IJAIT (International Journal of Applied Information Technology)

http://journals.telkomuniversity.ac.id/ijait/

Combination of Analytic Hierarchy Process and Simple Additive Weighting for Tourist Attractions Recommendation System

Elis Hernawati [a, *], Siska Komala Sari [a], Dedy Rahman Wijaya [a]

[a] *School of Applied Science, Telkom University, Bandung, Indonesia*

elishernawati@telkomuniversity.ac.id, siskaks@telkomuniversity.ac.id, dedyrw@tass.telkomuniversity.ac.id

ARTICLE INFO

Received January 10th, 2022
Revised June 15th, 2022
Accepted June 24th, 2022
Available online July 2nd, 2022

Keywords
AHP-SAW, tourist attractions, multi-criteria, decision making, ranking

ABSTRACT

Tourists always make the selection of the right tourist attractions before visiting tourist attractions. Tourists have different criteria in choosing the tourist attractions they want to see. There are many good tourist attractions on the island of Lombok, Indonesia, but of the many tourist attractions, tourists need recommendations for the best tourist attractions to visit. Decision-making methods can be used to create a ranking system. Analytical Hierarchical Process (AHP) is a decision-making method in Multi-Criteria Decision Making (MCDM) problems by combining qualitative and quantitative factors in complex issues. Simple Additive Weighting (SAW) is a decision-making method to generate a rating preference value. The purpose of this paper is to utilize a combination of AHP-SAW to decide the weight of the criteria and the significance of alternative tourist attractions. The calculation of the AHP-SAW combination resulted in ranking the best tourist attractions. This study uses five alternative tourist attractions on the island of Lombok, namely Pink Beach (A1), Senggigi Beach (A2), Tanjung Aan Beach (A3), Marese Hill (A4), and Mayura Park (A5), taken from several trusted sites. In addition, the five criteria used are visitor reviews, visitor ratings, ticket prices, the distance of tourist attractions from the airport, and visiting time. The results showed that the AHP-SAW combination resulted in a consistent ratio value of 0.0371, so the criterion-weighted data could be used to calculate the preference value and ranking of alternative tourist attractions. The best alternative for tourist attractions is Tanjung Aan Beach (A3), with a preference value of 0.9554.

* Corresponding author at:
School of Applied Science, Telkom University
Jl. Telekomunikasi No. 1, Terusan Buah Batu, Bandung, 40257
Indonesia
E-mail address: elishernawati@telkomuniversity.ac.id

ORCID ID:
- First Author: 0000-0002-5855-3615
- Second Author: 0000-0001-5207-6144

https://doi.org/10.25124/ijait.v5i02.4472
Paper_reg_number IJAIT000050206 2022

1. Introduction

Lombok is one of the best tropical islands in Indonesia. Lombok Island has always been a favorite tourist destination for tourists, both domestic and foreign [1]. Lombok Island has attractive tourism potential that can increase tourist visits. Currently, tourists know information about tourist objects through verbal communication (family, relatives, friends, school, relations) and electronic media information (television, radio, social media, and websites). However, tourists have many different criteria in choosing tourist attractions. From these multi-criteria, it can be used as a basis for making decisions in recommending the best tourist attractions.

In previous studies, a decision support system utilizing the SAW technique was utilized for the determination of Purworejo vacation spots [2]. This study uses five criteria: cost, distance, facilities, and age. The result of the research is to rank the recommendations for the best alternative tourist attractions in Purworejo. Another review examines the design of the Lombok Island tourism information system utilizing the Simple Additive Weighting Method. The research resulted in a tourism information system and a ranking of the best alternative tours based on the criteria for admission prices, historical values, transportation, number of lodgings, and the nearest tourist distance. Research [3] proposes suggestions utilizing the Simple Additive Weighting (SAW) technique utilizing 12 models. The aftereffects of this review are applications that can be gotten to on the web. Other research [4] discusses the Multi-Criteria Decision Making (MCDM) utilizing the Fuzzy-AHP method to rank tourism trends from online media. The unique positioning is the recreation or picnic area attraction, with a last weight calculation value of 0.6361. Fuzzy-AHP can be positioned ideally with an MSE value of 0.0002. Other research [5] In this study utilizes a mix of AHP-SAW. In his research, ten electives travel industry towns tried utilizing AHP-SAW, and the vacationer town in Pemuteran was the most famous. The first rank got a score of 0.9241. The second rank scored 0.9117 in the second place; The third place got a score of 0.9115. Other research [6] uses the "AHP-TOPSIS" method to evaluate human capital in helping organizations.

Further research [7] proposed the advancement of the Simple Additive Weighting (SAW) and FAST (Framework for the Application of Systems Thinking) methods utilizing the PHP and MySQL programming languages as databases for inn determination. Other research [8] proposed an Analytical Hierarchical Process (AHP) to select the best dump site near the Durg-Bhilai area. In the study [9], it is proposed to use the AHP method for selecting students who care enough to get poor scholarships. Other studies [10] compared conventional AHP and fuzzy AHP to choose an effective oil refinery.

However, from several previous studies, there is still little use for the combination of AHP and SAW methods to find the best vacation destinations. In this paper, we utilized the "Multi-Criteria Decision Making (MCDM)" model [10][11]. The method utilized is AHP and SAW. We use the "Analytical Hierarchical Process" (AHP) [12] to discover the overall significance of the options by using comparisons of alternatives based on several predetermined criteria. Moreover, when the criteria weights have been adjusted, AHP can separate the decision problem [6]. The SAW method will be used to calculate weighted alternative normalization to produce preference values that can be ranked to determine recommended tourist attractions. Our proposed approach yields strong outcomes when sensitivity is performed on the weighting models.

The rest of this paper is arranged as follows: section two depicts the related works. Section three describes the methodology. Section four discusses experiments and results. Finally, section five explains the conclusion and future work.

2. Materials and Method

This research is based on information on tourist attractions and visitor reviews taken from the websites www.tripadvisor.com and www.gotravelaindonesia.com 2019. Data from the website is used to determine the rating value of recommended tourist attractions. The AHP and SAW methods were used in this study.

AHP method is one of the foremost well-known pairwise comparison strategies for decision-making in Multi-Criteria Decision Making (MCDM) problems [6]. The AHP method aims to assist decision-makers in combining qualitative and quantitative components in complex issues. The AHP process works as follows [6].

1. Find out unordered problems
2. Find the criteria and alternatives
3. Choice of components through pairwise comparison
4. The relative weights of the decision components are predicted using the eigenvalue method
5. Consistent matrix characteristics checked
6. All weights of decision elements are aggregated

The AHP method is used to determine weighted standard data. The process of the AHP method starts by determining the pairwise comparison matrix. The pairwise comparison matrix was changed according to the Saaty Scale. Table 1 shows the Saaty scale [5].

Table 1 Saaty Scale of Pairwise Comparisons

Score Interest/Intensity	Information/Linguistics
1	equal
3	moderate
5	strong
7	demonstrated
9	extreme
2,4,6,8	Intermediate value

To calculate matrix normalization, calculate feature vectors, and check the consistency of the hierarchy use the formula for calculating the consistency index shown in **Error! Reference source not found.** [13].

$$CI = \frac{(\lambda max - n)}{(n-1)} \quad \text{Equation 1}$$

n is the number of elements/criteria. To calculate the Consistency Ratio shown in **Error! Reference source not found.** [13].

$$CR = CI/IR \quad \text{Equation 2}$$

Consistency ratio (CR) is used to measure the consistency in the pairwise comparison [14], *CI*=consistency index, and *IR* is random index consistency. Saaty (1994) has set the acceptable CR values for different matric sizes. The CR value is

0.1 for matrices greater than four by 4. The matrix consistency check is carried out based on the results of the consistency ratio calculation. The pairwise comparison matrix must be readjusted if the CR is greater than 0.1. If the CR is less than 0.1, the pairwise comparison matrix is declared consistent, and the calculation is correct. The preference for calculating value and ranking at the next stage can be continued. The SAW method is a weighted addition method [15][7]. The basic concept of the SAW method is to discover the weighted sum of execution rating for each elective in all attributes.

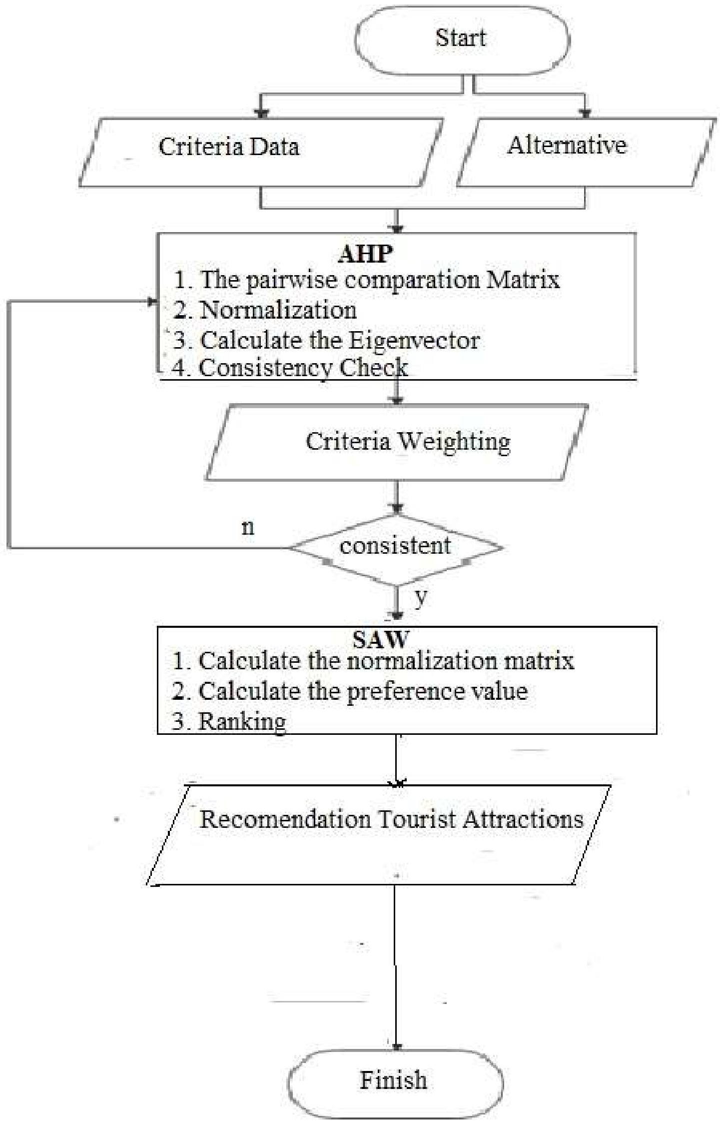

Figure 1 Flowchart of Research Implementation AHP-SAW Method to Recommend Tourist Attractions

The SAW method is used to normalize alternative data. The weighted criteria data was calculated using the AHP method, and alternative data was normalized using the SAW method. They will be used to calculate the weighted alternative normalization to produce a preference value that can be ranked to determine recommended tourist attractions.

Alternative and criteria weighting determined utilizing the AHP method is continued to make the matrix normalization process. The formula for making the matrix normalization process is shown in **Error! Reference source not found.** and **Error! Reference source not found.** [15][16].

$$Rij = \frac{Xij}{Max\ Xij} \quad \text{If j is a benefit attribute,} \qquad \text{Equation 3}$$

$$Rij = \frac{Min\ Xij}{Xij} \quad \text{If j is a cost attribute,} \qquad \text{Equation 4}$$

Evaluate each alternative (Vi). Vi is the rank for each alternative, Rij is the score of the i-th alternative against the jth criteria, and Wj is the weighting criterion. To calculate the rank for each alternative (Vi) shown in Equation 5 [15][17].

$$Vi = \sum_{j=1}^{n} WjRij \qquad \text{Equation 5}$$

The SAW method is used to normalize alternative data. The standard weight data is calculated using the AHP method. Alternative data normalized using the SAW method will be used to calculate the weighted alternative normalization to produce a preference value that can be ranked to determine recommendations for favorite tourist attractions [5]. The flowchart of methodology is shown in Figure 1.

3. Result and Discussion

The first step was preparing comparative and alternative data for tourist attractions. Alternative data are Pink Beach (A1), Sengigi Beach (A2), Tanjung Aan Beach (A3), Bukit Marese (A4), and Taman Mayura (A5) on the island of Lombok, Indonesia. Data comparison criteria are visitor reviews (C1), ratings (C2), entrance ticket prices (C3), the distance of tourist attractions (C4) from the airport, and visiting time (C5). Alternative data are shown in Table 2, alternative data and criteria data [18][19][20][21].

Table 2 Alternative Data and Criteria Data

Alternative	Criteria				
	C1	C2	C3	C4	C5
A1	344	4	10000	55.2	24
A2	579	3.5	15000	50.8	24
A3	869	4.5	10000	24.7	24
A4	154	4.9	0	23	12
A5	2	3.5	2500	32.1	10

The calculation starts by creating a pairwise comparison matrix. In the following stage, the standard comparison matrix is changed according to the Saaty scale and is shown in Table 3.

Table 3 Pairwase Comparison Matrix Converted by Saaty Scale

Criteria	C1	C2	C3	C4	C5
C1	1	5	4	3	7
C2	1/5	1/1	1/2	1/2	3
C3	1/4	2	1/1	4/2	3
C4	1/3	2	2/4	1/1	3
C5	1/7	1/3	1/3	1/3	1/1

Then normalization is done by partitioning the component esteem by the quantity of column esteems. Eigenvector values are produced dependent on the number of criteria for each row and are shown in Table 4.

Table 4 Normalization Matrix

Criteria	C1	C2	C3	C4	C5
C1	0.5263	0.4840	0.6349	0.4392	0.4118
C2	0.1053	0.0971	0.0790	0.0732	0.1765
C3	0.1316	0.1942	0.1580	0.2928	0.1765
C4	0.1737	0.1942	0.0790	0.1464	0.1765
C5	0.0737	0.0320	0.0521	0.0483	0.0588
Total	1.9262	10.3333	6.3333	6.8333	17.0000

After getting the eigenvectors for each criterion, the next step is to calculate the max can be computed based on the pairwise comparison matrix multiplied by the eigenvectors. Each product result is divided by the feature vector, and the average value is max. The calculation results are shown in Table 5.

Table 5 Calculate The Max

Criteria	C1	C2	C3	C4	C5	Total	Eigenvector	Max
C1	0.6241	0.6638	0.9530	0.5773	0.4637	2.6255	0.4993	5.2589
C2	0.1248	0.1328	0.1191	0.0962	0.1987	0.5373	0.1062	5.0594
C3	0.1560	0.2655	0.2383	0.3849	0.1987	0.9947	0.1906	5.2187
C4	0.2080	0.2655	0.1191	0.1924	0.1987	0.7871	0.1539	5.1126
C5	0.0892	0.0443	0.0794	0.0641	0.0662	0.2746	0.0530	5.1807

Table 6 Criteria Weighting Data

Criteria	Eigenvector (Weight)
C1	0,49925
C2	0,10620
C3	0,19061
C4	0,15395
C5	0,05300

Table 5 can calculate (lambda) max, namely the average value of the consistency vector of 5.1661 and the value of the consistency index (CI) of 0.0415. After getting the CI, the consistency ratio (CR) can be calculated, equal to 0.0371. Based on the Alonso-Lamata RI value, the number of criteria is 5, and the Random Consistency Index (IR) used is 1.12. Suppose the CR value is greater than or equal to 0.1. In that case, the value is declared inconsistent, and the criteria comparison process must be repeated until the CR value is less than 0.1. The AHP decision-making process results in the weight of the criteria in the table Table 6.

Then use the SAW method to generate ranking values. The SAW method begins with standardizing alternatives, calculating weighted alternative normalization, and calculating preference values and rankings. The subsequent stage is to determine the preference value given to the decision-maker. The W value is the weight value generated from the AHP method. The normalization matrix is shown in **Error!**

Reference source not found.. This matrix can be utilized to compute the weight vector.

Table 7 The Normalization Matrix

Alternative	Criteria				
	C1	C2	C3	C4	C5
A1	0.4	1	0.75	0.2	1
A2	0.6	0.8	1	0.4	1
A3	1	1	0.75	1	1
A4	0.2	1	0.6	1	0.8
A5	0.2	0.8	0.6	0.8	0.6

Next, calculate the preference value by adding all the weighted normalization alternatives, where the criterion weights generated from the AHP process are multiplied by the alternative matrix normalization values. The final results of data processing using AHP-SAW are shown in the table Table 8.

Table 8 Preference value and Alternative Ranking

Alternative	Criteria					Preference Value	Rank
	C1	C2	C3	C4	C5		
A3	0.4993	0.1062	0.1430	0.1539	0.0530	0.9554	1
A2	0.2996	0.0850	0.1906	0.0616	0.0530	0.6897	2
A1	0.1997	0.1062	0.1430	0.0308	0.0530	0.5326	3
A4	0.0999	0.1062	0.1144	0.1539	0.0424	0.5168	4
A5	0.0999	0.0850	0.1144	0.1232	0.0318	0.4541	5

This study will examine the combination of AHP-SAW can be a recommendation system to objectively determine the best tourist attractions. Comparison with other studies from [3] provides recommendations of 24 Anyer beach attractions to tourists. Recommendations were generated using the Simple Additive method Weighting (SAW) using 12 criteria. The results of the ranking of the three best alternatives are shown in the table Table 9

Table 9 Alternative Ranking [3]

No	Code	Alternatif Name	Total	Rank
1	A3	Pantai 0 KM	0.87	1
2	A8	Pantai Sambolo	0.86	2
3	A18	Pantai Karangbolong	0.69	3

The difference in previous research is the weight of the criteria using the values 1 and 0, which are determined by the user not using the AHP process. While in this study, from the AHP process, the weight of the criteria resulted in a consistent ratio of 0.0371.

4. Conclusions

This study produces recommendations to determine the best tourist attractions on the island of Lombok using the AHP-SAW method. Alternative data and criteria data were taken from several sites, namely www.tripadvisor.com, www.nativeindonesia.com, and www.gotravelaindonesia.com. The study used five alternative tourist attractions selected with criteria determined based on the review, assessment, price, distance, and time. After going through modeling, calculations, and testing, the AHP-SAW method produces a consistent ratio value of 0.0371. The data weighting criteria is less than 0.1, so it can be used to calculate preference values and rank alternative tourist attractions. The ranking results can be used as a recommended value for the best tourist attractions.

This research has a limitation because data processing results are not implemented into a programming language. This research can be continued as a reference for developing a tourist e-catalog application that tourists can use in finding and choosing tourist attractions.

Bibliography

[1] A. Trisandy, “10 Tempat Wisata di Lombok yang Memikat dan Wajib Dikunjungi, Hits! No Title.” .

[2] P. Kuswantoro, “Sistem Pendukung Keputusan Pemilihan Tempat Wisata Menggunakan Metode Promethee,” pp. 91–96, 2017.

[3] S. Suherman, S. Samsuni, and I. L. Hakim, “Sistem Rekomendasi Wisata Pantai menggunakan Metode Simple Additive Weighting,” *Ilk. J. Ilm.*, vol. 12, no. 1, pp. 1–7, 2020, doi: 10.33096/ilkom.v12i1.481.1-7.

[4] S. Saifullah, “Fuzzy-AHP approach using Normalized Decision Matrix on Tourism Trend Ranking based-on Social Media,” *J. Inform.*, vol. 13, no. 2, p. 16, 2019, doi: 10.26555/jifo.v13i2.a15268.

[5] N. Sari, “Implementation of the AHP-SAW Method in the Decision Support System for Selecting the Best Tourism Village,” *J. Tek. Inform. CIT Medicom*, vol. 13, no. 1, pp. 23–32, 2021, [Online]. Available: https://www.medikom.iocspublisher.org/index.php/JTI/article/view/51.

[6] A. K. M. Masum, A. N. M. R. Karim, F. B. Al Abid, S. Islam, and M. Anas, “A new hybrid AHP-topsis method for ranking human capital indicators by normalized decision matrix,” *J. Comput. Sci.*, vol. 15, no. 12, pp. 1746–1751, 2019, doi: 10.3844/JCSSP.2019.1746.1751.

[7] K. Kabassi, C. Karydis, and A. Botonis, “AHP, fuzzy SAW, and fuzzy WPM for the evaluation of cultural websites,” *Multimodal Technol. Interact.*, vol. 4, no. 1, 2020, doi: 10.3390/mti4010005.

[8] R. Chandrakar and S. Limje, “A hybrid of QFD and AHP-TOPSIS for Durg dumping waste projects,” *J. Proj. Manag.*, vol. 3, no. 2018, pp. 143–150, 2018, doi: 10.5267/j.jpm.2018.2.003.

[9] F. F. H. Hadi and G. Gushelmi, “Sistem Pengambilan Keputusan Pemilihan Siswa Yang Berhak Mendapatkan Beasiswa Miskin Dengan Metode Analytical Hierarchy Process (Ahp),” *J. Teknol. Dan Sist. Inf. Bisnis*, vol. 3, no. 1, pp. 157–166, 2021, doi: 10.47233/jteksis.v3i1.173.

[10] F. Mulubrhan, A. A. Mokhtar, and M. Muhammad, “Comparative analysis between fuzzy and traditional analytical hierarchy process,” *MATEC Web Conf.*, vol. 13, pp. 0–4, 2014, doi: 10.1051/matecconf/20141301006.

[11] B. Rima Aditya and M. Handoko Wijoyo, “Development IT Adoption Method for E-learning in Merged University,” *IJAIT (International J. Appl. Inf. Technol.*, vol. 1, no. 02, pp. 10–17, 2017, doi: 10.25124/ijait.v1i02.870.

[12] A. Görener, K. Toker, and K. Uluçay, “Application of Combined SWOT and AHP: A Case Study for a Manufacturing Firm,” *Procedia - Soc. Behav. Sci.*, vol. 58, pp. 1525–1534, 2012, doi: 10.1016/j.sbspro.2012.09.1139.

[13] A. Ghosh and S. K. Kar, “Application of analytical hierarchy process (AHP) for flood risk assessment: a case study in Malda district of West Bengal, India,” *Nat. Hazards*, vol. 94, no. 1, pp. 349–368, 2018, doi: 10.1007/s11069-018-3392-y.

[14] Cheng & Li, “An Approach To Determine Measures,” *Meas. Bus. Excell.*, vol. 5, no. 3, pp. 30–36, 2001.

[15] A. Setiadi, Y. Yunita, and A. R. Ningsih, “Penerapan Metode Simple Additive Weighting(SAW) Untuk Pemilihan Siswa Terbaik,” *J. Sisfokom (Sistem Inf. dan Komputer)*, vol. 7, no. 2, p. 104, 2018, doi: 10.32736/sisfokom.v7i2.572.

[16] A. Suryana, E. Yulianto, and K. D. Pratama, “Perancangan Sistem Pendukung Keputusan Penilaian Prestasi Pegawai Menggunakan Metode Saw, Ahp, Dan

Topsis," *J. Ilm. Teknol. Infomasi Terap.*, vol. 3, no. 2, pp. 130–139, 2017, doi: 10.33197/jitter.vol3.iss2.2017.129.

[17] A. Suryana, E. Yulianto, and K. D. Pratama, "Perancangan Sistem Pendukung Keputusan Penilaian Prestasi Pegawai Menggunakan Metode Saw, Ahp, Dan Topsis," *J. Ilm. Teknol. Inf. Terap.*, vol. 3, no. 2, pp. 130–139, 2017, [Online]. Available: http://jitter.widyatama.ac.id/index.php/jitter/article/view/216.

[18] "Tripadvisor," 2019. https://www.tripadvisor.co.id/Attraction_Review (accessed Jun. 21, 2021).

[19] "Wisata Indonesia Terbaru," *nativeindonesia.com*, 2021. www.nativeindonesia.com.

[20] "Gotravela Indonesia," *gotravelaindonesia.com*, 2020. https://www.gotravelaindonesia.com/.

[21] T. Agency, "Wisata di Lombok." https://www.instagram.com/wisatadilombok/ (accessed Jun. 08, 2022).