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Tour Package Decision Support System According to Consumer Budget on Travel and Tour Using the Analytical Hierarchy Process (AHP) Method

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Abstract: CV. BAHANA SURYA TRAVEL & TOUR is a company engaged in the field of travel agency which includes airline and ship ticketing agents, domestic and international tour travel agents and transportation services domiciled in the city of Makassar. The problem that exists today is how to determine the recommended price for tour packages according to the budget of prospective tourists. From this, this research intends to design a decision support system for tour packages according to consumer budgets on travel and tours using the Analytical Hierarchy Process (AHP) method. The AHP method helps in determining the priority weight of each parameter that becomes a reference/consideration in making decisions. This study resulted in a system that helps prospective tourists to choose a package of tourist attractions according to their budget using the Analytical Hierarchy Process (AHP) method.

Keywords: Decision Support System; Analytical Hierarchy Process (AHP).

A. Introduction

The Commanditaire Vennootschaap (CV). BAHANA SURYA is a company operating in the travel agency sector, offering services as an official ticketing agent for airlines and shipping lines, organizing domestic and international tours, and providing transportation services, based in Makassar. CV. BAHANA SURYA also offers tourist car rental services. CV. BAHANA SURYA's service area covers the entire city of Makassar and South Sulawesi in general. In addition, CV. BAHANA SURYA also offers travel services throughout Indonesia and internationally with a variety of travel

options. In this modern age, almost everything can be done virtually, given that most people today are busy with demanding jobs or an ever-increasing workload that can leave them exhausted. These hardworking individuals deserve to enjoy a vacation that brings joy and peace of mind, away from the chaos of the city—with its noise, pollution, traffic jams, and crowds—which can sometimes make vacationers feel overwhelmed while trying to relax and enjoy their free time. Travel & Tour services involve the sale of fully packaged vacation or tour packages that include hotel accommodations, transportation, meals and



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drinks, and a travel itinerary for visiting tourist attractions, whether natural attractions, cultural tourism, art tourism, and others, available as private tours (tours not combined with other participants) or open trips (tours combined with other participants, with a specific target number of participants). These tour packages are available for domestic tours. Travel&Tour's travel packages offer services designed for those who wish to enjoy a vacation and experience the beauty of tourist destinations located in cities across Indonesia.

This study was conducted at CV. BAHANA SURYA Tour & Travel to develop a decision support system that automatically generates travel packages for prospective visitors wishing to vacation there, using the Analytical Hierarchy Process (AHP) method. The Analytical Hierarchy Process (AHP) is a structured method for managing and analyzing complex decisions using mathematical and psychological concepts. The AHP method helps determine the priority weights of each parameter that serves as a reference or consideration in the decision-making process.

Based on the problem background described above, the researcher will conduct a study titled: "Decision Support System For Tour Packages Tailored To Consumer Budgets In The Travel And Tour Industry Using The Analytical Hierarchy Process (AHP)" to assist travel and tour companies in conducting targeted marketing campaigns to the public.

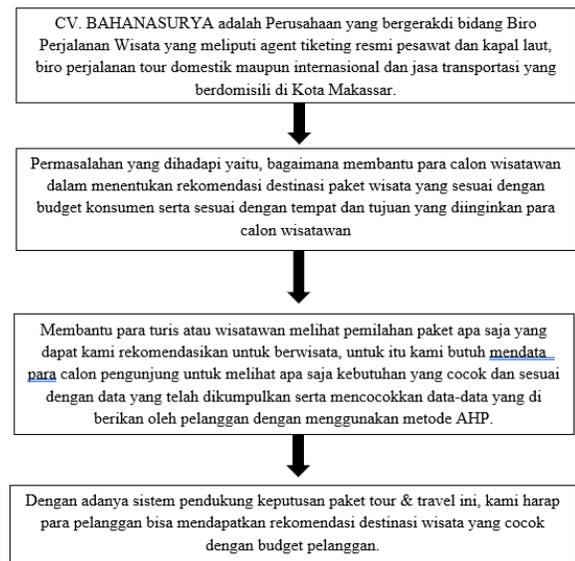


Figure 1. framework

B. Materials and Methods

The AHP method was first developed by Thomas L. Saaty, a mathematician at the University of Pittsburgh in the United States, in the early 1970s.

The steps used in the AHP method are as follows:

- 1) Defining the problem and determine the desired solution.
- 2) Create a hierarchical structure starting with the overall objective, followed by sub-objectives, criteria, and alternatives at the lowest level of the criteria hierarchy.
- 3) Create a pairwise comparison matrix that illustrates the relative contribution and influence of each element on the objective or criteria at the next higher level. Comparisons are made based on decision-making assessments by evaluating the level of importance of an element relative to others.
- 4) Comparisons are made in pairs, resulting in a total of $n \times [(n-1)/2]$ evaluations, where n is the number of elements being compared.

- 5) Calculate the eigenvector values and test for consistency; if inconsistent, repeat the data collection.
- 6) Repeat steps 3, 4, and 5 for all levels in the hierarchy
- 7) Determine the eigenvectors for each pairwise comparison matrix. The eigenvector values serve as the weights for each element. This step synthesizes the evaluations to prioritize the elements from the lowest hierarchical level up to the achievement of the objective.
- 8) Checking the consistency of the hierarchy.

Essentially, the mathematical formulation of the AHP model is carried out using matrices. For example, suppose that in an operational subsystem there are n operational elements, namely A_1, A_2, \dots, A_n ; the results of the pairwise comparisons of these operational elements will form a comparison matrix.

Table 1. Pairwise Comparison Matrix.

	A1	A2	.....	An
A1	a 1	a 2	.....	a 1 n
A2	A21	A22	.....	a 2 n
.
.
An	a n1	a n2		ann

Matrix A ($n \times n$) is a reciprocal matrix, and it is assumed to contain n elements, namely w_1, w_2, \dots, w_n , which will be evaluated in terms of pairwise comparisons. The pairwise comparison values (judgments)

between (w_i, w_j) can be represented as shown in the matrix (equation below).

$$\frac{w_j}{w_i} = a(i, j); i, j = 1, 2, \dots, n$$

.....

Table 2. Comparison of Matrix with Intensity Values.

	A1	A2	.....	An
			...	
A1	W1/W1	W1/W2	.....	W1/Wn
	1	2	...	n
A2	W2/W1	W2/W2	.....	W2/Wn
	1	2	...	n
An	Wn/W1	Wn/W2	.....	Wn/Wn
	1	1	...	n

The values of w_i and w_j , where i and $j = 1, 2, \dots, n$, are obtained from selected participants, namely individuals who are competent in the issues being analyzed. When this matrix is multiplied by the column vector $w = w_1, w_2, \dots, w_n$, it yields A with n eigenvalues. This equation is illustrated in Figure 2.

$$\begin{bmatrix} w_1 & w_1 & \dots & w_1 \\ w_1 & w_2 & \dots & w_n \\ w_2 & w_2 & \dots & w_2 \\ w_1 & w_2 & \dots & w_n \\ w_n & w_n & \dots & w_n \\ w_1 & w_2 & \dots & w_n \end{bmatrix} \times \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_n \end{bmatrix} = \lambda \times \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_n \end{bmatrix}$$

Figure 2. Matrix Equations.

The variable n in the figure can generally be replaced by a vector λ in the following equation:

$Aw = \lambda w$ (2) Where $\lambda = (\lambda_1, \lambda_2, \dots, \lambda_n)$ Each λ_n that satisfies the above equation is called an eigenvalue, while the vector w that satisfies the above equation is called an eigenvector. Matrix A is a reciprocal matrix with $a_{ii} = 1$ for all i , such that it satisfies the following equation:

$$\sum_{i=1}^n \lambda_i = n \dots \dots \dots (3)$$

If matrix A is a consistent matrix, then all eigenvalues are zero except for one, which is equal to n . If matrix A is an inconsistent matrix, small variations in a_{ij} will cause the largest eigenvalue, λ_{max} , to remain close to n , while the other eigenvalues approach zero. The value of λ_{max} can be found using the following equation:

$$Aw = \lambda_{max} w \text{ or } [A - \lambda_{max} I] = 0 \dots \dots \dots (4)$$

Where I is the identity matrix. The values of the weight vector w can be found by substituting the value of λ_{max} into the equation $Aw = \lambda_{max} w$. In practice, consistent conditions are difficult to achieve. The value of a_{ij} will deviate from the ratio w_i / w_j , so the equation $Aw = nw$ will not be satisfied. The deviation of λ_{max} from n is a parameter called the Consistency Index (CI), which is defined as follows:

$$CI = \frac{\lambda_{max} - n}{n - 1} \dots \dots \dots (5)$$

The CI value is meaningless without a benchmark to determine whether the CI indicates a consistent matrix. Saaty provides this benchmark by conducting random comparisons on 500 samples. Saaty argues that a matrix generated from random comparisons is absolutely inconsistent. From this random matrix, a CI value is obtained, known as the Random Index (RI).

Thus, by comparing the CI with the RI, a benchmark is established to determine the consistency level of a matrix, known as the Consistency Ratio (CR), through the following equation:

$$CR = \frac{CI}{RI} \dots \dots \dots (6)$$

Tabel 3. Random Index Value.

Order	Matrices	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	RI	0.00	0.00	0.58	0.90	1.12	1.24	1.33	1.41	1.47	1.52	1.56	1.59	1.62	1.64	1.65

Saaty states that a comparison matrix is consistent if the CR value is no greater than 0.1 (10%).

C. Result and Discussion

1. Pengujian blackbox

Black-box testing focuses on the information domain of the software, creating test cases by partitioning a program's input domain to provide thorough test coverage.

This testing method also focuses on the functional requirements of the software; therefore, black-box testing enables software developers to create a set of input conditions that will cover all the functional requirements of a program.

Black-box testing aims to identify defects in several categories, including:

1. Incorrect or missing functions
2. Interface errors
3. Errors in data structures or external database access
4. Performance errors
5. Initialization and termination errors.

2. System Testing

System testing was conducted using direct testing methods based on the Black

Box technique, which involved testing the functionality of the application, its buttons, and the accuracy of the application's output.

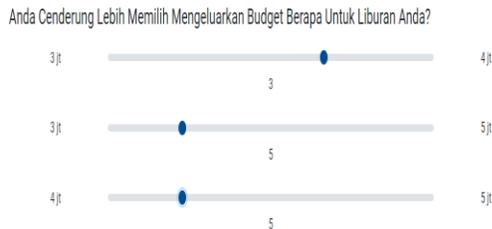


Figure 3. Criteria

Before entering the calculation table, we must decide which budget criteria are more important based on the consumer's budget. After that, we proceed to the table section. Once all fields in the criteria table have been filled in, each column is summed, and the totals are placed in the green table. Next, we normalize the criteria table by dividing each row of the criteria table by the total of that row's criteria, so $1.00/4.20 = 0.24$, $3.00/4.20 = 0.71$, and so on. Then, we average each row to obtain the average values or eigenvectors.

Table 4. Alternative.

3jt								
	Tanjung	Toraja	Bantimurung		Tanjung	Toraja	Bantimurung	
Tanjung	1,00	0,20	0,14	Tanjung	0,08	0,05	0,10	0,07
Toraja	5,00	1,00	0,33	Toraja	0,38	0,24	0,23	0,28
Bantimurung	7,00	3,00	1,00	Bantimurung	0,54	0,71	0,68	0,64
	13,00	4,20	1,48		1,00	1,00	1,00	
4jt								
	Tanjung	Toraja	Bantimurung		Tanjung	Toraja	Bantimurung	
Tanjung	1,00	3,00	0,20	Tanjung	0,16	0,43	0,13	0,24
Toraja	0,33	1,00	0,33	Toraja	0,05	0,14	0,22	0,14
Bantimurung	5,00	3,00	1,00	Bantimurung	0,79	0,43	0,65	0,62

	6,33	7,00	1,53		1,00	1,00	1,00	
5jt								
	Tanjung	Toraja	Bantimurung		Tanjung	Toraja	Bantimurung	
Tanjung	1,00	0,33	0,14	Tanjung	0,16	0,05	0,09	0,10
Toraja	3,00	1,00	0,20	Toraja	0,47	0,14	0,13	0,25
Bantimurung	7,00	5,00	1,00	Bantimurung	1,11	0,71	0,65	0,82
	11,00	6,33	1,34		1,74	0,90	0,88	

Table 5. Lambda, Consistency Index.

	λ maks
	3,190978
CI	0,095489
CR	0,164636

Next, we calculate the maximum lambda by multiplying the values in the green table of the criteria table by the eigenvectors in the blue table: $4.20 \times 0.30 + 1.53 \times 0.61 + 11.00 \times 0.09 = 3.190978$. To determine the CI (consistency index), use the formula below, where (n) is the number of criteria, so $CI = (3.190978 - 3)/(3 - 1) = 0.095489$.

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

Meanwhile, the CR (consistency ratio) uses the formula where the RI (random

index) is as shown in the table below; since the matrix size is 3, the RI value is 0.58, so $CR = 0.095489 / 0.58 = 0.164636$

Table 6. Random Index Consistency List.

Matrix Size	IR Value
1,2	0,00
3	0,58
4	0,90
5	1,12
6	1,24
7	1,32
8	1,41
9	1,45
10	1,49

All average values will be collected, and the average value of the criteria will be placed to the left of the average value of the alternative. Then, the rows of the average values and alternatives will be multiplied by the columns of the criteria, resulting in a table where the Eigenvector of the alternatives is multiplied by the Eigenvector of the criteria, and will produce a final weight, which is the recommended result; the weight with the higher numerical value is the recommended result from the AHP calculation.

D. Conclusion

1. Recognizing that prospective travelers often grapple with an overwhelming array of choices and the logistical complexities of destination selection, our innovative platform serves as a comprehensive digital concierge that utilizes sophisticated filtering to present personalized itineraries which remain strictly within the user's defined financial parameters.

2. By instituting a robust framework for the multi-dimensional analysis of gathered user data, we are able to discern subtle nuances in consumer sentiment and behavioral patterns, which subsequently informs our rigorous quality assurance protocols as we strive to eliminate operational deficiencies and elevate the overall standard of the customer journey.

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