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Mountain Selection for Beginner Climbers: a Simple Additive Weighting (SAW) Method

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***Abstract*--Over the years, mountain climbing has become more popular among ordinary people, with interest suddenly spiking during this recent time. A well-prepared and route-knowledgeable climber is most likely to win half the battle. The task of selecting a mountain for first-time climbers can be a daunting one. The Simple Additive Weighting (SAW) method can help beginner climbers determine which mountain is best for them. This method enables users to assign weights to each criterion and alternative based on their preferences, facilitating direct comparisons between options, and calculating all possible combinations, making the process faster and more accurate. According to this study, a campsite, mountain height, natural resources, mountain beauty, and terrain difficulty are major factors to consider when choosing a mountain. The alternatives consist of six mountains in North Sulawesi—Mount Klabat, Lokon, Soputan, Mahawu, Empung, and Tampusu—assessed according to the established criteria. In conclusion, the Decision Support System using the SAW method was successfully developed to help beginner climbers choose mountains based on their preferences. This system includes features such as mountain search, SAW calculations, and top recommendations. Future updates could consist of more detailed mountain specifications and a broader selection of mountains.**

***Keywords*: Beginner Climber; Decision Support System; Mountain Selection; North Sulawesi; Simple Additive Weighting.**

I. INTRODUCTION

Mountaineering has become an increasingly popular outdoor activity, with public interest growing significantly in recent years [1]-[4]. Increasingly, popular outdoor activity, with public interest grows significantly in recent years [1]-[3]. Beginner climbers face significant challenges in selecting a suitable mountain for their abilities and comfort level. Unlike experienced climbers, beginners lack the knowledge and experience to assess the various factors that make a mountain appropriate for their skill level, such as campsite availability [5], [6], mountain altitude [7], [8], natural resources [9], [10], mountain beauty [11], [12], and terrain difficulty [13], [14]. Each of these factors plays a significant role in ensuring a safe and enjoyable climbing experience for novices. For example, the availability of well-equipped campsites is critical for comfort and safety, particularly for less experienced climbers who may require established facilities [5]. Likewise, mountain altitude is an important consideration, as lower elevations allow for gradual acclimatization to the environment, making the climb less physically demanding [7]. Access to natural resources like water and food is essential to sustain climbers throughout their journey [9]. The scenic beauty of a mountain provides additional motivation, offering a unique experience and inspiring views [11], while terrain difficulty should be manageable, avoiding highly technical or dangerous routes [13]. Without proper guidance, beginners may struggle to choose a mountain that aligns with their capabilities, potentially leading to unsafe or unenjoyably experiences. This issue makes it difficult for novices to make informed decisions about which mountains to climb, emphasizing the need for a tool to help them navigate these considerations effectively.

The mountains of North Sulawesi provide an ideal setting for this research. Notable peaks in the region, such as Mount Klabat (2,100 meters), Mount Lokon (1,580 meters), Mount Soputan (1,784 meters), and Mount Mahawu (1,324 meters), offer a range of terrains and natural features that appeal to climbers of varying skill levels [15], [16]. Mount Klabat is the tallest mountain in the region and offers stunning views and adequate camping facilities [15], [16]. Mount Lokon presents a challenging terrain and limited natural resources but remains appealing to climbers due to its beauty [17], [18]. Mount Soputan is known for its picturesque scenery and

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easier trails, making it a favorite among beginner climbers [19], [20]. Mount Mahawu, provides ample camping spots and very accessible terrain [21], [22]. Although Mount Empunghas limited natural resources, it boasts beautiful vistas [23], [24]. Lastly, Mount Tampusu features gentle terrain and abundant natural resources, making it suitable for beginner climbers [25], [26]. This diversity makes North Sulawesi an excellent case study for exploring how different criteria impact mountain selection for beginner climbers.

To assist beginners in making informed decisions, this study employs the Simple Additive Weighting (SAW) method within a Decision Support System (DSS). The SAW method allows for assigning weights to each selection criterion based on user preferences, enabling direct comparisons between evaluated mountains [27], [28]. This streamlined decision-making process simplifies the selection for beginners by providing data-driven recommendations. Additionally, the SAW method's reliance on simple arithmetic operations—addition and multiplication—facilitates quick calculations and ensures the system remains user-friendly [29], [30].

The SAW method has been widely applied in decision support systems (DSS) [27]-[30]. Hamid et al. [28] used SAW to evaluate the quality of basic food items in Indonesia, helping consumers identify high-quality products and combat food fraud. SAW normalizes criteria and assigns weights to rank alternatives effectively while recognizing that changes in food attributes can impact the results. Taherdoost [29] provides a theoretical overview of SAW, detailing its concepts, benefits, and limitations. Another study [30] compared the SAW and TOPSIS methods for assessing the best area in PT. Pertamina Gas, finding SAW to be more sensitive and optimal. Unlike these studies, this research applies the SAW method to select mountains based on beginner-friendly criteria, offering a novel approach. By focusing on beginner climbers' needs, this study presents a specialized solution tailored to this group. It also provides new regional insights by concentrating on lesser-known mountains in North Sulawesi. The SAW method streamlines decision-making by enabling easy comparisons of weighted preferences, making the process more accessible for beginners. This research fills a gap in decision support systems by targeting beginners and offering simplified, data-driven recommendations in the context of outdoor recreation.

This research aims to build a Decision Support System (DSS) using the Simple Additive Weighting (SAW) method to assist beginner climbers choose suitable mountains. It evaluates mountains based on five criteria, namely campsite availability, altitude, natural resources, beauty, and terrain difficulty. The idea is to facilitate making decisions with the help of data-driven recommendations, concentrating on focusing on lesser-known mountains in North Sulawesi and offering personal, easy-to-use tools for beginners in climbing.

The organization of this paper is as follows. Section 1 will give the research background for a reader to get familiar with the study. Section 2 offers an overview of the related works and the research methods. Section 3 communicates the research results that are discussed. Section 4 concludes and gives room for the next work.

II. Research Method

In January 2024, the questionnaires were made available on Google Forms and completed by 120 respondents from the climbing community in North Sulawesi. Most respondents were male (60.8%), while females accounted for 39.2%. The age range of the respondents varied from 15 to 60 years old.

The software development methodology employed was Rapid Application Development (RAD), while Unified Modeling Language (UML) was used for modeling the tools.

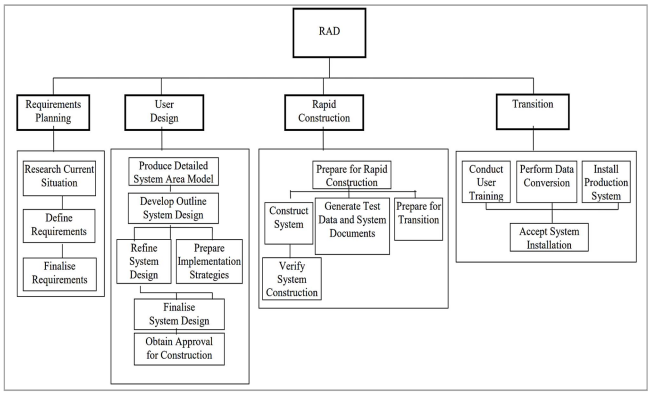

Fig. 1. Rapid Application Development [31]

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Phase 1: Requirements Planning:

At this stage, stakeholders (designers, clients, and developers) establish the project goals, features, budget, and timelines as well as expectations for users.

Phase 2: User Design:

The next stage of the process is user design, where the team will develop prototypes which are released in iterations for testing and feedback. Regular client communication also helps in improving the UX by prototyping designs.

Phase 3: Rapid Construction:

Once the prototype design is finalized, development begins, leading to the final product. In traditional software development, coding occurs here, while in no-code or low-code platforms, the prototype often becomes the final product, speeding up the process.

Phase 4: Transition:

Once the product is complete, it is launched. This phase includes user training, testing, data conversion, and system changeover. Stakeholders identify bugs and assess the system's performance.

This research uses SAW for beginner climbers to assign weights to each selection criterion based on user preferences. SAW employs two types of attributes for matrix normalization, namely benefit criteria and cost criteria. The following are steps used in SAW [27]-[30]:

1. Set the alternative (AI).
2. Specify the criteria (C_i) that will be used as a reference to determine a criterion along its types of attributes.
3. Determine the conformity rating of each alternative on each criterion (W).

$$W = [W_1\ W_2\ W_3\ W_4\ W_5] \quad (1)$$

4. Create a decision matrix based on the criteria (C_i), then normalize the matrix based on the equation adjusted to the type of attribute (profit attribute or cost attribute) so that the normalized matrix R is gained.
   a. If the type of attribute includes profit:

$$R_{ij} = \frac{X_{ij}}{MaxX_{ij}} \quad (2)$$

   b. If the type of attribute includes cost:

$$R_{ij} = \frac{MinX_{ij}}{X_{ij}} \quad (3)$$

Note:

R_{ij} = alternative performance rating on each normalized attribute.
$MaxX_{ij}$ = maximum value of elements in each attribute.
$MinX_{ij}$ = minimum element value in each attribute.
Benefit = if the type attribute is profit and the the greatest values are the best.
Cost = if the type attribute is profit and the the small values are the best.

Normalized Matrix:

$$R = \begin{bmatrix} r11 & r12 & \dots & rij \\ \vdots & & & \vdots \\ ri1 & ri2 & \dots & rij \end{bmatrix} \quad (4)$$

5. The final result is obtained from the ranking process, namely the sum of the multiplication of the normalized matrix R with the weight vector so that the largest value is selected as the best alternative (A_i) as a solution.

$$pi = \sum_{j=1}^{m} W_j r_{ij} \quad (5)$$

III. Result and Discussion

This section will address the calculation of user preferences for criteria and alternatives using the SAW method, the implementation of the database, and the implementation of user interfaces.

A. Calculation Using the SAW Method

Following the steps of the SAW method, this study identified five criteria for beginner climbers to assign weights according to their preferences, with six mountains considered as the alternatives.

1. Determine the alternative (AI).

TABLE I
Alternatives

Code	Alternative
A1	KLABAT 2,100 MDPL
A2	LOKON 1,580 MDPL
A3	SOPUTAN 1,784 MDPL
A4	MAHAWU 1,324 MDPL
A5	EMPUNG 1,340 MDPL
A6	TAMPUSU 1,186 MDPL

   a. Stipulate the criteria that will be applied as a reference to define a criterion along its types of attributes.

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TABLE II
Criteria Selection (W)

Code	Criteria	Weight	Type of Attribute
C1	Campsite availability	20,34	*Benefit*
C2	Mountain altitude	20,04	*Cost*
C3	Natural resources	20,01	*Benefit*
C4	Mountain beauty	19,93	*Benefit*
C5	Terrain difficulty	19,67	*Cost*

In the SAW method, "crisp" criteria are clear, objective, and precisely defined metrics used to assess alternatives. These well-structured criteria improve the SAW method's effectiveness by providing unambiguous data, making comparisons and decision-making more straightforward and reliable. Table III presents the clearly defined, objective criteria used in this research.

TABLE III
Crisp For Criteria

Code	Criteria	*Crips*	Weight
C1	Campsite availability	Least available	20
		Less available	40
		Sufficiently available	60
		Available	80
		Very available	100
C2	Mountain altitude	1000-1200	20
		1201-1400	40
		1401-1600	60
		1601-1800	80
		>1800	100
C3	Natural resources	Least abundance	20
		Less abundance	40
		Fairly abundance	60
		Abundance	80
		Very abundance	100
C4	Mountain beauty	Least beautiful	20
		Less beautiful	40
		Fairly beautiful	60
		Beautiful	80
		Very beautiful	100
C5	Terrain difficulty	Very difficult	20
		Difficult	40
		Fairly difficult	60
		Easy	80
		Very easy	100

b. Determine the conformity rating of each alternative on each criterion.

The rating of each alternative was based on the data gathered from the literature as depicted in Table IV.

TABLE IV
Alternative Selection

	C1	C2	C3	C4	C5
A1 KLABAT	Available	>1800	Abundance	Very beautiful	Very difficult
A2 LOKON	Less available	1401-1600	Least abundance	Beautiful	Fairly difficult
A3 SOPUTAN	Very available	1601-1800	Very abundance	Very beautiful	Easy
A4 MAHAWU	Sufficiently available	1201-1400	Fairly abundance	Beautiful	Very easy
A5 EMPUNG	Sufficiently available	1201-1400	Least abundance	Very beautiful	Difficult
A6 TAMPUSU	Available	1000-1200	Very abundance	Fairly Beautiful	Fairly difficult

Table IV needs to be rated using the crisp criteria values shown in Table III. The alternative criterion rating is displayed in Table V.

TABLE V
Alternative Criterion Rating

	C1	C2	C3	C4	C5
A1 KLABAT	80	100	80	100	20
A2 LOKON	40	60	20	80	60
A3 SOPUTAN	100	80	100	100	80
A4 MAHAWU	60	40	60	80	100
A5 EMPUNG	60	40	20	100	40
A6 TAMPUSU	80	20	100	60	60

c. Create a decision matrix based on the criteria (C_i), then normalize the matrix based on the equation adjusted to the type of attribute (profit attribute or cost attribute) so that the normalized matrix R is obtained.

$$X = \begin{bmatrix} 80 & 100 & 80 & 100 & 20 \\ 40 & 60 & 20 & 80 & 60 \\ 100 & 80 & 100 & 100 & 80 \\ 60 & 40 & 60 & 80 & 100 \\ 60 & 40 & 20 & 100 & 40 \\ 80 & 20 & 100 & 60 & 60 \end{bmatrix}$$

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$$R = \begin{bmatrix} 0,8 & 0,2 & 0,8 & 1 & 1 \\ 0,4 & 0,33 & 0,2 & 0,8 & 0,33 \\ 1 & 0,25 & 1 & 1 & 0,25 \\ 0,6 & 0,5 & 0,6 & 0,8 & 0,2 \\ 0,6 & 0,5 & 0,2 & 1 & 0,5 \\ 0,8 & 1 & 1 & 0,6 & 0,33 \end{bmatrix}$$

d. The final result is gained from the ranking process, namely the sum of the multiplication of the normalized matrix R with the weight vector so that the largest value is selected as the best alternative (A_i) as a solution. Preferences (P) for each alternative are as follows:

TABLE VI
Final Results

P	Preferential Calculation	Result	Ranking
P1	$w_1.r_{11}+w_2.r_{12}+w_3.r_{13}+w_4.r_{14}+w_5.r_{15}$ (20,34*0,8)+(20,04*0,2)+(20,01*0,8)+(19,93*1)+(19,67*1)	75,89	**#1 (Klabat)**
P2	$w_1.r_{21}+w_2.r_{22}+w_3.r_{23}+w_4.r_{24}+w_5.r_{25}$ (20,34*0,4)+(20,04*0,33)+(20,01*0,2)+(19,93*0,8)+(19,67*0,33)	41,19	#6 (Lokon)
P3	$w_1.r_{31}+w_2.r_{32}+w_3.r_{33}+w_4.r_{34}+w_5.r_{35}$ (20,34*1)+(20,04*0,25)+(20,01*1)+(19,93*1)+(19,67*0,25)	70,21	#3 (Soputan)
P4	$w_1.r_{41}+w_2.r_{42}+w_3.r_{43}+w_4.r_{44}+w_5.r_{45}$ (20,34*0,6)+(20,04*0,5)+(20,01*0,6)+(19,93*0,8)+(19,67*0,5)	60	#4 (Mahawu)
P5	$w_1.r_{51}+w_2.r_{52}+w_3.r_{53}+w_4.r_{54}+w_5.r_{55}$ (20,34*0,6)+(20,04*0,5)+(20,01*0,2)+(19,93*1)+(19,67*0,2)	50,09	#5 (Empung)
P6	$w_1.r_{61}+w_2.r_{62}+w_3.r_{63}+w_4.r_{64}+w_5.r_{65}$ (20,34*0,8)+(20,04*1)+(20,01*1)+(19,93*0,6)+(19,67*0,33)	74,77	#2 (Tampusu)

Based on the results in Table VI, it is apparent that many beginner climbers prefer Mount Klabat as their first choice. Mount Klabat, the highest mountain in North Sulawesi at 1,995 meters, offers a rewarding challenge for beginner climbers with its clear and relatively safe trail. Well-organized with signposts and resting posts, the hike is supported by facilities like parking lots and food stalls, making it accessible and comfortable for beginners [32], [33]. Its popularity within the climbing community ensures beginners can easily find guidance, while the summit rewards them with breathtaking views of Lake Tondano, Mount Lokon, and Manado Bay [34]. On the other hand, Mount Lokon is generally the least preferable for beginner climbers due to its technical trails, steep terrain, and limited signage, which can be intimidating and potentially confusing [35]-[37]. Additionally, unpredictable weather, longer hike durations, and the risks associated with being an active volcano further contribute to its challenges for beginner climbers [38].

Mount Tampusu ranks second due to its lush tropical forests and offers relatively easier hiking trails, making it suitable for beginner climbers seeking scenic views of the surrounding landscapes [39]. Mount Soputan, an active volcano, presents more challenging and technical routes, attracting experienced climbers who are drawn to its rugged terrain and the thrill of volcanic activity [40], [41]. Mount Empung features diverse flora and fauna along its trails, providing a unique experience for hikers, while Mount Mahawu offers shorter and more accessible trails, coupled with breathtaking panoramic views from its summit, making it popular among novice hikers and nature enthusiasts [41].

B. Database

Fig. 2 to 4 demonstrate the database implementation for the decision support system. The calculation using the SAW method is done and the results are stored in Fig. 4. The steps of calculation can be seen in previous section.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
1	id_alternative	smallint(5)		UNSIGNED	No	None		AUTO_INCREMENT
2	name	varchar(30)	latin1_swedish_ci		No	None		
3	description	text	latin1_swedish_ci		No	None		

Fig. 2. Table for Criteria

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#	Name	Type	Collation	Attributes	Null	Default
1	id_criteria	tinyint(3)		UNSIGNED	No	None
2	criteria	varchar(100)	latin1_swedish_ci		No	None
3	weight	float			No	None
4	attribute	set('benefit', 'cost')	latin1_swedish_ci		Yes	NULL

Fig.3. Table for Alternatives

#	Name	Type	Collation	Attributes
1	id_alternative	smallint(5)		UNSIGNED
2	id_criteria	tinyint(3)		UNSIGNED
3	value	float		

Fig. 4. Table for Evaluation

C. Implementation of User Interfaces

Fig. 5 - 7 are some of the user interfaces for the decision support system to select appropriate mountains for beginner climbers. Fig.5 depicts the weights of alternatives and criteria. This configuration is then used for the rating of each alternative as illustrated in Table III. Fig. 7 illustrates the final results regarding preferences for each alternative. This result is the same as shown in Table IV.

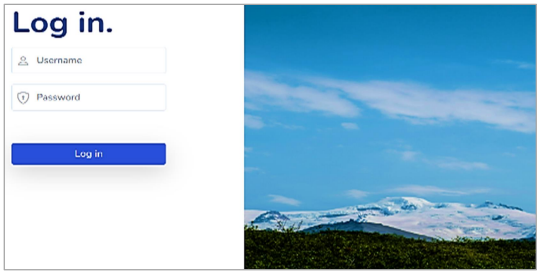

Fig. 5. Login Page

IV. Conclusion

This research aimed to develop a Decision Support System (DSS) using the Simple Additive Weighting (SAW) method to help beginner climbers in North Sulawesi select mountains that align with their abilities and comfort levels. The system evaluates mountains based on five key criteria: campsite availability, mountain altitude, natural resources, mountain beauty, and terrain difficulty. Six mountains—Klabat, Lokon, Soputan, Mahawu, Empung, and Tampusu—were assessed as alternatives. The SAW method processes user preferences and provides data-driven recommendations. The results indicate that Mount Klabat is the most recommended for beginner climbers due to its clear trails, organized facilities, and scenic views. It is followed by Mount Tampusu, Mount Soputan, Mount Mahawu, Mount Empung, and lastly Mount Lokon, which presents more challenges due to its technical trails and volcanic activity, making it more suitable for experienced climbers.

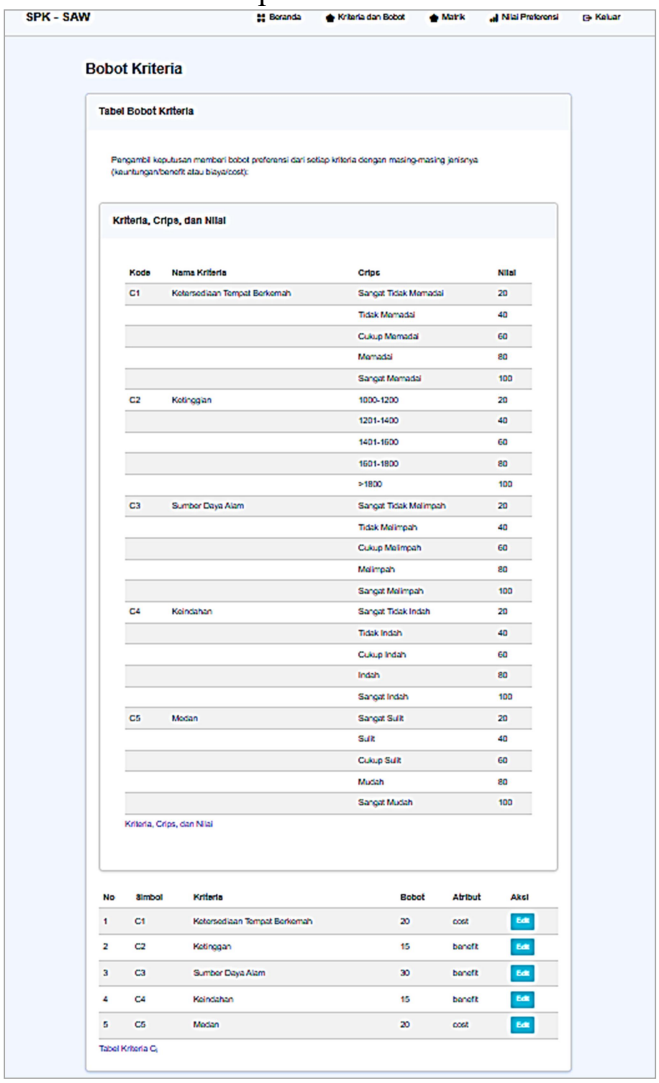

Fig. 6. The Weights of Alternatives and Criteria

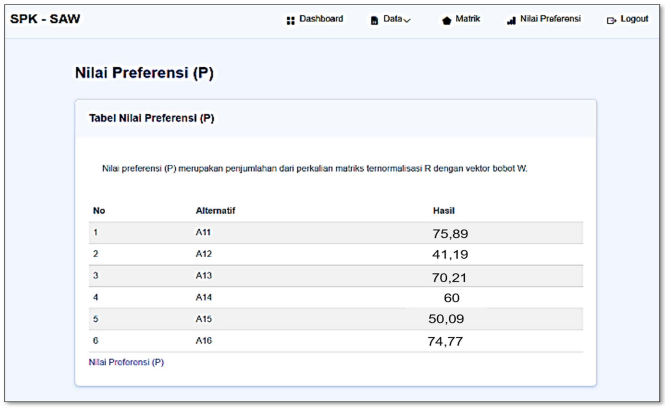

Fig. 7. Final Results

While the study successfully highlights the most suitable mountains for beginners, several limitations exist, including a narrow sample size and subjective evaluation criteria. External

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factors, such as changing environmental conditions, could also affect the recommendations' reliability. Future research could expand the decision support system to include additional criteria like climber safety measures and environmental conservation, as well as explore the socio-economic impacts of mountaineering on local communities. Integrating real-time data on weather and route safety could further enhance the system's effectiveness. Additionally, adapting the DSS for other regions could broaden its applicability and improve decision-making for novice climbers.

V. Acknowledgment

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