Implementation of ELECTRE Method in Determining the Priority of a Sustainable Tourist Attraction Development in Gorontalo Regency

S Nawir¹, R Manda²*, T Rahman² and A U Fatmah³

¹Department of Earth Science and Engineering, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo, Indonesia

²Department of Informatics Engineering, Faculty of Engineering, Universitas Negeri Gorontalo, Indonesia

³Department of Indonesian Language and Literature Education, Faculty of Language and Culture, Universitas Negeri Gorontalo, Indonesia

*manda.rohandi@ung.ac.id

Abstract. Prioritizing the development of a tourist attraction in Gorontalo regency is necessary, due to the limited budget allocation and the spread of tourist attractions that make it difficult to managed and supervised. Decision support system (DSS) that implementing Multi-Attribute Decision Making (MADM) such as Elimination Et Choix Traduisant La Realite (ELECTRE) method is required to assist the local government to make decision what kind of tourist attraction is the priority to developed. The purpose of this research is to help the local government in determine the priority of a sustainable tourist attraction development in Gorontalo regency. ELECTRE method is used to assess and rank the tourist attractions based on the advantages and disadvantages through paired comparison on the same criteria. The process of collecting data is through interviews and literature review. The calculations of ELECTRE method obtained that the Reksonegoro Tourism Village or Soekarno Landing Site Museum is the most potential tourist attraction to be a priority for sustainable development. The result is provided sensible and straightforward rankings and, importantly, the decision makers more objective in determining the priority of a sustainable tourist attractions development.

1. Introduction

Gorontalo regency as well as other areas in Indonesia, has potential to be a tourist attraction because its natural resources and unique culture. As one of the areas in Gorontalo province that rely on tourism as their main source of income, tourism potential development strategies are needed in increasing the economic growth to create new jobs and stimulate the production sector. The unplanned tourism development can lead to environmental damage and social which can destroy the lives of local society also continuity of the businesses itself [1]. There are many sights in Gorontalo regency which have potential to be developed, it based on topography of the area that consists of lakes, mountains and
beaches. As well as other potentials, Gorontalo regency also has its local wisdom, it is included in the customs area "Uduluwo limo lo pohala'a" with a diversity of culture, such as historic sites, dances, customs and legends. Nevertheless, the number of visitors who come less encouraging, with a total rating about 58,674 people, which is still dominated by local tourists as many as 58,588 people and the rest are foreign tourists which are about 86 people [2].

The development of tourism potential in Gorontalo regency has been done, with the management of culture, Communication and Information Department (DISPARBUDKOMINFO) in some natural attractions and culture (as shown in Table 1). Yet, local governments are still difficult in terms of management, utilization and monitoring of the existing tourist attractions. One of many reasons is the spread of the tourist attractions are making it difficult to determine the priority of tourist attractions that has the potential to be developed. Besides, the number of criteria that must be fulfilled to obtain a tourist attraction as the priority which need to be developed also be other problems. There are five essential elements to allow tourists satisfied in enjoying their journey, namely Attractions / charm, facilities, infrastructure, transportation / accessibility, and hospitality / security[3]. These five elements can be used as criteria in determining the tourism potential to be developed.

Table 1. List of tourist attractions organized by DISPARBUDKOMINFO, Gorontalo regency[4][5]

| No. | Tourist Attractions                      |
|-----|-----------------------------------------|
| 1.  | Gorontalo Traditional House/Banthayo Poboide |
| 2.  | Keagungan Tower/Pakaya Tower             |
| 3.  | Pentadio Hot Water Bathing Place         |
| 4.  | Snakes Cave                             |
| 5.  | Taluhu Barakati Bathing Place            |
| 6.  | Bongo Religious Village                 |
| 7.  | Diloniyohu Hot Water Bathing Place       |
| 8.  | Taulaa Beach                            |
| 9.  | Ilomata Beach                           |
| 10. | Scouts Camping Hill (PPN)               |
| 11. | Panipi King Grave                       |
| 12. | Reksonegoro Tourism Village             |
| 13. | Soekarno Landing Site Museum             |
| 14. | Bongo Religious Village                 |

One approach that could be used to assist the local government in determining the priority of potential tourist attractions development is a **Decision Support System** (DSS) that implement **Multi-Attribute Decision Making** (MADM). There is plenty of DSS definition, including by Triswana, et al, DSS is a system that integrates database and model base in a dialogue display and be used to interactively by the user to assist decision-making[6]. According to Turban, et al, DSS is a set of model-based procedures for data processing and assessment to assist the managers in decision-making[7].

There are several DSS methods that implement the MADM in decision-making, one of them is using ELECTRE method. It is expected that the implementation of this method could to assist the local government in determining which tourist attractions are the most potential to be developed sustainably.

So far, the definition of DSS is depends on which viewpoint it’s seen. But in general, DSS is defined by looking at the following aspects:
1. The System is computer-based
2. Could help solve the problem of a manager
3. Semi-structured problems
4. Interactive between the system and the manager
5. Using data analysis

The Objectives of DSS as follows[8]:
1. DSS could assist managers in decision making for the semi-structural problems
2. DSS could support the assessment of a manager
DSS could improve the effectiveness and efficiency of a manager in decision making

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2. The ELECTRE Method

Among several of DSS methods based on multi-criteria are commonly used, ELECTRE is a DSS method was often used in decision making for cases with many alternatives, but with fewer criteria involved. Elimination Et Choix Traduisant La Realite (ELECTRE) originated in Europe around 1960, used in assessing and ranking based on the advantages and disadvantages trough paired comparison on the same criteria[9].

The steps to solve a problem using ELECTRE method is as follows[8]: Please follow these instructions as carefully as possible so all articles within a conference have the same style to the title page. This paragraph follows a section title so it should not be indented.

2.1. Normalization of decision matrix

Each of the attributes is changed to a value that comparable by normalization every value of $x_{ij}$ using the formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{n}x_{ij}^2}}$$

Thus, the rationalization matrix obtained as follow:

$$R = \begin{bmatrix}
    r_{11} & r_{12} & \cdots & r_{1n} \\
    r_{21} & r_{22} & \cdots & r_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    r_{m1} & r_{m2} & \cdots & r_{mn}
\end{bmatrix}$$

$R$ is a matrix that has been normalized, which $m$ express alternatives and $n$ express criteria, and $r_{ij}$ is normalized measurement of choice from alternatives $i$ in conjunction with criteria $j$.

2.2. Weighting the normalized matrix

Each of the columns in matrix $R$ is multiplied by the weights ($w_j$) as determined by the decision makers, so that the normalization matrix that has been weighted is $V = RW$.

$$V = \begin{bmatrix}
    v_{11} & v_{12} & \cdots & v_{1n} \\
    v_{21} & v_{22} & \cdots & v_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    v_{m1} & v_{m2} & \cdots & v_{mn}
\end{bmatrix} = \left( R \begin{bmatrix}
    r_{11} & r_{12} & \cdots & r_{1n} \\
    r_{21} & r_{22} & \cdots & r_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    r_{m1} & r_{m2} & \cdots & r_{mn}
\end{bmatrix} \right) \times W \begin{bmatrix}
    w_1 & 0 & \cdots & 0 \\
    0 & w_2 & \cdots & 0 \\
    \vdots & \vdots & \ddots & \vdots \\
    0 & 0 & \cdots & w_n
\end{bmatrix}$$

(2)

2.3. Determining the sets of concordance and discordance index

Each pair of alternatives k and l (k,l = 1, 2, 3, ..., m where k ≠ l), A set of j criteria is divided into two sets, the concordance and discordance. A criterion in an alternative would be concordance if:

$$C_{kl} = \{j, v_{kj} \geq v_{lj} \text{ for } j = 1, 2, 3, ..., n. \}$$

Instead, it will be discordance if:

$$D_{kl} = \{j, v_{kj} < v_{lj} \text{ for } j = 1, 2, 3, ..., n. \}$$
\[ C_{il} = \{ j, v_{lj} < v_{lj} \} \text{ for } j = 1, 2, 3, ..., n. \] (4)

2.4. Calculate the matrix concordance and discordance
Search the value of each element in the matrix concordance by adding any weight that is included in the set of concordance, using the formula:

\[ C_K = \sum_{j \in L_K} w_j \] (5)

For discordance matrix, finding the value of each element of the matrix by dividing the maximum difference of criteria included in the set discordance with a maximum difference of the value of all the criteria, it mathematically written:

\[ C_K = \frac{m}{m} \left( \frac{\|v_K - v_l\|_F}{\|v_K - v_l\|_V} \right) \] (6)

2.5. Determine the dominant matrix of concordance and discordance
A concordance dominant matrix \( (F) \) may be formed using a threshold, by comparing the value of the matrix element concordance with the threshold value. Mathematically, it can be written:

\[ F_K \geq \xi \] (7)

Where \( \xi \) as a value of threshold which obtained from:

\[ \xi = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} C_{ik}}{m(m-1)} \] (8)

So that the matrix elements \( F \) obtained by:

\[ F_K = \begin{cases} 1, & j_i C_K \geq \xi \\ 0, & j_i C_K < \xi \end{cases} \]

Discordance dominant matrix \( (G) \) can be formed with a threshold value \( d \), which mathematically can be written:

\[ d = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} L_{ik}}{m(m-1)} \] (9)

Thus, the matrix element \( G \) obtained by:

\[ G_K = \begin{cases} 1, & j_i L_K \geq d \\ 0, & j_i L_K < d \end{cases} \]

2.6. Determine aggregate dominance matrix
Aggregate dominance matrix \( (E) \) is the matrix that each element corresponds to a multiplication of the matrix elements \( F \) and \( G \), it mathematically be written:

\[ E_K = F_K \times G_K \] (10)

2.7. Elimination alternative less favorable
Matrix \( E \) is the matrix that gives the option of each alternative in sequence, wherein if, one the alternative is a better than other alternatives. So that the rows in a matrix \( E \) that has the least score can be eliminated. Thus, the best alternative is an alternative that dominates other alternatives.

3. Development Criteria of Destination
Tourism is one component of the revenue of the country that is important for development. The development of tourism is actually an effort to utilize and develop all potential of objects and tourist attractions in the form of natural beauty, diversity Flora and fauna, unique culture, as well as historical and archaeological heritage. Gorontalo regency as one of the areas in Indonesia which is rich in tourism potential, also continues to build and develop all those potentials.

In the development of tourism potential, there are several elements that can be used to determine the priority of tourism development. These elements can be used as criteria for determining the
priority of tourism which to be developed further. According Spillane[3] There are five essential elements to allow tourists satisfied in enjoying the trip, namely:

1. Attractions / Fascination are things that could attract tourists to come traveled
2. Facilities are things that can help supporting the rating in the tour
3. Infrastructure construction is contained below and above the ground in a travel destination
4. Transport / accessibility is an element of carriers and modes for tourists to reach tourist attractions
5. Hospitality / security is an element of acceptance of local people towards tourist

4. Analysis of ELECTRE Method in Determining the Priority of Tourist Attraction Development in Gorontalo Regency

The data is collecting from literature that related to the research, interview with the staff of DISPARBUDKOM and from direct observation. Natural and cultural attractions administered by the Office PARBUDKOMINFO Gorontalo regency, must meet the five elements/criteria that can be prioritized as a tourism attraction which to be future developed. The five criteria are the attraction/attractiveness, facilities, infrastructure, transportation/accessibility, and hospitality/security (written with C1, C2, ..., C5). Each criterion is given a compatibility rating for each alternative on each criterion with a score from one to five, where 1 = Very bad, 2 = Bad, 3 = Enough, 4 = Good, 5 = Very good. In this case the compatibility rating for each alternative on each criterion is takes from table 2.

Table 2. List of tourist attractions rating for each alternative on each criterion.

| No. | Alternatives                                | C1 | C2 | C3 | C4 | C5 |
|-----|--------------------------------------------|----|----|----|----|----|
| 1   | Gorontalo Traditional House/Banthayo Poboide | 3  | 5  | 5  | 5  | 5  |
| 2   | Keagungan Tower/Pakaya Tower                | 3  | 4  | 4  | 5  | 4  |
| 3   | Pentadio Hot Water Bathing Place            | 4  | 4  | 4  | 5  | 4  |
| 4   | Snakes Cave                                 | 4  | 1  | 1  | 2  | 3  |
| 5   | Taluhu Barakati Bathing Place               | 3  | 3  | 4  | 4  | 4  |
| 6   | Bongo Religious Village                     | 5  | 4  | 4  | 4  | 5  |
| 7   | Diloniyohu Hot Water Bathing Place          | 3  | 2  | 3  | 3  | 4  |
| 8   | Taulaa Beach                                | 5  | 2  | 2  | 3  | 5  |
| 9   | Ilomata Beach                               | 5  | 2  | 2  | 2  | 5  |
| 10  | Scouts Camping Hill (PPN)                   | 3  | 3  | 4  | 3  | 4  |
| 11  | Panipi King Grave                           | 3  | 3  | 3  | 3  | 4  |
| 12  | Reksonegoro Tourism Village                 | 3  | 4  | 4  | 5  | 5  |
| 13  | Soekarno Landing Site Museum                 | 3  | 4  | 4  | 4  | 5  |
Furthermore, the level of importance (preference weighted value) also being assessed by using scales one to five, as follows: 1 = very low, 2 = low, 3 = enough, 4 = high, 5 = very high. Based on collected data, we have the preference weighted value for each criterion as follows: Attraction(C1)= 5, Facilities(C2)=3, Infrastructures(C3)=3, Transportation/accessibility(C4)= 4, hospitality/security (C5) = 4. Therefore \( w = (5, 3, 3, 4, 4) \). Now let’s start to solve the problem using ELECTRE method[8]. The first step is to normalize the decision matrix using formula 1, and thus we have rationalized matrix as shown in figure 1. The second step is to weighting the normalized matrix using formula 2, and so we have the normalization matrix that has been weighted as shown in figure 2. The third step is to determine the sets of concordance and discordance index using formula 3 and 4, and thus we have the sets of concordance and discordance index as shown in figure 3 and 4. The fourth step is to calculate the concordance and discordance matrix using formula 5 and 6, and thus we have new concordance matrix by adding any weight that is included in the set of concordance and new discordance matrix by dividing the maximum difference of criteria included in the set discordance with a maximum difference of the value of all the criteria as shown in figure 5 and 6. The fifth step is to determine the dominant matrix of concordance and discordance with threshold values \( c \) and \( d \). The concordance threshold \( c \) is obtained using formula 8, and so we have a dominant matrix of concordance as shown in figure 7, with \( c = 12.4 \). In addition, the discordance threshold \( d \) is obtained by formula 9, and thus we have dominant discordance matrix as shown in figure 8, with \( d = 0.63 \). The sixth step is to determining aggregate dominance matrix by formula 10, and so we have aggregate dominance matrix as shown in figure 9. The last step is to eliminate the alternative that less favorable, and thus the result indicate that alternative reksonegoro tourism village(A12) or Soekarno landing site museum (A13) is the most potential tourist attraction to be a priority for sustainable development.
5. The Prototype Application of ELECTRE in Determining the Priority of Tourist Attraction Development in Gorontalo Regency

The application used .Net programming language and tool using Visual Basic .Net 2010 for application development. This application consist of four main forms that used to input alternatives, criterion, ratings, and to obtain the decision using ELECTRE method. Figure 9 show a form to input alternatives for the tourist attractions. The attributes of this form is consist of ID, name and description of a tourist attraction. Figure 10 show a form to input criteria and weighted value of each criterion. Both of the forms could save or delete the data. The data of input alternatives, and input criteria and weighted forms, is taken from table 2 and w values. Figure 11 show a form to input the rating of each alternative on each criterion. In this form we could start to search the best rank of tourist attractions using ELECTRE method by pressing the Count button. The application will start to calculate the input rating and show the result of each step of the ELECTRE method from value and normalized matrix to ranking tabs as shown in figure 12.
6. Conclusion

Obtaining the priority of tourist attraction that has potential to be developed is highly required for the local government due to the limited budget and spread of tourist attractions. One of the solutions in advising the decision maker in Gorontalo regency is from the use of DSS method which can contribute to rank the object sensible and straightforward.

One of the DSS methods which implemented Multi-Attribute Decision Making (MADM) is ELECTRE method. This method has 7 steps in taking assessment and rank based on strength and weakness by pair comparison from the same criteria. The implementation of ELECTRE method toward the DSS prototype application in deciding the priority of tourist attraction to develop in Gorontalo regency obtained that Reksonegoro tourism village (A12) or Soekarno landing site museum (A13) has the most potential tourist attraction to be a priority for sustainable development. These DSS application only help to give suggestion to the decision maker about any kind of tourist attraction that can be prioritized more objective, unfortunately the final decision remains with the decision makers.
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