International Journal of Computing and Digital Systems
2025, VOL. 17, NO. 1, 1–11

http://dx.doi.org/10.12785/ijcds/1570969994

Combination of Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) Methods in Selection of Betel Planting Land

Rezki[1*], Rusydi Umar[2] and Abdul Fadlil[3]

[1,2]*Master Program of Informatics, Universitas Ahmad Dahlan, Yogyakarta, Indonesia, 55166*
[3]*Department of Electrical Engineering, Universitas Ahmad Dahlan, Yogyakarta, Indonesia 55166*

Received 30 October 2023, Revised 5 December 2024, Accepted 5 December 2024

Abstract: This research combines two methods, namely the Analytic Hierarchy Process (AHP) and Simple Additive Weighting (SAW), for betelplanting land selection. The research involved analyzing 248 land data with five assessment criteria, namely Land Elevation (Y1), Rainfall (Y2), Temperature (Y3), Soil pH (Y4), and Sunlight (Y5). The AHP method is used to calculate the relative weight of each criterion by involving pairwise comparisons. Furthermore, the SAW method is used to give a value to each land alternative based on the criteria that have been assessed. The goal is to improve accuracy results in the decision-making process. The results show that the Consistency Ratio (CR) value obtained is -0.8253, which is smaller than the consistency limit of 0.1 according to AHP theory. This confirms that the calculation results are consistent and reliable. This research is expected to provide recommendations to residents or communities in the Sorong Regency area in choosing land for betel planting. In addition, suggestions for future research are to increase the number of land alternatives so that the results obtained are more accurate and reliable.

Keywords: AHP, SAW, Land Selection, Betel, Decision Making

1. Introduction

The betel plant has significant economic value in various cultures in Indonesia and the Southeast Asian region. Betel is traditionally used in various ceremonies and the health sector, especially as an ingredient in traditional medicine [1]. As a result, betel cultivation has become a crucial agricultural activity in many regions. The importance of selecting suitable land for betel plant growth is significant as it can affect the productivity and sustainability of the farming business. Land selection involves various factors, such as soil elevation, rainfall, temperature, soil pH, sunlight, and social and economic aspects [2].

Betel plant is a type of plant that achieves optimal growth in areas with a cool climate or above 300 meters above sea level. This plant needs sunlight from about 60% to 70%. Betel can grow in various soil types with medium texture, slightly acidic (pH 6-7), somewhat moist, and soft sandy. Betel should be planted in fertile soil, rich in humus, and loose soil structure [3]. Betel plants grow as vines and depend on other tree trunks, with a plant height that can reach between 5 to 15 meters. Betel stems are greyish-green, round, fibrous, and grooved. Betel leaves are single, growing alternately, with heart-shaped or slightly rounded asymmetrical leaf bases and pointed leaf tips. Leaf colour varies, ranging from yellow to dark green [4].

Therefore, in selecting sites for betel cultivation, it is important to thoroughly consider factors such as topography, accessibility and environmental conditions. Local knowledge of land characteristics and soil quality is invaluable for overcoming these challenges, allowing farmers to select sites that best suit the needs of the betel crop and optimize yields. Sorong district in West Papua has unique geographical characteristics, consisting of a hilly landscape and dense tropical rainforest. The region has great potential for agricultural activities, including betel cultivation. However, Sorong has a diverse topography, including lowlands, highlands and hills, which affects aspects such as land accessibility and drainage. High rainfall throughout the year and variations in soil quality also affect betel cultivation. Local knowledge of land conditions and soil quality plays an important role in the

E-mail address: rezki@um-sorong.ac.id, rusydi@mti.uad.ac.id, fadlil@mti.uad.ac.id

selection of betel cultivation sites by farmers in this area.

People in Sorong Regency, particularly in West Papua, have made betel consumption an integral part of their culture since childhood. This tradition has been passed down from generation to generation, and children are usually taught how to consume betel from an early age. However, local communities face several challenges related to the quality of betel produced in their region. Betelfrom Sorong Regency is less desirable for several reasons. Firstly, betelfrom this area often has larger fruits, needs more durability, and spoils quickly. Variations in environmental conditions in each area of Sorong Regency, such as differences in altitude, rainfall, temperature and soil pH, can affect the growth and quality of betel grown in each region.

The objective of this research is to provide more precise guidance in the selection of betel planting sites in Sorong Regency by combining the Analytic Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods. The primary objective of this research is to enhance the efficiency of the process of selecting betel cultivation sites by employing a more structured and accurate approach, thereby providing practical solutions to farmers and decision-makers in the agricultural sector to address the challenge of identifying the optimal location for betel cultivation. It is anticipated that the integration of the AHP and SAW methodologies will facilitate a more profound comprehension of the interrelationship between geographical conditions and betel cultivation, thereby enabling the formulation of recommendations that can enhance the productivity and quality of betel in Sorong Regency. Consequently, this research is expected to provide more efficacious guidance for farmers and decision-makers in supporting the growth and sustainability of betel cultivation in this region.

2. Research Methods

A. *Stages of research*

The decision-making process is an essential stage in management that involves choosing among several alternative courses of action to achieve specific goals and objectives [5], [6], [7]. The steps to reach the right decision include collecting relevant data and information and considering various factors influencing the decision [8]. The actions required in the decision-making process are illustrated in Figure 1.

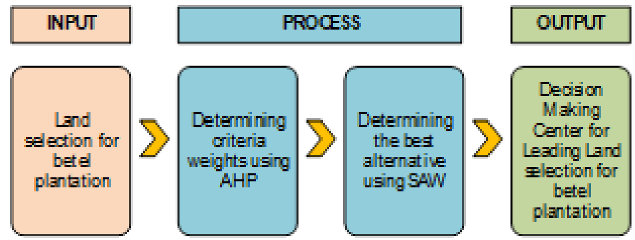

Figure 1. Figure Stages of research

The following is an explanation of the decision-making stages based on Figure 1.

1. Input stage

At this stage, data and essential factors related to selecting betel cultivation sites (such as soil elevation, rainfall, temperature, soil pH, and sunlight) were integrated. Interviews with representatives from the Sorong District Agriculture Office constituted a key stage in the data collection process. These experts provided valuable perspectives on the local characteristics that influence betel growth and gained a deeper understanding of the factors that should be considered, including local preferences and current agricultural policies.

2. Process stage

At this stage, a calculation process involves two approaches: AHP and SAW. The AHP approach establishes the order of priority between existing criteria. In contrast, the SAW method calculates criteria weights and ranks alternatives based on the assessed criteria values. Integrating these two methods allows for a more in-depth and comprehensive analysis of the best location for betelcultivation. By utilizing the advantages of each technique, this research can provide a more accurate and reliable picture in supporting strategic land selection decisions for betel cultivation.

2.1 Analytical hierarchy process (AHP)

AHP (Analytical Hierarchy Process) is an approach that adopts the concept of functional hierarchy and is useful for solving complex and unstructured problems [8], [9], [10], [11], [12], [13], [14], [15], [16], [17]. In AHP, these complex problems are represented as a hierarchical model with various interrelated hierarchical levels. One key characteristic of AHP is the use of human perception as one of the important elements in decision-making [18], [19], [20], [21], [22]. This method enables human stakeholders, such as experts or decision makers, to articulate their preferences and integrate subjective judgment into the decision-making process[23], [24], [25], [26], [27].

The AHP method uses a pairwise comparison scale to describe the degree of comparison between the elements being evaluated. In the context of AHP, these elements can be criteria, alternatives, or other factors that need to be compared to make a decision. This pairwise comparison scale helps decision makers express the extent to which one element is more important or dominant than another element. The pairwise comparison scale in AHP is often measured in terms of different degrees of comparison, where each degree has a specific meaning. In the AHP method, there is a commonly used standard comparison scale, which is compiled based on an individual's subjective assessment of the degree of comparison. The AHP standard comparison scale consists of the following values.

The steps of the AHP method are as follows:

- Calculating the sum of column weights[28]

$$A_{ij} = \sum_{i=1}^{n} A_{ij} \quad (1)$$

where A_{ij} is the pairwise matrix element in the i-th row and j-th column, and n epresents the total number of criteria being assessed.

- Calculating the normalization matrix [29]

$$N_{ij} = \frac{A_{ij}}{\sum A_j} \quad (2)$$

where N_{ij} is a normalization matrix element located in the i-th row and j-th column, A_{ij} is a criterion pairing matrix element that indicates the comparison between the criteria in the i-th row and the criteria in the j-th column, and $\sum A_j$ is the total of the weights given in the j-th column.

- Calculating eigenvectors [30]

$$W_i = \frac{1}{n} \sum_{j=1}^{n} N_{ij} \quad (3)$$

In this context, W_i represents the elements within the eigenvector situated in the i-th row, while N_{ij} denotes the element in the normalization matrix at the i-th row and j-th column. This serves to gauge the relative impact of the criteria on the decision-making process. The total count of criteria assessed is represented by n.

- Calculating relative criteria priority value [31]

$$P_i = \frac{W_i}{\sum_{i=1}^{n} W_i} \quad (4)$$

In this scenario,$P_i$represents the priority weight assigned to the i-th criterion, W_i denotes the element within the eigenvector situated in the i-th row, and n represents the number of measures.

- Calculating the maximum eigenvalue [32]

$$\lambda\ max = \sum_{i=1}^{n} W_i \times P_i \quad (5)$$

In this context, $\lambda\ max$ represents the maximum eigenvalue utilized as the primary determinant in establishing the priority weight of the criteria. W_i represents the element within the eigenvector located in the i-th row, P_i signifies the priority weight assigned to the i-th criterion, and n denotes the number of measures.

- Calculating the consistency index [33]

When decision makers make pairwise comparisons between criteria or alternatives in the AHP method, the results are represented in matrix form. One crucial step is to calculate the $\lambda\ max$ (maximum eigenvalue) of this comparison matrix. The next step is to use it in the Consistency Ratio (CR) calculation to evaluate the level of consistency of the comparisons that have been made.

$$I = \frac{\lambda \max - n}{n - 1} \quad (6)$$

where CI is the consistency index,$\lambda\ max$ is the maximum eigenvalue, and n is the number of criteria.

- Calculating consistency ratio [34]

Calculating the randomized consistency index [35]

For tables AHP 5x5, RI = 1.12.

$$CR = \frac{CI}{RI} \quad (7)$$

where CR is the consistency ratio, CI is the consistency index, and RI is the Random consistency index used as a reference value in assessing the consistency of comparisons which can be seen in Table II. The smaller the CR value, the better the consistency in pairwise comparisons [36], [37]. The CR value usually has to be less than 0.1 to be considered consistent. If the CR value is greater than 0.1, the pairwise comparison may need to be corrected or clarified by the decision maker. Thus, the RI value is an important part of measuring consistency in AHP analysis, helping to ensure that the pairwise comparisons performed by the decision maker are valid and reliable. The RI value has been calculated previously as a reference in this process [38], [39].

2.2 Simple additive weighting (SAW)

The Simple Additive Weighting (SAW) method, also known as the weighted sum method, is well-known for its involvement in a series of crucial steps[40], [41], [42]. One of the initial procedures in the SAW method involves normalizing the decision matrix, which converts the data into a scale that facilitates comparison with all available alternatives[43]. The SAW method employs two types of criteria: cost criteria (which prioritize the lowest value in the selection process)[44], [45] and benefit criteria (which prioritize the highest value). As outlined in [46], the following steps are essential in executing the SAW method:

TABLE I. Pairwase Comparison Scale

Importance	Defenision	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate inportance	Experience and judgement slightly favour one activity over another
5	Essential importance	Experience and judgement slightly strongly favour one activity over another
7	very strong importance	An activity is favoured very strongly practice over demonstrated in another its dominance
9	Extreme importance	The eviedence favouring one activity over another is of highest possible
2,4,6,8	Intermediate values	When compromise is needed between two

TABLE II. The Random Consistency Index (RCI)

N	RCI
1	0
2	0
3	0.58
4	0.9
5	0.12
6	0.124
7	1.34
8	1.41
9	1.45
10	1.49
11	1.51
12	1.48
13	1.56
14	1.57
15	1.59

• The alternative rating is a designation assigned to each choice during the analysis or decision-making phase. It indicates the extent to which each option aligns with predetermined criteria or specifications in a particular scenario [47], [48].

• Convert initial data into a matrix. Converting data into matrix form simplifies the organization and simplification of data that was originally scattered, thus enabling its easier use in the decision-making process [49], [50].

• Perform normalization by converting each alternative into a uniform range of values, generally from 0 to 1. This aims to simplify comparison and integration in the ranking process using predefined equations[51], [52], [53]

$$R_{ij} = xij/maxxijifjbenefitattributes$$

R$_{ij}$ $= minxij/xijifjattributecost$(8)

R_{ij} refers to the performance rating adjusted into a normalized form, and x_{ij} is the value in row i column j of the decision matrix.

• Creating a decision matrix is used for calculating the preference value and ranking of each alternative. The results of this calculation, then, become a guide in determining the best alternative based on the weight prioritized on the previous criteria according to a predetermined equation[54]

$$V_i = \sum_{j=1}^{n} W_j \; R_{ij} \tag{9}$$

where V_i is the final value of the alternative, W_j is the predetermined weight, and $R_{ij}$is the normalized performance rating.

3. Output stage

At this stage, the final result of the entire series of calculations is to determine the best location for betel cultivation. This process produces a ranking assessment for each alternative based on predetermined criteria. This step aims to find the most suitable place for betel plant growth.

B. Data collection

The efficacy of the testing phase in research is contingent upon the availability of comprehensive data and information [55]. The subject of this research is land data in the Sorong Regency area. In the collection of research data, several methods were employed, namely:

a. Literature study
The literature study entailed a comprehensive search and analysis of data from a multitude of sources, including scientific papers, books, articles, magazines, and other literature. This approach was undertaken with the objective of enriching the theoretical foundation. Additionally, online searches were conducted to obtain information pertinent to the research topic, ensuring consistency between the theories employed and the writing.

b. Observation
Observation is a method of data collection that involves making direct observations in the field. In this case, the observations were conducted at the Agriculture Office in Sorong Regency with the objective of determining the testing needs.Interviuw

c. Researcher conducted interviews with staff at the Sorong District Agriculture Office with the objective of ascertaining the needs of the target population, which would be used for testing purposes.

3. Result and discussion

A. Stages of research

This research focuses on two main variables, namely criteria and alternatives. The criteria used to determine the selection of betel planting sites based on the data obtained from this study are outlined in detail in Table I, which includes relevant information to evaluate and select the most suitable sites for betel planting based on several predetermined criteria. The factors listed in TableI are crucial in evaluating potential locations for betel cultivation since they provide a strong framework for assessing the various factors impacting the success of cultivation in a given area. By considering these factors, this research can assist stakeholders and decision-makers in identifying the most suitable locations with a high probability of success for betel planting. In other words, these criteria serve as important guidelines for selecting betel planting sites using smart, data-driven methods

TABLE III. Criteria Data

No	Criteria	Symbol
1	Soil Elevation	Y1
2	Rainfall	Y2
3	Temperature	Y3
4	Soil pH	Y4
5	Sunlight	Y5

TableIII presents the selection criteria for identifying suitable land for betel cultivation, which includes five key factors. Firstly, soil elevation (Y1) directly impacts the local climate and temperature surrounding betel plants. Secondly, rainfall (Y2) plays a crucial role in maintaining soil moisture and texture, which is vital for healthy root growth. Thirdly, temperature (Y3) is a critical consideration as betel thrives in warm climates, albeit not excessively hot ones. Soil pH (Y4) significantly influences nutrient availability for betel plants, while adequate exposure to sunlight (Y5) is essential for optimal growth and productivity. The Sorong district, located in a tropical region near the equator, experiences a wet tropical climate characterized by consistently high temperatures year-round. Intense sunlight and the influence of warm, humid sea air from its coastal proximity elevate air temperatures in Sorong. Wind patterns, especially during the dry season, can bring in dry and hot air from inland areas, which can contribute to temperature spikes. Therefore, it is essential to consider the aforementioned criteria when identifying suitable land for successful betel cultivation in Sorong.

TableVII is an alternative of 248 data, obtained through a series of interviews with the Sorong District Agriculture Office.

B. Process stage

1. Analytical Hierarchy Process Method (AHP) In a pairwise comparison matrix, each element is compared to the other elements using a relative importance scale that can be seen in TableI. This scale is a numerical scale from 1 to 9, where 1 represents "equal importance" or "equally desirable," while the other values reflect different levels of preference or importance. Using this scale, we can measure the extent to which the elements in the pairwise comparison matrix are interrelated and determine the relative degree of preference or importance to each element.

The pairwise comparisons in TableV can be explained as follows:

a. The comparison value between the same Criteria (Y1-Y1, Y2-Y2, Y3-Y3, Y4-Y4, Y5-Y5) is 1 which means the two activities are equally important.

b. Level of importance of criteria Rainfall with land elevation i.e. rainfall If a compromise between its two weights is required = (2).

c. Level of importance of the criterion Soil elevation with sunlight i.e. soil elevation Experience and judgment slightly favor one activity over another weight = (3).

d. The significance level of rainfall criteria in relation to soil pH, namely rainfall. Experience and judgment slightly favor one activity over the other, with a weight of (3)

e. The significance level of rainfall criteria concerning sunlight, namely rainfall. Experience and judgment slightly favor one activity over another, with a weight of (5).

f. The significance level of the temperature criteria in conjunction with land elevation, such as temperature, is determined. In cases where a balance is needed between the two factors, the weight is set to (2).

g. Level of importance of temperature criteria with rainfall i.e. temperature If a compromise is needed between the two weights = (2).

h. The significance level of temperature criteria in relation to sunlight, specifically temperature. Experience and judgment slightly favor one activity over another, with a weight of (5).

i. The level of importance of the soil pH criterion with soil eleation, namely soil pH Experience and judgment slightly favor one activity over another activity weight = (3).

j. Level of importance of soil pH criteria with temperature i.e. soil pH When a compromise is needed between the two weights = (2).

k. The level of importance of the criterion of soil pH with sunlight, namely soil pH Experience and judgment slightly favor one activity over another, the weight = (5)

Table V.presents a comparison of the criteria employed

TABLE IV. Initial Data

No	CODE	Y1(Benefit)	Y2(Benefit)	Y3(Benefit)	Y4(Benefit)	Y5(Benefit)
1	A1	300	3200	30	6.2	65%
2	A2	400	2600	33	6.5	80%
3	A3	340	3200	27	7	60%
4	A4	280	3300	27	6.2	69%
5	A4	350	2900	30	6	50%
...	...	...	...	...	...	...
244	A244	270	3546	30	6.2	68%
245	A245	380	2960	30	6	96%
246	A246	270	3200	29	5.7	97%
247	A247	290	2500	30	6.5	75%
248	A248	382	3300	32	6.4	77%

TABLE V. Pairwase Comparison

Criteria	Y1	Y2	Y3	Y4	Y5
Y1	1	0.5	0.33	0.33	3
Y2	2	1	0.33	3	5
Y3	2	2	1	05	5
Y4	3	0.33	2	1	5
Y5	0.33	0.2	0.2	0.2	1

as the foundation for the AHP method calculation process. This data serves as the basis for determining the relative weight of each criterion that affects a decision. The process for determining the weight of each criterion is as follows:

Step 1: Calculate the sum of criteria weights

This is done using equation 1. This calculation will produce an eigenvector that will be used as the basis for calculations to evaluate the level of consistency.

$$\sum A_{C1} = 1 + 2 + 2 + 3 + 0.3 = 8.33$$

$$\sum A_{C2} = 0.5 + 1 + 0.5 + 0.33 + 0.2 = 2.53$$

$$\sum A_{C3} = 0.5 + 2 + 1 + 2 + 0.2 = 5.70$$

$$\sum A_{C4} = 0.33 + 3 + 0.5 + 1 + 0.2 = 5.03$$

$$\sum A_{C5} = 3 + 5 + 5 + 5 + 1 = 19.00$$

Step 2: Calculating the normalization matrix

The next step is normalizing the matrix column using equation 2. Normalization involves determining the mean of every column within a matrix and subsequently dividing each element within the column by this mean value.

$$N \begin{vmatrix} 1/8.33 & 2/2.53 & 2/5.70 & 2/5.70 & 0.33/19 \\ 0.5/8.33 & 0.5/2.53 & 0.5/5.70 & 0.33/5.03 & 0.2/19 \\ 0.5/8.33 & 2/2.53 & 1/5.70 & 2/5.03 & 0.2/19 \\ 0.33/8.33 & 3/2.53 & 0.5/5.70 & 1/5.03 & 0.2/19 \\ 3/8.33 & 5/2.53 & 5/5.70 & 5/5.03 & 1/19 \end{vmatrix}$$

The result of matrix normalization calculation

$$N= \begin{vmatrix} 0.120 & 0.197 & 0.088 & 0.066 & 0.158 \\ 0.158 & 0.395 & 0.351 & 0.596 & 0.263 \\ 0.240 & 0.263 & 0.175 & 0.099 & 0.263 \\ 0.360 & 0.132 & 0.351 & 0.199 & 0.263 \\ 0.040 & 0.079 & 0.035 & 0.040 & 0.053 \end{vmatrix}$$

Step 3: Calculating eigenvectors For computing the eigenvector, apply equation 3. The outcomes derived from this computation yield eigenvectors essential for conducting pairwise comparison analysis of criteria.

$$W= \begin{vmatrix} 0.629 \\ 1.845 \\ 0.975 \\ 1.304 \\ 0.246 \end{vmatrix}$$

Step 4: Calculating relative criteria priority values

In calculating the relative priority of criteria, equation 4 is used as a calculation tool that refers to the previously established formula. The following is the calculation result:

$$P= \begin{vmatrix} 0.126 \\ 0.369 \\ 0.195 \\ 0.261 \\ 0.049 \end{vmatrix}$$

Step 5: Calculating the maximum eigenvalue Calculating the maximum eigenvalue using equation5 produces the following calculation results.

$\lambda \ max = (0.629 \times 0.126) + (1.845 \times 0.369) + (0.975 \times 0.195)(1.304 \times 0.261) + (0.246 \times 0.049) = 0.0792 + 0.6807 + 0.1903 + 0.3403 + 0.0121 = 1.3026$

Step 6: Calculating the consistency index

In this phase, the consistency index value is determined using Equation 6. This calculation entails subtracting the sum of λ_i from the total number of criteria, then dividing the result by the number of criteria minus one. This computation provides a clearer assessment of consistency in the decision-making process.

$CI = \frac{1.3026-5}{5-1} = -0.9243$

Step 7: Calculating consistency ratio A consistency index is used in this calculation, which is calculated based on equation 7. The consistency index is derived by dividing the consistency index value by the random consistency index value associated with the quantity of criteria utilized

$CR = \frac{-0.9243}{1.12} =$ -0.8253

From the calculation results, the CR value is = -0.8253 or ¡0.1. This result shows that the hierarchy of criteria importance scale is consistent, so the AHP pairwise matrix is feasible.

Step 8: Priority weight table The results of calculations with the AHP method have produced priority weights, which are then presented in TableVI.

TABLE VI. Criteria Priority Weight Data

No	Criteria	Weight
1	Soil Elevation	0.126
2	Rainfall	0.369
3	Temperature	0.195
4	Soil pH	0.261
5	Sunlight	0.049

TableVI contains criteria weights obtained from the AHP method calculation. This weight is significant because it will be used in the SAW method calculation process.

Table VI shows that the Rainfall criterion (Y2) has the most significant weight, 0.6807, equivalent to 68

Then, the soil pH criterion (Y4) weighs 0.3403 or 34

Temperature (Y3) weights 0.1903 or 19The Land Elevation criterion (Y1) weighs 0.0792 or 7

With these weights, the SAW method is then used to determine the most suitable land alternatives based on the weights of these criteria.

2. Simple additive weighting method (SAW)

Once the criteria weights have been established through the AHP method, the subsequent stage is to identify the optimal alternative through the SAW method. This procedure encompasses a sequence of organised steps, outlined below:

Step 1: Entering alternative values

At this point, an evaluation is conducted to assess how each alternative performs in relation to all predefined attributes or criteria. The objective is to gauge the degree to which each alternative fulfills the predetermined criteria. Information regarding this alternative is provided in TableVII.

TableVII shows the initial decision data used in the SAW method calculation. This data is used together with 248 alternative data, where each alternative is assessed based on five criteria: Y1 (benefit), Y2 (benefit), Y3 (benefit), Y4 (benefit), and Y5 (benefit). The value of each of these criteria will be used in the SAW method calculation to determine the matrix normalization value.

Step 2: Convert initial data into a matrix

In this step, the alternative initial data is converted into matrix form. The details of this matrix can be seen below.

Step 3: Perform normalization

The SAW method conducts normalization by dividing the value within each cell in the criteria column by the maximum value attainable for that specific criterion. This procedure stands as a critical phase in SAW analysis, intending to establish equitable influence of each criterion on the eventual computation. The normalization process is executed through the utilization of equation 8

$$R_{11} = \frac{300}{300;400;340;280;n;270;380;270;290;382} = \frac{300}{750} = 0.4$$

$$R_{21} = \frac{400}{300;400;340;280;n;270;380;270;290;382} = \frac{400}{750} = 0.3$$

$$R_{31} = \frac{340}{300;400;340;280;n;270;380;270;290;382} = \frac{340}{750} = 0.45$$

The results of the matrix normalization calculation are presented in Table VIII.

Table VIIIis the result of calculating the value in each matrix column of each existing criterion. The results of this calculation are the first step to calculating the value of Vi. In this table, the values that have been divided will be used as the basis for the Vi value calculation process.

Step 4: The stage of creating a decision matrix

At the stage of making a decision matrix, the step is to multiply the weights from the AHP method with the normalization results contained in TableV, then add them up using equation 9 as explained below:

$v_1 = (0.126 * 0.40) + (0.369 * 0.50) + (0.195 * 0.06) + (0.261 * 0.79) + (0.049 * 1) = 0.608$

$v_2 = (0.126 * 0.53) + (0.369 * 0.40) + (0.195 * 0.66) + (0.261 * 0.83) + (0.049 * 0.8) = 0.602$

$v_3 = (0.126 * 0.45) + (0.369 * 0.50) + (0.195 * 0.54) + (0.261 * 0.90) + (0.049 * 0.1) = 0.629$

$v_4 = (0.126 * 0.37) + (0.369 * 0.51) + (0.195 * 0.54) + (0.261 * 0.79) + (0.049 * 1) = 0.598$

TABLE VII. Initial Data

No	Alternative	code	Y1	Y2	Y3	Y4	Y5
1	Mariat Gunung	A1	300	3200	30	6.2	5
2	Klaru	A2	400	2600	33	6.5	4
3	Klamono	A3	340	3200	27	7	5
4	Malasom	A4	280	3300	27	6.2	5
5	Malaewele	A5	350	2900	30	6	3
...	...	...	...	...	...	...	
244	Saluk	A244	270	3546	30	6.2	5
245	Klawari	A245	380	2960	30	6	3
246	Klawren	A246	270	3200	29	5.7	5
247	Klalin Mos	A247	290	2500	30	6.5	5
248	Kamlin	A248	382	3300	32	6.4	5

$$X=\begin{vmatrix} 300 & 32000 & 30 & 6.2 & 5 \\ 400 & 2600 & 33 & 6.5 & 4 \\ 340 & 3200 & 27 & 7 & 5 \\ 280 & 3300 & 27 & 6.2 & 5 \\ 350 & 2900 & 30 & 6 & 3 \\ ... & ... & ... & ... & ... \\ 270 & 3546 & 30 & 6.2 & 5 \\ 380 & 2960 & 30 & 6 & 3 \\ 270 & 3200 & 29 & 5.7 & 5 \\ 290 & 2500 & 30 & 6.5 & 5 \\ 382 & 3300 & 32 & 6.4 & 5 \end{vmatrix}$$

TABLE VIII. Normalization Matrix Value

No	CODE	Y1	Y2	Y3	Y4	Y5
1	A1	0.40	0.50	0.6	0.79	1
2	A2	0.53	0.40	0.66	0.83	0.8
3	A3	0.45	0.50	0.54	0.90	1
4	A4	0.37	0.51	0.54	0.79	1
5	A4	30.47	0.45	0.6	0.77	0.6
...	...	...	...	...	...	...
244	A244	0.36	0.55	0.6	0.79	1
245	A245	0.51	0.46	0.6	0.77	0.6
246	A246	0.36	0.50	0.58	0.73	1
247	A247	0.39	0.39	0.6	0.83	1
248	A248	0.51	0.51	0.64	0.82	1

$v_5 = (0.126 * 0.47) + (0.369 * 0.45) + (0.195 * 06) + (0.261 * 0.77) + (0.049 * 0.6) = 0.572$

The results of the Vi value calculation are presented in TableIX.

TableIX is the final result of this research, showing the best locations for betelcultivation that have been determined using the AHP and SAW methods. This table reflects the rankings and weights of each alternative site based on previously established criteria. This analysis process can help find the most suitable location for betelcultivation by considering various relevant factors. Thus, this table provides a clear and structured picture of the best option in site selection for betelcultivation.

C. *Output stage*

The calculation results of the AHP and SAW methods show that Alternative 105, Klafyo, ranks top in selecting betel cultivation sites in Sorong Regency. Followed by Alternative 110, or Tarsa, which ranked second, and Alternative 91, which is Sas, ranked third out of a total of 248 alternatives that have been analyzed in this study. These findings provide a clear picture of the most suitable locations for betelcultivation in the Sorong Regency area, taking into account the various criteria that have been established. These results provide a solid basis for farmers and agricultural decision-makers to select betel cultivation sites.

The research conducted only focuses on the Sorong Regency area, so it has limitations in data collection that may affect the generalizability of the findings. Therefore, in future research, the potential to expand the geographical scope of the research is of interest. By expanding the geographical scope, researchers can capture the diversity in environmental and social factors that influence betel growth and quality in other regions. This could be done by conducting a more detailed analysis of specific variables, such as climate, soil, or local farming practices, to identify the most influential factors as well as the development of more sophisticated and appropriate site selection methods utilizing more advanced technologies and analytical approaches, so that this research can contribute to developing more effective tools for farmers and decision-makers in determining the optimal location for betel cultivation.

4. Conclusion

This research employs the analytic hierarchy process (AHP) and the simple additive weighting (SAW) method using 248 land data points across five criteria: land elevation (Y1), rainfall (Y2), temperature (Y3), soil pH (Y4), and sunlight (Y5). The objective is to facilitate informed decision-making regarding the selection of land for betel planting. The results of this study demonstrate that through calculations performed in MS Excel, a CR value of -0.8253

TABLE IX. The Result Of Value Ranking With SAW

No	CODE	Y1	Y2	Y3	Y4	Y5	Vi	Rank
1	A105	0.087	0.355	0.117	0.237	0.029	0.286	1
2	A110	0.103	0.360	0.128	0.184	0.049	0.285	2
3	A91	0.108	0.323	0.117	0.217	0.049	0.815	3
4	A92	0.090	0.360	0.105	0.210	0.039	0.805	4
5	A98	0.071	0.307	0.124	0.247	0.049	0.800	5
...	...	...	...	...	...	...		
244	A193	0.059	0.081	0.117	0.224	0.049	0.531	244
245	A160	0.065	0.081	0.117	0.214	0.049	0.527	245
246	A155	0.047	0.144	0.117	0.207	0.009	0.525	246
247	A108	0.105	0.029	0.124	0.214	0.049	0.525	217
248	A11	0.058	0.212	0.101	0227	0.049	0.642	248

was obtained, which is below the 0.1 limit. This result aligns with the theoretical framework of CR calculation in the AHP method, indicating a consistent outcome. The findings of this study are expected to provide more precise guidance in determining the optimal location for betel cultivation. This research is not only useful for farmers in choosing the optimal land for betel cultivation, but also has an important impact on environmental conservation and natural resource management. By employing the AHP and SAW methods and analyzing extensive data, this research offers a reliable approach to decision-making regarding the selection of suitable betel cultivation sites. Moreover, the consistent results provide additional confidence that the approach can be effectively applied in real situations. It is hoped that these findings will serve as a basis for more effective decision-making in agriculture and environmental management, as well as a foundation for further research to improve the accuracy of the analysis in the context of betel cultivation and agriculture in general.

References

[1] K. K. dan A. Desmayanti, "Review on ethnomedicinal and potential effect of antibacterial plants against halitosis," *J. Food Pharm. Sci.*, vol. 10, p. 644–665, 2022.

[2] S. M. K. dan Wahyunengsih, "Implementasi wirausaha tani sirih kuning dalam memberdayakan ekonomi masyarakat di kampung cipedak," *JSKPM*, vol. 6, p. 456–461, 2022.

[3] S. N. A. d. S. M. R. Retnowati, P. Purwatiningtyas, "Potensi tanaman sirih (betel) sebagai bahan baku pemberdayaan ekonomi produktif masyarakat," *Aksiologiya J. Pengabdi. Kpd. Masy*, vol. 6, p. 586, 2022.

[4] P. E. S. dan L. S. Sudjiman, "Analisis sistem informasi manajemen berbasis komputer dalam proses pengambilan keputusan," *TeIKa*, vol. 8, p. 55–66, 2020.

[5] d. A. B. F. A. Yudhana, R. Umar, "Decision making using the mabac method to determine the leading small and medium industry centers in yogyakarta," *Ingénierie des systèmes d InfIKa*, vol. 27, p. 5887–893, 2022.

[6] I. D. W. M. K. A. A. d. H. S. H. Zabihi, M. Alizadeh, "A gis-based fuzzy-analytic hierarchy process (f-ahp) for ecotourism suitability decision making: A case study of babol in iran," *Tour. Manag. Perspect., v*, vol. 36, p. 100726, 2020.

[7] S. G. dan D. K. Mahalik, "A comparative study on performance measurement of indian public sector banks using ahp-topsis and ahp-grey relational analysis," *OPSEARCH*, vol. 4, p. 1213–1239, 2019.

[8] H. H. C. D. C. d. D. B. N. Horňáková, L. Jurík, "Ahp method application in selection of appropriate material handling equipment in selected industrial enterprise," *Wirel. Networks*, vol. 2, p. 1683–1691, 2021.

[9] d. P. D. U. Saini, M. Rishi, "Cbarriers affecting cut flower transportation in india - using ahp and fahp technique," *Eur. Econ. Lett*, vol. 13, p. 806–818, 2023.

[10] M. P. d. M. S. N. S. Chaudhary, A. Kumar, "Land evaluation and sustainable development of ecotourism in the garhwal himalayan region using geospatial technology and analytical hierarchy process," *Environ. Dev. Sustain*, vol. 24, p. 2225–2266, 2022.

[11] d. E. A. A. L. Tunçel, Ö. Arslan, "An application of fuzzy ahp using quadratic mean method: Case study of enc preparation process for intended voyages," *J. ETA Marit. Sci*, vol. 11, p. 56–66, 2023.

[12] W. Tarawneh, "A comparative adoption of cots database components using the hybrid ahp-topsis and ahp-vikor methodologies," *Indian J. Sci. Technol*, vol. 14, p. 1718–1733, 2021.

[13] D. Huang, "A supplier selection method based on ahp," *J. Phys. Conf. Ser*, vol. 1176, p. 042055, 2019.

[14] F. C. d. C. K. O. Dogan, M. Deveci, "A corridor selection for locating autonomous vehicles using an interval-valued intuitionistic fuzzy ahp and topsis method," *Soft Comput*, vol. 24, p. 8937–8953, 2020.

[15] E. Bostancioglu, "Double skin façade assessment by fuzzy ahp and comparison with ahp," *Archit. Eng. Des. Manag*, vol. 17, p. 110–130, 2021.

[16] Y. S. d. M. S. D. Artikanur, Widiatmaka, "Ahp-geotopsis method to analyze priority areas for sugarcane plantation development in lamongan regency," *IOP Conf. Ser. Earth Environ. Sci*, vol. 950, p. 012078, 2022.

[17] E. Şener dan Ş. Şener, "Landfill site selection using integrated fuzzy

logic and analytic hierarchy process (ahp) in lake basins," *Arab. J. Geosci*, vol. 13, p. 1130, 2022.

[18] S. A. A. dan A. Ahmad, "Suitability analysis for municipal landfill site selection using fuzzy analytic hierarchy process and geospatial technique," *Environ. Earth Sci*, vol. 10, p. 227, 2022.

[19] L. O. d. M. J. J. Kropivšek, P. Grošelj, "A comprehensive evaluation model for wood companies websites based on the ahp/r-topsis method," *Forests*, vol. 12, p. 706, 2021.

[20] T. T. dan E. AYDEMİR, "A financial ratio analysis on bist information and technology index (xutek) using ahp-weighted grey relational analysis," *Düzce Üniversitesi Bilim ve Teknol*, vol. 9, p. 195–209, 2021.

[21] S. S. d. O.-S. C. M. BOGDAN, B. RENATE, "Applying ahp and fuzzy ahp management methods to assess the level of financial and digital inclusion," *Econ. Comput. Econ. Cybern. Stud. Res*, vol. 55, p. 165–182, 2021.

[22] D. T. Loi, "Applying ahp and fuzzy ahp management methods to assess the level of financial and digital inclusion," *Econ. Comput. Econ. Cybern. Stud. Res*, vol. 55, p. 165–182, 2023.

[23] Y. F. d. X. Z. J. Wu, Y. Hei, "An analysis of the requirements for smart guiding services in museums using the kano-ahp method," *J. Artif. Intell. Pract*, vol. 6, p. 45–57, 2023.

[24] d. N. S. A. Gouareh, B. Settou, "A new geographical information system approach based on best worst method and analytic hierarchy process for site suitability and technical potential evaluation for large-scale csp on-grid plant: An application for algeria territory," *Energy Convers. Manag*, vol. 235, p. 113963, 2020.

[25] d. H. H. F. Noviyanto, A. Tarmuji, "Food crops planting recommendation using analytic hierarchy process (ahp) and simple additive weighting (saw) methods," *Int. J. Sci. Technol. Res*, vol. 9, p. 2, 2020.

[26] H. V. R. M. T. d. R. H. T. A. Veisi, K. Khoshbakht, "Integrating farmers' and experts' perspectives for soil health-informed decision-making in conservation agriculture systems," *Environ. Syst. Decis*, vol. -, pp. –, 2023.

[27] L. S. d. V. I. V. E. B. Agyekum, F. Amjad, "Optimizing photovoltaic power plant site selection using analytical hierarchy process and density-based clustering – policy implications for transmission network expansion, ghana," *Sustain. Energy Technol. Assessments*, vol. 47, p. 101521, 2021.

[28] B. A. d. Y. T. A. Al-Hanbali, K. Shibuta, "Analysis of the land suitability for paddy fields in tanzania using a gis-based analytical hierarchy process," *Geo-Spatial Inf. Sci*, vol. 25, p. 212–228, 2022.

[29] A. G. B. N. C. M. d. D. M. B. Settou, N. Settou, "A high-resolution geographic information system-analytical hierarchy process-based method for solar pv power plant site selection: a case study algeria," *Clean Technol. Environ. Policy*, vol. 23, p. 219–234, 2021.

[30] R. S. E. Rev, "Selection of ideal sites for the development of large-scale solar photovoltaic projects through analytical hierarchical process – geographic information systems (ahp-gis) in peru," *Clean Technol. Environ. Policy*, vol. 149, p. 111310, 2021.

[31] M. B. dkk, "Land-use suitability assessment using delphi and analytical hierarchy process (d-ahp) hybrid model for coastal city management: Kuala terengganu, peninsular malaysia," *ISPRS Int. J. Geo-Information*, vol. 10, p. 621, 2021.

[32] d. J. L. Y. Park, S.-W. Lee, "Comparison of fuzzy ahp and ahp in multicriteria inventory classification while planning green infrastructure for resilient stream ecosystems," *Sustainability*, vol. 12, p. 9035, 2020.

[33] M. M. d. D. K. H. D. Schuhmann, M. Rupp, "Additive vs. conventional manufacturing of metal components: Selection of the manufacturing process using the ahp method," *Processes*, vol. 10, p. 1617, 2022.

[34] d. D. C. D. Sharma, S. Sridhar, "Comparison of ahp-topsis and ahp-ahp methods in multi-criteria decision-making problems," *Int. J. Ind. Syst. Eng*, vol. 34, p. 203, 2020.

[35] W. X. dan Q. Meng, "An integrated pca–ahp method to assess urban social vulnerability to sea level rise risks in tampa, florida," *Sustainability*, vol. 15, p. 2400, 2023.

[36] d. M. R. W. Wongvilaisakul, P. Netinant, "Dynamic multi-criteria decision making of graduate admission recommender system: Ahp and fuzzy ahp approaches," *Sustainability*, vol. 15, p. 9758, 2023.

[37] d. H. R. G.-N. Zhu, J. Hu, "A fuzzy rough number-based ahp-topsis for design concept evaluation under uncertain environments," *Appl. Soft Comput*, vol. 91, p. 106228, 2020.

[38] d. M. A. P. GMuhammad Ramdani, Arny Lattu, "Sistem pendukung keputusan calon karyawan baru menggunakan metode simple additive weighting di stikes sukabumi," *J. Inform. Teknol. dan Sains*, vol. 5, p. 106228, 2023.

[39] D. Pibriana, "Penggunaan metode simple additive weighting (saw) dalam pengambilan keputusan rekrutmen karyawan pada pt. abc," *Techno.Com*, vol. 19, p. 45–55, 2023.

[40] d. S. P. C. N. Nurhaeni, L. Swastina, "Analisis dan pemodelan sistem informasi penjadwalan perkuliahan menggunakan fuzzy simple additive weighting," *J. Inf. dan Teknol*, vol. 5, p. 39–44, 2023.

[41] d. N. W. S. Andayani, B. Sumarno HM, "Comparison of promethee –topsis method based on saw and ahp weighting for school e-learning readiness evaluation," *J. Phys. Conf. Ser*, vol. 1581, p. 012012, 2020.

[42] K. O. d. Z. N. A. Umarov, H. Akhmedhodjaev, "Determination of the influence of the speed of the saw cylinder of the saw gin on the density, speed and composition of the seed roll," *Engineering*, vol. 14, p. 131–137, 2022.

[43] d. L. M. C.-M. N. Vafaei, R. A. Ribeiro, "Assessing normalization techniques for simple additive weighting method," *Procedia Comput. Sci*, vol. 199, p. 1229–1236, 2022.

[44] H. G. d. A. F. A.Ajrina, R. Sarno, "Mining zone determination of natural sandy gravel using fuzzy ahp and saw, moora and copras methods," *Int. J. Intell. Eng. Syst*, vol. 13, p. 560–571, 2020.

[45] d. A. B. K. Kabassi, C. Karydis, "Hp, fuzzy saw, and fuzzy wpm for the evaluation of cultural websites," *Multimodal Technol. Interact*, vol. 4, p. 5, 2020.

[46] d. G. P. A. Mahmoud, T. Mukherjee, "A study of quality factor in saw resonators for saw gyroscope applications," *EEE International*

Frequency Control Symposium and International Symposium on Applications of Ferroelectrics (IFCS-ISAF), pp. 1–3, 2020.

[47] d. S. C. W. Firgiawan, N. Zulkarnaim, "A comparative study using saw, topsis, saw-ahp, and topsis-ahp for tuition fee (ukt)," *IOP Conf. Ser. Mater. Sci. Eng*, vol. 875, p. 012088, 2020.

[48] d. L. J. E. D. N. K. Y. Suartini, D. G. H. Divayana, "Comparison analysis of ahp-saw, ahp-wp, ahp-topsis methods in private tutor selection," *Int. J. Mod. Educ. Comput*, vol. 15, p. 28–45, 2023.

[49] S. R. K. G. F. G. D. d. L. L. T. Singh, P. Pattnaik, "Optimization on physicomechanical and wear properties of wood waste filled poly(lactic acid) biocomposites using integrated entropy-simple additive weighting approach," *South African J. Chem. Eng*, vol. 41, p. 193–202, 2023.

[50] R. A.-M. d. S. J. A. N. A. J. Al Nawaiseh, A. Albtoush, "Evaluate database management system quality by analytic hierarchy process (ahp) and simple additive weighting (saw) methodolog," *South African J. Chem. Eng*, vol. 28, p. 67–75, 2022.

[51] N. Z. A.-d. A. I. H. Y. H. Chrisnanto, F. Renaldi, "Gis-based ranking and categorization of potential impact on drought as disaster mitigation effort in bandung barat regency (kbb) using simple additive weighting (saw," *IOP Conf. Ser. Mater. Sci. Eng*, vol. 1098, p. 032043, 2021.

[52] L. C. C. dan D. N. Utama, "Decision support model for determining the best employee using fuzzy logic and simple additive weighting," *J. Comput. Sci*, vol. 18, p. 530–539, 2022.

[53] M. A. K. dan H. Jati, "Combination of k-means and simple additive weighting in deciding locations and strategies of university marketing," *JKhazanah Inform. J. Ilmu Komput. dan Inform.*, vol. 6, p. 132–141, 2020.

[54] M. D. B. N.-M. H. d. A. O. A. Redjem, A. Benyahia, "Combining the analytic hierarchy process with gis for landfill site selection: the case of the municipality of m'sila, algeria," *JKhazanah Inform. J. Ilmu Komput. dan Inform.*, vol. 65, p. 171–186, 2021.

[55] Y. A. . U. R. Fawait, A. B., "Pengambilan keputusan penentuan sentra industri kecil dan menengah unggulan menggunakan metode analytical hierarchy process (ahp)," *Jurnal Media Informatika Budidarma*, vol. 6, pp. 1110–1117, 2022.