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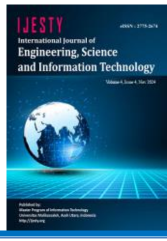

Analysis of the Choice of Transportation Modes from Lhokseumawe City to Medan City Using the Analytical Hierarchy Process Method

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Abstract

Interprovincial movement activities from the city of Lhokseumawe to the city of Medan is a busy travel route because land routes connect many cities. Minibusses and buses serve transportation needs across these cities. Travelers tend to choose minibusses because of their convenience, fast travel time, and the excellent level of comfort provided. The bus mode also offers smooth and comfortable travel, making it a popular choice among travelers on the Lhokseumawe to Medan route. This research aims to determine the characteristics and percentage of transportation mode choices by travelers. The approach used is the analytical hierarchy process method. The results of the analysis showed that the percentage of travelers interested in choosing a particular mode resulted in 42% of passengers choosing the Hiace Minibus, 24% choosing the Sempati Star Bus, 20% choosing the Putra Pelangi Bus, and 14% choosing the Kurnia Bus. The criteria that influence the choice of transportation mode are convenience with a percentage of 22%, time with a percentage of 19%, comfort with a percentage of 16%, cost with a percentage of 15%, headway and safety with a percentage of 14%.

Keywords: *Activity, City, Transportation, Analytical Hierarchy Process.*

1. Introduction

Transportation is the movement of goods and people from the point of origin to the destination. This activity includes three main elements, namely the cargo being transported, the availability of vehicles as means of transportation, and the existence of accessible routes. The process starts from the origin movement, where the transportation activity begins, and ends at the destination, where the activity ends. Therefore, the transportation sector plays an important role in supporting economic activities and providing services that contribute to economic development.

The city of Lhokseumawe has an area of 181.06 km2. When traveling from the city of Lhokseumawe to the city of Medan and vice versa, travelers must choose various types of land transportation, especially buses or minibusses. To determine the mode of transportation, travelers consider various factors such as the purpose of the trip, distance traveled, cost, and other related factors.

Choosing a mode of transportation involves various aspects and criteria for smooth travel using transportation from the place of origin to the destination. These aspects and criteria include travel time, cost, headway, convenience, comfort, and safety. To determine which criteria are most important in choosing a mode of transportation, it is necessary to prioritize these criteria [3]. This research aims to assess the weight of these different criteria, identifying priority criteria that should be emphasized in the management and improvement of public transportation.

2. Literature Review

2.1. Transportation

The term transportation comes from the Latin word transportare, where trans means to cross and portare means to carry or transport (something) from one place to another. This means that transportation is a service that can move people and goods from one place to another. Thus, transportation can be defined as the business and activity of transporting or carrying goods and passengers from one place to another.

2.2. Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) is a method known as multi-criteria decision-making, this method is used to solve problems with many criteria. AHP works by giving priority to important alternatives following predetermined criteria. More specifically, the AHP Method outlines the objectives, criteria, and alternatives for completing the ranking of various hierarchical structures.

1. Priority Setting

   Determining the element priority plan is done by compiling pairwise comparisons, namely comparing in pairwise form all the elements for each sub-hierarchy. The comparison is transformed in matrix form. For example, there are n objects denoted by (A1, A2, ..., An) which will be assessed based on their importance levels, including Ai and Aj, presented in a pairwise comparison matrix.

Table 1. Pairwise comparison matrix

	A1	A2	…	An
A1	a11	a12	…	a21
A2	a21	a22	…	a2n
:	:	:	:	:
An	am1	am2	:	Amn

The value a11 is the comparison value of element A1 (row) to A1 (column) which states the relationship:

1. How important is A1 (row) to criterion C compared to A1 (column) or
2. How much does Ai (row) dominate over Ai (column)
3. How many characteristics of criterion C are found in A1 (row) compared to A1 (column)

Table 2. Hierarchy element rating scale

Intensity of Interest	Verbal Definition	Explanation
1	Equally important	Both elements have the same influence
3	A little more important	The assessment slightly favors one element compared to its partner.
5	More important	The assessment strongly favors one element compared to its partner
7	Very important	One element is very influential and its dominance is visible
9	More important	The evidence that one element is more important than its counterpart is clear
2,4,6,8	The middle value of the assessment above	A grade is given if there is doubt between two assessments
	Reciprocal	If the comparison between elements i and j produces one of the values above, then the comparison between elements j and i will produce the opposite value

The numerical values used in calculating all comparisons are obtained from the comparison scale determined by Saaty, which has a value range between 1 and 9. The AHP model is based on a pair comparison matrix, where the elements in the matrix are the judgments of the decision maker. A decision maker will evaluate, understand, or estimate the possibility of a thing or event faced. These matrices are found at each hierarchical level of the AHP model structure which breaks down a problem systematically.

2. Eigen Value and Eigen Vector

   A comparison matrix is arranged at each level (level) to determine which criteria are most preferred or important if the decision maker has included his perception or assessment for each comparison between criteria at one level (level) or which can be compared.

3. Weighting for Each Criterion and Alternative

   In the AHP method, the weighted average calculation is carried out using the geometric average. The geometric mean value is considered to be the result of a group assessment of the values given by respondents. The following is an example of calculating the geometric mean:

   Then the geometric mean:

   $XG = \sqrt{63}(1/9)\times(1/9)\times\ldots(9)$ …………………………………………………………………………………… (1)

4. Calculation of Partial Weights and Matrix Consistency

   Calculation of the consistency ratio and consistency matrix uses the following formulas.

   - Consistency Ratio Calculation

     = (Weighted Average Calculation Matrix) x (Weight Vector for each row) ………………………………………. (2)

   - Vector Consistency Calculation

     = (Consistency Ratio / Partial Weight of each row) ……………………………………………………………. (3)

- Average Entry (Z_max)
  Z_max = (Vector Consistency) / n ………………………………………………………………………………. (4)
- Consistency Index (CI)
  CI = (Z_max-n) / (n-1) ………………………………………………………………………………. (5)
- Consistency Ratio (CR)
  CR = CI / (Random Consistency Index) ………………………………………………………………………………. (6)

The respondent's response is said to be consistent if the CR value is <0.1. The random index value for n = 6 is 1.24 and for n = 4 is 0.90 (value obtained from the random index value table).

5. Consistency and Ratio Test
One of the AHP methods that differentiates it from other decision making models is that there is no absolute consistency requirement. Collecting opinions between one factor and another is independent of each other, and this can lead to inconsistencies in the answers given by respondents. However, too much inconsistency is also undesirable. If there are significant inconsistencies, it may be necessaryto re-interview with the same number of people.
The following formula can be used to determine the Consistency Index of a matrix of order n, as used by Saaty (1994):
CI = ((λ max - n)/(n-1)) ……………………..………………………………………………………………. (7)

3. Research Method

The research method that will be carried out is to conduct field research to identify the choice of transportation modes. Method used to find out the identified preferred mode of transportation, use the Analytic Hierarchy Process (AHP) method. By using this method, a priority scale will be found for several alternative modes of transportation routes from Lhokseumawe to Medan. The complete research steps of the AHP method are shown in Figure 1 below:

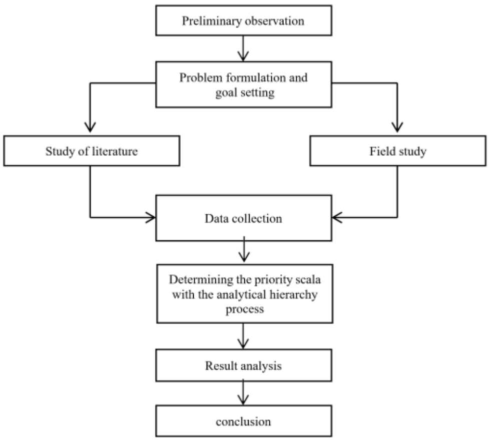

Fig 1. Research Metodology

4. Result and Discussions

The hierarchical structure in the problem of determining the choice of transportation mode can be seen in the picture below:

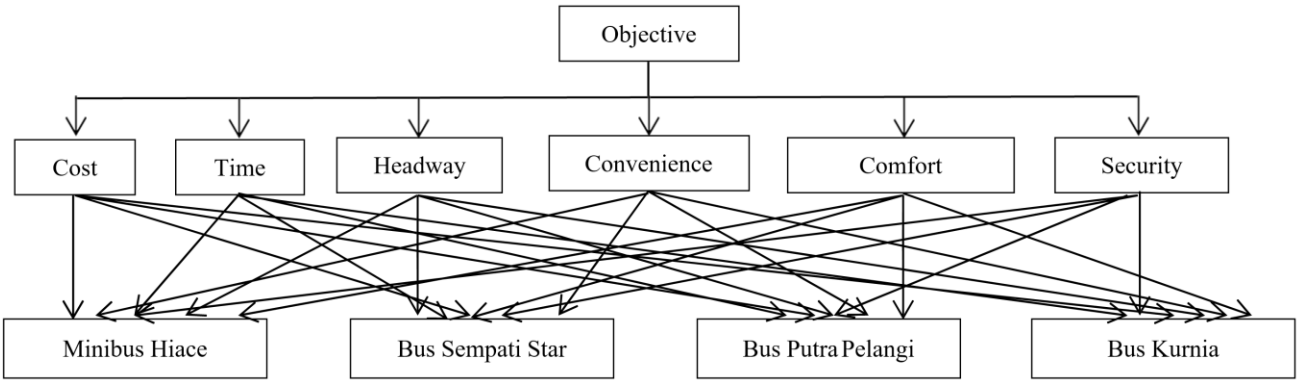

Fig 2. Hierarchical structure of alternative mode selection

Based on Figure 1, the criteria include time, cost, headway, convenience, comfort and safety. Alternatives are Hiace minibuses, Sempati Star buses, Putra Pelangi buses and Kurnia buses. The selection of these criteria is based on the perceived impact on the choice of transportation mode, while the alternative was chosen because the alternative is an option that serves trips from the city of Lhokseumawe to the city of Medan.

4.1. Criteria Output Analysis

The output criteria analysis aims to determine which criteria influence travelers when traveling from the city of Lhokseumawe to the city of Medan. The results in the image below are the combined results of all respondents.

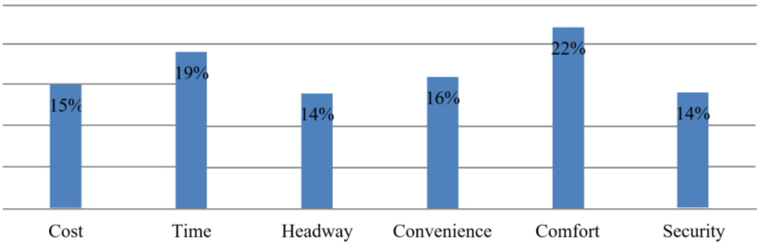

Fig 3. Percentage graph in choosing mode

Based on the graph above, it is found that the weight of the percentage value of travelers on the factors that influence the choice of mode is the convenience criterion with a weight of 22%. Furthermore, the time factor weighs 19%, the comfort factor is 19%, the cost factor is 15% and the headway and safety factor is 14%. The convenience factor is the main aspect according to respondents.

4.2. Alternative Mode Output Analysis

Analysis of the output of alternative modes is to obtain priority weight values in choosing the mode of transportation that travelers prioritize when traveling from the city of Lhokseumawe to the city of Medan in terms of each predetermined criteria. The results in the graph below are the results of all respondents combined.

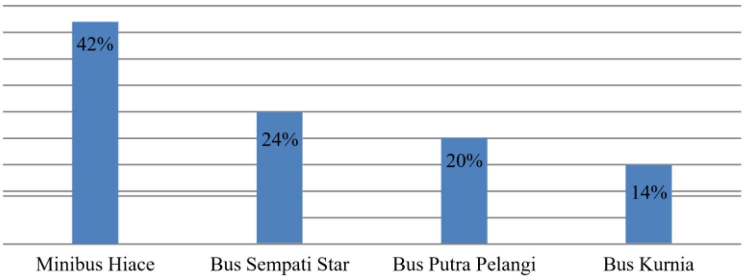

Fig 4. Graph of percentage of alternative mode choices

Based on the graph above, it is found that the priority mode of transportation when traveling from Lhokseumawe city to Medan city based on the traveler's weight value is the Hiace minibus with a weight of 42%. Furthermore, the Sempati Star bus has a weight of 24%, the Putra Pelangi bus has a weight of 20% and the Kurnia bus has a weight of 14%. This proves that Hiace minibuses are the alternative mode of choice for respondents.

Based on the research results and data processing obtained using the Analytical Hierarchy Process (AHP) method, the following stepswere carried out.

1. Pairwise comparison matrix
   The pairwise comparison matrix at level 2 (reasons) was obtained from distributing questionnaires to travelers. This matrix is designed tocompare each criterion and assess the importance of one criterion compared to other criteria.

Table 3. Results of the comparison matrix questionnaire for each respondent's criteria

Criteria	Respondents					
	Time	Cost	Headway	Comfort	Convenie nce	Security
Time	1	1/7	5	1/7	1/8	9
Cost	7	1	1/1	2	1/4	8
Headway	1/5	1	1	1/3	1/6	1/9
Comfort	7	1/2	3	1	2	1/7
Convenience	8	4	6	1/2	1	1/4
Security	1/9	1/8	9	7	4	1

The data in the table above was obtained from the results of distributing questionnaires to respondents traveling from the city of Lhokseumawe to the city of Medan.

2. Average weighting for each criterion
   Calculating the weighted average is done using the geometric mean value. This geometric mean value represents a collective evaluation of the values given by traveler respondents. The geometric mean is calculated for the elements at the second level between each criterion.

Table 4. Calculation of average weighting for criteria

Criteria	Weight					
	Time	Cost	Headway	Comfort	Convenie nce	Security
Time	1.000	1.205	1.141	1.359	1.210	1.086
Cost	0.830	1.000	0.946	0.859	1.262	1.587
Headway	0.876	1.038	1.000	0.994	1.375	1.401
Comfort	0.736	1.164	1.006	1.000	0.882	1.317
Convenience	0.877	0.793	0.727	1.134	1.000	0.962
Security	0.921	0.630	0.714	0.759	1.039	1.000

The values in table 2 are obtained from the results of geometric calculations of the average of all questionnaires obtained from 63 travelerrespondents.

3. Normalization and partial weights
   Each column is processed using the same model as above. Calculating normalization aims to find the average value of each pairwisematrix row. The results are in the table below.

Table 5. Normalization matrix and partial weights of criteria

Criteria	Normalized weight						Partial weight
	Time	Cost	Headwa y	Comfort	Convenie nce	Security	
Time	0.191	0.207	0.206	0.223	0.179	0.148	0.192
Cost	0.158	0.172	0.171	0.141	0.186	0.216	0.174
Headway	0.167	0.178	0.181	0.163	0.203	0.191	0.180
Comfort	0.140	0.200	0.182	0.164	0.130	0.179	0.166
Convenience	0.167	0.136	0.131	0.186	0.148	0.131	0.150
Security	0.176	0.108	0.129	0.124	0.154	0.136	0.138
Amount	1.000	1.000	1.000	1.000	1.000	1.000	1.000

The partial weight values in table 3 are obtained from the sum of the normalization matrices for each row divided by the number of elements.

4. Consistency Ratio
   = (Average weighting matrix) x (Weight vector for each row)

$$\underbrace{\begin{vmatrix} 1.000 & 1.205 & 1.141 & 1.359 & 1.210 & 1.086 \\ 0.830 & 1.000 & 0.946 & 0.859 & 1.262 & 1.587 \\ 0.876 & 1.038 & 1.000 & 0.994 & 1.375 & 1.401 \\ 0.736 & 1.164 & 1.006 & 1.000 & 0.882 & 1.317 \\ 0.877 & 0.793 & 0.727 & 1.134 & 1.000 & 0.962 \\ 0.921 & 0.630 & 0.714 & 0.759 & 1.039 & 1.000 \end{vmatrix}}_{(X)} \; x \; \underbrace{\begin{vmatrix} 0.192 \\ 0.174 \\ 0.180 \\ 0.166 \\ 0.150 \\ 0.138 \end{vmatrix}}_{(Y)} = \underbrace{\begin{vmatrix} 1.181 \\ 1.054 \\ 1.093 \\ 1.005 \\ 0.908 \\ 0.835 \end{vmatrix}}_{(Z)}$$

Information :
(X): Average weight value of the questionnaire matrix
(Y): Weight vector for each row
(Z): Consistency ratio value

5. Vector Consistency
   = Vector consistency = (Consistency Ratio / partial weight of each row)

1.181	/	0.192	=	6.147
1.054	/	0.174	=	6.060
1.093	/	0.180	=	6.060
1.005	/	0.166	=	6.059
0.908	/	0.150	=	6.060
0.835	/	0.138	=	6.059

   The consistency vector value is determined by dividing each consistency ratio value by the weight of the partial values for each row.

6. Average entry (Zmax)

$$Z_{maks} = \frac{Konsistensi\,Vektor}{\text{n}}$$

$$Z_{maks} = \frac{6.147 + 6.060 + 6.060 + 6.059 + 6.060 + 6.059}{6}$$

$$Z_{maks} = 6.074$$

7. Consistency Index (CI)

$$CI = \frac{Z_{maks} - n}{\text{n} - 1}$$

$$CI = \frac{6.074 - 6}{6 - 1}$$

$$CI = 0.015$$

8. Consistency Rasio (CR)
   Calculation of ratio consistency using the formula: CR=CI/(Random Index)

Table 6. Random index values

Matrix	1.2	3	4	5	6	7	8	9	10	11	12	13	14	15
Mark RI	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

9. Recapitulation of Partial Weights for Each level

Table 7. Recap of priority weight values for criteria and alternatives

Value of each level				Priority weight	
Level 2		Level 2		Level 2	Level 2
Time	0.192	Minibus Hiace	0.517	0.099	0.192
		Bus Sempati Star	0.241	0.046	
		Bus Putra Pelangi	0.161	0.030	
		Bus Kurnia	0.080	0.015	
Cost	0.174	Minibus Hiace	0.171	0.029	0.174
		Bus Sempati Star	0.248	0.043	
		Bus Putra Pelangi	0.270	0.046	
		Bus Kurnia	0.311	0.054	
Headway	0.180	Minibus Hiace	0.456	0.082	0.180
		Bus Sempati Star	0.259	0.046	
		Bus Putra Pelangi	0.187	0.033	
		Bus Kurnia	0.099	0.017	
Comfort	0.166	Minibus Hiace	0.327	0.054	0.166
		Bus Sempati Star	0.274	0.045	
		Bus Putra Pelangi	0.220	0.036	
		Bus Kurnia	0.179	0.029	

Convenience	0.150	Minibus Hiace	0.515	0.077	0.150
		Bus Sempati Star	0.238	0.035	
		Bus Putra Pelangi	0.161	0.024	
		Bus Kurnia	0.085	0.012	
Security	0.138	Minibus Hiace	0.225	0.031	0.138
		Bus Sempati Star	0.293	0.040	
		Bus Putra Pelangi	0.265	0.036	
		Bus Kurnia	0.217	0.029	

The partial weight values for each level are obtained from the results of pairwise matrix normalization for each criterion and alternative. It can be seen in each calculation of the criteria and alternatives for each factor.

5. Conclusion

A total phenolic content of 192 mg GAE/g was produced by the ethanol extract of black turmeric rhizome, indicating that it possesses considerable antioxidant potential. A significant indication that black turmeric rhizome can operate as a source of natural antioxidants is the presence of substantial levels of phenolic chemicals. This confirms what other research has shown, which is that antioxidant activity is directly proportional to the overall flavonoid and phenolic concentration. This indicates that an extract's capacity to combat free radicals and offer protection to the body is directly proportional to the concentration of phenolic and flavonoid chemicals it contains. Additional research also indicates that an increase in total phenolic content is directly proportional to an increase in antioxidant activity. Therefore, the therapeutic potential of black turmeric rhizome extract is not only promising, but it can also serve as an alternative in the development of health products that prioritize antioxidant protection.

References

[1] Adisasmita, S. (2011). Transportation and Regional Development. Yogyakarta: Graha Ilmu.
[2] Efendi, A., & Budiman, D. (2022). Analytical Hierarchy Process (AHP) in the Comparison of Determining the Choice of Air Transportation Modes and Sea Transportation Modes. The Enlightener: Scientific Journal of the Muhammadiyah University of Buton, 8 (3), 796–806.
[3] Haradongan, F. (2014). Analysis of Stated Importance for Transport Mode Choices Using Ahp. Journal of Land TransportationResearch, 16, 153–160.
[4] Hidayat, E. (2017). Modeling of Passenger Transportation Mode Selection on Road Access at Kulon Progo Yogyakarta International Airport. Journal of Civil Engineering, 1–201.
[5] Hussain, M., Ajmal, M. M., Khan, M., & Saber, H. (2015). Competitive priorities and knowledge management: An empiricalinvestigation of manufacturing companies in the UAE. Journal of Manufacturing Technology Management, 26(6), 791–806.
[6] Kristyanto, A., Hasanuddin, A., & Putra, P. P. (2022). Analysis of Jember University Students' Choice of Transportation Modes toCampus. Span: Theoretical and Applied Journal of Civil Engineering, 10(1), 49–58.
[7] Lubis, N. A. (2010). Analysis of Medan-Binjai Transportation Mode Selection Using the Analytical Hierarchy Process (AHP)Method. 7(1).
[8] Nurkukuh, D. K., & Kurniawati, A. I. (2020). Study of Public Transportation Choices in Yogyakarta City. National Proceedings ofIndustrial and Information Technology Engineering XV 2020 (ReTII), 2020, 21–25.
[9] Rahmalia, A., Riyanto, B., & Darsono, S. (2020). Analysis of the Choice of Transportation Modes for the Semarang - JakartaRoute. 18, 181–190.
[10] Saaty, T. L. (1994) Decision Making for Leaders, Jakarta: PT. PustakaBinamanPressindo
[11] Studi, P., Civil, T., Muhammadiyah, U., Utara, S., & Medan, K. (2021). The Influence of "Analytical Hierarchy Process (AHP)" on the Choice of Passenger Transportation Mode Between Mini Bus and Trans Metro Deli Bus in Medan City (Case Study). 1(November).
[12] Syawaluddin (2007) Analysis of Factors that Influence the Choice of Campus Mode using the Analytic Hierarchy Process Method, Medan: Final Assignment for the Department of Civil Engineering, Faculty of Engineering, USU.
[13] Tamin, O. Z. (2007). Towards the Creation of a Sustainable Transportation System in Big Cities in Indonesia. Transportation Journal, 7(2), 87–104.
[14] Tangi, D. S., Karels, D. W., & Hangge, E. E. (2022). Selection of Public Transport Modes in South Golewa, Ngada Regency. Journal of Civil Engineering, 11(1), 77–90.C. Cheng et al., "Cropland use sustainability in Cheng–Yu Urban Agglomeration, China: Evaluation framework, driving factors and development paths," J. Clean. Prod., vol. 256, p. 120692, 2020, doi: https://doi.org/10.1016/j.jclepro.2020.120692.
[15] C. Wang, L. Ma, Y. Zhang, N. Chen, and W. Wang, "Spatiotemporal dynamics of wetlands and their driving factors based on PLSSEM: A case study in Wuhan," Sci. Total Environ., p. 151310, 2021, doi: https://doi.org/10.1016/j.scitotenv.2021.151310.\
[16] S. Jalalul Akbar, M. Maizuar, K. Yusuf, and J. Arfiandi, "Monitoring the Dynamic Behavior of PCI Bridges Using Short Period

Seismograph and CSI Bridge Modeling," Int. J. Eng. Sci. Inf. Technol., vol. 1, no. 4, 2021, doi: 10.52088/ijesty.v1i4.168.
[17] S. Ali Rafsanjani, F. E. Rooslan Santosa, and R. Durrotun Nasihien, "Analysis of Planning for Clean Water Needs at Grand Sagara West Surabaya Hotel With the Green Buillding Concept," Int. J. Eng. Sci. Inf. Technol., vol. 1, no. 2, 2021, doi: 10.52088/ijesty.v1i2.55.