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FUZZY SIMPLE ADDITIVE WEIGHTING FOR OPTIMIZATION TOURIST DESTINATION RECOMMENDATIONS

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ABSTRACT

The difficulty of choosing destinations according to tourist preferences requires the development of an appropriate Decision Support System to optimize tourist destination recommendations. This research aims to develop a Decision Support System using the Fuzzy SAW algorithm to support the growth of the tourism sector. This research develops a decision support system. The objects used are 13 tourist destinations in Karangasem Regency, Bali. The algorithm used is Fuzzy Simple Additive Weighting, where the algorithm considers costs and benefits. Determine the criteria, then determine alternative costs and benefits and give fuzzy weight to the criteria for use. The result of this study is the ranking of tourist destination recommendations according to Fuzzy SAW calculations. This research contributes to implementing the appropriate SAW algorithm in the tourism sector. In addition, the results of this study make it easier for tourists to choose tourist destinations that suit their preferences so that they can support the growth of the tourism sector.

Keywords: *Fuzzy Simple Additive Weighting, Decision Support System, Tourist Destination, Tourism Growth, Karangasem Regency*

1. INTRODUCTION

Tourism is a human need for recreation or broadening horizons [1]. Tourism contributes significantly to various countries' economies [2]–[5]. Recommendation systems are becoming important as travelers seek personalized travel experiences [6], [7]. Tourist destinations tailored to tourist preferences will affect the growth of the tourism sector and sustainable tourism [8], [9].

In fact, tourists are often confused about choosing destinations that suit their needs [10], [11]. Developing decision support systems for tourist destination recommendations also often uses an algorithmic approach that does not follow the problem [12]–[15] This is because tourist preferences are subjective and influenced by facilities, costs, distance, and travel time [16].

Fuzzy Simple Additive Weighting (SAW) is a promising approach to solving multi-criteria and uncertain valuation problems [2][17]. Fuzzy SAW is a simple multi-criterion decision-making method whose implementation can adapt to increasing alternatives [18]. Fuzzy SAW is an optimization of the Simple Additive Weighting method that integrates fuzzy logic to manage uncertain information [19]. Fuzzy SAW optimizes tourism destination recommendations, enabling a more personalized and contextual approach [20].

This research aims to develop a decision support system that can be implemented well in the tourism sector. This considers traveler preferences' diverse and often uncertain nature [21], [22]. In addition, tourism is very dependent on costs and benefits, which are the basis for applying the SAW algorithm [23][24]. This study explores the application of the Fuzzy SAW algorithm as a new approach to optimize travel destination recommendations. By combining the power of Fuzzy Logic and weighted decision-making, this

method can potentially improve the quality of the tourism experience and further boost the tourism industry.

2. RELATED WORKS

Multi-criteria decision-making has been adopted by many researchers in various fields including tourism [25][26]. An overview study of Fuzzy multi-criteria decision-making models in tourism industries found that tourism destination selection are the most attractive research issues in tourism industries. These models can help address uncertainty and heterogeneous tourist preferences [27]. Other studies about recommendation of halal culinary tourism, combines Analytical Hierarchy Process and Simple Additive Weighting to make decision. The result found that this algorithm is able to classify and provide halal tourism information precisely, accurately, consistently and validated [28].

In this study focused on implementation of Fuzzy Simple Additive Weighting as an algorithm to analyzed the multi-criteria of tourist preference. The combination of Fuzzy Logic and Simple Additive Weighted able to make recommendation of tourism destination from multi-criteria decision-making tourist preferences. The result could make tourism experiences better and help the tourism industry grow even more.

3. RESEARCH METHOD

This study developed a decision support system model for tourism area recommendations using data from 13 tourist areas spread across Karangasem Regency, Bali Province. The tourist area data used is sourced from the Karangasem Regency Government, which is published on the website https://tourism.karangasemkab.go.id/ as well as direct observation of several tourist areas in Karangasem Regency, Bali Province.

The algorithm used to build this Decision Support System is Simple Additive Weighting, where this algorithm considers costs and benefits to produce a decision[29]. The SAW method requires the process of normalizing the decision matrix (x) to a scale that can be compared with all alternative ratings (r) [30] [31]. The SAW formula is given as follows:

$$r_{ij}\begin{cases}\dfrac{x_{ij}}{Max_i\, x_{ij}} & If\ j\ is\ the\ benefit\ atribute \\ \dfrac{Min_i\, x_{ij}}{xij} & If\ j\ the\ cost\ atribute\end{cases} \quad (1)$$

The preference values for each alternative (v) are given as follows:

$$v_i = \sum_{j=1}^{n} W_j r_{ij} \quad (2)$$

The system begins by determining alternatives and criteria based on primary and secondary data sources, then determines costs and benefits and gives weight to the criteria for use. The weighting of the criteria is given using fuzzy numbers consisting of Very Low (SR) = 0, Low (R) = 0.25, Medium (S) = 0.5, High (T) = 0.75, and Very High (ST) = 1 [32]. After meeting all data needs for calculation, calculations are carried out using the formulation of the SAW method. SAW will determine the results of normalization, ranking results, and assessment.

4. RESULT AND DISCUSSION

4.1 Data Collection

The first stage that needs to be prepared is to collect data on tourist destinations in Karangasem. Data were collected from primary data sources (direct interviews with the Karangasem Culture and Tourism Office) and secondary data sources (books, internet, articles). Data collection produces data regarding the details of tourist destinations in Karangasem, which are presented in the following table:

Table 1. Data on Destinations in Karangasem Regency

No	Tourist Destinations	Entrance Ticket (IDR)	Distance	Facilities	Opening Time	Age Restrictions
1	Pura Lempuyang	IDR 25.001 – IDR 50.000	0 – 20 km	Parking, Places of Worship, Toilets, Places to Eat, Places to Stay, Wi-Fi	Morning	All Ages
2	Tirta Gangga	IDR 5.001 - IDR 25.000	0 – 20 km	Parking, Places of Worship, Toilets, Places to Eat, Places to Stay, Wi-Fi	Morning	All Ages
3	Pura Besakih	IDR 25.001 - IDR 50.000	20,01 - 40 km	Parking, Places of Worship, Toilets, Places to Eat, Places to Stay, Wi-Fi	Morning	All Ages
4	Bukit Asah	IDR 5.001 - IDR 25.000	0 – 20 km	Parking, Toilets	Morning	All Ages
5	Bukit Surga	IDR 5.001 - IDR 25.000	0 – 20 km	Parking, Toilets	Morning	All Ages
6	Blue Lagoon Beach	IDR 25.001 - IDR 50.000	20,01 - 40 km	Parking, Toilets, Dining, Lodging, Wi-Fi	Morning	All Ages
7	Air Terjun Gerojog Sambeh	IDR 25.001 – IDR 50.000	20,01 - 40 km	Parking, Toilets	Morning	Adult
8	Air Terjun Yeh Labuh	IDR 25.001 – IDR 50.000	20,01 - 40 km	Parking, Toilets	Morning	Adult
9	Taman Wisata Edelweis	IDR 25.001 – IDR 50.000	20,01 - 40 km	Parking, Toilets	Morning	All Ages
10	Taman Jinja Bali	IDR 25.001 – IDR 50.000	20,01 - 40 km	Parking, Toilets	Morning	All Ages
11	Virgin Beach	IDR 25.001 – IDR 50.000	0 – 20 km	Parking, Toilets, Dining, Lodging, Wi-Fi	Morning	All Ages
12	Taman Soekasada Ujung	IDR 5.001 – IDR 25.000	0 – 20 km	Parking, Toilets, Dining, Lodging, Wi-Fi	Morning	All Ages
13	Pantai Padang Bai	IDR 50.001 - IDR 100.000	20,01 - 40 km	Parking, Places of Worship, Toilets, Places to Eat, Wi-Fi	Morning	All Ages

Source: Processed by researchers

Table 1 shows that there are 13 data on tourist objects located in the Karangasem area, which have been validated through direct visits and by matching data obtained through the Department of Culture and Tourism, Karangasem Regency, Bali Province, ranging from beach destinations and natural destinations as well as criteria data from tourist objects that will be used in the calculation of SAW.

4.2 Define criteria

SAW is one of the multi-criteria algorithms that recognize 2 (two) attributes, namely benefit and cost criteria [33]. The fundamental difference between these two criteria is at the time of selection of criteria made when making decisions. In the SAW method, there are weights and criteria needed to determine the passage of the best tourist destinations [28], [34]–[36], in selecting tourist destinations in Karangasem by determining the criteria needed first. The criteria were obtained based on Karangasem observations and previous studies references. The criteria obtained will be taken into consideration for the selection of tourist destinations. The criteria obtained for the selection of tourist destinations in Karangasem there are five criteria are as follows:

Table 2. Criteria and Alternatives

No	Criteria	Alternative
1	Cost (C1)	Cost
2	Distance (C2)	Benefit
3	Facilities (C3)	Benefit
4	Time (C4)	Benefit
5	Age (C5)	Benefit

Source: Processed by researchers

The benefit criteria in this system are Distance (C2), Facilities (C3), Time (C4), and Age (C5). In comparison, the cost criterion in this system is Cost (C1).

4.3 Determine the weight of each criterion

The weighting process is carried out by visitors or users directly so that the resulting weight value is dynamically determined by user

perception. In other words, users have different priority criteria in choosing tourist destinations. There are two types of weighting in this system. The first is the match weighting on each alternative and the importance weighting on each alternative used as the Preference (W) weight. Match weighting on each alternative is carried out to facilitate data processing using the SAW method [37], [38]. Each data is done by converting data into fuzzy form. The match weighting on each alternative will be shown in the table.

Table 3. Cost Criteria (C1)

C1	Budget	Description	Value
	Rp. 5.000 – Rp. 25.000	Very Cheap	0
	Rp. 25.001 – Rp. 50.000	Cheap	0.25
	Rp. 50.001 – Rp. 100.000	Medium	0.5
	Rp. 100.001 – Rp. 250.000	Expensive	0.75
	Rp. 250.001 – Rp. 500.000	Very Expensive	1

Source: Processed by researchers

From the table above, the Cost criteria are given in advance the price range from the cheapest to the most expensive, namely Rp. 5,000 – Rp. 500,000 with information from Very cheap with a weight value of 0, cheap with a weight value of 0.25, medium with a weight value of 0.5, expensive with a weight value of 0.75, and very expensive with a weight value of 1.

Table 4. Distance Criteria (C2)

C2	Distance	Description	Value
	0 – 20 km	Very Close	1
	20,01 – 40 km	Near	0,75
	40,01 – 60 km	Medium Range	0,5
	60,01 – 80 km	Far	0,25
	80,01 – 100 km	Very far away	0

Source: Processed by researchers

From the table above, the Distance criteria are given first the distance from the city center from very close to very far, which is 0 – 100 km, with information from Very close to the weight value of 1, close to the weight value of 0.75, medium with a weight value of 0.5, far with a weight value of 0.25 and very far with a weight value of 0.

Table 5. Facility Criteria (C3)

C3	Facilities	Description	Value
	Parking, places of worship, toilets, restaurant, places to stay, Wi-Fi	Very Complete	1
	Parking, toilet, restaurant, lodging, Wi-Fi	Complete	0,75
	Parking, restaurant, toilet, Wi-Fi	Quite Complete	0,5
	Parking, toilet, Wi-Fi	Incomplete	0,25
	Parking, toilet	Very incomplete	0

Source: Processed by researchers

From the table above, the criteria Facilities are given in advance what facilities tourists need from very complete to very incomplete. There are parking lots, places of worship, toilets, places to eat, lodging places with information from very complete with a weight value of 1, complete with a weight value of 0.75, quite complete with a weight value of 0.5, incomplete with a weight value of 0.25 and very incomplete with a weight value of 0.

Table 6. Time Criteria (C4)

C4	Time	Nilai
	Night	1
	Afternoon	0,75
	Evening	0,5
	Morning	0,25
	Early Morning	0

Source: Processed by researchers

From the table above, the time criteria are given in advance of the opening time of the tourist destinations from early morning to night, namely from 06.00 – 00.00 with information from early morning with a weight value of 0, morning with a weight value of 0.25, afternoon with a weight value of 0.5, afternoon with a weight value of 0.75 and night with a weight value of 1.

Table 7. Age Criteria (C5)

C5	Age (year)	Description	Value
	1 – 5	Toddler	0
	5,1 – 11	Children	0,25
	11,1 – 17	Teen	0,5
	17,1 – 35	Adult	0,75
	>35	All ages	1

Source: Processed by researchers

From the table above, the age criteria are given in advance the age limit that can enter the tourist destinations from those that allow all ages to toddlers who are qualified from ages 1 – 35 and above with information from All ages with a weight value of 1, adults with a weight value of 0.75, teenagers with a weight value of 0.5, children with a weight value of 0.25 and toddlers with a weight value of 0.

4.4 Provide match rating values.

Based on predetermined criteria, an example of calculation in a case will be given. From this case, value matching will be carried out based on the criteria of each alternative. 13 tourist destinations in Karangasem will be alternatives. Of the 13 alternative locations contained in the case, one of the 13 alternative locations will be selected which will be the best alternative choice, as follows:

Table 8. Alternative data on each criterion

A	Criterion				
	C1	C2	C3	C4	C5
A1	Cheap	Very Close	Very Complete	Morning	All Ages
A2	Very Cheap	Very Close	Complete	Morning	All Ages
A3	Cheap	Near	Very Complete	Morning	All Ages
A4	Very Cheap	Very Close	Very Incomplete	Morning	All Ages
A5	Very Cheap	Very Close	Very Incomplete	Morning	All Ages
A6	Cheap	Near	Complete	Morning	All Ages
A7	Cheap	Very Close	Complete	Morning	All Ages
A8	Cheap	Near	Very Incomplete	Morning	Adult
A9	Cheap	Near	Very Incomplete	Morning	All Ages
A10	Cheap	Near	Very Incomplete	Morning	Adult
A11	Cheap	Near	Very Incomplete	Morning	All Ages
A12	Very Cheap	Very Close	Complete	Morning	All Ages
A13	Medium	Near	Complete	Morning	All Ages

Source: Processed by researchers

From this data, a decision matrix x is formed, which is converted into fuzzy numbers. Data obtained as follows:

Table 9. Match rating of alternative on each criterion

Alternative	Criterion				
	C1	C2	C3	C4	C5
A1	0,25	1	1	0,25	1
A2	0	1	0,75	0,25	1
A3	0,25	0,75	1	0,25	1
A4	0	1	0	0,25	1
A5	0	1	0	0,25	1
A6	0,25	0,75	0,75	0,25	1
A7	0,25	1	0,75	0,25	1
A8	0,25	0,75	0	0,25	0,75
A9	0,25	0,75	0	0,25	1
A10	0,25	0,75	0	0,25	0,75
A11	0,25	0,75	0	0,25	1
A12	0	1	0,75	0,25	1
A13	0,5	0,75	0,75	0,25	1

Source: Processed by researchers

4.5 Normalizing the matrix

The SAW method recognizes 2 (two) attributes, namely benefit criteria and price criteria (cost). The fundamental difference between these two criteria is at the time of selection of criteria made when making decisions. In the SAW method, weights and criteria are needed to determine the passage of the best tourist destinations. The next step is to normalize the X matrix to calculate the value of each criterion based on the criteria assumed as cost and benefit criteria, with the following formula:

1. Cost Criteria (C1) – cost

$$r_{11} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0,25)} = \frac{0}{0,25} = 0,25$$

$$r_{21} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0)} = \frac{0}{0} = 0$$

$$r_{31} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0,25)} = \frac{0}{0,25} = 0,25$$

$$r_{41} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0)} = \frac{0}{0} = 0$$

$$r_{51} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0)} = \frac{0}{0} = 0$$

$$r_{61} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0,25)} = \frac{0}{0,25} = 0,25$$

$$r_{71} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0,25)} = \frac{0}{0,25} = 0,25$$

$$r_{81} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0,25)} = \frac{0}{0,25} = 0,25$$

$$r_{91} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0,25)} = \frac{0}{0,25} = 0,25$$

$$r_{101} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0,25)} = \frac{0}{0,25} = 0,25$$

$$r_{111} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0,25)} = \frac{0}{0,25} = 0,25$$

$$r_{121} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0)} = \frac{0}{0} = 0$$

$$r_{131} = \frac{\min(0,25; 0; 0,25; 0; 0; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0,25; 0; 0,5)}{(0,5)} = \frac{0}{0,5} = 0,5$$

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2. Distance Criteria (C2) – benefit

$$r_{12} = \frac{(1)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{1}{1} = 1$$
$$r_{22} = \frac{(1)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{1}{1} = 1$$
$$r_{32} = \frac{(0{,}75)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{42} = \frac{(1)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{1}{1} = 1$$
$$r_{52} = \frac{(1)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{1}{1} = 1$$
$$r_{62} = \frac{(0{,}75)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{72} = \frac{(1)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{1}{1} = 1$$
$$r_{82} = \frac{(0{,}75)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{92} = \frac{(0{,}75)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{102} = \frac{(0{,}75)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{112} = \frac{(0{,}75)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{122} = \frac{(1)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{1}{1} = 1$$
$$r_{132} = \frac{(0{,}75)}{\max(1;1;0{,}75;1;1;0{,}75;1;0{,}75;0{,}75;0{,}75;0{,}75;1;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$

3. Facility Criteria (C3) – benefit

$$r_{13} = \frac{(1)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{1}{1} = 1$$
$$r_{23} = \frac{(0{,}75)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{33} = \frac{(1)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{1}{1} = 1$$
$$r_{43} = \frac{(0)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0}{1} = 0$$
$$r_{53} = \frac{(0)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0}{1} = 0$$
$$r_{63} = \frac{(0{,}75)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{73} = \frac{(0{,}75)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{83} = \frac{(0)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0}{1} = 0$$
$$r_{93} = \frac{(0)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0}{1} = 0$$
$$r_{103} = \frac{(0)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0}{1} = 0$$
$$r_{113} = \frac{(0)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0}{1} = 0$$
$$r_{123} = \frac{(0{,}75)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{133} = \frac{(0{,}75)}{\max(1;0{,}75;1;0;0;0{,}75;0{,}75;0;0;0;0;0{,}75;0{,}75)} = \frac{0{,}75}{1} = 0{,}75$$

4. Time Criteria (C4) – benefit

$$r_{14} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{24} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{34} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{44} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{54} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{64} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{74} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{84} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{94} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{104} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{114} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{124} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$
$$r_{134} = \frac{(0{,}25)}{\max(0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25;0{,}25)} = \frac{0{,}25}{0{,}25} = 1$$

5. Age Criteria (C5) – benefit

$$r_{15} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$
$$r_{25} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$
$$r_{35} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$
$$r_{45} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$
$$r_{55} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$
$$r_{65} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$
$$r_{75} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$
$$r_{85} = \frac{(0{,}75)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{95} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$
$$r_{105} = \frac{(0{,}75)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{0{,}75}{1} = 0{,}75$$
$$r_{115} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$
$$r_{125} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$
$$r_{135} = \frac{(1)}{\max(1;1;1;1;1;1;1;0{,}75;1;0{,}75;1;1;1)} = \frac{1}{1} = 1$$

Table 10. Normalized Matrix Table

Alternatives	Criteria				
	C1	C2	C3	C4	C5
A1	0,25	1	1	1	1
A2	0	1	0,75	1	1
A3	0,25	0,75	1	1	1
A4	0	1	0	1	1
A5	0	1	0	1	1
A6	0,25	0,75	0,75	1	1
A7	0,25	1	0,75	1	1
A8	0,25	0,75	0	1	0,75
A9	0,25	0,75	0	1	1
A10	0,25	0,75	0	1	0,75
A11	0,25	0,75	0	1	1
A12	0	1	0,75	1	1
A13	0,5	0,75	0,75	1	1

Source: Processed by researchers

4.6 Ranking the results of alternative recommendations

At this stage, there is a summation of the results of normalized matrix multiplication with weight values. The results of these calculations are then ranked. The highest value alternative becomes

the best recommendation in making decisions. In this case, the decision maker assigns weights based on the importance of each criterion.

Weight vector: $w = (0,25 ; 1 ; 0,75 ; 1 ; 0,5)$
After obtaining a normalized table, a multiplication of the WxR matrix and the sum of the multiplication results will be made to get the best alternative with the following formula:

$V_1 = (0,25 \times 0,25) + (1 \times 1) + (0,75 \times 1) + (1 \times 1) + (0,5 \times 1) = 3.3125$
$V_2 = (0,25 \times 0) + (1 \times 1) + (0,75 \times 0,75) + (1 \times 1) + (0,5 \times 1) = 3.0625$
$V_3 = (0,25 \times 0,25) + (1 \times 0,75) + (0,75 \times 1) + (1 \times 1) + (0,5 \times 1) = 3.0625$
$V_4 = (0,25 \times 0) + (1 \times 1) + (0,75 \times 0) + (1 \times 1) + (0,5 \times 1) = 2.5$
$V_5 = (0,25 \times 0) + (1 \times 1) + (0,75 \times 0) + (1 \times 1) + (0,5 \times 1) = 2.5$
$V_6 = (0,25 \times 0,25) + (1 \times 0,75) + (0,75 \times 0,75) + (1 \times 1) + (0,5 \times 1) = 2.875$
$V_7 = (0,25 \times 0,25) + (1 \times 1) + (0,75 \times 0,75) + (1 \times 1) + (0,5 \times 1) = 3.125$
$V_8 = (0,25 \times 0,25) + (1 \times 0,75) + (0,75 \times 0) + (1 \times 1) + (0,5 \times 0,75) = 2.1875$
$V_9 = (0,25 \times 0,25) + (1 \times 0,75) + (0,75 \times 0) + (1 \times 1) + (0,5 \times 1) = 2.3125$
$V_{10} = (0,25 \times 0,25) + (1 \times 0,75) + (0,75 \times 0) + (1 \times 1) + (0,5 \times 0,75) = 2.1875$
$V_{11} = (0,25 \times 0,25) + (1 \times 0,75) + (0,75 \times 0) + (1 \times 1) + (0,5 \times 1) = 2.3125$
$V_{12} = (0,25 \times 0) + (1 \times 1) + (0,75 \times 0,75) + (1 \times 1) + (0,5 \times 1) = 3.0625$
$V_{13} = (0,25 \times 0,5) + (1 \times 0,75) + (0,75 \times 0,75) + (1 \times 1) + (0,5 \times 1) = 2.9375$

The ranking calculation table is contained in the following table:

Table 10. Final Ranking

A	Criteria					Final Result
	C1	C2	C3	C4	C5	
A1	0,25	1	1	1	1	3.3125
A2	0	1	0,75	1	1	3.0625
A3	0,25	0,75	1	1	1	3.0625
A4	0	1	0	1	1	2.5
A5	0	1	0	1	1	2.5
A6	0,25	0,75	0,75	1	1	2.875
A7	0,25	1	0,75	1	1	3.125
A8	0,25	0,75	0	1	0,75	2.1875
A9	0,25	0,75	0	1	1	2.3125
A10	0,25	0,75	0	1	0,75	2.1875
A11	0,25	0,75	0	1	1	2.3125
A12	0	1	0,75	1	1	3.0625
A13	0,5	0,75	0,75	1	1	2.9375

Source: Processed by researchers

The results of the calculation of values v_i in the table above, obtain the weight of each tourist destination. The results will then be used as a ranking reference based on the criteria chosen by tourist visitors. The result of this study is the ranking of tourist destination recommendations according to Fuzzy SAW's calculations. The results can make the tourism experience better according to tourist preferences and help the tourism industry develop further.

5. CONCLUSSION

Decision Support System with a fuzzy SAW approach can provide recommendations for tourist areas in Karangasem Regency, Bali Province, with criteria according to tourist preferences. The developed system can calculate the value of the weight of criteria based on alternative costs and benefits. The developed system can rank tourist destinations based on Fuzzy calculations. This research contributes to creating a decision support system for tourist destination recommendations to support tourism growth. This research still has gaps in extracting criteria and combining the SAW algorithm with other algorithms for increased accuracy.

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