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Implementation of Electre Method in Determining Tourism Places in North Sumatera

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ABSTRACT

A tourist in determining the purpose of his tour, must be based on several criteria that are used as a determining factor in choosing. These criteria are taken into consideration by tourists in determining which tourist attractions will be chosen. Thus this study aims to assist tourists in choosing tourist attractions in North Sumatra based on the desired criteria and / or provide information to tourists about the best tourist attractions in North Sumatra in accordance with the desired criteria. The Elimination Et Choix Traduisant La Realita (ELECTRE) method which is a system that uses a multicriter decision making method based on the outranking concept by using a pairwise comparison of alternatives based on each appropriate criterion. This research resulted in a recommendation for natural tourist attractions in North Sumatra, namely Teluk Dalam tourism in the Nias Islands.

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INTRODUCTION

North Sumatra Province has an area of 72,981.23 Km2 and has 33 cities / regencies with each city / regency having a diverse tourism potential. Tourism destinations are part of community life that has a strategic role in terms of regional economic development and the community around tourist attractions. Diverse tourism potential can have positive and negative impacts on the preservation of nature, culture, economy, education and religion. The development of tourism can also result in social changes in society, such as changes in lifestyle, behavior, relationships, and violations of existing norms in society.

Along with the development of the era more and more tourist attractions are there both in the form of nature and city tourism. For this reason, a decision support system is needed in choosing tourist attractions in accordance with the wishes of tourists. Opportunities in the selection of tourist attractions can be optimized by utilizing a decision support system that helps tourists in choosing tourist attractions according to tourist criteria, tourist facility facilities, costs, distance and time to travel, souvenirs at tourist attractions, and so forth. In this case the decision support system becomes a basic information for tourists in choosing where to travel.

The selection of tourist attractions can be done by Fuzzy Multiple Attribute Decision Making (FMADM) which is used to find optimal alternatives from a number of alternatives with certain criteria by determining the weight value for each attribute, then proceed with the ranking process that will select the

alternatives that have been given. In this study, researchers used the ELECTREE method for selecting tourist attractions based on the desired criteria.

The decision support system was introduced by G. Anthony Gorry and Michael S. Scott Morton (Diana, 2018). Decision support system is a system or activity in supporting decision making from several existing alternatives. Decision support systems are closely related to information systems and professionals to get accurate data. (Aprilia, 2019) used FMADM in determining hotel choices in Medan City.

The ELECTREE method is one of the multi criteria criteria based decision support systems originating from Europe around the 1960s (Diana, 2018). ELECTREE comes from the word Elimination Et Choix Traduisant La Realita (Elimination and Choice Expressing Reality). This method is used in assessing and ranking based on strengths and weaknesses through pairwise comparisons on the same criteria (Figueira, et al., 2005). (Marlinda, 2016) produced a web application that provides recommendation information to users by using the ELECTRE method of listing tourist attractions in the city of Yogyakarta.

RESEARCH METHODE

This research is a quantitative study, data obtained using an online questionnaire with a random sample of tourists visiting the Province of North Sumatra. The results of the data are processed using the ELECTREE method, which is a method used in assessing and ranking based on strengths and weaknesses through pairwise comparisons on the same criteria.

Data analysis is the activity of grouping data based on variables after data from all respondents or data sources are collected. In this study, the steps taken to analyze data are as follows:

a.Determine the matching rating of each alternative on each criterion, rated with one to five. By determining the value, which is: 1 = Very Bad, 2 = Poor, 3 = Enough, 4 = Good, 5 = Very Good,

b. Determining the value of criteria (weighting preferences) can be determined by judging by one to five. 1 = Very Low, 2 = Low, 3 = Enough, 4 = High, 5 = Very High

RESULT AND ANALYSIS

System Analysis And Design

This study discusses the implementation of the ELECTREE method in determining tourist attractions to be visited in the Province of North Sumatra. After taking data by means of an online questionnaire or questionnaire in the University of Medan City environment, then further analyzing the data obtained. The problem discussed in this study is how to determine the choice of tourist attractions in North Sumatra by using the ELECTREE method.

The criteria established by researchers in determining the selection of tourist attractions in North Sumatra are: Distance, Time, Cost, Safety, Culinary and Souvenirs. To find a bright spot for a researcher in determining the selection of tourist attractions in North Sumatra, a system that can determine the order (priority) in multi Criteria analysis can provide information on tourist attractions in North Sumatra that are recommendations to the public.

System Implementation

In conducting the analysis using the Electre method which is to calculate the value of e_{kl}= 1 in matrix E, if an alternative has the number of values e_{kl} = 1 more than the number of e_{kl}= 1 in another alternative, it can be decided that the first alternative is a better alternative, but if the values of e_{kl}= 1 dominate each other then a comparison of values is performed using the Weight Normalized value comparison value. Determine the alternatives and criteria in this study the alternatives determined are the kinds of tourist attractions that exist including: A1 = Lake Toba, A2 = Berastagi, A3 = Piso-piso Waterfall, A4 = Teluk Dalam

While there are five criteria used as a reference in decision making, namely: C1 = Distance, C2 = Time, C3 = Cost, C4 = Security, C5 = Culinary, C6 = Souvenir

Determination of the range of criteria:

Table 3.1 Determine the range of criteria

Criteria	Skor	Skor	Skor	Skor	Skor
Distance	0-90 Km	91-181 Km	182-272 Km	273-363 Km	364-454 Km
	5	4	3	2	1

Time	0-60 minute	61-121 minute	122-182 minute	183-243 minute	244-304 minute
	5	4	3	2	1
Cost	Cheap Enough	Cheap	Expensive Enough	Expensice	Very Expensive
	5	4	3	2	1
Security	Not Safe	Less Safe	Safe Enough	Safe	Very Safe
	1	2	3	4	5
Culinary	Not Good	Poorly	Passably	Good	Very Good
	1	2	3	4	5
Souvenir	Not Good	Poorly	Passably	Good	Very Good
	1	2	3	4	5

Based on table 3.1 regarding the determination of the range of criteria, so the matching ratting table of each alternative to each criterion becomes:

Table 3.2 Ratting the suitability of each alternative to the criteria

Alternative	Criteria					
	Distance (C1)	Time (C2)	Cost (C3)	Security (C4)	Culinary (C5)	Souvenir (C6)
Lake toba(A1)	4	2	2	4	4	5
Berastagi (A2)	5	4	4	3	3	4
Sipiso -pisoWaterfall (A3)	4	2	5	2	3	3
Teluk Dalam (A4)	2	4	1	4	4	5

The table above is a decision matrix that has been determined by the decision maker. So the decision matrix formed from the table as follows:

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

To resolve the problem regarding the decision support system for tourist site selection using the ELECTRE method will be carried out with the steps described previously, i.e:

1. Calculate the normalized decision matrix

   Normalization is done to eliminate duplication of data, to reduce complexity and to facilitate the modification of data, so that data can be described in tabular form and analyzed based on certain requirements. With the formula: $r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^{\,2}}}$ (1)

   The following calculates the elements of a normalized decision matrix.

$|x_1| = \sqrt{4^2+5^2+4^2+2^2} = 7.8102$

$r_{11}=\frac{4}{7.8102}=0.5125$

$r_{21}=\frac{5}{7.8102}=0.6402$

$r_{31}=\frac{4}{7.8102}=0.5125$

$r_{41} = \frac{2}{7.8102} = 0.2560$

$|x_2| = \sqrt{2^2+4^2+2^2+4^2} = 6.3245$

$r_{12}=\frac{2}{6.3245}=0.3162$

$r_{22}=\frac{4}{6.3245}=0.6325$

$r_{32}=\frac{2}{6.3245}=0.3162$

$r_{42} = \frac{4}{6.3245} = 0.6325$

$|x_3| = \sqrt{2^2+4^2+5^2+1^2} = 6.7823$

$r_{13}=\frac{2}{6.7823}=0.2949$

$r_{23}=\frac{4}{6.7823}=0.5898$

$r_{33}=\frac{5}{6.7823}=0.7372$

$r_{43} = \frac{1}{6.7823} = 0.1474$

$|x_4| = \sqrt{4^2+3^2+2^2+4^2} = 6.7082$

$r_{14}=\frac{4}{6.7082}=0.5963$

$r_{24}=\frac{3}{6.7082}=0.4472$

$r_{34}=\frac{2}{6.7082}=0.2981$

$r_{44} = \frac{4}{6.7082} = 0.6963$

$|x_5| = \sqrt{4^2+3^2+3^2+4^2} = 7.0711$

$r_{15}=\frac{4}{7.0711}=0.5657$

$r_{25}=\frac{3}{7.0711}=0.4243$

$r_{35}=\frac{3}{7.0711}=0.4243$

$r_{45} = \frac{4}{7.0711} = 0.5657$

$|x_6| = \sqrt{5^2+4^2+3^2+5^2} = 8.6603$

$r_{16}=\frac{5}{8.6603}=0.5773$

$r_{26}=\frac{4}{8.6603}=0.4619$

$r_{36}=\frac{3}{8.6603}=0.3464$

$r_{46} = \frac{5}{8.6603} = 0.5773$

So the normalized matrix is as follows:

$$R = \begin{bmatrix} 0.5121 & 0.3162 & 0.2949 & 0.6963 & 0.5657 & 0.5773 \\ 0.6402 & 0.6325 & 0.5898 & 0.4472 & 0.4243 & 0.4619 \\ 0.5121 & 0.3162 & 0.7372 & 0.2981 & 0.4243 & 0.3464 \\ 0.2560 & 0.6325 & 0.1474 & 0.5963 & 0.5657 & 0.5773 \end{bmatrix}$$

2. Determine the factor (weight) in each criterion

Weighting on a normalized matrix is done by multiplying each element of the normalized matrix with a predetermined weight, i.e:

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

3. Normalized weighting of the matrix

$$V_{ij} = W_j \,.\, X_{ij} \qquad (2)$$

$$V = \begin{bmatrix} 1.5363 & 0.6324 & 1.1796 & 2.9815 & 2.8285 & 2.8565 \\ 1.9206 & 1.2650 & 2.3592 & 2.2360 & 2.1215 & 2.3095 \\ 1.5363 & 0.6324 & 2.9488 & 1.4905 & 2.1215 & 1.7320 \\ 0.7680 & 1.2650 & 0.5896 & 2.9815 & 2.8285 & 2.8565 \end{bmatrix}$$

4. Determine the set of concordance index and discordance index

a. Concordance. A criterion in an alternative if:

$C_{kl} = \{j, v_{kj} \geq v_{ij}\}$ if $j = 1,2,3,\ldots, n$ (3)

The results obtained are:

Concordance	Lake Toba	Berastagi	Sipiso-piso Waterfall	Teluk dalam
Lake Toba	-	(4,5,6)	(1,2,4,5,6)	(1,3,4,5,6)
Berastagi	(1,2,3)	-	(1,2,4,5,6)	(1,2,3)
Sipiso-piso Waterfall	(1,2,3)	(3,5)	-	(1,3)
Teluk Dalam	(2,4,5,6)	(2,4,5,6)	(2,4,5,6)	-

b. Discordance. A criterion in an alternative if:

$D_{kl} = \{j, v_{kj} < v_{ij}\}$ if $j = 1,2,3,\ldots, n$ (4)

The results obtained are:

Disrcordance	Lake Toba	Berastagi	Sipiso-piso Waterfall	Teluk dalam
Lake Toba	-	(1,2,3)	(3)	(2)
Berastagi	(4,5,6)	-	(3)	(4,5,6)
Sipiso-piso Waterfall	(4,5,6)	(1,2,4,6)	-	(2,4,5,6)
Teluk Dalam	(1,3)	(1,3)	(1,3)	-

5. Calculating concordance and discordance matrices

a. Calculate the concordance matrix with the formula:

$C_{kl} = \sum_{j \in C_{kl}} w_j$ (5)

$C_{12} = w_4 + w_5 + w_6 = 5 + 5 + 5 = 15$

$C_{13} = w_1 + w_2 + w_4 + w_5 + w_6 = 3 + 2 + 5 + 5 + 5 = 20$

$C_{14} = w_1 + w_3 + w_4 + w_5 + w_6 = 3 + 4 + 5 + 5 + 5 = 22$

Resulting in a matrix:

$$\begin{bmatrix} - & 15 & 20 & 22 \\ 9 & - & 20 & 9 \\ 9 & 9 & - & 7 \\ 17 & 17 & 17 & - \end{bmatrix}$$

b. Calculate the discordance matrix, containing the elements calculated from the discordance index results, as follows:

$$d_{12} = \frac{\max\left\{\left|v_{1j} - v_{2j}\right|\right\} j \in D_{12}}{\max\left\{\left|v_{1j} - v_{2j}\right|\right\} \forall j}$$

$$= \frac{\max\left\{\left|1.5363 - 1.9206\right|; \left|0.6324 - 1.2650\right|; \left|1.1796 - 2.3592\right|\right\}}{\max\left\{\left|1.5363 - 1.9206\right|; \left|0.6324 - 1.2650\right|; \left|1.1796 - 2.3592\right|\right.}$$

$$\left.; \left|2.9815 - 2.2360\right|; \left|2.8285 - 2.1215\right|; \left|2.8865 - 2.395\right|\right\}$$

$$= \frac{1.1796}{1.1796} = 1$$

$$d_{13} = \frac{\max\left\{\left|v_{1j} - v_{3j}\right|\right\} j \in D_{13}}{\max\left\{\left|v_{1j} - v_{3j}\right|\right\} \forall j}$$

$$= \frac{\max\left\{\left|1.1796 - 2.9488\right|\right\}}{\max\left\{\left|1.5363 - 1.5363\right|; \left|0.6324 - 0.6324\right|; \left|1.1796 - 2.9488\right|\right.}$$

$$\left.; \left|2.9815 - 1.4905\right|; \left|2.8285 - 2.1215\right|; \left|2.8865 - 1.7320\right|\right\}$$

$$= \frac{1.7693}{1.7693} = 1$$

$$d_{14} = \frac{\max\left\{\left|v_{1j} - v_{4j}\right|\right\} j \in D_{14}}{\max\left\{\left|v_{1j} - v_{4j}\right|\right\} \forall j}$$

$$= \frac{\max\left\{\left|0.6324 - 1.2650\right|\right\}}{\max\left\{\left|1.5363 - 0.7680\right|; \left|0.6324 - 1.2650\right|; \left|1.1796 - 0.5896\right|\right.}$$

$$\left.; \left|2.9815 - 2.9815\right|; \left|2.8285 - 2.8285\right|; \left|2.8865 - 2.8865\right|\right\}$$

$$= \frac{0.6326}{0.7683} = 0.82337$$

Resulting in a matrix:

$$\begin{bmatrix} - & 1 & 1 & 0.82337 \\ 0.63199 & - & 0.79887 & 0.42128 \\ 0.84275 & 1 & - & 0.42128 \\ 1 & 1 & 1 & - \end{bmatrix}$$

6. Determine the concordance and discordance dominant matrices
   a. Calculates the concordance dominant matrix. The dominant concordance matrix element F is built with the help of the treshold value, namely by comparing each value of the concordance matrix element with the treshold value.

$$\underline{c} = \frac{\sum_{k=1}^{m}\sum_{l=1}^{m} c_{kl}}{m(m-1)} \quad (6)$$

$$\underline{c} = \frac{15 + 20 + 22 + 9 + 24 + 9 + 9 + 9 + 7 + 17 + 17 + 17}{4(4-1)} = 14.5833$$

The result is : $\underline{c} = 14.5833$

So the matrix element F is determined as follows:

$$f_{kj} = \begin{cases} 1, \text{if } c_{kj} \geq \underline{c} \\ 0, \text{if } c_{kj} \leq \underline{c} \end{cases} \quad (7)$$

So the concordance dominant matrix is:

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

b. Calculates the discordance matrix. The dominant discordance matrix element G can be obtained with the treshold value.

$$\underline{d} = \frac{\sum_{k=1}^{m}\sum_{l=1}^{m} d_{kl}}{m(m-1)} \tag{8}$$

$$\underline{d} = \frac{1+1+0.82337+0.63199+0.79887+0.42128+0.84275+1+0.42128+1+1+1}{4(4-1)}$$

$$\underline{d} = 0.828295$$

The result is : $\underline{d} = 0.828295$

So the element matrix g is determined as follows:

$$g_{kj} = \begin{cases} 1, \text{if } d_{kj} \geq \underline{d} \\ 0, \text{if } d_{kj} \leq \underline{d} \end{cases} \tag{9}$$

So the dominant discordance matrix is:

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

7. Determine the aggregate dominance matrix, with the formula

$$e_{kl} = f_{kl} \times g_{kl} \tag{10}$$

So the resulting matrix of aggregate dominance is:

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

8. Eliminate alternatives that are less favorable:

Matrix E gives a sequence of choices for each alternative, i.e. if $e_{kl} = 1$ then the A_k alternative is a better alternative than the alternative A_l. So that the rows in the matrix E that have $e_{kl} = 1$ the fewest numbers can be eliminated. In the matrix E the first row A_1 has the number $e_{kl} = 1$ is 2, whereas A_2 and A_2 does not have the number $e_{kl} = 1$, and the fourth row A_4 has the number $e_{kl} = 1$ is 3. Thus based on the results of calculations that have been carried out using the ELECTREE method the selection of the best tourist attractions on the alternative is Teluk Dalam.

CONCLUSION

North Sumatra is the fourth largest province in Indonesia which has the potential of tourist attractions that can be visited by local and foreign tourists. With so many kinds of natural attractions in North Sumatra, a decision support system was made in choosing natural attractions in North Sumatra that can be visited by tourists based on the desired criteria using the ELECTRE method. The Elimination Et Choix Traduisant La Realita (ELECTRE) method is a priority determination method that can be said to be quite simple, this method is used in assessing and ranking based on strengths and weaknesses through pair comparisons on the same criteria. In order of priority the best is influenced by the type of preference used. Modeling the criteria used in the decision support system for the selection of tourist attractions in North Sumatra can be a solution in the process of selecting an alternative tourist destination. By comparing alternative values using the ELECTRE method the best alternative order is obtained with objective results. Based on the results of the implementation of the system design, it can be concluded that the Teluk Dalam tourism site which is

highly recommended is the selection of tourist attractions in North Sumatra. This is because Teluk Dalam is $e_{kl} = 1$ the alternative that has the most number of alternatives, and also means that this alternative is very dominant against the existing criteria, namely time, safety, culinary, and souvenir criteria. Besides Teluk Dalam is also a foreign tourist spot because of the beauty of its beaches which are a favorite of world surfers.

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