International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue-17
December 2017

Multi-criteria Decision Support System for Selection of Trips by Using Analytical Hierarchy Process (AHP)

San Thida
Faculty of Information Science University of Computer Studies, Yangon, Myanmar
Sthida09@gmail.com

Abstract

Multi-criteria decision support systems are a type of information system whose principal objective is to support a human decision maker during the process of arriving at a decision. It is a selection of the best action from a set of alternatives, each of which is evaluated against multiple, and often conflicting criteria. Among many multi-criteria decision-making approaches, the Analytic Hierarchy Process (AHP) has been coming into applications in relevant areas. The AHP (Analytical Hierarchy Process) which is one of the mathematical methods can be very useful in involving several decision makers or travelers with different conflicting objectives to arrive at a consensus decision. The decision makers or travelers have to face and take attention with a lot of criteria; such as cost, place type, time taken, transportation type and star rate while choosing the best successful trip in their vacations. This paper presents a decision support system method for travelers to find the wonderful trip in vacations by using AHP.

Keywords: Analytical Hierarchy Process (AHP), Multi-criteria Decision Making (MCDM).

1. Introduction

Just as sleep is necessary for our body similarly holidays are important for relaxation and change – they provide relief from the monotony of our daily routine. They are important for our mental and emotional well being. Holidays trip give us a break from our routine and help us to refresh ourselves and go back to work with renewed energy. After working hard throughout the year, holidays are eagerly awaited by many people alike. A variety of decision making methods and tools are available to support the choice of best trip decision making for people. The purpose of this paper is to review and assess the application of a well – known and widely used decision making methodology, called the analytical hierarchy process (AHP), to major problems wonderful trip decision making. There are various Multiple Criteria Decision Making (MCDM) methods. Among them, Analytical Hierarchy Process (AHP) is one of the most widely used MCDM methods. AHP structures a decision problem into a hierarchy with a goal, decision criteria, and alternatives. It is a decision-making framework using a unidirectional hierarchical relationship among decision levels. In a hierarchy, alternatives depend on criteria, criteria affect goal.

The objective of the thesis is to test the Analytic Hierarchy Process (AHP) applicability with the process for decision making in the selection of trip program. In this paper, AHP helps to figure out the best outcome which features that the travelers need and how to select the successful trip that really want. In order to select a number of trips to meet the individual basic requirements, the following criteria are established: they are cost, place type, time taken, transportation type and star rate. Furthermore, this is a web based decision support system that supports the travelers to choose the appropriate trip.

We will present six sections in this paper. This section introduces about the trip selection system using analytic hierarchy process. The remaining sections of this paper are organized as follows. In Section 2, the theories about the decision support system, multi criteria decision making, analytical hierarchy process and consistency ratio will be discussed. The next Section will clarify the case study of the system. The last section describes the conclusion of the system.

2. Background Theory

AHP is a decision making tool in complex problems. It has been widely used in solving many complicated decision problems. AHP has been applied in some areas, including contractor selection for clients, hamper selection, and university selection for prospective students in order to achieve their different objectives and purposes. These applications are described below.

Decision support systems are interactive, computer-based systems that aid users in judgment and choice activities. They provide storage and retrieval but enhance the traditional information access and retrieval functions with support for model building and model-based reasoning. They support framing, modeling, and problem solving [4].

Multi-criteria decision making (MCDM) is a set of systematic procedures for analyzing complex decision problem. It consists of constructing a global preference relation for a set of alternatives evaluated using several criteria. It select the best actions from a set of alternatives, each of which is evaluated against multiple, and often conflicting criteria. There are various MCDM methods. Among them, the AHP is one of the MCDM methods.[2]

AHP is an approach that is suitable for dealing system related to make a choice from among multiple alternatives and which provides a comparison of the considered options. AHP is a powerful and flexible decision making process which is developed by Thomas Saaty. 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 the best decision, but also provides a clear rationale for the choices made. AHP basically consists of the following steps:[2]

1. Pair-wise comparison of criteria
2. Establish priority vector for criteria
3. Pair-wise comparison of alternatives
4. Establish priority vector for alternatives and
5. Obtaining the overall ranking.

In each of the comparison steps, this system uses numerical values (1,3,5,7,9) for the preferences. This preferences is shown in the following table:

Table1: Fundamental Scales for Pair-Wise Comparison

Numerical Scale	Definition of Important
1	Equally important
3	Moderately important
5	Strongly important
7	Very strongly important
9	Extremely important
2,4,6, and 8	Intermediate value

In pair-wise comparison, a ratio scale of 1-9 is used to compare any two elements. A reciprocal value is assigned to the inverse comparison, that is ; $a_{ij}=1/a_{ji}$, where $a_{ij}(a_{ji})$ denotes the importance of the $i^{th}(j^{th})$ element. In this stage, the following three steps procedure is used to calculate the priority in pair-wise comparisons.

- To sum the value in each column of the pair-wise comparison matrix.
  - Sum the elements of each column j:

$$\sum_{i=1}^{n} a_{ij}$$

- To divide each element in the pair-wise comparison matrix by its column total, the resulting matrix is called the normalized pair-wise comparison matrix.
  - Divide each value by its column sum:

$$a_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}$$

- To compute the average of the elements in each row, these average vales are defined as the priorities for the criteria.
  - Mean of row i:

$$p_i = \frac{\sum_{j=1}^{n} a_{ij}}{n}$$

2.1. AHP Algorithm

The application of the AHP algorithm is as follows:

1. Accept each weight value for criteria.
2. Set the priority matrix for overall criteria.
   (i) Create the Matrix
   (ii) Create the normalize Matrix
   (iii) Calculate the Priority Vector
3. Set the priority matrix for each criteria.
   (i) Create the Matrix
   (ii) Create the normalize Matrix
   (iii) Calculate the Priority Vector
4. Set the priority matrix for overall ranking.
   (i) Create Ranking
   (ii) Calculate the Priority Vector
5. Find the Highest Priority and Highest Ranking.

2.2. Consistency Ratio (CR)

Consistency can check pair-wise comparison matrix to make sure decision maker comparisons were consistent or not in the following steps: First step is to find the weighted sum matrix which can be evaluated by multiplying each columns and their priority vectors in pair-wise comparisons matrices of alternatives for each criteria. Second step is dividing all the elements of the weighted sum matrices by their respective priority vector element, then compute the average of these values to obtain λ_{max}. Third step is we can find the consistency index CI , as follows:

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

Where, λ_{max} is eigen value, n is the number of elements and CI is consistency index. Final step is by selecting appropriate value of random consistency ratio, RI, for a matrix size using table below. For example, we can use RI=0.58 for matrix size 3.

Table 2: Random Consistency Ratio

Matrix size	1	2	3	4	5	6	7	8	9
Random consistency	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

Then, the calculation for consistency ratio is:

$$CR = \frac{CI}{RI}$$

If the value of CR is less than 0.1, the judgments are acceptable. Otherwise, the judgments aren't acceptable [6].

3. Case Study

In this study, selection criteria and the corresponding decision rule were derived to choose the best trip, using the AHP method. This process is implemented using a computer application. At the beginning of the system, the travelers need to enter data because every traveler would like to check the cost of visit place depending upon the place name, type of place, time taken, type of transportation and popular ranking to get the suggestion. First, the travelers must input the three main points: amount of budget, amount of time, choose the popular rating. Second, the travelers need to select the each detail priority level(First priority, Second priority, Third priority, Fourth priority, Fifth priority). Third, the travelers require to define the values for three factors of transportation type and set the popular rating. After the choose of preferences, the system will calculate the AHP approach and then will report the best places as the decision result.

Step 1: Pair-wise Comparison of Criteria

In this step, all criteria are compared with each other to determine the relative importance of each factor in the accomplishing the overall result.

	cost	Place Type	Time Taken	Transportation	Popular ranking
cost	1	9/7	9/5	9	3
Place Type	7/9	1	7/5	7	7/3
Time Taken	5/9	5/7	1	5	5/3
Transportation	1/9	1/7	1/5	1	1/3
Popular ranking	3/9	3/7	3/5	3	1
	2.778	3.572	5	25	8.333

Figure 1:Pair-wise comparison matrix between Criteria

Step 2: Establish priority vector for criteria

In this step, the system will sum values in each column of the pair-wise comparison matrix. Then, it will divide each element in the pair-wise comparison matrix by its column total. At last, it will calculate the average of the elements in each row of the matrix that provides the priorities for the criteria. The following figure is the priority vector calculation for each criterion.

	Priority Vector
cost	0.360
Place Type	0.28
Time Taken	0.2
Transportation	0.04
Popular ranking	

Figure 2 : Normalized of Matrix Pair-wise comparison for Criteria

Step 3: Pair-wise comparison of Alternatives

In step3, the system performs comparison process repeatedly for all of each criterion and each one consists of two matrixes. They are pair-wise comparison matrix and normalized matrix of pair-wise comparison.

	R1	R2	R3	R4	R5	R6	R7
R1	1	9/9	9/9	9/9	9/9	9/9	9/9
R2	9/9	1	9/9	9/9	9/9	9/9	9/9
R3	9/9	9/9	1	9/9	9/9	9/9	9/9
R4	9/9	9/9	9/9	1	9/9	9/9	9/9
R5	9/9	9/9	9/9	9/9	1	9/9	9/9
R6	9/9	9/9	9/9	9/9	9/9	1	9/9
R7	9/9	9/9	9/9	9/9	9/9	9/9	1
	7	7	7	7	7	7	7

Figure 3: Pair-wise Comparison Matrix for Cost

	R1	R2	R3	R4	R5	R6	R7		Priority Vector
R1	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R2	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R3	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R4	0.143	0.143	0.143	0.143	0.143	0.143	0.143	=	0.143
R5	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R6	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R7	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0

Figure : Normalized of Matrix Pair-wise comparison for Cost

	R1	R2	R3	R4	R5	R6	R7
R1	1	9/9	9/9	9/9	9/9	9/9	9/9
R2	9/9	1	9/9	9/9	9/9	9/9	9/9
R3	9/9	9/9	1	9/9	9/9	9/9	9/9
R4	9/9	9/9	9/9	1	9/9	9/9	9/9
R5	9/9	9/9	9/9	9/9	1	9/9	9/9
R6	9/9	9/9	9/9	9/9	9/9	1	9/9
R7	9/9	9/9	9/9	9/9	9/9	9/9	1
	7	7	7	7	7	7	7

Figure 4: Pair-wise Comparison Matrix for Popular Rate

	R1	R2	R3	R4	R5	R6	R7		Priority Vector
R1	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R2	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R3	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R4	0.143	0.143	0.143	0.143	0.143	0.143	0.143	=	0.143
R5	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R6	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R7	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0

Figure 5: Normalized of Matrix Pair-wise comparison for Popular Rate

	R1	R2	R3	R4	R5	R6	R7
R1	1	5/5	5/5	5/9	5/9	5/5	5/9
R2	5/5	1	5/5	5/9	5/9	5/5	5/9
R3	5/5	5/5	1	5/9	5/9	5/5	5/9
R4	9/5	9/5	9/5	1	9/9	9/5	9/9
R5	9/5	9/5	9/5	9/9	1	9/5	9/9
R6	5/5	5/5	5/5	5/9	5/9	1	5/9
R7	9/5	9/5	9/5	9/9	9/9	9/5	1
	9.4	9.4	9.4	5.222	5.222	9.4	5.222

Figure 6: Pair-wise Comparison Matrix for Time Taken

	R1	R2	R3	R4	R5	R6	R7		Priority Vector
R1	0.106	0.106	0.106	0.106	0.106	0.106	0.106		0.106
R2	0.106	0.106	0.106	0.106	0.106	0.106	0.106		0.106
R3	0.106	0.106	0.106	0.106	0.106	0.106	0.106		0.106
R4	0.191	0.191	0.191	0.191	0.191	0.191	0.191	=	0.191
R5	0.191	0.191	0.191	0.191	0.191	0.191	0.191		0.191
R6	0.106	0.106	0.106	0.106	0.106	0.106	0.106		0.106
R7	0.191	0.191	0.191	0.191	0.191	0.191	0.191		0.191
	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0

Figure 7: Normalize Pair-wise Comparison for Time Taken

	R1	R2	R3	R4	R5	R6	R7
R1	1	9/9	9/9	9/5	9/7	9/5	9/5
R2	9/9	1	9/9	9/5	9/7	9/5	9/5
R3	9/9	9/9	1	9/5	9/7	9/5	9/5
R4	5/9	5/9	5/9	1	5/7	5/5	5/5
R5	7/9	7/9	7/9	7/5	1	7/5	7/5
R6	5/9	5/9	5/9	5/5	5/7	1	5/5
R7	5/9	5/9	5/9	5/5	5/7	5/5	1
	5.444	5.444	5.444	9.8	7	9.8	9.8

Figure 8: Pair-wise Comparison Matrix for Place Type

	R1	R2	R3	R4	R5	R6	R7		Priority Vector
R1	0.184	0.184	0.184	0.184	0.184	0.184	0.184		0.184
R2	0.184	0.184	0.184	0.184	0.184	0.184	0.184		0.184
R3	0.184	0.184	0.184	0.184	0.184	0.184	0.184		0.184
R4	0.102	0.102	0.102	0.102	0.102	0.102	0.102	=	0.102
R5	0.143	0.143	0.143	0.143	0.143	0.143	0.143		0.143
R6	0.102	0.102	0.102	0.102	0.102	0.102	0.102		0.102
R7	0.102	0.102	0.102	0.102	0.102	0.102	0.102		0.102
	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0

Figure 9: Normalize Pair-wise Comparison for Place Type

	R1	R2	R3	R4	R5	R6	R7
R1	1	9/7	9/9	9/9	9/5	9/7	9/7
R2	7/9	1	7/9	7/9	7/5	7/7	7/7
R3	9/9	9/7	1	9/9	9/5	9/7	9/7
R4	9/9	9/7	9/9	1	9/5	9/7	9/7
R5	5/9	5/7	5/9	5/9	1	5/7	5/7
R6	7/9	7/7	7/9	7/9	7/5	1	7/7
R7	7/9	7/7	7/9	7/9	7/5	7/7	1
	5.889	7.571	5.889	5.889	10.6	7.571	7.571

Figure 10: Pair-wise Comparison Matrix for Time Taken

	R1	R2	R3	R4	R5	R6	R7		Priority Vector
R1	0.17	0.184	0.184	0.184	0.184	0.184	0.184		0.17
R2	0.132	0.184	0.184	0.184	0.184	0.184	0.184		0.132
R3	0.17	0.184	0.184	0.184	0.184	0.184	0.184		0.17
R4	0.17	0.102	0.102	0.102	0.102	0.102	0.102	=	0.17
R5	0.094	0.143	0.143	0.143	0.143	0.143	0.143		0.094
R6	0.132	0.102	0.102	0.102	0.102	0.102	0.102		0.132
R7	0.132	0.102	0.102	0.102	0.102	0.102	0.102		0.132
	1.0	1.0	1.0	1.0	1.0	1.0	1.0		1.0

Figure 11: Normalized of Matrix Pair-wise comparison for Transportation

Step 4: Establish Priority Value for Alternatives

In this step, we calculate the priority vector for all alternatives in this system.

	Cost	Place Type	Time Taken	Transportation	Popular Rate
R1	0.143	0.184	0.106	0.17	0.143
R2	0.143	0.184	0.106	0.132	0.143
R3	0.143	0.184	0.106	0.17	0.143
R4	0.143	0.102	0.191	0.17	0.143
R5	0.143	0.143	0.191	0.094	0.143
R6	0.143	0.102	0.106	0.132	0.143
R7	0.143	0.102	0.191	0.132	0.143

Figure 12: Priority vector for all alternatives

Step 5 : Obtaining the overall ranking

In this final step is to obtain the overall ranking of the alternatives by mathematically combining the alternatives priority matrix and criteria priority vector from step 1 to step 4. If in this step gets the higher value, the most suitable of the visiting place for the travelers. Then,

R1= [(0.143*0.36) + (0.184*0.28) + (0.106*0.2) + (0.17*0.04) + (0.143*0.12)]/5

= 0.03

R2= [(0.143*0.36) + (0.184*0.28) + (0.106*0.2) + (0.132*0.04) + (0.143*0.12)]/5

= 0.029

R3= [(0.143*0.36) + (0.184*0.28) + (0.106*0.2) + (0.17*0.04) + (0.143*0.12)]/5

= 0.03

R4= [(0.143*0.36) + (0.102*0.28) + (0.191*0.2) + (0.17*0.04) + (0.143*0.12)]/5

= 0.028

R5= [(0.143*0.36) + (0.143*0.28) + (0.191*0.2) + (0.094*0.04) + (0.143*0.12)]/5

= 0.03

R6= [(0.143*0.36) + (0.102*0.28) + (0.106*0.2) + (0.132*0.04) + (0.143*0.12)]/5

= 0.025

R7= [(0.143*0.36) + (0.102*0.28) + (0.191*0.2) + (0.132*0.04) + (0.143*0.12)]/5

= 0.028

At the end of this stage, the final results are prepared as shown in the following figure. According to the final result, this system proposes the travelers or decision makers to visit a place which one is 'R1':

Place Name	Priority	Rank
R1	0.03	I
R3	0.03	II
R5	0.03	III
R2	0.029	IV
R4	0.028	V
R7	0.028	VI
R6	0.025	VII

Figure 13 : Propose results for travellers

4. Conclusion

This system has intended to implement the Trip selection in vacation by using AHP and provides the travellers to know how trip select their vacations in terms of the selected criteria. AHP has applied to a large variety of decisions: marketing, political, social, and forecasting and prediction, health care and many others. In this paper, the AHP is used for selecting a suitable trip for travelers. By using this system, the travelers can get many categories of visiting places and can choose the preference place easily. Moreover, it can save the time and cost to choose the best place because of giving suggestion with list of priority.

References

1. Janos Fulop, “Introduction to Decision Making Methods”, Laboratory of Operations Research and Decision Systems, Computer and Automation Institute, Hungarian Academy of Sciences.
2. Thomas L. Saaty, “Decision Making With The Analytic Hierarchy Process”, University of Pittsburgh, USA, Int. J. Services Sciences, Vol, 1, 2008.
3. Jenny Brown, Michelle Schwartz and Kris Horton,”The best places to eat, sleep and play in Singapore”, Trip Advisor Inc., copyright 2011.
4. Marek J. Druzdzel and Roger R. Flynn, “Decision Systems” Decision Systems Laboratory, School of Information Sciences and Intelligent Systems Program, University of Pittsburgh.
5. Kamal M. Al-Subhi, “Application of the AHP in Project Management’, King Fahd University of Petroleum & Minerals, KFUPM Box 1468, Dhahran 31261, Saudi Arabia, May 1999.
6. Kamal M, Al-Subhi Al-Harbi, “Application of the AHP in Project Management”, King Fahd University of Petroleum & Minerals, KFUPM Box 1468, Dhahran 31261, Saudi Arabia, May 1999.
7. Eren Ozceylan, “A Decision Support System to Compare the Transportation Modes in Logistics.”, Selcuk University, Department of Industrial Engineering Campus,42031, Konya, Turkey.