, the two-tailed significance values showed values less than 0.05 for most of the item-to-total score relationships, indicating statistically significant correlations. This indicates that the questionnaire items have a fairly strong relationship with the constructs being measured.

These results indicate that each question item adequately represents the research variables. Therefore, the questionnaire instrument used met validity requirements and is suitable for use in research data collection. Items showing lower correlations were still considered based on their suitability and relevance to the research objectives, ensuring that the questionnaire is generally suitable for use in project risk analysis.

4.3. Reliability Testing

The reliability testing of the questionnaire instrument was conducted to determine the level of internal consistency of the questions in measuring the research variables. Reliability testing was conducted using the Cronbach's Alpha coefficient, which is the most commonly used method to assess the reliability of scale-based research instruments.

Reliability Statistics

Cronbach's Alpha	N of Items
.820	20

Based on the results of data processing using statistical software, a Cronbach's Alpha value of 0.820 was obtained for 20 items. This value indicates a good level of internal consistency, as it is above the minimum required reliability limit. In social research and project management, an instrument is considered reliable if the Cronbach's Alpha value is greater than 0.60, and is categorized as good if the value exceeds 0.70.

A Cronbach's Alpha value of 0.820 indicates that the questionnaire items are strongly related to each other and consistently measure the same construct. Therefore, the questionnaire instrument can produce stable and reliable data when used under similar measurement conditions.

Based on these results, it can be concluded that the research questionnaire has met reliability requirements and is suitable for use as a data collection tool in the next stage of project risk analysis.

4.4. Principal Component Analysis (Factor Analysis)

Principal component analysis is conducted to reduce a number of research variables into a few main factors that can represent the data structure more concisely and informatively. The method used in this study is Principal Component Analysis, with the aim of identifying the components that contribute most to explaining variation in risk assessment data.

Based on the analysis results presented in the Total Variance Explained table, the number of factors was determined based on the criterion of having an eigenvalue greater than one. The extraction results indicate that eight main components meet this criterion. The first component has an eigenvalue of 5.316, contributing 26.582 percent of the variance. The second component has an eigenvalue of 3.251 and explains 16.256 percent of the variance. The third component has an eigenvalue of 2.700, contributing 13.499 percent of the variance. The fourth through eighth components have eigenvalues of 1.802, 1.687, 1.454, and 1.035, respectively, with decreasing variance contributions.

Cumulatively, these eight main components explain 86.232 percent of the data variation, indicating that most of the information in the questionnaire data can be well represented by the formed factors. This high cumulative value indicates that the resulting factor structure is adequate to describe the risk patterns found in the research data.

After the extraction process, factor rotation was performed using the Varimax method to clarify the variable loading structure for each factor. The rotation results showed a more balanced distribution of variance across factors. The first component after rotation explained 16.319 percent of the variance, followed by the second component at 16.273 percent, the third component at 12.030 percent, and so on, up to the eighth component, which explained 8.720 percent of the variance. This rotation did not change the total amount of explained variance, but it helped clarify the interpretation of the factors by reducing the dominance of one factor over another.

Based on these results, it can be concluded that the eight main factors formed effectively represent the relationships between the risk variables in this study. These factors were then used as a basis for grouping risks and interpreting the dominant risk patterns affecting project implementation. Further interpretation of the meaning of each factor was conducted by referring to the results of the Rotated Component Matrix, namely by examining the items with the highest factor loading values for each factor.

V. CONCLUTION

Based on the results and discussion of previous research, the following conclusions can be drawn:

1. The main risks in the project were identified through items P1 to P20. Based on the questionnaire processing using modality to represent collective perceptions, the dominant risks were in the very high category, namely

differences in the price of basic materials, difficulties in obtaining spare parts for construction equipment, local community opposition to work engagement, and local traditional rituals. High-category risks included unstable weather conditions and damage to the coverdam, while other risks were distributed among the medium and low categories, according to the recapitulation of modality values.

2. The risk level mapping resulted in a grouping of very high, high, medium, and low, indicating priority for phased management. The most dominant risk impacts were related to cost and time, particularly in the financial and socio-cultural clusters. Technical risks related to weather and the coverdam had the potential to reduce productivity and trigger the need for recovery work. Monthly reports for the December 2025 period were used as empirical reinforcement to support the link between respondent perceptions and the dynamics of project implementation, as recorded in the progress, obstacles, and field follow-up.

3. Risk response and control must be implemented based on priority levels. Very high risks require strategic control through strengthening procurement governance, cost and supply chain control, spare parts management and equipment reliability, and strengthening stakeholder management, including adapting work plans to local socio-cultural dynamics. High risks require adaptive technical controls focused on weather preparedness and strengthening coverdam inspections and maintenance. Medium and low risks are controlled through standard operating procedures, strengthening field coordination, monitoring equipment and workforce performance, and ensuring that the risks are met.

consistent implementation of occupational safety, as well as regular monitoring through periodic projectevaluations.

4. The questionnaire instrument in this study has met the analytical feasibility criteria, as the validity test results indicate an adequate relationship between the question items and the constructs being measured. The reliability test yielded a Cronbach's Alpha value of 0.820, indicating good internal consistency. Principal component analysis yielded eight factors with eigenvalues greater than one, cumulatively explaining 86.232 percent of the data variation. Therefore, the instrument is declared valid, reliable, and its factor structure is adequate for use in subsequent project risk analysis.

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