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Identification of Risk Factors Affecting Performance in the Implementation of the Reconstruction of the Lindu Lake Access Road, Indonesia

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ABSTRACT: Sigi Regency is one of the areas that has experienced a fairly high increase in transportation, so there are many road functions that have decreased with damaged conditions due to excessive vehicle volume. The purpose of this study is to determine the risk factors that affect performance on the implementation of Lake Lindu Access Road Reconstruction. This study specifically tries to apply the AHP (Analytic Hierarchy Process) method in describing the risk factors that affect the performance of the Lake Lindu Access Road Reconstruction implementation. It is hoped that through this study it can be proven that the AHP method can help project actors be able to handle the risks that occur with the right strategy in order to reduce the negative impacts that can cause losses on construction projects. The study methods include data collection methods and analysis methods. For data collection, this study uses a questionnaire method, there are 11 respondents who are policy makers and who are competent in the field of highway work, both in terms of theory and practice in the field. Based on the analysis of the order of the weight of the risk criteria factors compared in pairs based on the data of the respondents' preferences from related agencies with a consistency ratio (CR)

KEYWORDS: Transportation, Road, Reconstruction, Risk, Performance

INTRODUCTION

Identification of risk factors is a very important initial stage in risk management(Ophiyandri et al. 2011), especially in the implementation of development projects or other strategic activities.(Omran and Subhe Suleiman 2017) The purpose of this process is to identify various potential events or conditions that can have a negative impact on the achievement of project or program objectives, both in terms of time, cost, quality, and sustainability of results.(Omar and Fayek 2016)

The identification process is carried out systematically by involving all related parties, in order to comprehensively describe the sources of risk that may arise(Ophiyandri et al. 2011). Risks can come from various aspects, including technical, operational, environmental, social, economic, and regulatory. For example, in the context of a construction project, technical risks can be in the form of design failures or errors in implementation methods; while external risks can include changes in government policy, extreme weather, or social conflict(Wahyu, Dhafin, and Ramdhani 2024).

Common methods used in identifying risk factors include interviews with experts, studies of previous project documentation, field surveys, and SWOT analysis. Each identified risk is then recorded in a risk register which will be used as a basis for the next stage, namely risk analysis and handling.(Denis 2024)

By conducting early and comprehensive identification, organizations or project implementers can prepare appropriate mitigation steps and increase readiness in facing uncertainty. This will ultimately help improve efficiency, minimize losses, and ensure the success of the overall implementation of activities.(Lu, Yu, and Chang 2014)

Reconstruction, especially post-disaster or large-scale infrastructure projects, often faces various challenges that can affect the overall performance of the project. To ensure the success of reconstruction, it is important to identify risk factors from the planning stage to implementation. This identification aims to recognize and anticipate potential obstacles that can cause delays, cost overruns, or decreased quality of work.(Ophiyandri et al. 2011)

Risk factors that affect the performance of reconstruction can be grouped into several main categories: technical, managerial, environmental, social, economic, and regulatory. Technical risks include design limitations, specification discrepancies, and unexpected field conditions. (Safapour, Kermanshachi, and Rouhanizadeh 2022a)From a managerial perspective, lack of coordination between related parties, weak monitoring systems, and ineffective project management can reduce performance. External factors such as extreme weather, difficult-to-access geographical conditions, and uncertainty about policies or permits also have the potential to greatly hinder implementation.(Safapour, Kermanshachi, and Rouhanizadeh 2022b)

In addition, social aspects such as local community resistance, conflicts of interest, or lack of public participation can be sources of risk in themselves. From an economic perspective, fluctuations in material prices, budget constraints,

and dependence on external resources are challenges that need to be anticipated early on(Elnaz, Sharareh, and Thahomina 2020).

By systematically identifying and analyzing risks, stakeholders can design effective mitigation strategies, such as strengthening management capacity, adjusting technical designs, or preparing flexible work schedules. This is very important to improve the efficiency, effectiveness, and resilience of reconstruction projects to various uncertainties that may occur during the implementation process.(Arya and Kansal 2016)

Performance in the Implementation of Highway Reconstruction refers to how effectively and efficiently the road reconstruction process is carried out to achieve project objectives, both in terms of quality, time, cost, and impact on the community(Santoso and Soeng 2016). This performance assessment is important to ensure that the reconstruction results are in accordance with technical standards and provide optimal benefits for road users and other stakeholders.

The following are some of the main aspects that determine performance in the implementation of highway reconstruction:

a. Quality of Work

Quality is the main indicator of the success of reconstruction. This includes compliance with technical specifications, the resistance of road structures to traffic loads, and the service life of roads after reconstruction. The use of quality materials, appropriate work methods, and strict technical supervision greatly affect quality.

b. Timeliness

Delayed road reconstruction can cause economic losses, congestion, and social disruption. Therefore, project performance is also measured by how timely the project is implemented according to the planned schedule.

c. Cost Efficiency

A good reconstruction project must be able to maximize the use of funds without wasting money. Cost efficiency is seen from the conformity between budget realization and the budget plan (RAB), as well as the minimum additional costs due to design changes or additional work.

d. Safety and Social Impact

Performance also includes aspects

Roads are one of the most vital public assets and the main medium of transportation. For that reason, it is very important to implement proper planning and conduct timely maintenance to ensure its sustainability. Project supervision or risk management is one of the crucial aspects in project implementation (Tang 2003)

Various things that need to be considered in project aspects include planning, organizing, supervising, and controlling, which includes identifying risks, assessing risks, preparing responses to risks, and controlling responses to risks (Rudzki, Gomulka, and Hoang 2022)

Understanding and managing risk in large-scale engineering projects is a challenge in the early phases (Bilau, Witt, and Lill 2017)

The Project Management Institute emphasizes that risk is an event or circumstance that cannot be ascertained and if it occurs, will affect project performance either positively or negatively, related to cost, quality, and time (Bilau, Witt, and Lill 2018)

Risk management is a comprehensive approach to recognizing, evaluating, and managing risks in order to achieve project goals and targets. It is the process by which decisions are taken to account for risks that have been identified or assessed, and to undertake actions aimed at reducing the impact or likelihood of their occurrence(Bilau, Witt, and Lill 2017).Project activities can be understood as a temporary activity that takes place over a limited period of time, with certain resource arrangements and aims to create a result or product whose quality has been firmly determined (Sospeter, Rwelamila, and Gimbi 2020)

Meanwhile, project effectiveness can be defined as the effort or method used by the project to carry out its activities properly, with measures of success reviewed from key indicators such as job security, budget, quality, and schedule. (Jacobsen et al. 2024)The most fundamental aspect is risk, which can be understood as an uncertainty with a known probability. Another definition of risk can be defined as measurable uncertainty that can lead to loss or damage(Akinradewo, Aigbavboa, and Akinradewo 2019).

RISK MANAGEMENT

Risk management is a structured process that includes the planning, identification, analysis, and response stages to potential risks that may arise, with the main objective of maximizing the likelihood and effect of favorable events and minimizing the likelihood and impact of adverse events on the project.(Kabirifar and Mojtahedi 2019)

Risk management is a structured method to identify possible risks so as to minimize unexpected events (Wahyu, Dhafin, and Ramdhani 2024).Risk management is a system designed to recognize all risks encountered in a business activity or project. This system can be used to address ways to manage risks. The framework for the risk management process includes several steps, including risk recognition, risk categorization, risk evaluation, risk reduction actions, and risk management (Denis 2024)

2.1 Risk Identification

Risks can be traced to their origin, the events that occur, and their impact. The process of recognizing risk is the most difficult and crucial stage in risk management, and this difficulty arises from the inability to predict future uncertainties. The process of identifying risk is essential in assessing risk. Both identification and risk assessment are a series of steps in risk management. (Maulana et al. 2025a)

Risk identification is important because it is the first stage that must be carried out because in this stage the

determination of risks and their characteristics that may affect the project is carried out. Failure in this stage will have a major effect on the next stage of risk management and will certainly affect the reliability of the project because of the many vulnerabilities / gaps that may occur in the future.

2.2 Analytic Hierarchy Process (AHP) Method

AHP has proven to be effective in various sectors and fields of study. Its ability to manage qualitative as well as quantitative information makes AHP a very suitable method for various issues related to prioritization (Denis 2024)

The AHP (Analytic Hierarchy Process) method is a decision support model developed by Thomas L. Saaty, a mathematician who worked at the University of Pittsburgh in the United States in the early 1970s. (Maulana et al. 2025a)

The AHP method is an approach to decision-making that utilizes elements of logic, feeling, experience, knowledge, emotion, and instinct to be optimized in a structured process. This method can also compare by pairing aspects that can and cannot be measured, both quantitative and qualitative data. In addition, AHP is a general theory of measurement that is used to generate a ratio scale from several comparisons that are discrete and continuous in nature (Maulana et al. 2025b)

METHODOLOGY

The method used in this research is a survey. Survey is a way to collect primary data by obtaining information directly from the research location. Collecting data or information and facts from the field is done through questionnaires and interviews, both orally and in writing, which requires direct interaction between researchers and respondents (Zhang et al. 2019)

2.1 Data Collection Methods

The data collection technique used is divided into two. First, primary data collection techniques, namely data obtained directly through the interview / questionnaire method to respondents who have been selected purposively or in other words, the selected respondents are respondents who are technically considered to know the problems regarding the research conducted by the author. The selected respondents are policy makers and those competent in the field of highway work, both in terms of theory and practice in the field.

Respondents were selected from technical agencies, namely from elements of the Central Sulawesi National Road Implementation Center, Design Supervision Consultant, DSC A6 Consultant and Lindu Sub-District Head. Secondary data was obtained from relevant technical agencies.

2.2 Data Analysis Method

The variables used in this research consisted of criteria/considerations that became the background of the priority selection of pavement types in Palu city. The criteria used in determining priorities were identified through literature, literature review and references from similar studies that have been conducted previously. In this research, the preparation of the hierarchy level used in the Analytical Hierarchy Process (AHP) method consists of 3 (three) levels, namely :

1) Level 1 (purpose), is the research objective of knowing the risk factors that affect performance.
2) Level II (Criteria) consists of several criteria in finding risk factors that affect time performance. These criteria are: Planning Condition Factor (A), Technical Factor (B), Environmental Factor (C), and Political Factor (D).
3) Level III (Development of Level II, hereinafter referred to as sub-criteria), Sub-criteria of Technical Factors, Environmental Factors, and Political Factors, obtained from secondary data obtained from related agencies.

The Hierarchical Structure in this study is as follows:

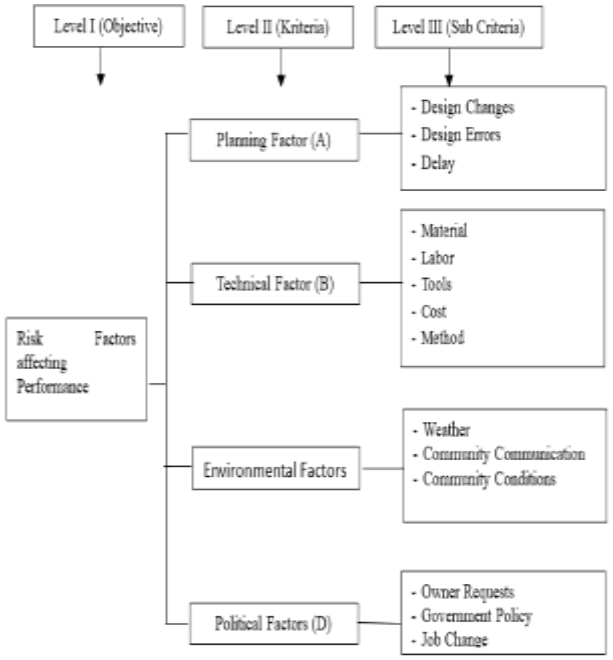


Figure 1. HP hierarchical structure for analyzing risk factors affecting performance

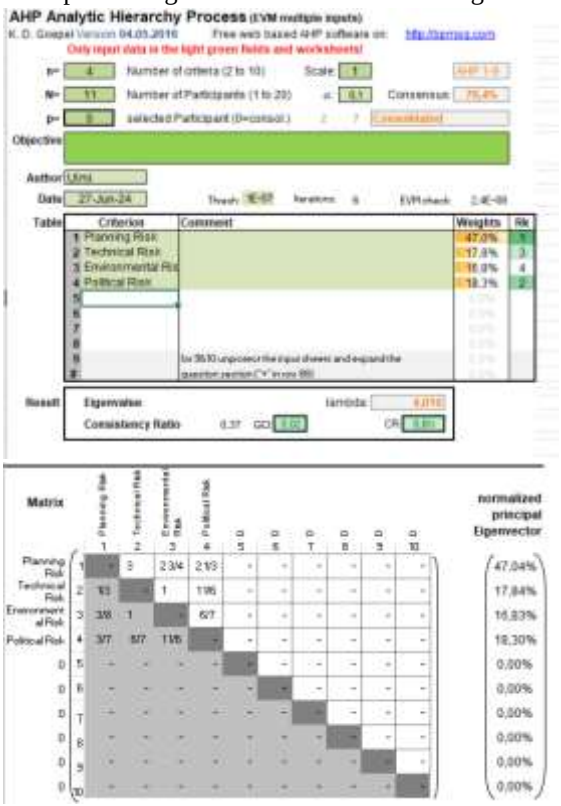
RESULTS AND DISCUSSION

This research uses the Analitycal Hierarchy Process (AHP) method. AHP is used to determine the weight of 4 predetermined criteria including technical aspects, cost aspects, implementation aspects and policy aspects. In each criterion there are sub-criteria which are also weighted to find out which sub-criteria in each criterion are most influential in determining the type of pavement. The Analitycal Hierarchy Process (AHP) in this study was carried out based on the characteristics of respondents who are policy makers and who are competent in the field of road works, both in terms of theory and practice in the field. In this research, researchers took 11 (eleven) respondents from related technical agencies.

Weighting of Risk Factors

Obtained the final results of the weighting of the criteria from all respondents from the respondents weighting the criteria with a consistency ratio (CR) of 0.6% (<10%), it can be seen that the influential factors in determining the risks that

affect time performance are Planning Risks with a weight value of 47.00%, Political Risks with a weight value of 18.30%, Technical Risks with a weight value of 17.80%, and Environmental Risks with a weight value of 16.80%. The results of data processing can be seen in the following table :

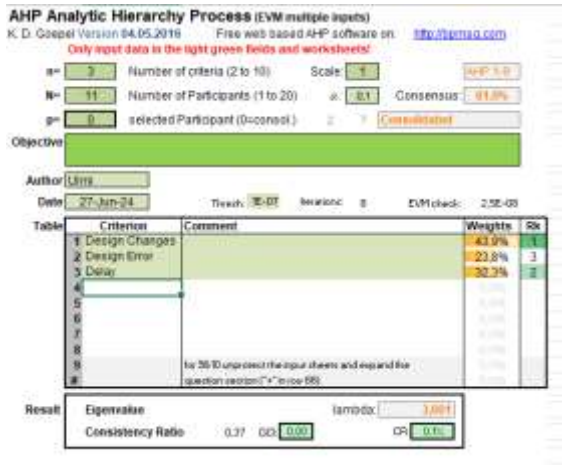


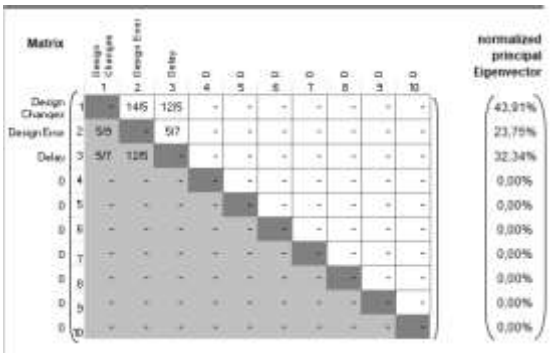
Source: *Primary Data Analysis Results, 2024*

Figure 2. Risk Factor Criteria Weighting

Weighting of Planning Risk Sub Criteria

Obtained the final results of the weighting of the criteria from all respondents from the respondents weighting the criteria with a consistency ratio (CR) of 0.1% (<10%), it can be seen that the influential factors in Planning Risk that affect time performance are Design Changes with a weight value of 43.90%, Design Delays with a weight value of 32.30%, and Design Errors with a weight value of 23.80%. The results of weighting between sub-criteria from technical aspects can be seen in the following figure :





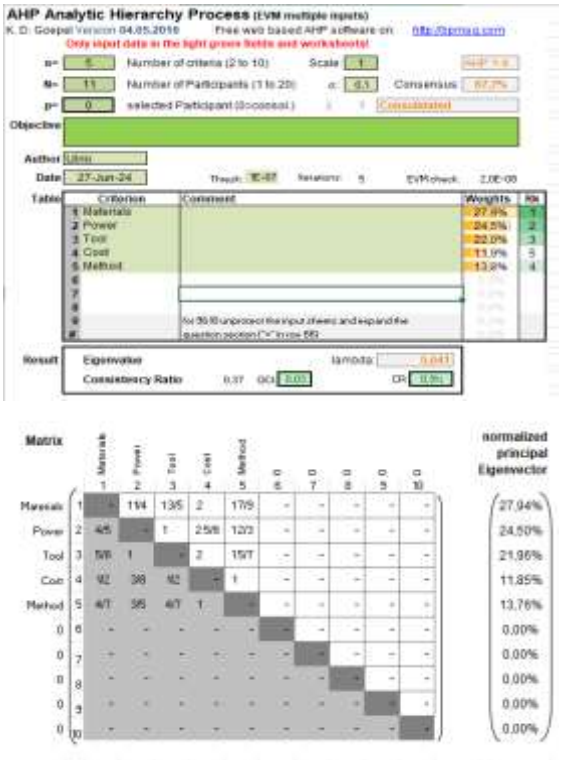
Source: *Primary Data Analysis Results, 2024*

Figure 3. Weighting of Planning Risk Sub-Criteria

Weighting of Technical Risk Sub Criteria

The Analitycal Hierarchy Process (AHP) method in this study is used to determine the weight of 4 predetermined factors, including planning factors, technical factors, environmental factors, political factors. In each factor, there are sub-factors that are also weighted to determine which sub-factors in each factor are most influential in determining the risks that affect performance.

The final results of weighting the sub-criteria from all respondents derived from the respondents weighting the criteria with a consistency ratio (CR) of 0.9% (<10%), it can be seen that the influential factors in Technical Risks that affect time performance are Material with a weight value of 27.90%, Labor with a weight value of 24.50%, Tools with a weight value of 22.00%, Work Methods with a weight value of 13.80%, and Cost 11.9%.

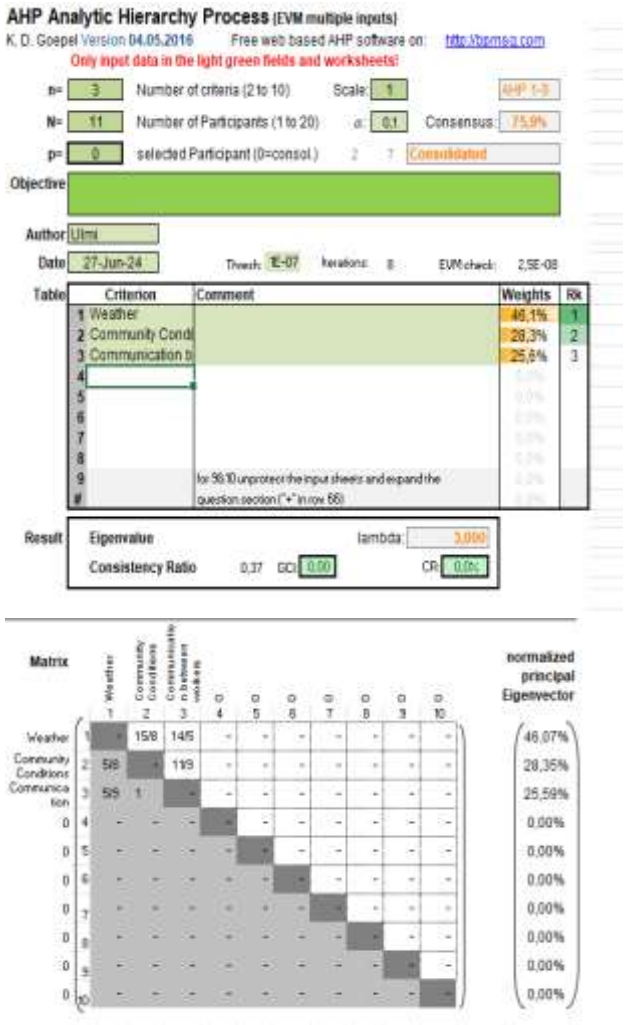


Source: *Primary Data Analysis Results, 2024*

Figure 4. Weighting of Technical Risk Sub Criteria

Weighting of Environmental Risk Sub Criteria

The final results of weighting the sub-criteria from all respondents derived from the respondents weighting the criteria with a consistency ratio (CR) of 0.1% (<10%), it can be seen that the influential factors in Environmental Risks that affect time performance are Weather with a weight value of 46.10%, Communication Between Workers with a weight value of 28.30%, and Community Conditions with a weight value of 25.60%.

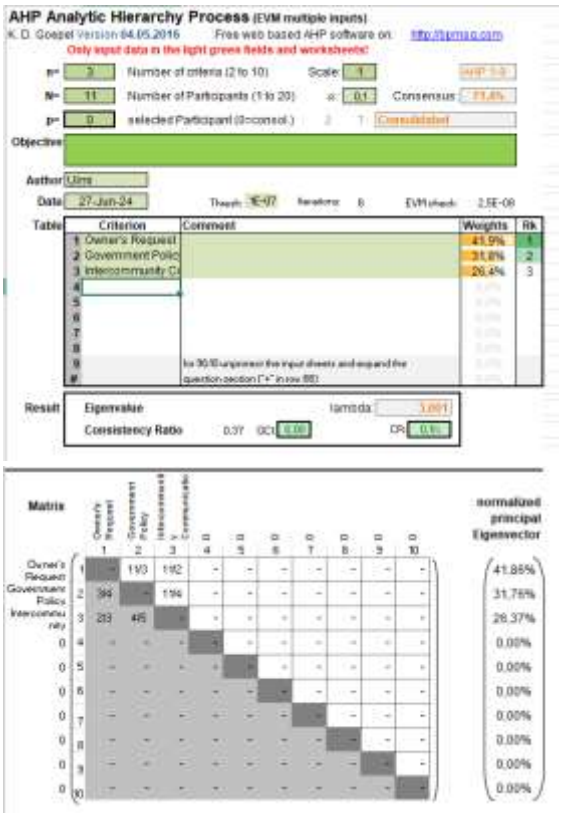


Source: *Primary Data Analysis Results, 2024*

Figure 4: Weighting of Environmental Risk Sub-Criteria

4.2.4 Political Risk Sub Criteria Weighting

The final results of weighting the sub-criteria from all respondents derived from the respondents weighting the criteria with a consistency ratio (CR) of 0.1% (<10%), it can be seen that the influential factors in Political Risk that affect the performance of time are Owner Demand with a weight value of 41.90%, Government Policy with a weight value of 31.80%, and Communication Between Communities with a weight value of 26.40%.



Source: *Primary Data Analysis Results, 2024*

Figure 5. Political Risk Sub Criteria Weighting

CONCLUSIONS

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

a. The most influential risk factors for the reconstruction of Lake Lindu road access are carried out by weighting methods using five risk criteria factors, namely planning risk, technical risk, environmental risk and political risk. The relative weight between the five risk criteria factors compared in pairs based on data from respondents' preferences from related agencies with a consistency ratio (CR) value of 0.1% (<10%) is planning risk with a weight of 47.00%, then followed by a political risk factor with a weight of 18.30%, followed by a technical factor of 17.80% and an environmental risk factor with a weight of 16.80%. While the weather is the sub-criteria of risk factors that most affect the performance of the reconstruction of the Lake Lindu access road.

b. From the results of the current study when compared with the ongoing implementation for the reconstruction of the lake lindu access road, the performance of the reconstruction of the lake lindu access road is carried out by the weighting method using the highest weight criterion factor of planning risk and weather risk sub criteria from the risk of environmental

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