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TRANSPORTATION ROUTE SELECTION ANALYSIS OF THE TUBAN-BOJONEGORO ROUTE DUE TO THE DAMAGE OF THE GLENDENG BRIDGE

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ABSTRACT

As a result of the damage to the Glendeng bridge, traffic flow was diverted via the Simo-Soko intersection to the Kaliketek Bridge and also via a boat crossing for two-wheeled vehicles, while four-wheeled vehicles were diverted to the Soko-Ponco highway. This 4 km long traffic diversion route is quite far for the local community. The aim of this research is to determine the effectiveness of alternative Kaliketek routes and boat crossings for two-wheeled vehicles. The method used in decision making and selecting solutions is the Analytical Hierarchy Process (AHP) method. In this study, sub-criteria values were obtained with the Geometrix Mean value for each sub-criterion, namely time 0.93, convenience 0.88, cost 0.00 and security 0.00. Meanwhile, the Priority Vector value is obtained by dividing the Geometrix Mean value by the total Geometrix Mean value. And from these calculations, the Priority Vector value for time is 0.51, comfort 0.49, cost 0.00 and security 0.00. Then calculate the sub-criteria evaluation criteria values and get a Geometrix Mean value for the Kaliketek route of 0.79 while for the ferry boat route it is 0.81. The Geometrix Mean value is used to find the VP value by dividing each Geometrix Mean value by the total Geometrix Mean value. From the calculation results, the Priority Vector value on the Kaliketek route was 0.49 and on the boat crossing route it was 0.51. The alternative choice of connecting route resulting from the construction of the 2-wheeled Simo-Glendeng Bridge is a boat route with a priority vector value of 0.51 and an emphasis on the time factor with a priority vector value of 0.51.

Keyword: *Broken bridge, AHP method, effective route for two wheels*

1. INTRODUCTION

A bridge is a structure built to connect two or more points that are separated [1] by rivers, valleys, ravines, or highways [2]. The main function of the bridge is to facilitate access and transportation between two separate places. Bridges can be built from a variety of materials, such as wood, stone, concrete, or steel, depending on environmental conditions and the location where they are built. There are also different types of bridges, such as suspension bridges, arch bridges, cable bridges and bascule bridges, each of which has different characteristics and uses.

Damage to a bridge can cause several adverse impacts, including: traffic accidents, transportation disruptions, economic disruption, social disruption, environmental damage, financial losses [3]. As with the damage that occurred to one of the connecting bridges between Bojonegoro Regency and Tuban Regency, namely the Glendeng Bridge which is located in Simo Village, Soko District. Damage to the supporting pillars and retaining wall of the bridge on the north side resulted in obstructed traffic

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activities. The people of the Soko area who are active in Bojonegoro and vice versa experience difficulties in terms of access. With the repair project on the bridge, traffic activities are completely stopped so that road users are required to find alternative traffic.

The traffic flow diversion through the three-way intersection before Glendeng Bridge to Kaliketek Bridge is intended for small vehicles, while large vehicles are diverted to the Soko-Ponco highway. The 4 km traffic diversion route is quite far for the local community. Apart from the Kaliketek Bridge alternative, people can also use boat crossings as access between cities. But the boat can only be used by two wheels. Therefore this study aims to determine the effectiveness of alternatives between Kaliketek routes and boat crossings.

Transportation can be interpreted as an activity or process of moving goods, people, or information from one place to another [4], [5] by using means of transportation such as cars, trains, planes, ships, or other means of transportation. Transportation is also an important part of the economic development [6] of a country because it allows the mobility of goods and services and facilitates accessibility between regions or countries. So the function of transportation is very important in modern human life [7]. Based on several previous studies, this research focuses on comparing the level of effectiveness and efficiency of alternative routes for two-wheeled vehicles due to bridge damage. So that people can choose an alternative route that is more effective and efficient from the two choices, namely the land route using the Simo – Kaliketek route and the crossing route using a boat.

2. RESEARCH METHOD

The research was conducted on the Tuban-Bojonegoro connecting road which passes through the Glendeng Bridge in Soko-Tuban District (Figure-1).

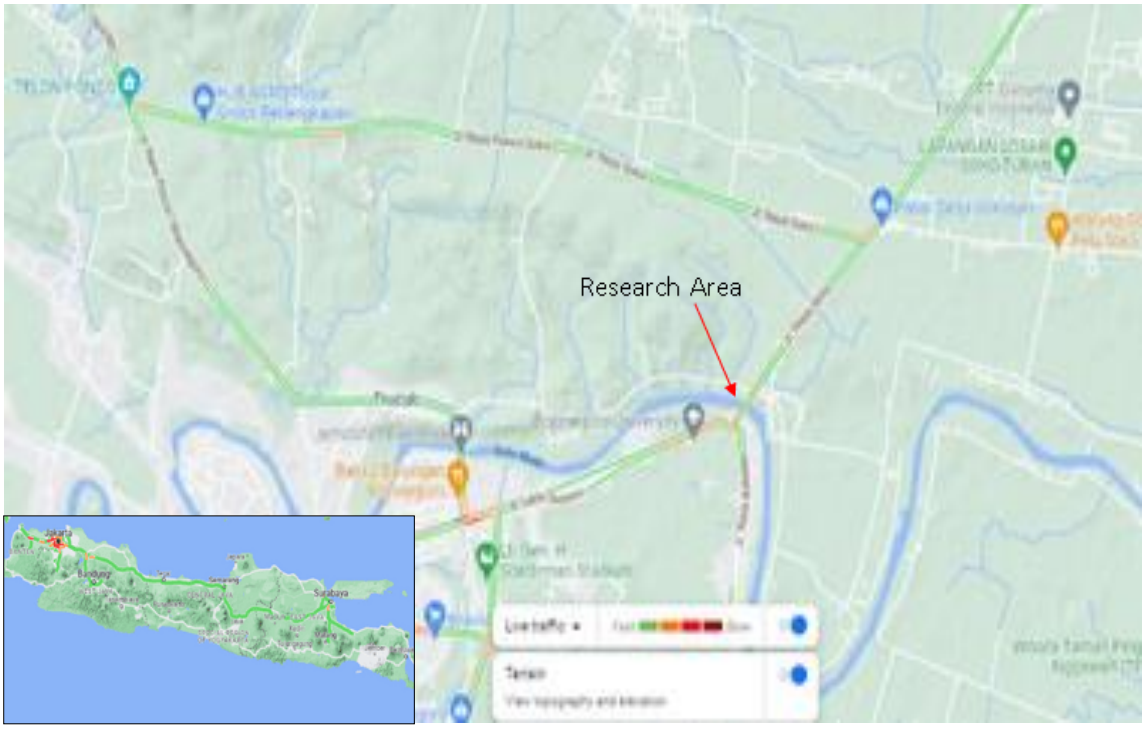

Figure-1 Research Area

In this study, data collection was carried out including primary data from survey results at the study location by conducting interviews with several road users and ferry boat users. The flow chart in this study can be seen in Figure 2 below:

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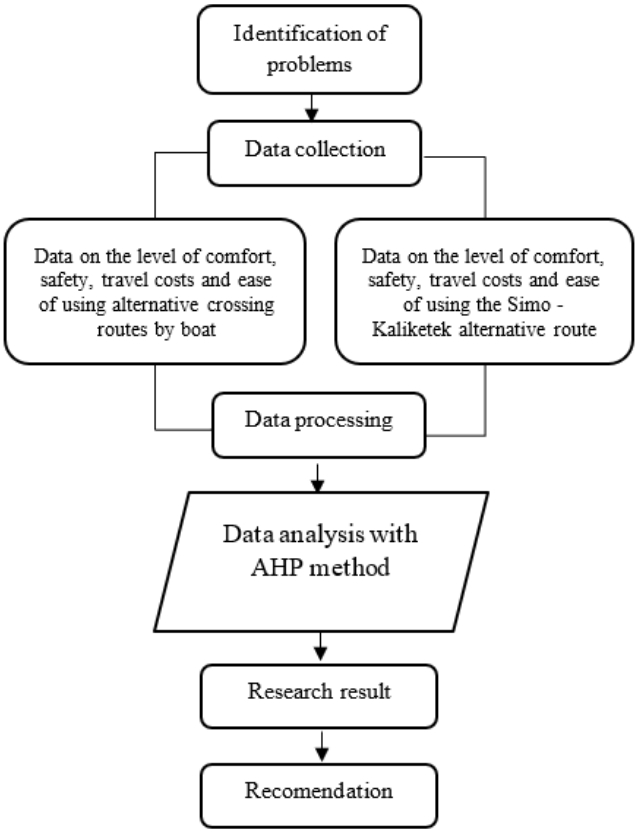

Figure 2. Research Flow

The analysis in this study uses the AHP (Analytical Hierarchy Process) method. Calculations can be done manually using Microsoft Excel or with the help of other software. AHP is reliable [8][9] because of its consistency, effectiveness, based on data, accommodating individual preferences, flexibility, and validity. The geometric mean theory is mathematically formulated as follows:

$$Aij = (Z1, Z2, Z3, \dots\dots, Zn) \qquad (1)$$

Where :
Aij = The average value of pairwise comparisons of criteria Ai with Aj for n participants
Zi = Comparison value between Ai and Aj for participant i, with i = 1,2,3,...,n
n = Number of participants
1. Calculating the consistency index
The indicator of consistency is measured by CI which is formulated [10]:

$$\text{CI} = \frac{\lambda\text{max} - \text{n}}{\text{n}-1} \qquad (2)$$

With
CI = consistency index
λmax = maximum eigenvalue
n = matrix order

2. Calculating the Consistency Ratio
AHP measures the overall consistency of various considerations through a consistency ratio [11] [12] which is formulated:

$$CR = \frac{CI}{RI} \qquad (3)$$

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With :
CR = Consistency Ratio
RI = random index

3. RESULTS OF ANALYSIS AND DISCUSSION

3.1. AHP Data Analysis

Data calculation is done manually using Microsoft Excel. The data was obtained from the results of a survey of 20 road user respondents.

3.2. Characteristics of Respondents

Distribution of road users grouped by type of work. From the results of the survey, 13 respondents were classified as entrepreneurs (R1) and 7 students (R2).

Table 1. Frequency of Respondents

Kode	Frekuensi (orang)	Presentase (%)
R1	13	65
R2	7	35
Jumlah	20	100,00

From the table above it can be seen that the frequency presentation of R1 (Entrepreneur) is 65% and R2 (student/student) is 35%.

3.3. Hierarchical Structure

The hierarchical structure in this study is divided into four, namely level 1 objectives, level 2 criteria, level 3 sub-criteria, and level 4 alternatives. Alternatives are grouped into sub-criteria as follows:
-Time: distance, accessibility, economy, destination
- Convenience: convenience, facilities, crowd
- Costs: income, fuel consumption
- Security: safety, accidents.
To make it easier for the writer to analyze the data, the hierarchical structure is arranged like the (Figure-3) below.

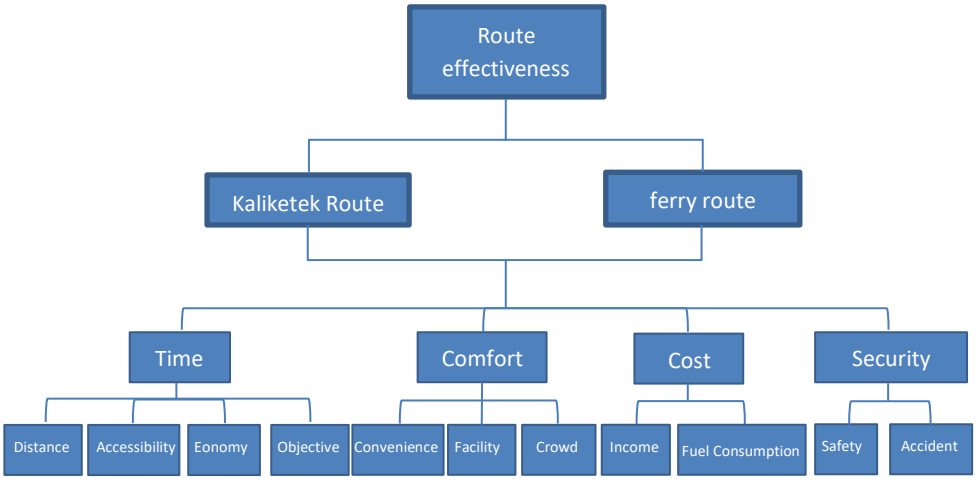

Figure-3 Hierarchical Structure

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3.4. Alternative Weight Analysis

In this study, alternatives are obtained by looking for factors that influence the sub-criteria. The flow of calculations is to create a pairwise comparison matrix for each R1 and R2.

3.5. Comparison Matrix R1

a. Time Subcriteria

Calculation of priority evaluation values is done by averaging the total value of each alternative paired comparison of 13 respondents. Calculations obtained the sum of the averages of each comparison with the value of distance 1.47, accessibility 9.20, economy 13.54, and destination 19.15. The weighted value for distance is 3.43, accessibility is 1.60, economy is 0.95 and destination is 0.58. While the cv value obtained is 6.38, accessibility 7.0, economy 6.55 and destination 6.55. Lambda is the average of cv and got a value of 6.62. CI value of 0.87 and CR value of 0.97.

b. Convenience sub-criteria

In this sub-criteria, 3 factors are obtained that influence the determination of the sub-criteria.
From the calculation results, the average number of each pair comparison is obtained with a convenience value of 1.38, facilities 7.25 and crowds of 11.23. From the calculation, the weighted value for convenience is 2.53 Facilities 0.96 Crowd 0.48. While the CV value obtained ease of 3.96 Facility 4.03 and crowd 3.97. Lambda is the average of the CV and obtained a value of 3.99. With a CI value of 0.49 and a CR of 0.85.

c. Cost Sub-criteria

In this sub-criteria, there are 2 factors that influence the determination of the cost sub-criteria, namely the income factor and the fuel consumption factor. From the analysis results, the average number of each pair comparison is obtained with an income value of 1.15 and fuel consumption of 7.85. From the calculation, the weighted value for income is 1.75 and fuel consumption is 0.25. Meanwhile, the CV value is 2.0 for income and 2.0 for fuel consumption. Lambda is the average of cv and gets a value of 2.0. While the value for CI and CR is 0.00. This means that the value between the two alternatives is consistent.

d. Security Sub-criteria

In this sub-criteria, there are 2 factors that influence the determination of the Safety sub-criteria, namely safety factors and accidents. From the calculation results, the average number of priority comparisons is obtained with a Safety score of 1.15 and Accident Events of 7.54. From the calculation results, the weighting value for Safety is 1.73 and Accident Event is 0.27. While the cv value is obtained for Safety 2.0 and Accident Occurrence 2.0. Lambda is the average of cv and obtained a value of 2.0 with a CI and CR value of 0.00

3.6. Comparison Matrix R2

a. Time Subcriteria

From the analysis, we get the sum of the averages of each comparison with a distance value of 1.56, accessibility 8.20, economy 13.21, and destination 16.00. From the calculation, the weighting value for distance is 3.13, accessibility is 1.69, economy is 0.98 and destination is 0.59. While the CV value obtained distance 6.22 accessibility 6.87 economy 6.28 and destination 6.22. Lambda value 6.40. CI values are 0.80 and CR 0.89.

b. Convenience sub-criteria

From the calculation results, the average number of each pair comparison is obtained with a value of Ease of 1.38, Facilities of 7.25 and Crowd of 11.2. From the calculation, the weighting value for Ease of 2.47 Facilities 1.03 Crowd 0.52. While the CV value obtained Ease of 3.96, Facility 4.15 and Crowd 4.06. Lambda value 4.06. CI values are 0.53 and CR 0.91.

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c. Cost Sub-criteria

From the calculation results, the average number of each pairwise comparison is obtained with an income value of 1.00 and fuel consumption of 6.86. From the calculation, the weighted value for income is 1.85 and fuel consumption is 0.32. Meanwhile, the CV value is 2.0 for income and 2.0 for fuel consumption. Lambda value 2.0. CI value 0.00 and CR 0.00.

d. Security Sub-criteria

From the calculation, the average number of priority comparisons is obtained with a Safety score of 1.15 and Accident Events of 7.54. From the calculation, the weighting value for Safety is 1.74 and Accident Event is 0.26. While the CV value obtained Safety 2.0 and Accident Occurrence 2.0. Lambda value 2.0. CI and CR values are 0.00

3.7. Calculation of the Geometric Mean (GM) and Priority Vector (Vp)

GM and Vp values are calculated after obtaining CR values from each alternative R1 and R2. From the calculation, the GM value of each sub-criteria is obtained, namely time 0.93, convenience 0.88, cost 0.00 and safety 0.00. While the Vp value is obtained by dividing the GM value by the total GM value. And from the calculation it is obtained that the Vp value for time is 0.51, comfort is 0.49, cost is 0.00 and security is 0.00.

3.8. Calculation of Criteria Evaluation Value against Sub-criteria

In the previous calculation, the selected sub-criteria is a time sub-criteria determined by the value of the priority vector (Vp).

3.9. Kaliketek Route against Time (R1)

From the calculation, it is obtained that the average value of pairwise comparisons with distance is 1.69, accessibility is 7.50, economy is 11.08 and destination is 14.54. The weighting value for distance is 2.82, accessibility is 1.67, economy is 0.95 and destination is 0.61. While the CV value obtained distance 5.97 accessibility 6.39 economy 5.93 and destination 5.84. Lambda is the average of the CV and obtained a value of 6.03. CI value 0.68 and CR 0.75.

3.10. Kaliketek Route against Time (R2)

From the calculation, the average value of pairwise comparisons is obtained with a distance of 1.88, accessibility 6.52, economy 9.05 and destination 13.57. The weighting value for distance is 2.29, accessibility is 1.65, economy is 0.99 and destination is 0.62. While the cv value obtained is 8.17, accessibility 6.02, economy 5.57 and destination 5.19. Lambda value 6.24. CI value 0.75 and CR value 0.83

3.11. Crossing Boat Route against Time (R1)

From the calculation results, the weighting value for distance is 3.30, accessibility is 1.28, economy is 0.88 and destination is 0.53. Distance CV value 5.90 accessibility 6.29 economy 5.92 and destination 5.90. Lambda value 6.00. CI value 0.67 and CR 0.74.

3.12. Crossing Boat Route against Time (R2)

From the calculation, the average value of pairwise comparisons is obtained with a distance of 1.55, accessibility 8.20, economy 13.14 and destination 15.71. From the calculation, the weighting value for distance is 3.12, accessibility is 1.60, economy is 0.99 and destination is 0.63. While the cv value obtained distance 6.12 accessibility 6.86 economy 6.32 and destination 6.32. Lambda is the average of the CV and obtained a value of 6.41. Lambda values are used to calculate CI and CR values and CI values of 0.80 and CR 0.89.

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3.13. Calculation of Geometric Mean (GM) and Priority Vector (Vp) in Route Selection against Time

The calculated comparison values are the R1 and R2 values obtained from the priority evaluation of the Kaliketek Route and the Ferry Boat Route against Time. From the calculation, the GM value for the Kaliketek route is 0.79 while the ferry boat route is 0.81. From the calculation, the VP value for the Kaliketek route is 0.49 and for the boat crossing route is 0.51. Then the effectiveness of alternative routes is obtained from the highest Vp value, namely 0.51 for ferry boat routes by emphasizing the time sub-criteria.

4. CONCLUSION

Based on the results of the research and discussion, the following conclusions are obtained:

1. Alternative value analysis is performed by calculating pairwise comparisons starting from alternatives, sub-criteria and criteria. In this study, the calculated value of the sub-criteria was obtained with the GM value of each sub-criteria, namely time 0.93, convenience 0.88, cost 0.00 and safety 0.00. While the Vp value is obtained by dividing the GM value by the total GM value. And from this calculation the value of Vp time is 0.51, comfort 0.49, cost 0.00 and security 0.00. Then calculate the value of the evaluation criteria for the sub-criteria and get a GM value for the Kaliketek route of 0.79 while the ferry boat route is 0.81. The GM value is used to find the VP value by dividing each GM value by the total GM value. From the calculation, the VP value for the Kaliketek route is 0.49 and for the boat crossing route is 0.51.
2. The choice of an alternative connecting route as a result of the construction of the Simo-Glendeng Bridge for 2 wheels is a ferry boat route with a priority vector value of 0.51 and an emphasis on the time factor with a priority vector value of 0.51.

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