Decision support system for selection of tourism in Tana Toraja using technique for order preference method by similarity to ideal solution (topsis)

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Abstract. Tana Toraja is one of the favorite tourist destinations in South Sulawesi. In Tana Toraja, there are many tourist sites that offer various advantages each. This can make tourists confused in determining the right tourist location to visit. Therefore we need a system that can provide the right information in determining the exact location of a tourist destination. This study aims to make it easy for prospective visitors to choose tourism objects in Tana Toraja that they wish. The method used in this study is the TOPSIS and fuzzy methods that can provide an alternative ranking of tourist attractions. The result of this Decision Support System is to produce recommendations for tourist attractions that can be visited by tourists.

1. Introduction
Tana Toraja is one of the districts in South Sulawesi, which is geographically located to the north of the island of Sulawesi. Tana Toraja is a tourist destination that is in high demand by tourists, both domestic and foreign. The tourist attractions offered are increasingly diverse such as natural landscape tours, traditional cemeteries, traditional houses, custom signs 'tuka', 'solo signs', traditional markets, culinary, waterfalls, and so on. To be able to assist tourists in determining the desired tourist location in accordance with their preferences and priorities, a decision support system will be able to assist in the decision-making stage. Decision support system (SPK) is one of the tools that can be used in decision making for decision-makers [1]. Decisions offered by decision support systems tend to be fast and quantitatively the best choices based on the level of importance/weight of the criteria given by management as the decision-maker [2]. With the help of a decision support system, decision making that is quite complex can be shortened. Tana Toraja is one of the districts in South Sulawesi, which is geographically located to the north of the island of Sulawesi. Tana Toraja is a tourist destination that is in high demand by tourists, both domestic and foreign.

The tourist attractions offered are increasingly diverse such as natural landscape tours, traditional cemeteries, traditional houses, custom signs 'tuka', 'solo signs', traditional markets, culinary, waterfalls, and so on. To be able to assist tourists in determining the desired tourist location in accordance with their preferences and priorities, a decision support system will be able to assist in the decision-making stage. Decision support system (SPK) is one of the tools that can be used in decision making for decision-makers. Decisions offered by decision support systems tend to be fast and quantitatively the best choices based on the level of importance/weight of the criteria given by management as the decision-maker. With the help of a decision support system, decision making that is quite complex can be shortened. The determination of tourist sites has been done in several studies, both using decision support systems and...
user-profiles. They are building a decision support system for website-based tourism for the Nigerian region using artificial intelligence. The advantage of this SPK is that it helps tourists in determining their planned visit in a shorter time and reduces travel costs [3].

SPK for tourism Mahamud, Masron, and Mohamed (2013) [4], which were built in combination using Geographic Information Systems (GIS), where SPK can display maps of tourist areas. This type of SPK can display data of the closest locations, public places around, and the route to a certain location. In this SPK, there are no input criteria or weights according to tourist conditions. The use of SPK, which received weighting criteria, was carried out by Taluay et al. (2015) [5], using the Analytic Hierarchy Process (AHP) for tourism in Talaud Island. SPK, which is built in this system, does not manage vehicle/attraction data provided by tourist sites. The basis of a decision support system is the characterization carried out by an interactive computer system that helps decision making using the help of data and models in overcoming unstructured problems. This system is designed to assist in making decisions, starting with identifying problems, taking relevant data, approaching decision making, and evaluating choices interactively [6].

2. Technique For Order Preference By Similarity To Ideal Solution (TOPSIS)

Technique For Order Preference by Similarity to Ideal Solution (TOPSIS) is a method that was first introduced in 1981. This method provides a hypothesis related to two artificial alternatives, namely alternatives for optimal solutions and alternatives for non-optimal solutions. The basis of this rationale comes from the concept of compromise, where alternative solutions have the shortest distance to the optimal solution and have the longest distance from the non-optimal solution Lokare and Jadhav (2016) [7]. The steps used in finding solutions with the TOPSIS method in general done by passing the following stages:

- a. Determine the criteria used as points that determine whether an option is the best solution in a case. Criteria can be any factors that influence decision making.
- b. Weighting criteria. Where at this stage, the criteria that influence decision making are given a weighting value based on the presentation of these criteria in determining decision making.
- c. Building a normalized decision matrix. Elements of this normalization are shown in Equation (1) below:

\[
T_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i} x_{ij}^2}}
\]

Where : \(rij\) = the result of normalization of decision matrix \(R\); \(i = 1,2,3,..., m; j = 1,2,3,..., m\);

- d. Construct the weighted normalized decision matrix shown in Equation (2) below:

\[
\bar{V} = \begin{bmatrix}
    w_{1}P_{11} & \cdots & w_{n}P_{1m} \\
    \vdots & \ddots & \vdots \\
    w_{1}P_{m1} & \cdots & w_{n}P_{mn}
\end{bmatrix}
\]

- e. Determine the negative ideal solution and the positive ideal solution shown in Equation (3) and Equation (4) below:

\[
+ = \{(\max Vij)(\min Vij)\ j = \}, \\
i = 1,2,3,...,m} = \{ 1+, 2+, ..., +\} \quad (3)
\]
\[ = \{(\max_{ij}(\min_{i,j})_{j} \mid i = 1, 2, 3, \ldots, m) = \{1^-, 2^-, \ldots, -\} \quad (4)\]

f. Calculate the separation.

It is a way to calculate or measure the distance between alternative solutions with positive ideal solutions and negative ideal solutions shown in Equation (5) and equation (6) below:

\[ S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_i^+)^2} \quad (5) \]
\[ S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_i^-)^2} \quad (6) \]

With \( i = 1, 2, 3, \ldots, n; \)

g. Calculating the proximity relative to the optimal solution shown in Equation (7) below:

\[ C_i^+ = \frac{S_i^-}{S_i^- + S_i^+} \quad (7) \]

With \( 0 < C < 1 \) dan \( i = 1, 2, 3, \ldots, n; \)

h. Provides alternative ranking that can be sorted based on the value of \( C_i^+ \) from the largest to the smallest.

3. Research Methodology

The stages of this research are initial research, determination of criteria and alternatives, determination of matrices and weight calculations, normalization of decision matrices, the weighting of normalized decision matrices, determination of positive ideal solutions and negative ideal solutions, calculation of distances to positive ideal solutions and negative ideal solutions, weight calculation preferences for each alternative, and determine the ranking and recommendations of the best attractions to visit.

4. Result And Discussion

4.1. Analysis and identification of system requirements

The steps of analyzing and identifying system requirements are:

4.1.1. Determine alternatives. There are 15 tourist attractions as an alternative in this study are Arum Jeram, Bebo 'Tumbang Datu, Buntu Burake, Buntu Kalando, Buntu Tondon, Kambira, Lemo, Makula', Pango-Pango, Sarambu Assing, Sassa ', Suaya, Tampangallo, Tilangan' and Tumakke.

4.1.2. Determine the criteria. There are four criteria used to determine tourist destinations, namely: C1: Cost, C2: Distance, C3: Transportation, and C4: Facilities.

4.1.3. Table of preference. The following is a table of preferences or importance of each criterion as in table 1 as follows:
Table 1. Preference or importance of each criterion.

| Price       | Distance | Transportation | Facilities | Level of Importance |
|-------------|----------|----------------|------------|--------------------|
| < 50,000    | <5       | Very less      | Very less  | 1                  |
| 51,000 – 100,000 | 5-10   | Less          | Less       | 2                  |
| 110,000 – 150,000 | 11-15  | Enough        | Enough     | 3                  |
| 151,000 – 200,000 | 16-20  | Well          | Well       | 4                  |
| >200,000    | >21      | Very good     | Very good  | 5                  |

4.1.4. Criteria weights. Decision making gives weight preferences based on the importance of the following criteria: W = (20, 30, 30.20) as can be seen in Table 2 below:

Table 2. Criteria of weights.

| Criteria      | Type   | Weight (w) | Weight(w)/100 |
|---------------|--------|------------|---------------|
| Price         | cost   | 20         | 0.2           |
| Distance      | cost   | 30         | 0.3           |
| Transportation| benefit| 30         | 0.3           |
| Amenities     | benefit| 20         | 0.2           |

4.2. Formation of preference weights and decision matrices

Based on alternative match rating data obtained from the initial selection results as in table 3.

Table 3. Alternative data.

| Name of Tourist Object | Id  | Price  | Distance | Transportation | Facilities |
|------------------------|-----|--------|----------|----------------|------------|
| Arum jeram             | A1  | 450,000| 20       | less           | enough     |
| Bebo’ tumbang datu     | A2  | 70,000 | 8        | good           | good       |
| Buntu burake           | A3  | 65,000 | 2        | good           | good       |
| Buntu kalando          | A4  | 70,000 | 7        | good           | good       |
| Buntu tondon           | A5  | 20,000 | 1        | good           | good       |
| Kambira                | A6  | 75,000 | 11       | good           | good       |
| Lemo                   | A7  | 50,000 | 9        | good           | good       |
| Makula’               | A8  | 60,000 | 10       | good           | good       |
| Pango-pango           | A9  | 110,000| 7        | enough         | very good  |
| Sarambu assing        | A10 | 130,000| 35       | good           | good       |
| Sassa’                | A11 | 70,000 | 9        | good           | good       |
| Suaya                 | A12 | 75,000 | 12       | good           | good       |
| Tampangallo           | A13 | 75,000 | 9        | good           | good       |
| Tilanga’              | A14 | 60,000 | 13       | good           | good       |
| Tumakke               | A15 | 65,000 | 12       | enough         | good       |

From table 1 and table 3, a matching rating can be obtained from each alternative to each criterion outlined in table 4 below.
Table 4. Match Rating Table of each alternative for each criterion.

| Id | Price | Distance | Transportation | Facilities |
|----|-------|----------|----------------|------------|
| A1 | 5     | 4        | 3              | 3          |
| A2 | 2     | 2        | 4              | 4          |
| A3 | 2     | 1        | 4              | 4          |
| A4 | 2     | 2        | 4              | 4          |
| A5 | 4     | 1        | 4              | 4          |
| A6 | 2     | 3        | 4              | 4          |
| A7 | 2     | 2        | 4              | 4          |
| A8 | 2     | 2        | 4              | 4          |
| A9 | 3     | 2        | 3              | 5          |
| A10| 3     | 5        | 4              | 4          |
| A11| 2     | 2        | 4              | 4          |
| A12| 2     | 3        | 4              | 4          |
| A13| 2     | 2        | 4              | 4          |
| A14| 2     | 3        | 4              | 4          |
| A15| 2     | 3        | 3              | 4          |

4.3. Completion using the TOPSIS method

4.3.1. Make a normalized decision matrix. Calculate the normalized decision matrix weighted by Cost, Distance, Transportation, and Facilities using the formula in the following equation 2: The results of the calculation of matrix normalization can be seen in the following table 5.

Table 5. Normalized matrix.

| Alternative | C1  | C2  | C3  | C4  |
|-------------|-----|-----|-----|-----|
| Normalization | R1  | R2  | R3  | R4  |
| A1          | 0.4927 | 0.3867 | 0.2027 | 0.1928 |
| A2          | 0.1971 | 0.1933 | 0.2703 | 0.2571 |
| A3          | 0.1971 | 0.0967 | 0.2703 | 0.2571 |
| A4          | 0.1971 | 0.1933 | 0.2703 | 0.2571 |
| A5          | 0.3941 | 0.0967 | 0.2703 | 0.2571 |
| A6          | 0.1971 | 0.2900 | 0.2703 | 0.2571 |
| A7          | 0.1971 | 0.1933 | 0.2703 | 0.2571 |
| A8          | 0.1971 | 0.1933 | 0.2703 | 0.2571 |
| A9          | 0.2956 | 0.1933 | 0.2703 | 0.3214 |
| A10         | 0.2956 | 0.4834 | 0.2703 | 0.2571 |
| A11         | 0.1971 | 0.1933 | 0.2703 | 0.2571 |
| A12         | 0.1971 | 0.2900 | 0.2703 | 0.2571 |
| A13         | 0.1971 | 0.1933 | 0.2703 | 0.2571 |
| A14         | 0.1971 | 0.2900 | 0.2703 | 0.2571 |
| A15         | 0.1971 | 0.2900 | 0.2027 | 0.2571 |

4.3.2. Make the weighted normalized decision matrix. After making the Normalized Matrix, we make the weighted normalized decision matrix. Criteria weights at this stage come from the weighting carried out by the TOPSIS method, as in the following settlement:
4.3.3. Determine the positive ideal solution matrix ($A^+$) and the negative ideal solution matrix ($A^-$)

Determine the positive and negative ideal solution matrix that is by finding the value of each of these criteria included in the cost or profit category, to calculate the positive ideal solution matrix ($+$):

a. The Positive Ideal Solution Matrix ($A^+$)

\[
y_1^+ = \min \{0.1696; 0.0264; 0.0245; 0.0264; 0.0075; 0.0283; 0.0188; 0.02260.0415; 0.0490; 0.0264; 0.02
83; 0.0283; 0.0226; 0.024\} = 0.0394
\]

\[
y_2^+ = \min \{0.1152; 0.0461; 0.0115; 0.0403; 0.0058; 0.0634; 0.0518; 0.05760.0403; 0.2016; 0.0518; 0.06
91; 0.0518; 0.0749; 0.0691\} = 0.0290
\]

\[
y_3^+ = \max \{0.0410; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.08
20; 0.0820; 0.0820; 0.0615\} = 0.0811
\]

\[
y_4^+ = \max \{0.0579; 0.0771; 0.0771; 0.0771; 0.0771; 0.0771; 0.02260.0964; 0.0771; 0.0771; 0.07
71; 0.0771; 0.0771; 0.0771\} = 0.0964
\]

b. The Negative Ideal Solution Matrix ($A^-$)

\[
y_1^- = \max \{0.1696; 0.0264; 0.0245; 0.0264; 0.0075; 0.0283; 0.0188; 0.0226; 0.0415; 0.0490; 0.0264; 0.02
83; 0.0283; 0.0226; 0.024\} = 0.0985
\]

\[
y_2^- = \max \{0.1152; 0.0461; 0.0115; 0.0403; 0.0058; 0.0634; 0.0518; 0.0576; 0.0403; 0.2016; 0.0518; 0.06
91; 0.0518; 0.0749; 0.0691\} = 0.1450
\]

\[
y_3^- = \min \{0.0410; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.0820; 0.08
20; 0.0820; 0.0820; 0.0615\} = 0.0608
\]
4.3.4. Find the distance between the weighted values of each alternative to the positive and negative ideal solutions. Determination of the distance value of a positive ideal solution is obtained from the calculation of the search for the distance value between the weighted values, by using equation three above, so the results can be seen in the following table 7.

Table 7. Matrix of positive and negative ideal solutions.

| Alternative distance | Positive (+) | Negative (-) | (D+) + (D-) |
|----------------------|--------------|--------------|-------------|
| A1                   | 0.1139       | 0.0290       | 0.1429      |
| A2                   | 0.0348       | 0.1088       | 0.1437      |
| A3                   | 0.0193       | 0.1332       | 0.1525      |
| A4                   | 0.0348       | 0.1088       | 0.1437      |
| A5                   | 0.0439       | 0.1210       | 0.1648      |
| A6                   | 0.0611       | 0.0874       | 0.1485      |
| A7                   | 0.0348       | 0.1088       | 0.1437      |
| A8                   | 0.0348       | 0.1088       | 0.1437      |
| A9                   | 0.0405       | 0.1030       | 0.1435      |
| A10                  | 0.1192       | 0.0483       | 0.1676      |
| A11                  | 0.0348       | 0.1088       | 0.1437      |
| A12                  | 0.0611       | 0.0874       | 0.1485      |
| A13                  | 0.0347       | 0.1088       | 0.1437      |
| A14                  | 0.0611       | 0.0874       | 0.1485      |
| A15                  | 0.0644       | 0.0850       | 0.1494      |

4.3.5. It is finding the preference value for each alternative. The preference value for each alternative is obtained from the results of the process of calculating the proximity of each alternative to a positive ideal solution and a negative ideal solution so that it is found that the alternative that has the greatest value is the best alternative.

\[ y4 = \min \{0.0579; 0.0771; 0.0771; 0.0771; 0.0771; 0.0771; 0.0771; 0.02260,0964; 0.0771; 0.0771; 0.0771; 0.0771; 0.0771; 0.0771 \} = 0.0579 \]

Furthermore, it can be seen in the following table 8.

Table 8. Table Preference values for each alternative.

| Name of Tourist Object | Alternative | V   |
|------------------------|-------------|-----|
| Arum jeram             | A1          | 0.2030 |
| Bebo’ tumbang datu     | A2          | 0.7576 |
| Buntu burake           | A3          | 0.8735 |
Buntu kalando  A4  0.7576  
Buntu tondon  A5  0.7338  
Kambira  A6  0.5885  
Lemo  A7  0.7576  
Makula’  A8  0.7576  
Pango-pango  A9  0.7178  
Sarambu assing  A10  0.2884  
Sassa’  A11  0.7576  
Suaya  A12  0.5885  
Tampangallo  A13  0.7576  
Tilanga’  A14  0.5885  
Tumakke  A15  0.5691  

They are then sorted according to Ranking from the largest to the smallest, as in the following table 9.

| Name of Tourist Object | Final   | Ranking |
|------------------------|---------|---------|
| Buntu burake           | 0.8735  | 1       |
| Bebo’ tumbang datu     | 0.7576  | 2       |
| Buntu kalando          | 0.7576  | 3       |
| Lemo                   | 0.7576  | 4       |
| Makula’                | 0.7576  | 5       |
| Sassa’                 | 0.7576  | 6       |
| Tampangallo            | 0.7576  | 7       |
| Buntu tondon           | 0.7338  | 8       |
| Pango-pango            | 0.7178  | 9       |
| Kambira                | 0.5885  | 10      |
| Suaya                  | 0.5885  | 11      |
| Tilanga’               | 0.5885  | 12      |
| Tumakke                | 0.5691  | 13      |
| Sarambu assing         | 0.2884  | 14      |
| Arum jeram             | 0.203   | 15      |

5. Conclusion
Based on the results of the research that has been done, the conclusion can be drawn that is:

1) The decision support system for the selection of tourist attractions in Tana Toraja is built through several stages, namely: a study of literature, determine alternatives and criteria, determine matrices and weights, Normalize Decision Matrices, Weighting Normalized Decision Matrices, Determination of Positive Ideal Solutions and Negative Ideal Solutions, Distance Calculation Towards Positive Ideal Solution and Negative Ideal Solution, Calculation Weight Preference for Each Alternative and Determine Ranking of Tourist Attraction.

2) Testing with the TOPSIS method was successfully carried out by giving results in the form of ranking tourist sites that can be recommendations for potential tourists to make a decision to visit.

3) Analysis of calculations using the TOPSIS method can be used as a reference in developing into an application that can be accessed via the internet.
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