Implementation of DSS for Tour Package Selection using TOPSIS and AHP

Thet Htet Aung, Khine Moe Nwe
University of Computer Studies Yangon, Myanmar
thet.07@gmail.com

Abstract

Decision Support System (DSS) provides information, models, and data manipulation tools to help make decisions in semi-structured and unstructured situations where no one knows exactly how the decision should be made. Computer based DSS are widely deployed in real projects. This paper is developed as decision support system for Myanmar people who are interested in traveling. In this paper, DSS is implemented for selecting the best tour package by using Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method and Analytic Hierarchy Process (AHP) method. The weight of each criterion is calculated first by using AHP, and then integrates with TOPSIS method to support tour package selection decision. In this system, TOPSIS and AHP method can help to get the best decision for the appropriate and suitable tour packages.

Keywords: DSS, AHP, TOPSIS, MCDM

1. Introduction

DSS is a type of information system whose principal objective is to support a human decision maker during the process of arriving at a decision. Decision support systems are gaining an increased popularity in various domains including business, engineering, the military, medicine and tourism. Multi-Criteria Decision Making (MCDM) is one type of decision support model. MCDM is an approach of problem solving that is employed to solve problems involving selection from among a finite number of alternatives which are characterized in terms of some criteria. TOPSIS and AHP are MCDM methods and are proved to be useful for modeling and analyzing various types of decision making situations in numerous fields of economic, science and technology [12]. In this paper, tour package selection system can support various users who are wishing to travel in local. A web-based DSS for choosing the best tour packages is to enhance the online tour services to Myanmar travelers (users), and the tour company managers or tour planners can gain many benefits in their decision making process. To meet user needs or requirements, TOPSIS and AHP can help to get the decisions by applying efficient processing techniques. This paper presents the development of a web-based DSS for E-Tourism services.

The rest of the paper is organized as follows: the next section defines motivation, Section 3 presents related work, the background theory is discussed in Section 4, methodology of the combined TOPSIS and AHP method is discussed in Section 5, proposed system is discussed in Section 6 and then Case-Study of proposed system is demonstrated in Section 7, final conclusion is expressed in Section 8.

2. Motivation

Myanmar people are interested in travelling on their holidays or vacation periods. They want to go somewhere according to their available budget (amount to spend), and number of person and also their preferences (such as duration, place, tour company, etc.). Nowadays, Internet, the web technology is the center of activity in developing DSS and can be expected to result in organizational environments that will be increasingly more global, complex, and connected [2]. The advent of the web has enabled organizational decision support systems, and has given rise to numerous new applications to existing technology as well as many decision support technologies. AHP can be used with both quantitative and qualitative data [10]. TOPSIS is very effective in multi-attribute decision analysis and is a classical method to solve multi-criteria decision making problem [4]. Therefore, TOPSIS and AHP method are used in DSS for selection of best alternative.

3. Related Work

The evaluation and selection of industrial projects before investment decision is done using technical and financial information. S.

Mahmoodzadeh, J. Shahrabi, M. Pariazar and M. S. Zaeri developed the methodology to provide a simple approach to asses alternative projects and help decision maker to select the best project by using fuzzy AHP and TOPSIS technique, in 2007 [7]. Flexible Manufacturing Cells (FMC) has been used as a tool to implement manufacturing processes to increase the competitiveness of manufacturing systems. In implementing a FMC, decision makers encounter the machine selection problem including a number of criteria (e.g. total purchasing cost, total floor space, productivity). Dr. R V Rao implemented machine selection in a FMC using a combined TOPSIS and AHP in March 2005 [8]. Suppliers are very important in the supply chain because their performances not only influence the benefits of the core enterprise in the supply chain but also determine whether win-win can be achieved or not. In the world journal of modeling and simulation, Min Wu from China develops a TOPSIS and AHP simulation methodology to deal with Supply Chain Management problems in January 2007 [11].

4. Background Theory

4.1. Decision Support System

An interactive software-based computerized information system intended to help decision makers compile useful information from raw data, documents, personal knowledge, and business models to identify and solve problems and to make decisions. DSSs provide data storage and retrieval functions. Database Management System is one of the fundamental components of DSSs.

Three fundamental components of DSS are:

- Database Management System: It serves as a data bank for the DSS. It stores large quantities of data that are relevant to the class of problems for which the DSS has been designed and provides logical data structures with which the user interact.
- The Model-Base Management: The model management Component handles representations of events, facts, or situation.
- The Dialog Generation and Management System: The User Interface Management Component is of course the component that allows a user to interact with the system [12].

4.2. Multi-Criteria Decision Making (MCDM)

MCDM refers to an approach of problem solving that is employed to solve problems involving selection from among a finite number of alternatives. A MCDM method is a procedure that specifies how criteria information is to be processed in order to arrive at a choice. MCDM is derived or interpreted as indicators of the strength of various preferences. Preferences differ from decision maker to decision maker, so the outcome depends on who is making the decision and what their goals and preferences are. In this system, two important MCDM methods namely Technique for Order Preference by Similarity to Ideal Solution and Analytic Hierarchy Process are used combined for decision making. The weight of each criterion is calculated first by using AHP, and then integrates with TOPSIS method to support tour package selection decision.

4.3. Analytic Hierarchy Process (AHP)

The AHP is one of the MCDM methods. AHP is an approach that is suitable for dealing with complex systems related to making a choice from among several alternatives and which provides a comparison of the considered options. This method was first presented by Saaty [10]. The AHP is based on the subdivision of the problem in a hierarchical form. By reducing complex decisions to a series of simple comparisons and rankings, then synthesizing the results, the AHP not only helps the analysts to arrive at the best decision, but also provides a clear rationale for the choices made. One of the main advantages of AHP is the relative ease with which it handles multiple criteria. In addition to this, AHP is easier to understand and it can effectively handle both qualitative and quantitative data. The core of AHP is the preference matrix consisting of pair-wise comparison [7]. The comparison are made using a scale of judgments that represents, how much more one element dominates another. The scale of AHP method for pair wise comparison is described in Table 1.

Table 1.The pair wise comparison scale for the AHP

Scale	Description
1/1	A has the same importance as B.
3/1	A has slightly more importance than B
5/1	A has more importance than B
7/1	A has a lot more importance than B
9/1	A totally dominates B
1/3	B has slightly more importance than A
1/5	B has more importance than A
1/7	B has a lot more importance than A
1/9	B totally dominates A

4.4. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The TOPSIS is a logical approach and is proved to be useful for modeling and analyzing various types of decision making situations in numerous fields of science and technology [5]. TOPSIS method deals with the problem of choosing an alternative from a set of candidate alternatives which are characterized in terms of some attributes or criteria. The chosen alternative should be as close to the ideal solution as possible and as far from the negative ideal solution as possible. The TOPSIS enables to save a lot of time while making process and reduces the cost of the evaluation process while improving the quality of the decision made. TOPSIS is the ability to identify the best alternative quickly.

5. Methodology of the combined TOPSIS and AHP method

The step-by-step procedure of proposed methodology is the following:

Step1: Initially, the first step of AHP is to build the hierarchy structure. The hierarchy is structured on different levels is shown in figure 1.

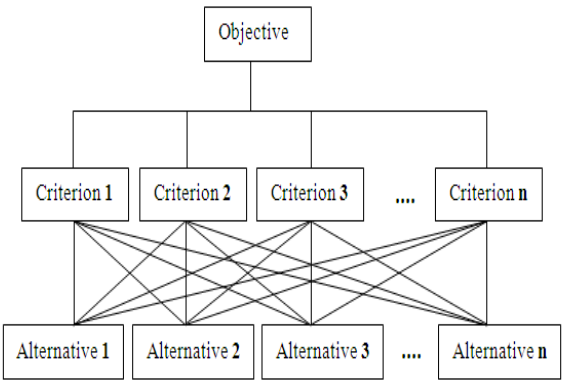

Figure 1.A hierarchy structure for AHP

In the above figure1, the top level denotes the overall objective of the decision maker, the intermediate level consists of several different criteria that contribute to the objective and the lowest level of the hierarchy describes the alternatives which are to be evaluated in terms of the criteria in the above level to reach the objective.

Step2: Construct a pair wise comparison matrix on each criterion using fundamental scales of AHP as described in Table 1. The pair wise comparison scales are used as user preferences for criteria.

Step3: AHP uses the Synthesization procedure that has provided the priorities for selecting the best result. This procedure is used by the following three steps.

(i) Sum the value in each column of the pair wise comparison matrix.
(ii) Divide each element in the pair wise comparison matrix by its column total.
(iii) Compute the average of the elements in each row of the matrix. Thesis average values provide the priorities for the criteria.

After step 3, we get a decision matrix and each row of this matrix is allocated to one alternative and each column is allocated to one criterion. Thus if the number of packages is 'm' and the number of criteria is 'n', then decision matrix is m x n matrix. This decision matrix is as input matrix to the following TOPSIS steps. Step 3 is used as the last step of AHP method in this proposed system.

$$
\begin{array}{c|cccccccc|}
 & 1 & 2 & 3 & - & - & - & n \\
\hline
1 & a_{11} & a_{12} & a_{13} & - & - & - & a_{1n} \\
2 & a_{21} & a_{22} & a_{23} & - & - & - & a_{2n} \\
3 & a_{31} & a_{32} & a_{33} & - & - & - & a_{3n} \\
- & - & - & - & - & - & - & - \\
- & - & - & - & - & - & - & - \\
- & - & - & - & - & - & - & - \\
m & a_{m1} & a_{m2} & a_{m3} & - & - & - & a_{mn}
\end{array}
$$

Figure 2.Sample decision matrix

Step4: Construct the normalized decision matrix. The normalized value r_{ij} is calculated as equation (1) where aij are the values of the above decision matrix value.

$$rij = \frac{aij}{\sum_{i=1}^{m} a\,ij^{2}} \qquad (1)$$

Step5: Get the user preference weight w_j for each criterion to know which criterion is more important for user. In this step, user can choose preference weights (0.1 to 0.9) that are predefined by the system.

Step6: Calculate the weighted normalized matrix by multiplying each element of the column of the normalized decision matrix by its associated weight w_j. The weighted normalized value v_{ij} is calculated as equation (2).

$$v_{ij} = w_j r_{ij} \qquad (2)$$

Step7: Obtain the positive ideal (best) solution v_j^* using equation (3) and negative ideal (worst) solution $v_j^{'}$ using equation (4).

$$vj^* = \{(max\, vij \mid j \in J), (min\, vij \mid j \in J')\} \qquad (3)$$

$$vj' = \{(min\ vij \mid j \in J),(max\ vij \mid j \in J')\} \quad (4)$$

Where J is associated with beneficial criteria and J' is associated with non-beneficial criteria.

Step8: Calculate the separation of each alternative from the ideal using Euclidean distance. The separation measure of each alternative from the positive ideal solution S_i^* is given as equation (5).

$$S_i^* = [\sum_{j=1}^{n} (v_j^* - v_{ij})^2]^{1/2} \quad (5)$$

Similarly, the separation measure of each alternative from the negative ideal solution Si' is as equation (6).

$$Si' = [\sum_{j=1}^{n} (v_j' - v_{ij})^2]^{1/2} \quad (6)$$

Step9: Finally, calculate the relative closeness to the ideal solution ci^* to get the best package and rank the alternatives in descending order. It can be expressed as equation (7).

$$ci^* = \frac{Si^*}{Si^* + Si'} \quad (7)$$

The C_i^* value lies between 0 and 1. The larger the C_i^* value the better the performance of the alternatives.

6. Proposed System

In this paper, the implementation of tour package selection system using combined TOPSIS and AHP method is proposed. This proposed system is firstly improved by AHP which involves building the hierarchy, pair wise comparisons and synthesis. And then, obtained results from AHP comparison and Synthesization have been used as input values to TOPSIS algorithm. TOPSIS can help decision maker to evaluate ranking by considering ideal and non-ideal solution and select the best alternatives with user needs.

There are three levels of user. They are guest, member and administrator. Guest user can browse and all Tour package information. If the guest user wants to get the best tour package supported by this system, user needs to register. In user registration, he/she must fill personal information and the system records their information in database. Member can also browse all tour package information according to trip type (such as beach or historical pagoda or leisure resources). To get the best tour package, member must enter their affordable budget and number of person and choose type of trip that they want to go. And then, the system shows the package information which cost is less than the user affordable budget according to chosen trip type. And then, member chooses the five packages among show packages and chooses their preference for criteria using fundamental scales of AHP method (1, 3, 5, 7, 9). After calculating with TOPSIS and AHP method, the system generates the best package which is more closely meet with the user preference place (or trip), duration ,live type ,food type , transportation and tour company.

Administrator also browses tour information and update information through the following steps:

1. Admin can add new tour packages information with trip name and detail, food type, live type, transportation, duration, minimum and maximum number of person, Tour Company and price.
2. Admin can edit and delete tour packages information.

The overview of the system is described in figure 3.

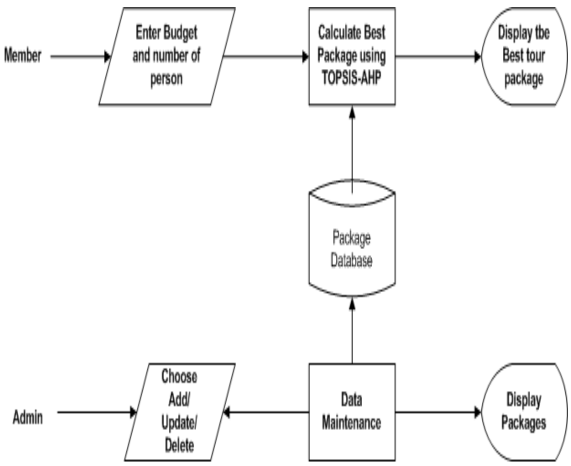

Figure 3.Overview of the system

7. Case-Study

Now to demonstrate the proposed system for tour package selection using the combined TOPSIS and AHP method, a case-study is considered. Steps of the tour package selection system are carried out as the following steps.

Step1: Firstly, it begins with setting up the hierarchy structure. As shown in figure 4, the objective of this proposed system is to select the best tour package. To get the objective, six criteria are used in this system. They are place to travel, duration, live type (e.g. hotel, guest house, and inn), transportation (e.g. Air-con express, light ace), food type and Tour Company. The user's selected five packages are set as alternatives. One alternative (package) consists of six criteria.

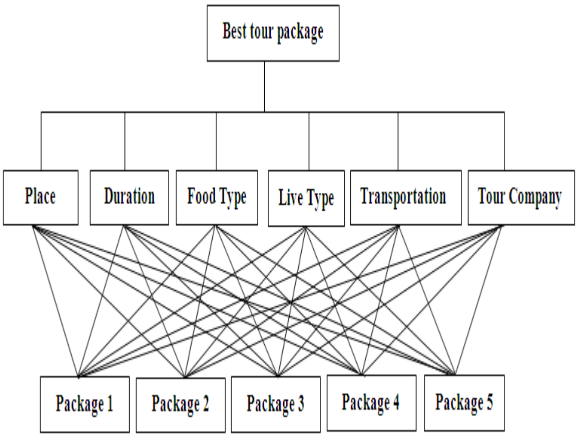

Figure 4.Hierarchy for selecting the best tour package

Step2: The next step is to find out the relative importance for different criteria with respect to the objective using pair wise comparison matrix of AHP method. In this comparison matrix, user's judgments upon each criterion are entered using the fundamental scales as shown in Table 1. An attribute compared with it is always assigned the value 1. So the main diagonal entries of the pair wise comparison matrix are all 1. The numbers 3, 5, 7 and 9 correspond to the judgments 'slightly more importance', 'more importance', 'a lot more importance' and 'totally dominate'. The matrix is filled with numerical values pointing the importance of the attribute on the left with respect to the importance of the attribute on the top, where i is the row of the matrix and j is the column of the matrix. In the matrix, $\mathbf{x}_{ij}$ = 1 where i = j and $\mathbf{x}_{ij}$ = 1/$\mathbf{x}$ij . For example, pair wise comparison judgment on Tour company criterion is shown in figure 5.

	GoldenTrip	MyatNoeThu	Shwelankayee
GoldenTrip	1	3	1/3
MyatNoeThu	1/3	1	1/5
Shwelankayee	3	5	1

Figure 5.Pair wise comparison matrix for tour company criterion

As described in Figure 5, GoldenTrip is slightly more importance than MyatNoeThu. So, relative importance value of 3 is assigned to GoldenTrip over MyatNoeThu and relative value of 1/3 is assigned to MyatNoeThu over GoldenTrip.

Step3: We calculate the Synthesization procedure to get the priority matrix for each criterion.

GoldenTrip	0.260
MyatNoeThu	0.106
Shwelankayee	0.633

Figure 6.Priority matrix for tour company criterion column of decision matrix

Similarly, we can calculate the input values of decision matrix for duration, live type, transportation, food, trip criteria columns. Finally, we can get a matrix is called a decision matrix (Table 2) as input for the TOPSIS steps. Each row of this matrix is allocated to one tour package (P) alternative and each column to one criterion.

Table 2.Decision matrix

	trip	duration	live type	transportation	Food type	Tour company
P1	0.175	0.833	0.696	0.134	0.167	0.633
P2	0.562	0.833	0.232	0.746	0.833	0.633
P3	0.562	0.833	0.072	0.120	0.833	0.106
P4	0.203	0.167	0.696	0.120	0.833	0.633
P5	0.061	0.833	0.232	0.746	0.833	0.260

Step4: Obtain the normalized decision matrix using equation (1).

Table 3.Normalized decision matrix

	trip	duration	live type	transportation	Food type	Tour company
P1	0.208	0.498	0.669	0.124	0.100	0.559
P2	0.668	0.498	0.223	0.693	0.498	0.559
P3	0.668	0.498	0.069	0.111	0.498	0.094
P4	0.241	0.100	0.669	0.111	0.498	0.559
P5	0.073	0.498	0.223	0.693	0.498	0.230

Step5: Get the user preference weight (wj) for each criterion. The following table is the sample preference weight for each criterion.

Table 4.Preference weight(wj)for each criterion

trip	duration	Live type	transportation	Food type	Tour company
0.6	0.3	0.4	0.1	0.2	0.5

Step6: The next task is to obtain the weighted normalize matrix by multiplying normalized decision matrix and preference weight (wj) for each criterion. For example, trip criterion weight (0.6) multiplies the values of the trip column of normalized decision matrix.

Table 5.Weighted normalized matrix

	trip	duration	live type	transportation	Food type	Tour company
P1	0.125	0.149	0.268	0.012	0.020	0.280
P2	0.401	0.149	0.089	0.069	0.100	0.280
P3	0.401	0.149	0.028	0.011	0.100	0.047
P4	0.145	0.030	0.268	0.011	0.100	0.280
P5	0.044	0.149	0.089	0.069	0.100	0.115

Step7: The next step is to obtain the best ideal (v_j*) and negative worst ideal (v_j') solution using equation (3) and equation (4). These are given as

$$v_j* = \{0.401, 0.149, 0.268, 0.069, 0.100, 0.280\}$$

$$v_j' = \{0.044, 0.030, 0.028, 0.011, 0.020, 0.047\}$$

Step8: Obtain the separation measures S_i* and S_i' using equation (5) and (6). These are described as follow.

$$S_i* = \begin{matrix} Package1 \\ Package2 \\ Package3 \\ Package4 \\ Package5 \end{matrix}\begin{bmatrix} 0.293 \\ 0.179 \\ 0.340 \\ 0.288 \\ 0.432 \end{bmatrix}, \quad S_i' = \begin{matrix} Package1 \\ Package2 \\ Package3 \\ Package4 \\ Package5 \end{matrix}\begin{bmatrix} 0.364 \\ 0.623 \\ 0.385 \\ 0.359 \\ 0.180 \end{bmatrix}$$

Step9: The relative closeness of a particular alternative to the ideal solution is calculated using equation (7) and given as follows:

$$C_i* = \begin{matrix} Package1 \\ Package2 \\ Package3 \\ Package4 \\ Package5 \end{matrix}\begin{bmatrix} 0.552 \\ 0.719 \\ 0.532 \\ 0.554 \\ 0.294 \end{bmatrix}$$

The larger the C_i^* value the better the performance of the alternative. From the above values, it is clear that the Package2 is the best choice for user preferences and weights. The second choice is Package4 and the last choice is Package5.

8. Conclusion

This system can help to get decision for the best package to meet the important criteria. This system is based on a combined MCDM method using TOPSIS and AHP and it can help to select a best tour package with user's affordable budget from amongst a large number of alternative tour packages. It can be concluded that the system can be employed as an efficient decision making for selecting the best tour package and user can get the best decision for the appropriate and suitable tour packages easily within a short time.

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