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(Research/Review) Article

Combination of SAW and TOPSIS Methods for Support Decisions on Rice Land Suitability

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Abstract: Rice plants (Oryza Sativa L.) are the main staple food commodity in Indonesia, as most of the Indonesian population relies on rice as their primary food. One of the causes of low rice production in Indonesia is that farmers generally cultivate rice improperly, such as in land preparation or land selection. Land suitability in rice cultivation greatly affects crop productivity. A process that can support decisions regarding rice land suitability is the development of a Decision Support System (DSS) website using a combination of the Simple Additive Weighting (SAW) method and the Technique for Order Performance of Similarity to Ideal Solution (TOPSIS). This combination is performed by taking the average (μ) of the final results from the SAW and TOPSIS methods. The final scores of each method are calculated separately, and then the average (μ) of these two results is taken to obtain the final ranking of the alternatives. The data used to determine the suitability of rice land is based on five criteria: soil type, soil pH, rainfall, temperature, irrigation and water supply. The alternative data used in the study includes six alternatives: Sungai Kunjang, Sambutan, Samarinda Utara, Palaran, Loa Janan Ilir, and Samarinda Seberang. The aim of this research is to provide information on alternative solutions to farmers or farmer groups in determining rice land suitability. The results of the combination of the SAW and TOPSIS methods show that the alternative with the highest final score is Samarinda Utara (A3), with a final score of 0.7337. Meanwhile, the alternative with the lowest final score is Sambutan (A2), with a final score of 0.4402.

Keywords: Rice; Land Suitability; Decision Support System; SAW; TOPSIS

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1. Introduction

Its total land area is approximately 200 million hectares, spread across five major islands: Sumatra, Java, Kalimantan, Sulawesi, and Papua (Bangun et al., 2020) Indonesia is also known as a maritime and agricultural country, as agriculture is crucial in providing staple food commodities for its people (Ariska and and Qurniawan 2021). Rice (Oryza sativa L.) is Indonesia's primary staple food crop, as most of the population relies on rice as their main food source. One of the main factors contributing to low rice production in Indonesia is the improper cultivation practices commonly used by farmers, such as incorrect soil management and land selection (Makmur et al., 2020).

A lack of knowledge and understanding among farmers regarding the characteristics of the land they cultivate, the types of crops suitable for planting, and the difficulty in accessing accurate land characteristic data can hinder their ability to determine land suitability. A decision support system can assist farmers in making informed decisions through proper planning before initiating agricultural activities. By utilizing such a system, farmers can assess land suitability for specific crops, thereby minimizing the risk of errors in selecting the appropriate crops for cultivation (Wijaya and Firmansyah 2024). Land suitability in crop farming significantly influences crop productivity. Soil is one of the most critical factors affecting the suitability of land for agricultural use (Laurens et al., 2021). Implementing a decision-support system can enhance the determination of land suitability.

A decision support system is a computer-based system designed to assist decision-makers by providing relevant information, generating predictions, and guiding them toward making more informed decisions (Nagara and Nurhayati, 2021). One approach to developing a decision support system combines the Simple Additive Weighting (SAW) method and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. This combination is achieved by averaging (μ) the final results of both methods. The final scores for SAW and TOPSIS are calculated separately, and then their average (μ) is taken to determine the final ranking of alternatives.

The combination of SAW and TOPSIS is widely used in decision-making, as these methods facilitate optimal decision-making based on predefined criteria and alternatives. Additionally, the SAW and TOPSIS methods offer simple and easy-to-understand calculations, the ability to measure the performance of the selected alternatives using a mathematical and structured approach, and efficient computation compared to other decision-making methods (Pertiwi, 2022) and Selection of Tourism Site using Analytic Network Process Method (Hadiwijaya et al., 2018), hybrid method for A Method of Weight Update in Group Decision-Making (Hamdani et al., 2017).

2. Related Work

Research conducted by Melani and Bachtiar analyzed the development of a Decision Support System (DSS) for recommending the promotion of civil servants using a combination of the TOPSIS and SAW methods. The study was conducted at the Regional Secretariat of East Kotawaringin. The research considered five alternatives: Kurniawan Wibowo, Idris Sugiono, Nuringsih Sujati, Meuthia Rakhmasari, and Maulana. Four criteria were used in the evaluation: completeness of documents, employee performance evaluation (SKP) for the last two years with good ratings, latest education level, and a minimum of four years in the current rank. The results indicated that Kurniawan Wibowo was the most eligible civil servant for promotion (Melani and Bachtiar, 2022).

Similarly, research conducted by Pertiwi et al. developed a DSS to determine the optimal location for a new branch of Muhri Fashion, utilizing a combination of the TOPSIS and SAW methods. Seven location alternatives were evaluated: Mentawa Baru Hulu, Mentawa Baru Hilir, Ketapang, Sawahan, Baamang Hulu, Baamang Tengah, and Baamang Hilir. The study employed nine criteria: land price, distance from the existing store, distance from the storage warehouse, competition level with similar stores, building price, proximity to densely populated residential areas, traffic congestion level, cleanliness level, and security level around the location. The findings revealed that Mentawa Baru Hilir was selected as the best location for the new Muhri Fashion branch, achieving the highest preference score of 0.751 (75.1%) (Pertiwi, 2022).

Irwan et al. researched the decision-making process for selecting online learning media during the COVID-19 pandemic using the SAW and TOPSIS methods. The study evaluated five alternatives: Zoom, WhatsApp Group, Google Meet, Google Classroom, and Lentera, based on five criteria: internet data usage, ease of access, user capacity, access time limits, and support for learning methods. The results indicated that Zoom was the most relevant online learning platform for students at UIN Alauddin Makassar (Irwan, 2022).

Similarly, research conducted by Nurfadilah and Sulaiman aimed to determine the best digital wallet in Surabaya. Using a combination of the SAW and TOPSIS methods, the study assessed five alternatives: GoPay, DANA, OVO, ShopeePay, and LinkAja. The evaluation was based on five criteria: convenience, promotions, security, service features, and benefits. Data were collected through a questionnaire distributed to 214 respondents in Surabaya who had used at least two digital wallets. The findings revealed that ShopeePay was ranked the best digital wallet, achieving the highest preference score of 0.997 (Nurfadilah and Sulaiman, 2023).

Furthermore, research conducted by Septy and Devega developed a DSS to determine recipients of Direct Cash Assistance (BLT) at the Limbungan village office. The study applied the TOPSIS and SAW methods to evaluate five recommended recipients: Ramlan, Zulmi Hanafi, Zulbakri, Novita Safitri, and Irwan. The evaluation was based on seven criteria: income, expenses, number of dependents, productive-age family members, residence status, house area, and land area. The results indicated that Ramlan was ranked as the top recipient of BLT, achieving the highest preference score of 0.645 (Septy and Devega, 2022).

Research conducted by Risandika et al. designed a Decision Support System (DSS) to recommend private Islamic high schools in Pontianak City using the SAW and TOPSIS methods. This study evaluated 20 alternative schools based on five criteria: accreditation, facilities, entrance fees, location, and accessibility. The criteria were determined based on a questionnaire distributed to 60 junior high school students. The results indicated that Bawari Islamic High School was the top recommendation, achieving a preference score of 0.7715 (Risandika et al.. 2023).

Similarly, research conducted by Fitrotunnisa and Amin analyzed the selection of residential houses in the West Semarang area using the SAW and TOPSIS methods. The study assessed eight alternatives: Townhouse 2 (A), Townhouse 3 (A), Townhouse 6 (A), Townhouse 10 (A), Townhouse 11 (A), Townhouse 12 (A), Townhouse 12B (A), and Townhouse 14 (A), based on five criteria: land type/area, price, building materials, house facilities, and road access. The findings revealed that the Townhouse 14 (A) model was the best alternative, obtaining the highest final preference score of 0.83 (Fitrotunnisa and Amin, 2021).

Research conducted by Ariyana et al. developed a Decision Support System (DSS) for evaluating the feasibility of lecturer research proposals using a combination of the TOPSIS and SAW methods, with 20 alternative datasets used for testing. This study considered five criteria: presentation skills and mastery of material, research problems, research methods, research outputs, and resource feasibility. The results indicated that the percentage of similarity between manual calculations and system-generated values, based on testing with 20 datasets, was 100% (Ariyana et al., 2018).

Similarly, research conducted by Rismayanti et al. developed a DSS for selecting KIP scholarship recipients using a combination of the SAW and TOPSIS methods at the National Institute of Technology (ITN) Malang. The alternatives evaluated were prospective KIP scholarship recipients, assessed based on seven criteria: father's occupation, mother's occupation, parents' income, number of dependents, home ownership, level of achievement, and number of achievements. The findings demonstrated that the DSS, developed by integrating the SAW and TOPSIS methods, was successfully implemented for KIP scholarship selection at ITN Malang (Rismayanti et al., 2021).

Furthermore, research conducted by Zulkarnain created a DSS for job vacancy recommendations in Bali using the SAW and TOPSIS methods. The alternatives considered were job vacancies in Bali, with data collected from job vacancy information websites. The study evaluated seven alternative job vacancies (A1–A7) based on five criteria: education, experience, maximum age, expertise, and location. The calculation results showed that alternative A2 had the highest preference score, 0.625 (Zulkarnain et al., 2022).

Based on related references, differences from previous research were identified, which serve as the foundation for this study. This research focuses on combining the SAW and TOPSIS methods to support decision-making regarding rice field suitability based on the criteria set by the Samarinda City Agriculture and Food Crops Service. This approach is expected to provide an effective solution for quickly, accurately, and efficiently selecting the most suitable rice fields.

2.1. Simple Additive Weighting

The SAW method is one of the DSS techniques based on the principle of calculating the weighted sum of alternatives for each criterion. The SAW method requires researchers or decision-makers to assign a weight value to each criterion. This method also involves a normalization process to convert the decision matrix (X) into a comparison ratio of all available alternatives (Dewasasmita and Hendry 2023). The calculation steps for the SAW method are as follows:

a. The normalized decision matrix (R) is obtained using Equation (1).

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{max\, x_{ij}} \; ; \text{ jika j } (benefit) \\ \dfrac{min\, x_{ij}}{x_{ij}} \; ; \text{ jika j } (cost) \end{cases} \quad \text{.......(1)}$$

Where,
r_{ij} = Normalized performance rating value
x_{ij} = Attribute value for each criterion
max x_{ij} = The highest value of each criterion

min x_{ij} = The lowest value of each criterion
benefit = A higher value indicates a better value
cost = A lower value indicates a better value

b. Preference value for each alternative using Equation (2).

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

Where,
V_i = Preference value of each alternative
w_j= The weight value of each criterion
r_{ij} = Normalized performance rating value

c. Technique for Order Preference by Similarity to Ideal Solution

TOPSIS is a multicriteria decision-making method introduced by Yoon and Hwang (1981). This method is based on the principle that the selected alternative should have the shortest distance from the positive ideal solution and the longest distance from the negative ideal solution from a geometric perspective. The Euclidean distance determines the relative proximity of an alternative to the optimal solution. The positive ideal solution combines the best possible values for each attribute, whereas the negative ideal solution consists of the worst possible ones. TOPSIS considers both the distance to the positive ideal solution and the distance to the negative ideal solution by calculating the relative proximity to the positive ideal solution (Sadali et al., 2023). The calculation steps for the TOPSIS method are. Normalized decision matrix (R) with Equation (3).

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (3)$$

Where,
r_{ij} = Normalized performance rating value
x_{ij} = Attribute values of each criteria

Weighted normalized decision matrix (Y) with Equation (4).

$$y_{ij} = w_j r_{ij} \quad (4)$$

Where,
y_{ij} = Weighted normalized matrix
w_j = The weight value of each criteria
r_{ij} = Normalized performance rating value

Positive ideal solution matrix with Equation (5).

$$A^+ = \left(y_1^+, y_2^+, y_3^+, \ldots, y_n^+\right) y_j^+ = \begin{cases} max\ y_{ij}\ ;\ \text{jika j kriteria } (benefit) \\ min\ y_{ij}\ ;\ \text{jika j kriteria } (cost) \end{cases} \quad (5)$$

Where,
A^+ = Positive ideal solution matrix values. Negative ideal solution matrix with Equation (6).

$$A^- = (y_1^-, y_2^-, y_3^- \ldots, y_n^-); \quad (6)$$

$$y_j^- = \begin{cases} min\ y_{ij}\ ;\ \text{jika j kriteria } (benefit) \\ max\ y_{ij}\ ;\ \text{jika j kriteria } (cost) \end{cases} \quad (7)$$

Where,
A^- = Negative ideal solution matrix values

The distance between the value of each alternative with the positive ideal solution matrix with Equation (8).

$$D_i^+ = \sqrt{\sum_{j=1}^{n}\left(y_{ij} - y_j^+\right)^2} \quad \text{(8)}$$

Where,

D_i^+ = The distance between the alternatives and the positive ideal solution matrix
y_j^+ = Positive ideal solution matrix values
y_{ij} = Weighted normalized matrix

The distance between the value of each alternative with the negative ideal solution matrix with Equation (9).

$$D_i^- \sqrt{\sum_{j=1}^{n}\left(y_{ij} - y_j^-\right)^2} \quad \text{(9)}$$

Where,

D_i^- = The distance between the alternatives and the negative ideal solution matrix
y_j^- = Negative ideal solution matrix values
y_{ij} = Weighted normalized matrix

Preference values for each alternative with Equation (10).

$$V_i \ \frac{D_i^-}{D_i^- + D_i^+} \quad \text{(10)}$$

Where,

V_i = Preference value of each alternative
D_i^+ = The distance between the alternatives and the positive ideal solution matrix
D_i^- = The distance between the alternatives and the negative ideal solution matrix

3. Materials and Methods

3.1. Proposed method

This research was conducted in several stages, beginning with the problem understanding phase, which includes problem identification, literature review, and data collection. Furthermore, the design, implementation, testing, and conclusion phases were carried out to support decision-making. The stages involved in this research are illustrated in Figure 1.

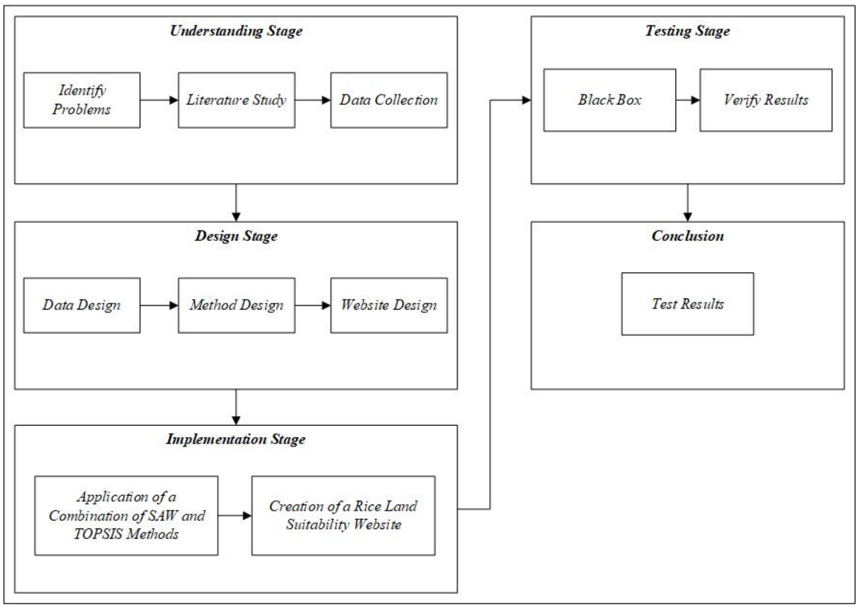

Figure 1. Proposed method

The Proposed method framework is illustrated in Figure 1. The proposal process can be described as follows:

a. Understanding Stage

This stage involves identifying the main problem: developing a Decision Support System (DSS) to determine rice field suitability. The literature review stage consists of collecting data by gathering information from books, articles, scientific papers, notes, and reports relevant to the research. The data collection stage involves conducting observations and interviews with relevant parties related to the research problem.

b. Design Stage

The data design stage involves using data that meets the criteria set by the Samarinda City Agriculture and Food Crops Service. The method design stage begins with creating a flowchart for calculations using the SAW and TOPSIS methods. The website design stage involves utilizing programming languages such as PHP for the system interface and MySQL for data storage, followed by creating UML diagrams, including use case diagrams, activity diagrams, and class diagrams. The website interface is designed to be as simple as possible to ensure ease of use and user understanding.

c. Implementation Stage

The implementation stage involves applying a combination of the SAW and TOPSIS methods by implementing the algorithm designed in the previous stage. The development of the rice field suitability website follows the predefined design, including the user interface and database integration.

d. Testing Phase

The black-box testing stage ensures that the website produces the expected output based on the input. To ensure accuracy, the verification testing stage involves comparing the website's calculation results with manually obtained results.

e. Conclusion and ranking

The test results indicate that the manually obtained and website-generated calculations function correctly and accurately, producing alternative rankings for the appropriate rice field suitability.

3.2. Data Design

The data design used in this study consists of the necessary data to support decision-making on rice field suitability. The criteria and attributes used for this purpose are presented in Table 1.

Table 1. Criteria and Attributes

Ci	Criteria	Weght	Atribute
C1	Soil Type	35%	*Benefit*
C2	Soil pH	20%	*Benefit*
C3	Rainfall	15%	*Benefit*
C4	Temperature	10%	*Cost*
C5	Irrigation and Water	20%	*Benefit*

The following table presents alternative data to support decision-making on rice field suitability. The alternative data can be found in Table 2.

Table 2. Alternative

Ai	Alternative
A1	Sungai Kunjang
A2	Sambutan
A3	Samarinda Utara
A4	Palaran
A5	Loa Janan Ilir
A6	Samarinda Seberang

The criteria used have sub-criteria with a value scale. The value scale is given to each criterion based on the largest to smallest value. The sub-criteria for soil type can be seen in Table 3.

Table 3. Sub Criteria of Soil Type

No.	Soil Type	Value	Description
1	Peat Land	2	Low
2	Organosol/Glei Humus Soil	3	Fair
3	Red Yellow Podsolic Soil	4	Medium
4	Aluvial Soil	5	High

Criteria based on soil pH, where the soil pH criteria have sub-criteria. The soil pH sub-criteria can be seen in Table 4.

Table 4. Soil pH Sub Criteria

No.	Soil pH	Value	Description
1	≤ 4,5	1	Low
2	4,6 – 5,5	2	Fair
3	5,6 – 6,5	3	Medium
4	≥ 6,6	4	High

The criteria are based on rainfall, which includes several sub-criteria. The rainfall sub-criteria are presented in Table 5.

Table 5. Rainfall Sub Criteria

No.	Rainfall	Value	Description
1	≤ 200 mm	1	Low
2	201 – 400 mm	2	Fair
3	≥ 401 mm	3	Medium

The criteria are based on temperature, which includes several sub-criteria. Table 6 presents the temperature sub-criteria.

Table 6. Temperature Sub Criteria

No.	Temperature	Value	Description
1	≤ 16 °C	5	Low
2	17 – 22 °C	4	Fair
3	23 – 28 °C	3	Medium
4	29 – 34 °C	2	High
5	≥ 35 °C	1	Very high

The criteria are based on irrigation and water availability, which include several sub-criteria. Table 7 presents the sub-criteria for irrigation and water availability.

Table 7. Sub Criteria for Irrigation and Water Resources

No.	Irrigation and Water	Value	Description
1	Surface Irrigation	1	Low
2	Irrigation with Water Pump	2	Medium
3	Rainfed Irrigation	3	High

Table 8 presents alternative data used to support decision-making on rice field suitability. The data includes alternative codes (A), soil type (C1), soil pH (C2), rainfall (C3), temperature (C4), and irrigation and water availability (C5). The alternative data for each criterion is detailed in Table 8.

Table 8. Alternative Data On Each Criteria

No.	**Ai**	**C1**	**C2**	**C3**	**C4**	**C5**
1	A1	Organosol Soil	6,5	3600 mm	35 °C	Rainwater Tank
2	A2	Organosol Soil	5,5	200 mm	26 °C	Rainwater Tank
3	A3	Red Yellow Podsolic Soil	5,8	220 mm	30 °C	Rainwater Tank
4	A4	Aluvial Soil	4,5	116 mm	28 °C	Rainwater Tank
5	A5	Organosol Soil	6,5	3300 mm	33 °C	Rainwater Tank
6	A6	Aluvial Soil	4,0	1255 mm	34 °C	Rainwater Tank

3.3. Design Method

The rice field suitability decision support system was developed using the SAW and TOPSIS methods. The combination was implemented by averaging (μ) the final results of both methods. The final score for each technique was calculated separately, and then the average (μ) of the two results was taken to determine the final ranking of alternatives. The steps used in designing the calculation of the combination of SAW and TOPSIS methods are as follows:

1. Entering alternative data and criteria that have been determined for assessment.
2. Create a decision matrix, which contains the value of each alternative against each criterion.
3. Weight each criterion according to its level of importance in decision-making.
4. SAW Method

a. Determining the normalized decision matrix (R) using Equation (1).

b. Determining the preference value for each alternative using Equation (2).

5. TOPSIS Method

a. Determining the normalized decision matrix (R) using Equation (3).

b. Determining the weighted normalized decision matrix (Y) using Equation (4).

c. Determining the positive ideal solution matrix using Equation (5).

d. Determining the negative ideal solution matrix using Equation (6).

e. Determining the distance between the alternative and the positive ideal solution matrix using Equation (7).

f. Determining the distance between the alternative and the negative ideal solution matrix using Equation (8).

g. Determine the preference value for each alternative using Equation (9).

6. After both methods are applied, a combination or merger is carried out by taking each alternative's average (μ) preference value from the SAW and TOPSIS methods.

7. Alternative ranking is done by sorting the alternatives based on the average (μ) preference value from the highest to the lowest. The best choice is the alternative with the highest average (μ) preference value. The flowchart illustrating the calculation process of the SAW and TOPSIS method combination for supporting rice field suitability decisions is shown in Figure 2.

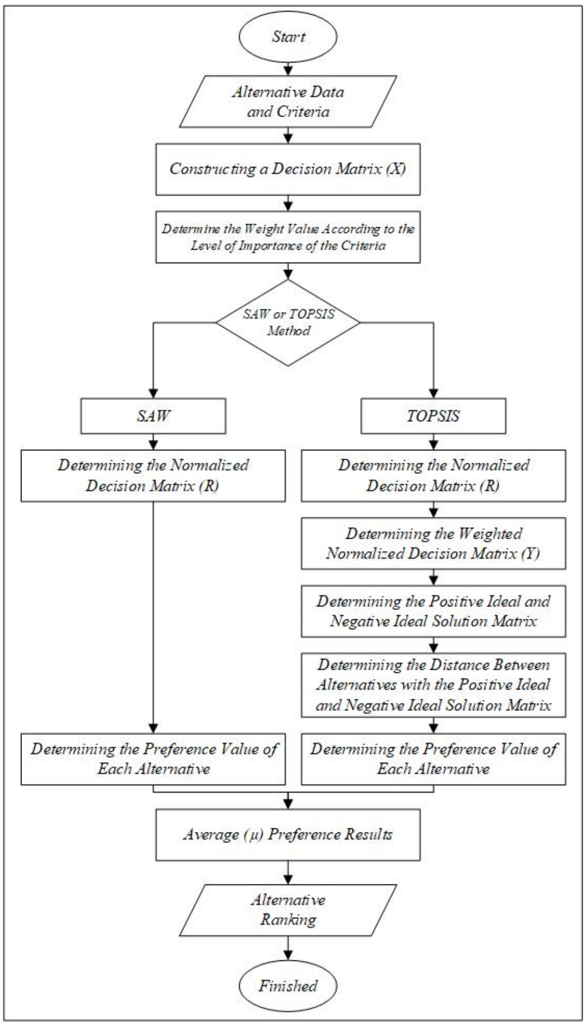

Figure 2. Combination of methods in decision making

4. Results of Discussion

Before proceeding with the calculation process, a decision matrix is prepared by assigning values to each alternative in Table 8 based on the criteria and sub-criteria, each with a predetermined value scale. The requirements are listed in Table 1, while the sub-criteria can be found in Tables 3 to 7. The resulting decision matrix is presented in Table 9.

Table 9. Decision Matrix

Alternative	Criteria				
	C1	C2	C3	C4	C5
A1	3	3	3	1	3
A2	3	2	1	3	3
A3	4	3	2	2	3
A4	5	1	1	3	3
A5	3	3	3	2	3
A6	5	1	3	2	3

The criteria weight is the value assigned to each criterion based on its importance in decision-making. The purpose of determining these weights is to establish the priority of each criterion about the research objectives, thereby enabling a more accurate evaluation of alternatives. The criteria weights are presented in Table 10.

Table 10. Criteria Weights

Criteria	Weight (%)	Weight (Equivalent)
C1	35%	0,35
C2	20%	0,20
C3	15%	0,15
C4	10%	0,10
C5	20%	0,20

4.1. Ranking with the SAW Method

Calculate the normalized decision matrix (R) using Equation (1). The normalized decision matrix (R) value is obtained as in Table 11.

Table 11. Normalized Decision Matrix (R)

Alternative	Criteria				
	C1	C2	C3	C4	C5
A1	0,6000	1	1	1	1
A2	0,6000	0,6667	0,3333	0,3333	1
A3	0,8000	1	0,6667	0,5000	1
A4	1	0,3333	0,3333	0,3333	1
A5	0,6000	1	1	0,5000	1
A6	1	0,3333	1	0,5000	1

Furthermore, the preference value is calculated using Equation (2), resulting in the values presented in Table 12.

Table 12. AW Preference Value

Alternative	V_i
A1	0,8600
A2	0,6267
A3	0,8300
A4	0,7000

A5	0,8100
A6	0,8167

4.2. Ranking using the TOPSIS method

The TOPSIS method is applied by calculating the normalized decision matrix (R) using Equation (3), resulting in the normalized decision matrix values in Table 13.

Table 13. Normalized Decision Matrix (R)

Alternative	Criteria				
	C1	C2	C3	C4	C5
A1	0,3111	0,5222	0,5222	0,1796	0,4082
A2	0,3111	0,3482	0,1741	0,5388	0,4082
A3	0,4148	0,5222	0,3482	0,3592	0,4082
A4	0,5185	0,1741	0,1741	0,5388	0,4082
A5	0,3111	0,5222	0,5222	0,3592	0,4082
A6	0,5185	0,1741	0,5222	0,3592	0,4082

At this stage, the weighted normalized decision matrix (Y) is calculated using Equation (4), resulting in the weighted normalized decision matrix values presented in Table 14.

Table 14. Weighted Normalized Matrix (Y)

Alternative	Criteria				
	C1	C2	C3	C4	C5
A1	0,1089	0,1044	0,0783	0,0180	0,0816
A2	0,1089	0,0696	0,0261	0,0539	0,0816
A3	0,1452	0,1044	0,0522	0,0359	0,0816
A4	0,1815	0,0348	0,0261	0,0539	0,0816
A5	0,1089	0,1044	0,0783	0,0359	0,0816
A6	0,1815	0,0348	0,0783	0,0359	0,0816

Determine the positive ideal solution matrix (A^+) using Equation (5) and the negative ideal solution matrix (A^-) using Equation (6) so that the values of the positive ideal solution matrix (A^+) and negative (A^-) are obtained as in Table 15.

Table 15. Positive and Negative Ideal Solution Matrix

PIS / NIS	Criteria				
	C1	C2	C3	C4	C5
A^+	0,1815	0,1044	0,0783	0,0180	0,0816
A^-	0,1089	0,0348	0,0261	0,0539	0,0816

Calculate the distance between each alternative and the positive ideal solution matrix using Equation (7) and the distance between each alternative and the negative ideal solution matrix using Equation (8). As a result, the distance values for both the positive and negative ideal solution matrices are presented in Table 16.

Table 16. Positive and Negative Ideal Solution Distance

Alternative	D_i^+	D_i^-
A1	0,0726	0,0941
A2	0,1024	0,0348
A3	0,0482	0,0847
A4	0,0941	0,0726

A5	0,0748	0,0888
A6	0,0719	0,0912

The final stage of TOPSIS is calculating the preference value using Equation (9), which obtains the preference value shown in Table 17.

Table 17. TOPSIS Preference Value

Alternative	V_i
A1	0,5645
A2	0,2536
A3	0,6373
A4	0,4355
A5	0,5428
A6	0,5592

4.3. Combination Process of SAW and TOPSIS Methods

After performing calculations using the SAW and TOPSIS methods, the next step combines both approaches by calculating the average (μ) of the final results or preference values obtained from each method. This average (μ) is used to determine the final ranking of alternatives in assessing the suitability of rice fields. The calculation of the average (μ) preference value from the combination of the SAW and TOPSIS methods is presented in Table 18.

Table 18. Average (μ) Preference Value

Alternative	μ_i
A1	0,7123
A2	0,4402
A3	0,7337
A4	0,5678
A5	0,6764
A6	0,6880

4.4. Test Results

The test results indicate that the developed decision support system functions properly and aligns with the predefined objectives. Through black box testing, the system successfully produces the expected output, while the verification test results confirm that the system's calculations are consistent and accurately match manual calculations.

a. Black Box Testing

The primary objective of black box testing is to evaluate whether the output aligns with the predefined specifications and requirements. Each function is tested based on the given input and the resulting output. The black box testing results can be seen in Table 19.

Table 19. Black Box Testing

No.	Testing user interface	Expected results	Description
1	Login Page (Administrator)	Can display the login page including username and password.	Appropriate
2	Login Button On Login Page (Administrator)	Check the username and password, then move to the home page if the data is correct.	Appropriate

3	Home Menu (Administrator/User)	Now able to display the home page.	Appropriate
4	Criteria Data Menu (Administrator)	Display criteria data page.	Appropriate
5	Sub Criteria Data Menu	Display sub criteria data page.	Appropriate
6	Alternative Data Menu	Can display alternative data page.	Appropriate
7	Calculation Data Menu	Can display the calculation data page.	Appropriate
8	Result Data Menu	Can display the results data page.	Appropriate
9	Button on Add Data on the Data Menu Page Criteria, Sub Criteria and Alternatives	Can display the add data form, then can save the data and the system updates the data.	Appropriate
10	Edit Data Button on the Criteria, Sub Criteria and Alternative Data Menu Page	Can display the data edit form, then can change the data again, then save the data and the system updates the data.	Appropriate
11	Delete Data Button on the Criteria, Sub Criteria and Alternative Data Menu Page	Button can delete data then system updates data.	Appropriate
12	Print Data Button On Result Data Menu Page	Buttons can display data print page and can download files.	Appropriate
13	Logout Button	The button can log the administrator out of the system..	Appropriate

b. Result Verification Testing

This test aims to ensure that the system produces consistent, accurate, and appropriate decisions based on the applied method, thereby supporting optimal decision-making for rice field suitability. The verification test results are in Table 20.

Table 20. Result Verification Testing

Alternative	System	Users	Description
A1	0,7123	0,7123	Appropriate
A2	0,4402	0,4402	Appropriate
A3	0,7337	0,7337	Appropriate
A4	0,5678	0,5678	Appropriate
A5	0,6764	0,6764	Appropriate
A6	0,6880	0,6880	Appropriate

4.5. Discussion

This study develops a web-based decision support system to determine rice field suitability, designed for two types of users: administrators, who manage data, and farmers, who access ranking results. Data were obtained from the Samarinda City Agriculture and Food Crops Service, and interviews with Mr. Badri were conducted to determine the criteria weights and assessment scale used in the SAW and TOPSIS methods. The results showed North Samarinda (A3) was the most suitable location with the highest score of 0.7337, while Sambutan (A2) ranked last with a score of 0.4402. Black box testing and verification confirmed the system's accuracy, demonstrating that the system's calculations aligned with manually conducted assessments. The use of combined methods is crucial for improving the understanding of research results, particularly when hybrid approaches are not employed. Studies indicate that combining methods yields significantly better preference recommendations compared to relying on a single method.

5. Conclusion

Based on the research conducted, this study successfully combines the SAW and TOPSIS methods to determine rice field suitability with accurate results. The system provides alternative solution information for farmers or farmer groups to select the most suitable rice fields based on the criteria set by the Samarinda City Agriculture and Food Crops Service. The decision results indicate that North Samarinda (A3) is the most suitable rice field, achieving the highest final score of 0.7337, while Sambutan (A2) has the lowest final score of 0.440. Some suggestions for future research include expanding the scope of this study by incorporating more alternative locations and more specific criteria. Additionally, various decision-making methods can be explored to meet better user needs, such as integrating maps or involving other stakeholders. Potential methods to consider include the Analytical Hierarchy Process (AHP), Analytic Network Process (ANP), Fuzzy Logic, Elimination and Choice Translating Reality (ELECTRE), and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE). Furthermore, incorporating a combined weighting method based on the similarity of criteria or criteria values could enhance decision accuracy.

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