Quest Journals
Journal of Architecture and Civil Engineering
Volume 7 ~ Issue 4 (2022) pp: 30-38
www.questjournals.org

Research Paper

Analytic Hierarchy Process for Priority Determination of Feasibility Development of Roads in Several Locations In Kutai Timur Regency

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ABSTRACT
The research objectives are to determine: (1) the weight of the priority scale hierarchy; (2) comparison of priority of integration factors against the hierarchy of road networks, and (3) comparison of priority of cost and financial factors.
The research was carried out for + 3 months, with the AHP approach method. The respondent who became the resource person was an expert (expert) conducted on 9 respondents, consisting of elements of the government, practitioners, and academics. Data analysis using Analytical Hierarchy Process (AHP).
The results showed that: (1) The priority scale hierarchy for level 2 on the criteria, namely the integration factor to the road network hierarchy (65.42%). This shows that the response of the expert to the improvement of the road network hierarchy is very important; (2) Comparison of the priority of integration factors to the road network hierarchy, namely providing access to collector and local roads (83.16%). This shows that the expert response wants a collector road that connects efficiently between national activity centers and local activity centers, and (3) Comparison of the priority of cost and financial factors, resulting in a weight for road construction costs of 47.93%. Some expert responses want road construction to be one thing that always goes hand in hand with technological advances and the human mind that uses it.

Keywords: AHP, Priority Feasibility, Road Construction

Received 02 Apr, 2022; Revised 16 Apr, 2022; Accepted 18 Apr, 2022 © The author(s) 2022.
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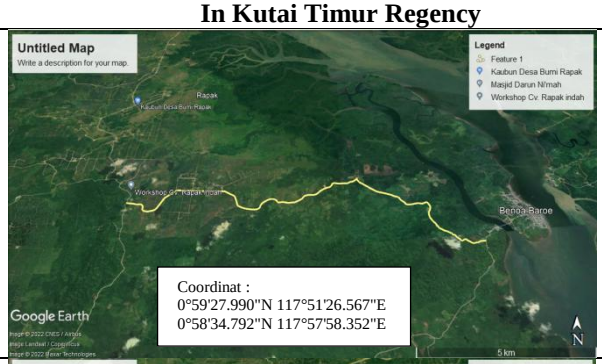
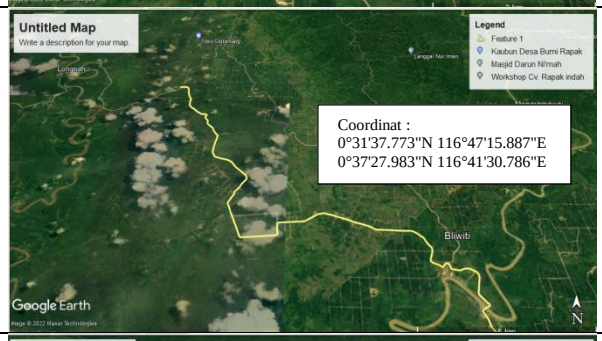
I. INTRODUCTION

Transportation is a supporter of the development of an area. Roads play an important role in realizing smooth land transportation. Steady road conditions determine the smooth implementation of land transportation to support economic activities. Steady road conditions require good management. The physical infrastructure of the road network has a very strong relationship with the economic growth of a region as well as the socio-cultural life of the community. In the economic context, roads as social capital for the community are a place to rely on economic development, so that high economic growth is difficult to achieve without the availability of adequate roads. Development is a process of continuous change from unfavorable conditions to better ones so that a new environmental balance occurs (Muntasar, 2011).

The regional program in East Kutai Regency carries out activities for road construction in several locations with the aim of improving transportation infrastructure in order to create a road network that can provide capacity according to needs and has good structural value with the aim of maintaining road stability so that it can still provide good service. optimal for the traffic flow that passes through it within the limits of repetition of standard loads and the planned structure. This research is to determine the feasibility of road construction by determining the priority scale that can be used as a policy reference in the preparation of the project program for the next fiscal year. Determining the priority scale of the road construction project must look at various criteria so as to produce accurate and precise results. The analytical hierarchy process (AHP) method used in solving decision problems is to allocate several criteria and sub-criteria that can be used as references in policy making so that they can carry out future planning that is projected and set priorities for handling.

Location of the road construction plan in East Kutai district, as presented in Table 1.

Table 1. Location of the Road Construction Plan in East Kutai Regency

Location	Road Section Name	Image of Road Construction Plan Location In Kutai Timur Regency
1	Road Cipta Graha - Kolek – Ronggang Road Length: 15,92 km	
2	Road Tanjung Manis - Susuk - Rimba Hijau Length: 51,81 km	
3	Road SDC Bridge - Simpang 3 Teluk Baru Length: 21,13 km	
4	Road SDC Bridge - Benua Baru - Muara Bengkal Length: 9,04 km	

Source: Results of Analysis and Google Earth, 2022

II. RESEARCH METHODS

A. Time and Location

The research was carried out for + 3 months with the location in the East Kutai Regency, East Kalimantan Province.

B. Data Collection Method

The research uses the AHP approach, the respondent who is the resource person for weighting is an expert who has expertise in accordance with the research topic (expert response) being carried out. According to Sugiyono (2009), respondents who are considered as experts/experts/experts are those who have competence consisting of those who have the authority/policy to decide, routine tasks and professions related to research. The expert response data sample was conducted on 9 respondents, consisting of the government, practitioners,

and academics who are the right people to be respondents in determining the weight of the influence of factors, variables, and indicators.

The AHP method begins with distributing questionnaires in the form of a google form to several respondents. The distributed questionnaire data were selected by purposive sampling technique, namely "the technique of determining the sample with certain considerations". The numbers given to the respondents' perceptions are a comparison scale of each criterion and sub-criteria factor. The processes that occur in the AHP method for the policy of prioritizing the feasibility of road construction in several locations in the East Kutai Regency.

C. Analytic Hierarchy Process Method (AHP)

Analytical Hierarchy Process(AHP) was developed by Thomas L. Saaty in the 1970s. AHP is a decision-making system using a mathematical model. AHP helps in determining the priority of several criteria by conducting pairwise comparison analysis of each criterion. AHP is also a flexible model that provides an opportunity for individuals or groups to build ideas and define problems by making their own assumptions and obtaining the desired solution from them. To support decision makers involving their experience, knowledge and intuition. AHP breaks down a decision problem into elements, according to their general characteristics, and levels, which correspond to the general characteristics of the elements. The top level is the "focus" of the problem or ultimate goal; the middle level corresponds to the criteria and sub-criteria, while the lowest level contains "decision alternatives". If every element of each level depends on all elements of the top level, then the hierarchy is complete; otherwise, it is defined incompletely. The elements of each level are compared in pairs with respect to the specific element in the immediate upper level.

III. RESULTS AND DISCUSSION

The processes that occur in the AHP method for policy on the feasibility scale of road construction in several locations in the East Kutai Regency are:

A.*Decompocition*

After the problem is defined, decompotion is carried out, namely breaking the whole problem into its elements. The structure of the identification criteria for respondents consists of 3 (three) levels, namely:

1. The first level, the goal is to determine the priority scale of the feasibility of road construction in several locations in the East Kutai Regency
2. The second level of criteria, consisting of 6 factors, namely:
   a. Integration factor to the road network hierarchy
   b. Integration factor to spatial
   c. Cost and financial factors
   d. Social impact factor
   e. Environmental impact factor
   f. Physical and technical factors
3. The third level is a development of level 2 and consists of several sub-criteria.

   Overall the hierarchy of priority scale determination can be described as the preparation of a hierarchical level consisting of 3 (three) levels, as shown in Figure 1.

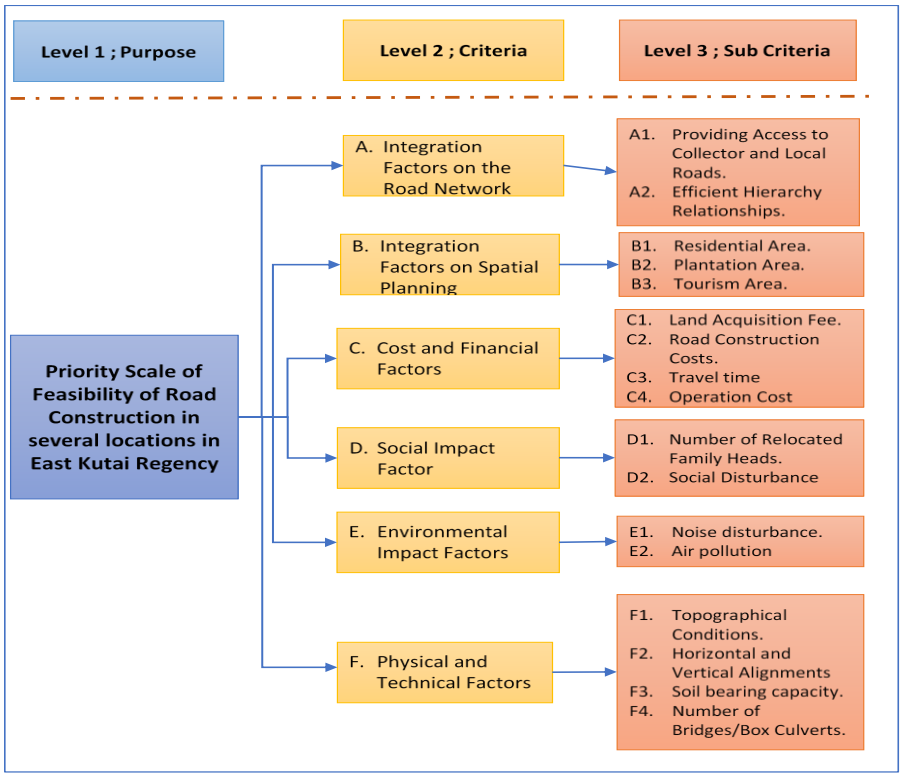


Figure 1. Hierarchy of Determining the Priority Scale of Road Construction Feasibility in Several Locations in the East Kutai Regency (Source: Analysis Results, 2022)

B.*Comparative Judgement*

This stage is to make an assessment of the relative importance of the two elements at a given level in relation to the level above it. This assessment is the core of the AHP, because the assessment will affect the priority of the elements. The results of this assessment will look better if they are presented in the form of a matrix called a pairwise comparison matrix.

The pairwise comparison scale is based on the fundamental values of AHP with a weighting from 1 for equally important to 9 for very important in accordance with Table 2, from the arrangement of the pairwise comparison matrix a number of priorities are generated which are the relative influence of a number of elements on the elements within the existing level. On Eigenvector calculation by multiplying the elements in each row and multiplying by the root of n, where n is the element. Then normalize to unify the number of columns obtained. By dividing each value by the total value, the decision maker can determine not only the order of priority ranking for each stage of the calculation but also the magnitude of the priority. The criteria are compared based on the opinion of each decision maker and then their priorities are calculated.

Table2. Formation of the initial sub-criteria matrix

	A	B	C	D	E	F
A	1	2,444	2,667	1,333	1,222	1,444
B	0,409	1	2,444	1,889	1,667	1,889
C	0,375	0,750	1	1,778	1,556	1,556
D	0,818	0,692	0,409	1	1,556	1,889
E	0,529	0,600	0,529	0,563	1	2,222
F	0,643	0,643	0,643	0,529	0,450	1
∑	3,775	6,13	7,692	7,092	7,450	10,000

Source: Analysis Results, 2022

C. *Synthesis of Priority*

Each pairwise comparison matrix is then searched for eigenvectors to get local priority, because the pairwise comparison matrix is present at each level, then to get global priority, synthesis must be carried out between local priorities. The procedure for performing the synthesis differs according to the form of the hierarchy. The ordering of elements according to their relative importance through a synthesis procedure is called priority setting.

Determining the level of importance to the criteria, answers are obtained based on the scale/range of assessment. The element weight calculation is done by using a matrix. If in an operating sub-system there are "n" operating elements, namely operating elements A1, A2, A3, ...An, the results of a pairwise comparison of these elements will form a comparison matrix. Pairwise comparisons start from the highest level of the hierarchy, where a criterion is used as the basis for making comparisons. The form of the pairwise comparison matrix of element weights as shown in Table 3.

Table3. Vector eigenvalues for the "criteria" priority setting scale

	A	**B**	**C**	**D**	**E**	**F**	**Total**	***wi***	***E-Vector***
A	1	2,444	2,667	1,333	1,222	1,444	15,344	2,557	0,654
B	0,409	1	2,444	1,889	1,667	1,889	5,947	0,991	0,254
C	0,375	0,750	1	1,778	1,556	1,556	1,210	0,202	0,052
D	0,818	0,692	0,409	1	1,556	1,889	0,681	0,113	0,029
E	0,529	0,600	0,529	0,563	1	2,222	0,210	0,035	0,009
F	0,643	0,643	0,643	0,529	0,450	1	0,063	0,011	0,003
∑	3,775	6,13	7,692	7,092	7,450	10,000	23,455	3,909	1

Source: Analysis Results, 2022

The maximum eigenvalue matrix is obtained from the initial matrix multiplied by the E-Vector of each matrix and then the multiplication results are added together. This is shown in the following matrix:

	A	B	C	D	E	F		*E-Vector*		
A	1	2,444	2,667	1,333	1,222	1,444		0,654		1,465
B	0,409	1	2,444	1,889	1,667	1,889		0,254		0,722
C	0,375	0,750	1	1,778	1,556	1,556	x	0,052	=	0,557
D	0,818	0,692	0,409	1	1,556	1,889		0,029		0,780
E	0,529	0,600	0,529	0,563	1	2,222		0,009		0,557
F	0,643	0,643	0,643	0,529	0,450	1		0,003		0,639
∑	3,775	6,13	7,692	7,092	7,450	10,000		1		4,720
								λmax	=	4,720

D. ***Logical Consistency Hierarchy***

Logical consistency states a measure of whether or not an assessment is consistent or weighted pairwise comparisons. This test is necessary, because in actual conditions there will be some deviations from the relationship so that the matrix is not perfectly consistent. This can occur due to inconsistencies in one's preferences.

Hierarchy is the easiest tool to understand complex problems where the problem is broken down into the elements concerned, arranges these elements hierarchically and finally makes an assessment of these elements while determining which decisions will be taken. The process of arranging elements hierarchically includes grouping elements into homogeneous components and arranging these components in the appropriate hierarchical level. Hierarchy is also a system whose decision levels are stratified with several decision elements at each decision level.

To quantify the qualitative opinion, a rating scale is used so that the opinion value will be obtained in the form of numbers. According to Saaty (1990), for various problems, a scale of 1 to 9 is the best scale in qualifying opinions, namely based on its accuracy based on the value of Root Mean Square (RMS) and Median Absolute Deviation (MAD). The value and definition of qualitative opinion in the Saaty (1990) comparison scale is in Table 4 below :

Table4. Pairwise Comparison Matrix Scale

Intensity of Interest	**Definition**	**Explanation**
1	One element is as important as the other elements (*equal importance*)	Both elements contribute equally to the trait
3	One element is slightly more important than the other elemen (*moderate more importance*)	Experience states a little in favor of one element
4	One element is clearly more important than the other elements (*essential, strong more importance*)	Experience shows strongly favoring one element
7	One element is clearly more important than the other elements (*demonstrated importance*)	Experience shows being strongly favored and dominated by a visible element in
9	One element is absolutely more important than the other elements (*absolutely more importance*)	Experience shows that one element is clearly more important

Intensity of Interest	Definition	Explanation
2,4,6,8	When in doubt between two adjacent values (*grey area*)	This value is given when a compromise is required
1/(2-9)	If criterion *C1* gets one point when compared to criteria *C2* has the opposite value when compared *C1*	If criteria C1 has a value of x when compared to criteria C2, then will be got criteria C2

Source : Saaty, 1990

The comparison values of the criteria that have been obtained are then processed to determine the ranking of criteria from all existing criteria, both qualitative criteria and quantitative criteria can be compared according to the predetermined judgment to produce weights and priorities. If the value is more than 10 percent then the assessment of the data must be corrected. Deviation from consistency is expressed by *CI* (consistency index);

$$CI` = \frac{\lambda_{maks} - n}{n-1} \quad (1)$$

where n is the size of the matrix.

Random matrix with a rating scale of 1-9 and its inverse as RI (random index) table 5. The comparison matrix can be accepted if the CR value (consistency ratio), is less or equal to:

$$CR = CI / RI \quad (2)$$

Table5. Random Matrix Mean Consistency (Value*RI*)

Matrix size	1	2	3	4	5	6	7
Random Index (*inconsistent*)	0,00	0,00	0,58	0,90	1,12	1,24	1,32

Source : Saaty, 1990

Table 6 is a consistency ratio (CR) value less than 0.1 which means less than 10%, then this value is in accordance with the consistency requirements, which must be less than 0.1 or 10%.

Table6. Recapitulation*ratio consistensi* (CR)

Criteria	Ratio Consistensy (CR)	Remark
Level 2 ; Criteria	-0,206 < 0,1	***consistent !***
Level 3; Sub Criteria, consist of; ▪ Integration Factors on the Road Network Hierarchy	0 < 0,1	***consistent !***
▪ Integration Factors on Spatial Planning	-0,850 < 0,1	***consistent !***
▪ Cost and Financial Factors	-0,287 < 0,1	***consistent !***
▪ Social Impact Factors	0 < 0,1	***consistent !***
▪ Environmental Impact Factors	0 < 0,1	***consistent !***
▪ Physical and Technical Factors	-0,362 < 0,1	***consistent !***

Source: Analysis Results, 2022

E.Roadworthiness Priority Policy Assessment

By applying the procedure described in the AHP method, Figure 2 shows the highest importance for the level 2 (two) criteria, namely the integration factor into the road network hierarchy (65.42%). This shows that the response of the expert to the improvement of the road network hierarchy is very important. The road network system is a unified road network consisting of a primary road network system and a secondary road network system that are interwoven in a hierarchical relationship. The road network system is prepared with reference to the regional spatial plan and by taking into account the connectivity between regions and/or within urban and rural areas. As a result of the eigenvectors of the comparison matrix criteria in Table 3, the components of which provide an estimate of the weights of the criteria weights. The main eigenvalues of this matrix are λmax = 4,720, with consistency ratio *CR* = -0,206 < 0,1the results are **consistent**.

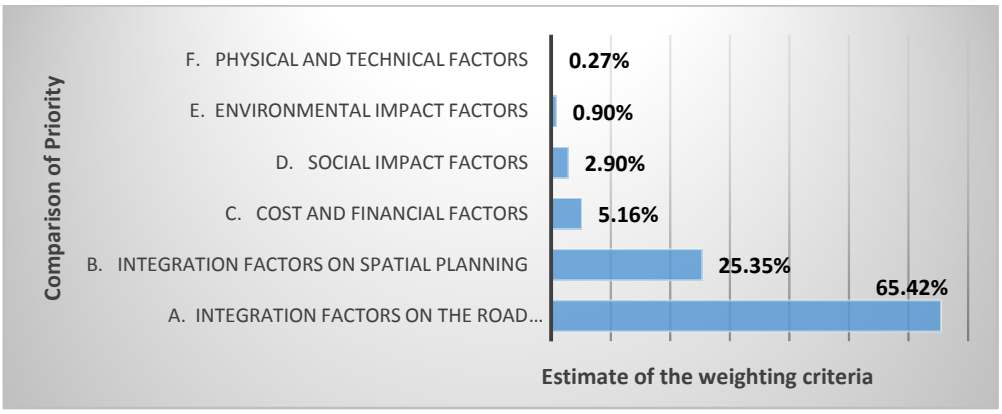


Figure 2.Second Level Priority Comparison (Source: Analysis Results, 2022)

Figure 3, the results show the highest importance for the sub-criteria for comparison of priority integration factors to the road network hierarchy, namely providing access to collector and local roads (83.16%). This shows that the expert response wants collector roads that connect efficiently between national activity centers and local activity centers, between regional activity centers, or between regional activity centers and local activity centers as well as local roads that efficiently connect national activity centers with environmental activity centers, regional activity centers with environmental activity centers, between local activity centers, or local activity centers with environmental activity centers, as well as between environmental activity centers.

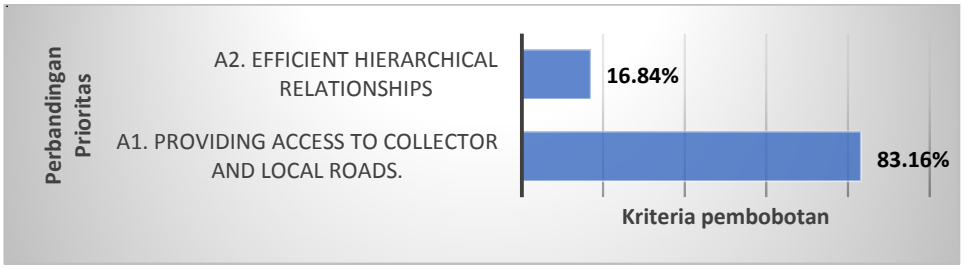


Figure3.Comparison of Priority Integration Factors againstRoad Network Hierarchy
(Source: Analysis Results, 2022)

Figure 4 shows the highest importance for the sub-criteria for the integration factor in spatial planning, namely the residential area, which results in a weight of 90.35%. Law Number 1 of 2011 concerning Housing and Settlement Areas states that the state is responsible for protecting all Indonesian people through the implementation of housing and settlement areas, so that people can live properly in a safe, healthy, harmonious and sustainable environment.

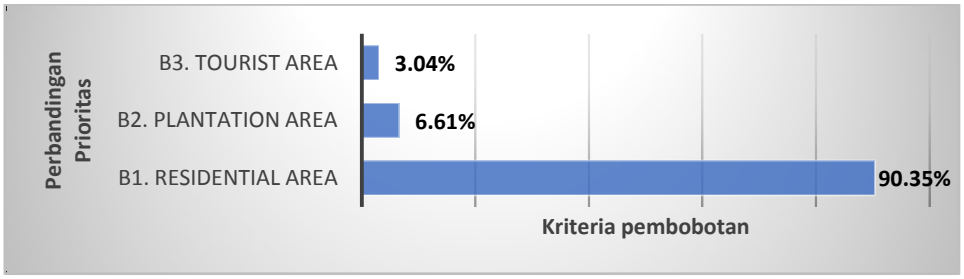


Figure 4.Priority Comparison of Integration Factors with Spatial Planning
(Source: Analysis Results, 2022)

Figure 5, showing the comparison of priority cost and financial factors, results in a weighting for road construction costs of 47.93%. Some expert responses want road construction to be one thing that always goes hand in hand with technological advances and the human mind that uses it, because roads are important facilities for humans to be able to reach an area they want to achieve.

The weight of land acquisition costs is 45.01%. Some of the expert responses wanted land acquisition as a last resort to control the necessary land and there was no other way to get the land. Land is needed for the

public interest of the government. There is adequate compensation for land owners. Implemented based on the President's decision.

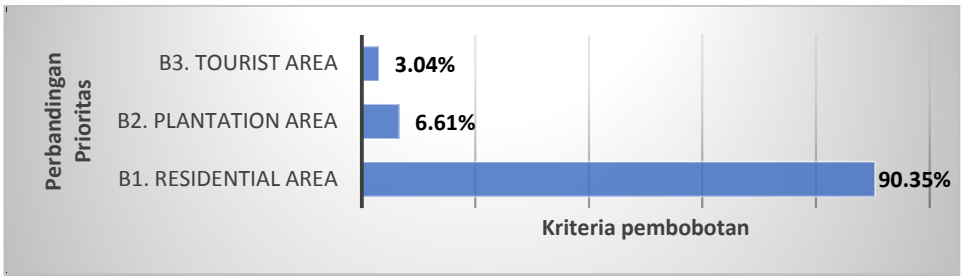


Figure 5.Comparison of Priority Cost and Financial Factors
(Source: Analysis Results, 2022)

Figure 6 shows a comparison of the priority factors of social impact, namely social disturbances with a weight of 83.51%. In this case, the social disruption of road construction is expected to have a social impact in the direction of getting better for community life, namely being able to enjoy various advances in various fields of life, be it social, economic, political, and cultural fields, so that the quality of community life is more in line with the progress achieved. by other rural or urban areas and facilitate access to transportation to obtain goods and services.

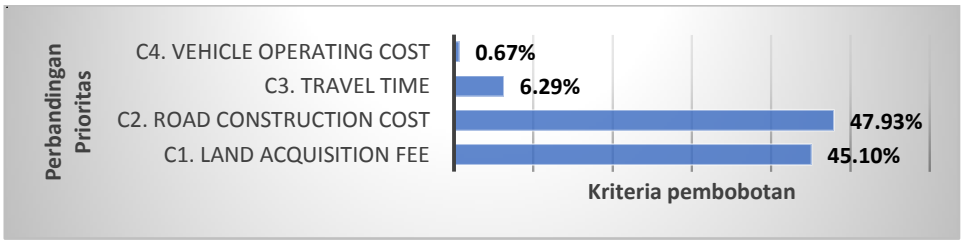


Figure 6.Comparison of Priority Social Impact Factors
(Source: Analysis Results, 2022)

Figure 7 shows a comparison of the priority environmental impact factors, namely air pollution of 83.51%. According to the expert's response, changes in land use which were previously in the form of rice fields, forests and settlements into roads will affect the function of the land in the long term. Damage to road access around the construction site and the pollution that appears, especially air pollution, is also felt to be very disturbing to the community, the government as the executor of development and related parties pay more attention to the environmental and social impacts caused by development activities as well as strengthening environmental protection. In addition, the government also needs to strengthen community participation in environmental management. Increasing environmental understanding requires cooperation and support from all parties, so it is necessary to revive the role of the community and government with an environmental perspective in development..

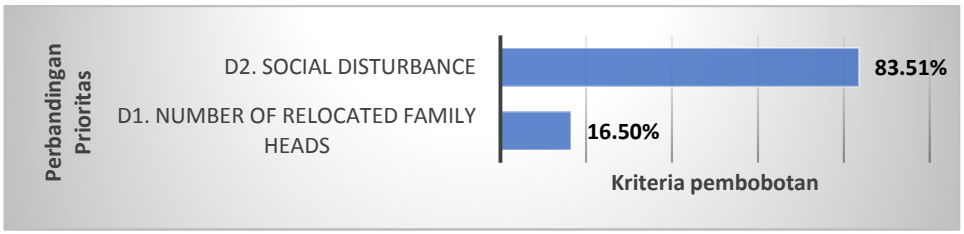


Figure 7.Comparison of Priority Environmental Impact Factors
(Source: Analysis Results, 2022)

Figure 8 shows a comparison of the priority of physical and technical factors, namely topographical conditions of 76.90%. Planning is the initial process of a goal or target to be achieved. The essence of planning is setting goals and formulating steps to achieve these goals. Topography scientifically means the study of the shape of the earth's surface and other objects such as planets, natural satellites (moons and so on), and asteroids. In a broader sense, topography is not only about the shape of the surface, but also vegetation and human

influence on the environment and even local culture. Topography generally presents surface relief, three-dimensional models, and identification of land types. Based on topographic measurement data, it can be analyzed that the geometric planning of the road is part of the road planning which focuses on planning the physical form so that it can fulfill the basic function of the road, namely providing optimum service to traffic flow and as access to houses. So the purpose of geometric road planning is to produce a safe infrastructure, efficient traffic flow services and maximize the ratio of the level of use / cost of implementation. The space, shape, and size of the road are said to be good if they can provide a sense of security and comfort to road users.

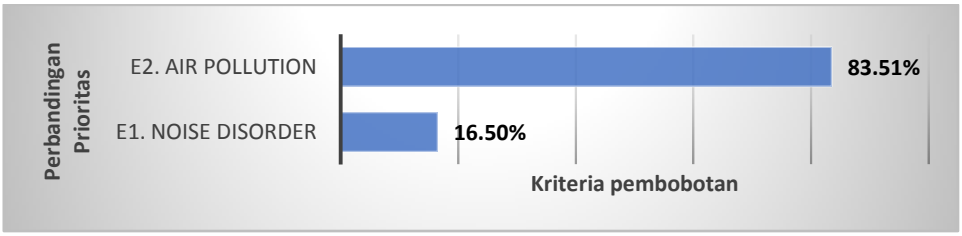


Figure 8.Priority Comparison of Physical and Engineering Factors
(Source: Analysis Results, 2022)

IV. CONCLUSION

Determination of the priority scale of the feasibility of road construction in several regional locations in East Kutai Regency based on respondents' assessment of several sub-criteria resulting in road transportation infrastructure is very important for road construction at predetermined locations, this is proven by priority analysis using the *analytical hierarchy process* (AHP) method with the following results:

1. The weight of the priority scale hierarchy for level 2 on the criteria, namely the integration factor to the road network hierarchy (65.42%). This shows that the expert response to wanting improvements to the road network hierarchy is very important.
2. Comparison of the priority of integration factors on the road network hierarchy, namely providing access to collector and local roads (83.16%). This shows that the expert response wants collector roads that connect efficiently between national activity centers and local activity centers, between regional activity centers, or between regional activity centers and local activity centers as well as local roads that efficiently connect national activity centers with environmental activity centers, regional activity centers with environmental activity centers, between local activity centers, or local activity centers with environmental activity centers, as well as between environmental activity centers.
3. Comparison of the priority of cost and financial factors, resulting in a weight for road construction costs of 47.93%. Some of the expert responses want road construction to be one thing that always goes hand in hand with technological advances and the thinking of humans who use it, because roads are important facilities for humans to be able to reach an area they want to achieve. For the cost of land acquisition of 45.01%, some of the expert responses wanted land acquisition as a last resort to control the necessary land and there was no other way to get the land. Land is needed for the public interest of the government.

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