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APPLICATION OF AHP METHOD FOR DECISION MAKING IN CHANGING ROAD PAVEMENT TYPES (CASE STUDY: JL. LELEMINA, PALU CITY)

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ABSTRACT

The selection of the right type of road pavement is a crucial factor in infrastructure planning, especially in improving the durability and cost efficiency of road maintenance. Lelemina Street in Palu City has significant pavement problems, including surface damage and increased traffic volume, so an in-depth analysis is needed to determine the most appropriate type of pavement. This study aims to apply the method ***Analytical Hierarchy Process*(AHP)** in decision making related to changes in road pavement types. AHP is used to compare various pavement alternatives based on several main criteria, such as cost, durability, ease of maintenance, and environmental impact. The results of the study indicate that the AHP method can provide a systematic and quantitative-based approach in determining the optimal pavement type. The best alternative is selected based on the weight of importance of each criterion, which is obtained through pairwise comparisons. Thus, the application of the AHP method can be an effective solution in supporting data-based decision making in road infrastructure planning.

KEYWORDS: AHP, Road, Pavement Type, Policy, Decision.

INTRODUCTION

Road infrastructure development is one of the important components in supporting economic growth (Sirega et.al,. 2023 Damanik et.al,. 2024; Matondang et.al,. 2024) and economic mobility of the community (Huda and Yuliati, 2024). According to Law Number 38 of 2004 concerning Roads, one of the roles of roads is as part of a very important means of transportation in supporting the economic, socio-cultural, environmental, political, defense and security sectors, and is used as much as possible for the prosperity of the people. Robbani and Nadhif (2024) state that roads are basic infrastructure needed by humans to move in order to meet their needs, both for the distribution of goods and services and as a route for land vehicles.

The selection of road pavement types affects quality standards, and has high durability (Febriansyah, 2023), maintenance costs (Maharani and Wasono, 2018), and road user comfort (Prayogo, 2018). However, in practice, decision-making related to changes in road pavement types often faces various challenges, such as budget constraints, environmental conditions, traffic volume, and other technical factors. Setiawan and Ketut (2024) stated that pavement is an important part of the road structure, the selection of road pavement types is one of the challenges in decision-making for road organizers. The selection of road pavement types is a consideration that must be evaluated objectively.

Lelemina Street in Palu City is one of the roads that has problems related to pavement quality. Handayasari and Cahyani (2016) explained that road pavement is a layer located between the base soil layer and the vehicle wheels and is a layer that is in direct contact with vehicles. Road surface damage is a common problem, including because the load received by the road cannot be borne by the base soil layer, road user behavior, environmental influences, and the implementation of road pavement structure construction. According to Harianto and Suhardi (2022), the road surface is prone to various types of damage due to rainwater penetration into damaged areas.

One method that can be used in the decision-making process is the Analytical Hierarchy Process (AHP). According to Mahendra and Indrawan (2020), AHP can help decision-making by choosing the best alternative based on certain criteria. The benefits of AHP are helping to organize complex problems into a hierarchical structure that is easier to understand, providing a systematic and structured way to evaluate alternative solutions, allowing the combination of various criteria with different measurement scales, and

increasing efficiency and objectivity in decision-making (Zahra and Susanto, 2024). This method is able to help in assessing various pavement alternatives by considering various relevant criteria, such as cost, durability, ease of maintenance, and environmental impact. By using the AHP approach, the decisions taken will be more objective and based on quantitative analysis and multi-criteria considerations.

This study aims to apply the AHP method in decision making related to changes in the type of pavement on Lelemina Road in Palu City. With this study, it is expected that optimal road pavement recommendations can be obtained, thereby improving the quality of infrastructure and efficiency in road management in the area. Based on this, a systematic study is needed for decision making in changing the type of road pavement using the AHP method in order to improve the performance and durability of the road.

METHOD

Research approach

This study uses the Analytical Hierarchy Process (AHP) approach as the main method in decision making related to changes in road pavement design. AHP is used to evaluate and determine the priority of criteria in selecting the type of road pavement by considering various technical and non-technical factors. The data processing process to calculate the weight of each criterion, sub-criteria and alternative pavement researchers use the assistance of Expert Choice software version.[11]

Location and Time of research

This research was conducted on Jalan Lelemina, Palu City, Central Sulawesi with a data collection period between January-February 2025.

Research design

This study uses a descriptive quantitative research approach with AHP-based decision-making techniques. While the type of data used is primary data obtained through interview surveys and questionnaires to respondents who have expertise in the field of road pavement and secondary data comes from reports from related agencies, road maintenance data, and literature studies.

Data collection technique

The data collection techniques used in this study to assist decision making regarding road pavement design consist of:

- Field observations were conducted by observing existing road conditions, traffic volume, and factors influencing pavement selection.
- The questionnaire was used to obtain the criteria weights and preferences of experts in selecting pavement types.
- In-depth interviews were conducted with experts and stakeholders to strengthen the quantitative results.
- The literature study used is an official document as an additional reference in the analysis.

Research respondents

This study used 5 respondents, consisting of 2 people from the Public Works Department of Palu City, 1 person from the Spatial Planning Department of Central Sulawesi Province, 1 person from the organizational section of the Regional Secretariat (Regional Government Budget Team) of Palu City, and 1 person from a practitioner in the field of road paving. The selection of respondents was based on expertise in the field of road paving and infrastructure development policies.

Research variables

With a clear hierarchical structure in this study, the use of objective methods based on various criteria factors and alternative types of pavement. The variables used in this study are:

- Criteria consisting of Technical criteria; Non-Technical criteria; resource criteria; Road condition criteria; Land Use criteria; and planning criteria.
- Alternative pavement types consist of: Rigid Pavement; Composite Pavement; AC-WC; HRS; Latasir; and Lapen.

Data analysis methods

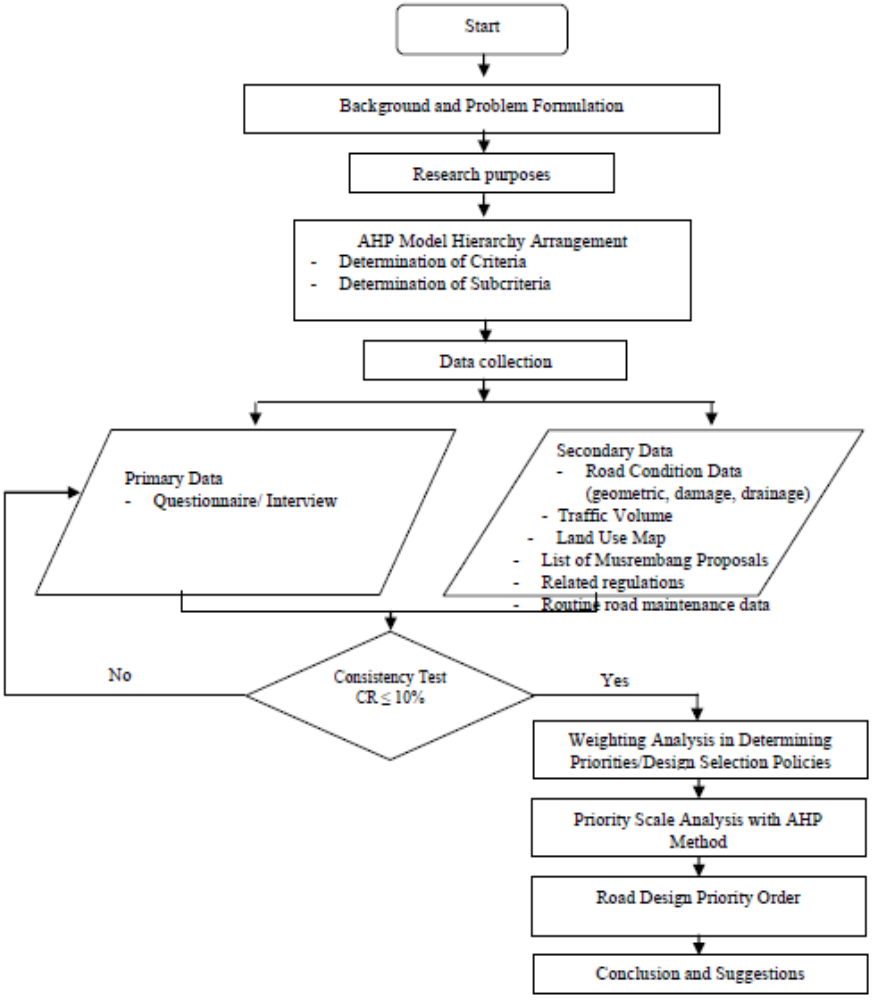

Figure 1: Research flowchart.

After collecting secondary data and distributing questionnaires to respondents, the results will be analyzed using the Analytical Hierarchy Process (AHP) method, developed by Thomas L. Saaty in 1986.

Analytical Hierarchy Process (AHP) in this study was conducted based on the characteristics of respondents who understand and are experts in the field of roads, financial planning and have experience in planning and implementing road works. In this study, the researcher took 5 (five) respondents who were considered experts and had experience in the field of road paving. The data processing process to calculate the weight of each criterion, sub-criteria and pavement alternatives researchers use the assistance of Expert Choice software version.[11] The calculation of priority weights is carried out on each criterion from the assessment given by all respondents (5 respondents) in making decisions to change the type of road pavement.

RESULTS AND DISCUSSION

The most determining criteria in changing road pavement construction

In the context of changing the type of road pavement, there are several criteria used to assess the factors that influence the decision. The following are the results of the analysis of the most determining criteria in road pavement construction using the AHP method, namely: Road condition aspects with a weight of (0.347), technical aspects (0.271), planning aspects (0.217), resource aspects (0.079), land use aspects (0.048) and non-technical aspects (0.038). This can be seen in Figure 2. below:

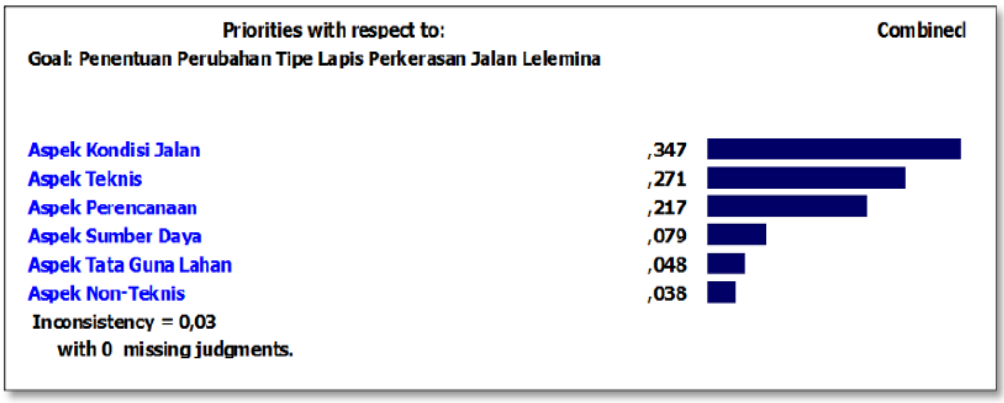

Figure 2: Priority of criteria in determining the selection of road pavement type.

Based on Figure 2, it shows thatIn changing the type of road pavement in Lelemina, the Road Condition factor is the most determining factor with the largest weight of 0.347 or 34.70%. of several existing criteria, so it becomes a priority. This is because the road condition aspect itself is a factor that influencessafety, comfort and efficiency of traffic on the road. On Lelemina Street itself, the existing road conditions are very damaged, affecting the comfort of vehicle users passing through the road.

This condition explains that on Lelemina Street, road damage is the main factor in determining changes in pavement type. Because road surface damage directly affects the comfort, maintenance costs, and safety of road users.Katmoko et al (2017) stated thatDamage that occurs on the road is usually undesirable, this is because it affects the quality of vehicle comfort.

Road conditions are a major factor in determining whether a road requires a change in pavement type. Roads that are severely damaged or do not meet traffic needs require significant construction changes. According to Mubaraki and Sallam (2021), minor damage

that is not immediately addressed will result in major and increasingly severe damage, road users are greatly disadvantaged because they become uncomfortable, speed is hampered/reduced, and many victims are caused by road damage that is not immediately addressed.

Alternative priorities in determining the selection of overall pavement layer type changes

The overall priority alternative for selecting the type of road pavement in changing the type of pavement layer is the final result and goal of the hierarchy that has been compiled. The following is an overall analysis of the Analytic Hierarchy Process (AHP) which can be seen in Figure 3 below:

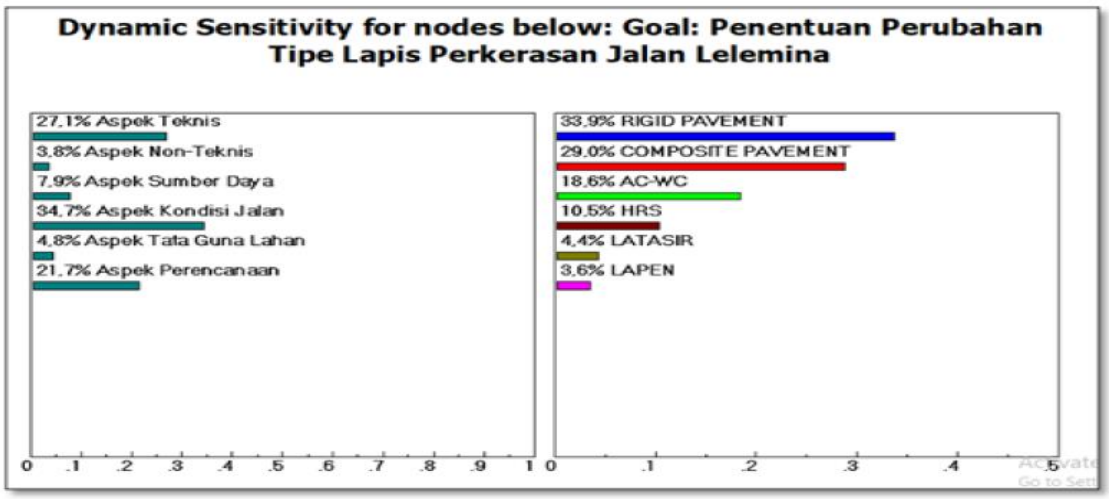

Figure 3: Alternative priorities in the overall determination of pavement layer type change.

Based on Figure 3 above, it illustrates the sequence of alternative types of pavement for changes in the type of pavement layer (case study of Jl. Lelemina) in Palu city, namely: the Rigid Pavement pavement type is the first priority with a weight value of 33.90%. The second priority is Composite Pavement with a weight value of 29.00%, AC-WC (Aspal Concrete Wearing Course) is the third priority with a weight value of 18.60%. The fourth priority is the HRS (Hot Rollers Sheet) pavement type with a weight of 10.50%. The fifth priority is the Latasir / sand sheet pavement type with a weight value of 4.40% and the last priority is Lapen (Macadam Penetration Layer) with a weight value of 3.60%.

The results show that Rigid Pavement is more dominant in terms of road conditions. At the previous road condition research location using flexible pavement, the road design life was

always not achieved and while road maintenance and improvement were carried out continuously, it was unsuccessful because damage continued to occur repeatedly. Therefore, a change in the type of pavement layer was made.

Rigid Pavement alternative has the highest weight or the first priority order of alternative pavement types for changes in pavement layer types, indicating that rigid pavement is more recommended to handle road conditions in Lelemina. The use of concrete is more appropriate to handle road conditions in Lelemina because it has higher resistance to damage conditions. The Rigid Pavement pavement layer type is a type of rigid pavement with the advantages of being stronger and more durable, easy maintenance and low maintenance costs, and is also able to accept high traffic loads.

According to Setiawan and Supratman (2025), concrete has been proven to provide high resistance to heavy traffic loads, increase the service life of pavements, and reduce long-term maintenance costs. This was also stated by Lestari andThe Jewels(2022); AK Fauzi (2020) that road repairs are needed to improve safety, and rigid pavements are more resistant to heavy loads and have a longer life of around 15–40 years, and are able to withstand high traffic volumes compared to flexible pavements.

The second priority alternative is the Composite Pavement type of pavement. This shows that the combination of concrete and asphalt is considered to provide a balance between the durability of concrete and the flexibility of asphalt. In addition, it is chosen as a more flexible and more economical alternative than pure Rigid Pavement.

In the third place, the priority alternative for decision-making in changing the type of road pavement is AC-WC (Asphalt Concrete - Wearing Course) with a percentage of 18.6%. This type of pavement is the top layer of asphalt pavement that provides better driving comfort than concrete, because it is smoother and reduces noise. Compared to rigid concrete, AC-WC has better flexibility, making it more resistant to cracks due to ground movement or thermal expansion. However, the designation of Lelemina Road is still not feasible. This is because Lelemina Road is often used by heavy vehicles such as trucks or buses. In addition, the geographical conditions of Lelemina Road are prone to waterlogging or unstable soil which makes the road conditions have a high level of humidity.

The HRS (Hot Rolled Sheet) pavement type is the fourth priority alternative for decision making in changing the type of the fourth road pavement layer with a weight of 10.5%. HRS-WC (Hot Rolled Sheet–Wearing Coarse) is a type of HRS pavement which is a surface wearing layer of asphalt pavement. Its function is as a waterproof layer, making the road surface smooth, supporting the vehicle load so that grooves do not form, and as a slip resistance to the pavement surface (Ruhaidani et al, 2023).

Based on the characteristics of the lelemina road. HRS is not strong enough to withstand heavy traffic and heavy loads of large trucks. Because HRS is more quickly deformed and wavy due to high pressure from large trucks. In addition, having high soil moisture conditions can accelerate road cracks or holes. So, the road will require more frequent maintenance if it continues to use HRS.

The fifth order for alternative decision-making priorities in changing the type of road pavement layer is latasir with a percentage value of 4.4% and the last is the type of macadam penetration pavement layer (lapen) with a percentage value of 3.6%. Thin layer of sand asphalt (Latasir) is a cover layer consisting of a mixture of sand and hard asphalt which is mixed and compacted in a hot state and at a certain temperature, with a compaction thickness of 1 - 2 cm, this layer is used as a non-structural layer (Lapian and Nauw 2017). While lapen is a pavement layer consisting of uniformly graded main aggregate and locking aggregate bound by asphalt by spraying it on top of the main aggregate and compaction is carried out layer by layer (Ministry of Public Works, 2016).

When looking at the characteristics of the lelemina road. Then, Latasir and Lapen are not at all suitable to be applied in this location for several main reasons including: its structural resistance is very low against heavy loads, so the road will be damaged quickly, high humidity accelerates the degradation of the asphalt layer, causing the road to have holes or peel off in a short time. So that it will cause maintenance to be very expensive, because these two methods require more frequent routine repairs than other types of pavement.

CONCLUSION

Based on the research results, the following conclusions can be drawn

a. The road condition aspect is the most influential criterion for the priority of road pavement types for decision making on changing the type of road pavement in Palu City with a relative importance weight of 34.70%, then the second priority is the technical

aspect criterion 27.10%, then followed by the planning aspect criterion 21.70% in the third priority, the fourth priority is the resource aspect with a weight of 7.90%, the land use aspect is the fifth priority with a weight of 4.80% and the non-technical aspect criterion 4.80%. Meanwhile, road damage is the most influential sub-criterion of road conditions in determining the selection of road pavement types.

b. The overall priority alternatives for selecting road pavement types for changes in road pavement layer types in Palu City resulting from this study are: Rigid Pavement pavement type 33.90%, Composite Pavement pavement type 29.00%, AC-WC (Asphalt Concrete Wearing Course) pavement type 18.6%, HRS (Hot Rollers Sheet) pavement type 10.50%, Latasir / sand sheet pavement type 4.40%, Lapen pavement type (Macadam Penetration Layer) 3.60%.

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