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Implementation Of Decision Selection In The Selection Of Transportation Modes Among Workers And Students In Medan City Using Ahp And Electric Methods

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Article Info	ABSTRACT
Article history:	The mode of transportation is a means of connecting used by workers and students to be able to help with all daily activities. The development of transportation modes is increasingly significant with the addition of wider technological sophistication, so that there are more and more diverse types of transportation modes. The purpose of this research is to determine the factors that have the most influence on the choice of mode and provide more effective decisions among workers and students in the selection of public transportation modes to be used. In this research, the decision support system (DSS) method is used, namely the analytical hierarchy process (AHP) and elimination et choix traduisant la reality (ELECTRE) by performing multi-criteria calculations that compare the criteria and alternatives. Where the results obtained in this research is that the most influential factor in the selection of transportation modes among workers is time efficiency with a weight of 25.9 %, while the influential factor for students is cost which produces a weight of 30.7 %. The most effective and efficient alternative mode of transportation among workers is Go-Jek Bike, while for students it is Transmetro Deli.
Keywords: Analytic Hierarchy Proccess, Selection of Transportation, DSS	

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1. INTRODUCTION

Medan City is the most populous city among other cities in North Sumatra, this is because the population in Medan City continues to grow every year. According to data from the Central Statistics Agency (BPS) of North Sumatra, the population of Medan City reached 2,524,321 million people in 2020, and a population density of 9,522.22 people/km2. With the development and growth of the population in the city of Medan, improvements to transportation methods keep pace with the times. So that transportation plays an important role in the development of a region or region. The purpose of the existence of transportation services is to simplify and shorten the distance and travel time of people. With the transportation policy that stipulates several modes of transportation, this creates problems for workers and students because they are faced with various transportation options of various types in the Medan City area, such as city transportation (angkot), Transmetro Deli buses, and several online motorcycle taxis including: Grab, Go-Jek, Maxim. According to data from the Medan City Transportation Service (Dishub) in 2020 the number of public transportation on conventional transportation, namely city transportation (angkot) is around 10,344 units far compared to online-based transportation which has reached 13,000 units and has spread across the Medan city area. Then on public transportation, TransMetro Deli buses currently have 72 fleet units operating in the Medan city area.

This causes workers and students to feel confused in choosing which transportation to use. So that researchers want to analyze the problems that occur among workers and students regarding the selection of transportation modes to choose which transportation is the most efficient that can be used by workers and students and to be able to find out what factors influence the selection of transportation modes on public transportation among workers and students. the student. In analyzing the existing problems, the researcher uses the decision-making system method to choose which decisions are the most important. The decision making used is using the AHP and ELECTRE methods. Both of these methods are very suitable for solving the above problems and are very effective because the AHP method is carried out by determining the priority weight of each criterion while in determining the ranking of alternatives a more suitable method is used, namely the ELECTRE method, this method is used to rank each alternative by producing complex results.

2. RESEARCH METHODE

2.1 Data Collection Techniques

This study uses primary data in the form of questionnaires distributed randomly to users of transportation modes among workers and students in the city of Medan.

2.2 Data Analysis Techniques

a. Analytical Hierarchy Process (AHP) Method

The stages of the Analytical Hierarchy Process (AHP) calculation procedure are:

1) Create a pairwise comparison matrix
2) Calculating pairwise comparison matrix normalization
3) Calculating the max eigenvalue and testing the consistency index and consistency ratio on each criterion. With the following formula:

$$CI = \frac{\lambda \max - n}{n} \quad CR = \frac{CI}{RI}$$

b. Elimination Et Choix Traduisant La Realita (ELECTRE) Method

The stages of the Elimination Et Choix Traduisant La Realita (ELECTRE) calculation procedure are:

1) Make a decision matrix first
2) Normalization of the decision matrix. normalization of the value of xij on a scale that can be compared (rij) and can be done with the formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^{2}}}$$

3) Determine the factor (weight) on each criterion. (wij) : W = (w1, w2, w3, ..., wn) with

$$\sum_{j=1}^{n} w_j = 1$$

4) The weighted matrix that has been normalized with the weight determined by the decision maker, with the formula: Vij = Wj . Xij
5) Determine the set of concordance index and discordance index
6) Calculating the dominant concordance matrix and discordance index
7) Determine the aggregation of the dominant concordance matrix and discordance index
8) Elimination of less favorable alternatives

3. RESULT AND ANALYSIS
3.1 Calculations Using the Analytical Hierarchy Process Method
a. Worker Category
1) The first step is to create a pairwise comparison matrix between criteria

Table 3.1 Pairwise Comparison Matrix of Criteria from Respondents' Assessment of Workers Category

Criteria	C1	C2	C3	C4	C5	C6
C1	1.000	0.392	0.519	0.922	0.765	0.772
C2	2.552	1.000	1.249	2.027	1.757	1.746
C3	1.927	0.801	1.000	2.116	1.919	1.941
C4	1.085	0.493	0.473	1.000	1.029	1.175
C5	1.307	0.569	0.521	0.972	1.000	1.068
C6	1.295	0.573	0.515	0.851	0.936	1.000
Sum	9.166	3.828	4.277	7.888	7.406	7.702

2) After obtaining the initial pairwise comparison matrix, it can be continued by normalizing the pairwise comparison matrix between criteria.

Table 3.2 Normalization of Pairwise Comparison Matrix between Criteria from the Assessment of Respondents in the Category of Workers

Criteria	C1	C2	C3	C4	C5	C6	Synthesis Value	Eigenvector
C1	0.109	0.102	0.121	0.117	0.103	0.100	0.653	0.109
C2	0.278	0.261	0.292	0.257	0.237	0.227	1.553	0.259
C3	0.210	0.209	0.234	0.268	0.259	0.252	1.433	0.239
C4	0.118	0.129	0.110	0.127	0.139	0.153	0.776	0.129
C5	0.143	0.149	0.122	0.123	0.135	0.139	0.810	0.135
C6	0.141	0.150	0.120	0.108	0.126	0.130	0.776	0.129
Sum	1.00	1.00	1.00	1.00	1.00	1.00	6.000	1.00

3) After obtaining the normalization of the pairwise comparison matrix, the next step is to find the value of the max eigenvalue and test the consistency index and consistency ratio on each criterion, namely in the following :

$$CI = \frac{\lambda \text{ maks - n}}{n - 1} \qquad CR = \frac{CI}{RI}$$

$$CI = \frac{6.0252 - 6}{6 - 1} = 0.005 \quad CR = \frac{0.005}{1.24} = 0.0041$$

Thus the consistency ratio (CR) value is met with the tolerance limit set by Saaty, which is < 0.1.

b. Student Category

Table 3.3 Matrix of Pairwise Comparison between Criteria of Respondents' Assessment of Student Categories

Criteria	C1	C2	C3	C4	C5	C6
C1	1	3.109	1.810	2.629	2.185	2.166
C2	0.3216	1	1.854	1.730	1.304	1.618
C3	0.5525	0.5394	1	2.422	1.885	1.561

C4	0.3804	0.578	0.4129	1	1.195	1.520
C5	0.4577	0.7669	0.5305	0.8368	1	2.168
C6	0.4617	0.618	0.6406	0.6579	0.46125	1
Sum	3.1739	6.6113	6.248	9.2757	8.03025	10.033

Table 3.4 Normalization of Pairwise Comparison Matrix between Criteria from Student Category Respondent Assessment

Criteria	C1	C2	C3	C4	C5	C6	∑ Baris	Eigen vector
C1	0.315	0.470	0.289	0.283	0.272	0.215	1.846	0.3077
C2	0.101	0.151	0.296	0.186	0.162	0.161	1.059	0.1765
C3	0.174	0.081	0.160	0.261	0.234	0.155	1.067	0.1778
C4	0.119	0.087	0.066	0.107	0.148	0.151	0.681	0.1135
C5	0.144	0.116	0.084	0.090	0.124	0.216	0.775	0.1293
C6	0.145	0.093	0.102	0.070	0.057	0.099	0.569	0.0949
Sum	1	1	1	1	1	1	6	1

It can be obtained by calculation using the same equation as the calculation for the category of workers in the following way:

$$CI = \frac{\lambda \text{ maks - n}}{n - 1} \qquad CR = \frac{CI}{RI}$$

$$CI = \frac{6.2998 - 6}{6 - 1} = 0.06 \qquad CR = \frac{0.06}{1.24} = 0.0483$$

So that the consistency ratio test is consistent with the value obtained 0.0483 <0.1 where the value has met the consistency requirements and can be continued to the electre method calculation stage.

3.2 Calculations Using the Elimination Et Choix Traduisant La Realita Method

a. Worker Category
Determine the decision matrix

$$X = \begin{bmatrix} 4 & 3 & 2 & 3 & 4 & 3 \\ 5 & 4 & 4 & 4 & 3 & 4 \\ 1 & 4 & 4 & 4 & 4 & 4 \\ 4 & 5 & 4 & 4 & 5 & 4 \\ 5 & 5 & 4 & 4 & 4 & 4 \\ 3 & 4 & 4 & 4 & 5 & 4 \end{bmatrix}$$

After the decision matrix has been formed, the next step is to calculate the normalization of the decision matrix.

$$R = \begin{bmatrix} 0.417 & 0.290 & 0.218 & 0.318 & 0.386 & 0.318 \\ 0.521 & 0.386 & 0.436 & 0.424 & 0.290 & 0.424 \\ 0.104 & 0.386 & 0.436 & 0.424 & 0.386 & 0.424 \\ 0.417 & 0.436 & 0.436 & 0.424 & 0.483 & 0.424 \\ 0.521 & 0.436 & 0.436 & 0.424 & 0.386 & 0.424 \\ 0.312 & 0.386 & 0.436 & 0.424 & 0.483 & 0.424 \end{bmatrix}$$

then it can be continued by giving weighting to the normalized decision matrix

$$V = \begin{bmatrix} 0.0454 & 0.0751 & 0.0521 & 0.0410 & 0.0522 & 0.0410 \\ 0.0568 & 0.1001 & 0.1043 & 0.0547 & 0.0392 & 0.0547 \\ 0.0113 & 0.1001 & 0.1043 & 0.0547 & 0.0522 & 0.0547 \\ 0.0454 & 0.1251 & 0.1043 & 0.0547 & 0.0653 & 0.0547 \\ 0.0568 & 0.1251 & 0.1043 & 0.0547 & 0.0522 & 0.0547 \\ 0.0340 & 0.1001 & 0.1043 & 0.0547 & 0.0653 & 0.0547 \end{bmatrix}$$

Concordance Index matrix :

	A1	A2	A3	A4	A5	A6
A1	0	0.13	0.24	0.10	0.13	0.10
A2	0.86	0	0.86	0.60	0.60	0.86
A3	0.89	0.89	0	0.49	0.63	0.75
A4	1	0.89	1	0	0.89	1
A5	1	1	1	0.86	0	0.86
A6	0.89	0.89	0.86	0.63	0.63	0

Discordance index matrix :

	A1	A2	A3	A4	A5	A6
A1	0	1	0.65	0.96	0.96	0.54
A2	0.26	0	0.28	0.95	0.52	0.87
A3	0.65	0.28	0	0.52	0.55	0.57
A4	0.96	0.43	0.73	0	0.87	0.45
A5	0.96	0.95	0.73	0.90	0	0.45
A6	0.21	0.87	0.55	0.45	0.90	0

Dominance concordance index

$$\begin{bmatrix} - & 0 & 0 & 0 & 0 & 0 \\ 1 & - & 1 & 0 & 0 & 1 \\ 1 & 1 & - & 0 & 0 & 1 \\ 1 & 1 & 1 & - & 1 & 1 \\ 1 & 1 & 1 & 1 & - & 1 \\ 1 & 1 & 1 & 0 & 0 & - \end{bmatrix}$$

Dominance discordance index

$$\begin{bmatrix} - & 1 & 0 & 1 & 1 & 0 \\ 0 & - & 0 & 1 & 0 & 1 \\ 0 & 0 & - & 0 & 0 & 0 \\ 1 & 0 & 1 & - & 1 & 0 \\ 1 & 1 & 1 & 1 & - & 0 \\ 0 & 1 & 0 & 0 & 1 & - \end{bmatrix}$$

The conditions for the formation of an aggregate in this matrix are carried out by equation as follows :

$$e_{kl} = f_{kl} \times g_{kl}$$

$$\begin{bmatrix} - & 0 & 0 & 0 & 0 & 0 \\ 1 & - & 1 & 0 & 0 & 1 \\ 1 & 1 & - & 0 & 0 & 1 \\ 1 & 1 & 1 & - & 1 & 1 \\ 1 & 1 & 1 & 1 & - & 1 \\ 1 & 1 & 1 & 0 & 0 & - \end{bmatrix} \times \begin{bmatrix} - & 1 & 0 & 1 & 1 & 0 \\ 0 & - & 0 & 1 & 0 & 1 \\ 0 & 0 & - & 0 & 0 & 0 \\ 1 & 0 & 1 & - & 1 & 0 \\ 1 & 1 & 1 & 1 & - & 0 \\ 0 & 1 & 0 & 0 & 1 & - \end{bmatrix} = \begin{bmatrix} - & 0 & 0 & 0 & 0 & 0 \\ 0 & - & 0 & 0 & 0 & 1 \\ 0 & 0 & - & 0 & 0 & 0 \\ 1 & 0 & 1 & - & 1 & 0 \\ 1 & 1 & 1 & 1 & - & 0 \\ 0 & 1 & 0 & 0 & 0 & - \end{bmatrix}$$

Eliminate less favorable alternatives

Matrix E provides a sequence of choices from each alternative which if e_kl = 1 then the alternative that can be taken is A5 which is a better alternative than the other alternatives.

b. Student Category

Determine the Decision matrix

$$X = \begin{bmatrix} 4 & 3 & 3 & 4 & 5 & 2 \\ 5 & 4 & 5 & 5 & 4 & 5 \\ 1 & 4 & 4 & 4 & 4 & 4 \\ 2 & 4 & 3 & 4 & 4 & 3 \\ 2 & 4 & 4 & 4 & 4 & 4 \\ 2 & 4 & 4 & 4 & 4 & 4 \end{bmatrix}$$

The following is the result of the decision normalization matrix :

$$R = \begin{bmatrix} 0.544 & 0.318 & 0.314 & 0.390 & 0.487 & 0.215 \\ 0.680 & 0.424 & 0.524 & 0.488 & 0.390 & 0.539 \\ 0.136 & 0.424 & 0.419 & 0.390 & 0.390 & 0.431 \\ 0.544 & 0.424 & 0.314 & 0.390 & 0.390 & 0.323 \\ 0.544 & 0.424 & 0.419 & 0.390 & 0.390 & 0.431 \\ 0.544 & 0.424 & 0.419 & 0.390 & 0.390 & 0.431 \end{bmatrix}$$

Calculate the weighting of the normalized decision matrix

$$V = \begin{bmatrix} 0.1675 & 0.0561 & 0.0559 & 0.0443 & 0.0631 & 0.0204 \\ 0.2093 & 0.0748 & 0.0932 & 0.0554 & 0.0504 & 0.0511 \\ 0.0418 & 0.0748 & 0.0745 & 0.0443 & 0.0504 & 0.0409 \\ 0.1675 & 0.0748 & 0.0559 & 0.0443 & 0.0504 & 0.0307 \\ 0.1675 & 0.0748 & 0.0745 & 0.0443 & 0.0504 & 0.0409 \\ 0.1675 & 0.0748 & 0.0745 & 0.0443 & 0.0504 & 0.0409 \end{bmatrix}$$

Concordance Index matrix

	A1	A2	A3	A4	A5	A6
A1	0	0.129	0.437	0.692	0	0
A2	0.870	0	0.694	0.692	0.692	0.692
A3	0.449	0	0	0	0	0
A4	0.692	0.692	0.692	0	0	0
A5	0.692	0.692	1	0.272	0	0
A6	0.692	0.692	1	0.272	0	0

Discordance Index matrix

	A1	A2	A3	A4	A5	A6
A1	0	1	1	1	1	1
A2	0.302	0	1	1	1	1
A3	0.528	0.192	0	0.315	0.757	0.315
A4	0.547	0.339	0.423	0	0	0
A5	0.711	0.106	0.315	0.972	0	0
A6	0.711	0.106	0.320	0	0	0

Calculating the aggregate of the corcodance index and discordance matrices can be done by multiplying between the two sets of matrices. The conditions for the formation of an aggregate in this matrix are carried out by equation as follows :

$$e_{kl} = f_{kl} \; x \; g_{kl}$$

$$
\begin{bmatrix}
- & 0 & 1 & 1 & 0 & 0 \\
1 & - & 1 & 1 & 1 & 1 \\
0 & 0 & - & 0 & 0 & 0 \\
1 & 1 & 1 & - & 0 & 0 \\
1 & 1 & 1 & 0 & - & 0 \\
1 & 1 & 1 & 0 & 0 & -
\end{bmatrix}
\times
\begin{bmatrix}
- & 1 & 1 & 1 & 1 & 1 \\
0 & - & 1 & 1 & 1 & 1 \\
1 & 1 & - & 0 & 1 & 0 \\
1 & 0 & 0 & - & 0 & 0 \\
1 & 0 & 0 & 1 & - & 0 \\
1 & 0 & 0 & 0 & 0 & -
\end{bmatrix}
=
\begin{bmatrix}
- & 0 & 1 & 1 & 0 & 0 \\
0 & - & 1 & 1 & 1 & 1 \\
0 & 0 & - & 0 & 0 & 0 \\
1 & 0 & 0 & - & 0 & 0 \\
1 & 0 & 0 & 0 & - & 0 \\
1 & 0 & 0 & 0 & 0 & -
\end{bmatrix}
$$

Eliminate less favorable alternatives. Matrix E provides a sequence of choices from each alternative which if e_kl = 1 then the alternative that can be taken is A2 which is a better alternative than the other alternatives.

4   CONCLUSION

This research resulted in the application of both AHP and ELECTRE methods which resulted in an assessment by each respondent in the worker and student categories. The priority weight resulting from the AHP calculation on the most influential factor in the worker category respondents, namely in the second criterion factor, there is the first rank with the time efficiency criterion which reaches a weight of 25.9%. While the priority weight value generated by the student category to the most influential factor is the cost factor which reaches a weight of 30.7%. While the alternative chosen in the calculation using the ELECTRE method in the assessment of respondents in the worker category, namely the alternative mode of transportation, the first rank is on Go-Jek Bike. For the alternative chosen from the assessment of the student category respondents is the Transmetro Deli mode of transportation as the first rank then followed by Angkot and.

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