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Decision Support Framework for Selection of Trips in Sagaing Region Myanmar

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Abstract: *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. Multi-criteria Decision Making (MCDM) 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. This paper deals with application of AHP for selection of an appropriate trip in Sagaing Region. 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. The results show that AHP may help to select the best trip in Sagaing Region.*

Key Words: *Analytical Hierarchy Process (AHP), Multi-Criteria Decision Making (MCDM), Decision Support Framework, Sagaing, Myanmar.*

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 Sagaing Region. 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. Therefore, one solution for this situation is the application of AHP in this region and providing it online for all interested visitors. The reasons for that are explained in the following sections. So, the main aim for this paper is to apply for the first time AHP in Sagaing Region. The Sagaing Region is a division of Myanmar, located in the north-western part of the country between latitude 21º31¹ north and longitude 94º 97¹ east. It is bordered by India's Nagaland and Manipur States to the north. Kachin State. Shan State and Mandalay Region to the east. Mandalay Region and Magway Region to the south and Chin State and India to the west. The region has an area of 93.527 km^2 and population(1996) of over 5,300,000. The capital is Monywa. Sagaing Region consists of 198 wards. Among these wards, the major cities are Monywa, Sagaing, Mingun, Shwebo and Mogok. In the native of Sagaing Region, the Naga New Year Festival is usually held in January. This festival is most well-known from all over the world and many tourists come to visit the rare tribe's culture of Myanmar. In the Sagaing Region across the Ayeyarwaddy River are the Mingun Pahtodawgyi and the largest Ringing bell known as Mingun Bell. The Sagaing Hill is the main place for meditation. Thanboddhay Pagoda in Monywa is another tourist destination. The followings are the map and Thanboddhay Pagoda, Mingun Pahtodawgyi , Mingun Bell in Sagaing Region.

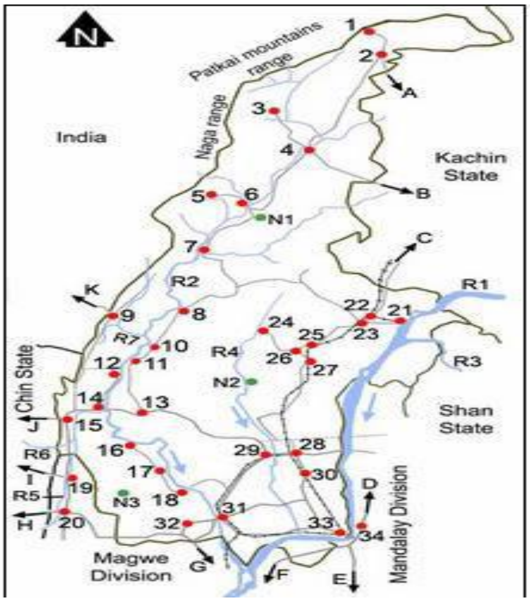

Figure 1: Map of Sagaing Region



Figure 2: Thanboddhay Pagoda in Sagaing Region
Figure 3: Mingun Pahtodawgyi in Sagaing Region
Figure 4: Mingun Bell in Sagaing Region

This decision support framework proposes the suitable trips for travelers to select the best trip in Sagaing Region. This paper is organized as follows. Section 2 describes the related work. In Section 3, the theories about the decision support system, multi criteria decision making, analytical hierarchy process and consistency ratio will be discussed, and then Section 4 will clarify the case study of the system. Section 5 describes the conclusion of the system.

2. RELATED WORK:

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.

In University selection [1], AHP model is used to select the suitable university for prospective students in order to achieve their different objectives and purposes. If the user inputs location of institution, job placements, teaching faculty, infrastructure and fees structure then the system displays the available university lists. Among the relevant universities, the students can choose all or at least two universities. These university selection system implements with five criteria and dynamically calculates with alternatives without worrying about the volume of the matrix may be large and the performance of the system will degrade. Besides, user can choose preference how much more important for each cluster to be weighted the priorities in decision for their different objectives and purposes.

In host country selection [2], AHP model is used for selecting the most appropriate host country for students. These selection system includes the criteria: Easy Application Procedure, Expenses for Education and Daily Life, Security of Life, Level of Socio cultural life and Easy Travel Connection and then calculates maximum six alternatives, such as

English speaking countries: England, USA, Canada, Australia, New Zealand and Mala. Then the system dynamically calculate the propose results.

3. BACKGROUND THEORY:

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 [5].

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[7].

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:[3]

- Pair-wise comparison of criteria
- Establish priority vector for criteria
- Pair-wise comparison of alternatives
- Establish priority vector for alternatives and
- 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:[1]

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:

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

3.1. AHP Algorithm

The application of the AHP algorithm is as follows:

- Accept each weight value for criteria.

- Set the priority matrix for overall criteria.
  - (i) Create the Matrix
  - (ii) Create the normalize Matrix
  - (iii) Calculate the Priority Vector
- Set the priority matrix for each criteria.
  - (i) Create the Matrix
  - (ii) Create the normalize Matrix
  - (iii) Calculate the Priority Vector
- Set the priority matrix for overall ranking.
  - (i) Create Ranking
  - (ii) Calculate the Priority Vector
- Find the Highest Priority and Highest Ranking.

3.2. 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 [3].

4. 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 5 :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	0.12

Figure 6: 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 7 : 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 8 : 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 9 : 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 10 : 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 11: 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 12: 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 13: 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 14: 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 15: 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 16: 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 17: 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 travellers. 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 18 : Propose results for travellers

5. CONCLUSION:

This system has intended to implement the Trip selection in Sagaing Region 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. By using this system, the travellers 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.

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