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Weighted Multi-Criteria Assessment of Rice Quality Using The TOPSIS Method

Budy Satria[1,*], Sandi Fadilah[2]

[1] Faculty of Information Technology, Department of Informatics, Universitas Andalas, Padang, Indonesia
[2] Digital Business Study Program, STIE Tuah Negeri, Dumai, Indonesia
Email: [1,*]budy.satria@it.unand.ac.id, [2]fadilahsandi@gmail.com

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CORRESPONDENCE AUTHOR

Email: budy.satria@it.unand.ac.id

A B S T R A C T

Rice is a staple food for the Indonesian people, and its availability must be guaranteed by the government. The background of this research is based on the increasing demand for high-quality rice from consumers, thus challenging producers to set optimal rice quality standards. The process of selecting quality rice is still carried out using conventional methods in Bulog warehouses, namely by checking every rice data received by the quality control team tasked with assessing the quality of incoming rice. To overcome this problem, a decision support system is needed that can provide fair, objective, and efficient decisions. This study aims to evaluate the quality of rice from 10 alternatives using five criteria: milling degree, head grain, moisture content, broken grain, and grit grain, with a total weight of 100%. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is applied. This research was conducted by following a series of steps, including building a Decision Matrix, Normalizing the Decision Matrix, Calculating the Weighted Normalized Decision Matrix, Determining the Ideal Positive and Negative Solutions, Calculating the Distance to the Ideal Positive and Negative Solutions, and Calculating the Preference Score. The results of the study showed that from 10 alternative data, 5 types of rice were obtained with the highest preference values, namely Harum Solok Rice (0.8363), Anak Daro Rice (0.7955), Kuruik Kusuik Rice (0.7210), Ampek Angkek Rice (0.6919), and Saganggam Panuah Rice (0.6727). The conclusion of this study is that the application of the TOPSIS method is effective in objectively assessing rice quality. In further research, it is recommended to utilize a combination of other decision support methods to acquire new knowledge and refine preference values, as well as to develop these methods into user-friendly interfaces

1. INTRODUCTION

Rice is a staple food for most Indonesians. As an agriculturally based country, Indonesia relies significantly on agricultural products to meet its food needs [1], one of which is rice. The Central Statistics Agency (BPS) explained that in 2025, rice consumption accounted for 36.94% of the total daily calories and 28.18% of the total daily protein intake [2]. As a staple food [3] Rice quality plays a crucial role in determining consumer satisfaction, sales value, and producer competitiveness in the market. The demand for rice-based foods in Indonesia has continued to increase annually, in line with the country's growing population. The increasing demand for good-quality rice from consumers makes it difficult for producers to set optimal rice quality standards [4]. Rice quality is evaluated based on several criteria, including separation rate, intact grains, moisture content, damaged and broken grains, and taste after cooking. Currently, the Logistics Agency (BPN) still uses traditional methods to select quality rice, which involves checking each rice item individually by the quality control team assigned to Bulog's warehouses. Furthermore, some rice varieties that do not meet the standard criteria are still being accepted into Bulog's warehouses, potentially impacting rice distribution and leading to a backlog. This can lead to rice spoilage and render it unfit for consumption [5]. The assessment process is often conducted subjectively by examiners or using manual techniques that require significant time and effort. This situation often results in inconsistent evaluation results, making it difficult to objectively compare one rice sample with another. To address this problem, a system is needed that can produce fair, objective, and effective decisions [6].

In the digital era and data-driven decision-making, an objective, measurable, and systematic method for measuring rice quality is essential to ensure more accurate decision-making by producers, quality control agencies, and consumers. In this study, the authors implemented a decision support system (DSS) as a solution to address the issue of measuring rice quality through a value-based decision-making process. A decision support system (DSS) is a system that can provide decision-making suggestions based on various criteria determined through specific decision-making methods [7]. One of the methods used in this research is the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). TOPSIS is a decision-making technique that involves multiple criteria to select the best option from a number of choices by referring to predetermined criteria [8]. Additionally, the TOPSIS method can also determine the order of preference by measuring the proximity to the positive and negative ideal solutions [9].

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The TOPSIS method has been widely used in research methods, as was done in previous research to optimize the potato supply chain [10]. The research results obtained final preference scores of 0.7394, 0.6273, 0.4497, 0.4017, and 0 for each sequence. Research related to the TOPSIS method has also been conducted for selecting superior rice seed varieties [11]. Based on the analysis and evaluation conducted using the TOPSIS approach, the top three rice seed varieties tested were Cakrabuana, Inpari 42, and Inpari 36, with scores of 0.60, 0.59, and 0.55, respectively. The TOPSIS method has also been used in selecting quality catfish seeds [12]. The research results showed that the Dumbo catfish had the highest preference score, specifically 0.7726, while the Python catfish ranked second with a value of 0.5419, and the Pearl catfish ranked third with a value of 0.3849. Other research was also conducted by [13]. The results showed that the TOPSIS method was effective in providing plant recommendations based on various criteria, producing the best ranking with the highest reference value. The TOPSIS method has also been used to select locations for storing palm oil processing waste in Pagar Merbau [14]. The TOPSIS approach can yield objective results in selecting waste collection sites, considering a range of technical, environmental, and social criteria. Criteria related to nutritional needs and plant age have the most significant impact, so areas with these conditions are prioritized for sustainability.

Prior research has primarily employed TOPSIS for rice seed selection; however, it is not yet widely used to evaluate the quality of finished or commercial rice products. To close this gap, this study assesses rice quality at the warehouse level using a weighted multi-criteria TOPSIS technique. The method's success in integrating various assessment aspects and providing consistent, easily understood ranking results makes it an appropriate approach for measuring rice quality using multiple criteria (benefit and cost). This research is also expected to contribute to the development of decision support systems in the field of food quality control, as the application of the TOPSIS method to evaluate rice quality remains limited in existing research. The purpose of this study is to objectively assess and analyze rice quality using the TOPSIS method. By adopting this approach, it is anticipated that the research will develop a structured and objective rice quality measurement model that can serve as a guideline for decision-making regarding rice quality at the producer, regulatory body, and consumer levels.

2. RESEARCH METHODOLOGY

2.1 Decision Support System (DSS)

Little first proposed the idea of a decision support system (DSS) in the 1970s. According to Little (1970), a decision support system is a set of protocols and models that managers can use to gather information and factors that need to be considered in a decision [15]. A Decision Support System (DSS) is a computer-based system that aims to facilitate the decision-making process in various sectors, thereby assisting management in making decisions related to semi-structured problems [16]. A decision support system generates various decision options as an effort to solve a problem through the use of data and models [17].

2.2 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The TOPSIS method is a multicriteria decision-making technique introduced by Yoon and Hwang in 1981. This approach is simple in concept, but has its own complexity in solving problems, which is shown by the way this technique is solved, namely by choosing the best alternative that not only has the closest distance from the positive ideal solution but also has the furthest distance from the negative ideal solution [18]. The stages in using the TOPSIS method are as follows

1. **Determine Alternative Data**

The alternative data used in this study are types of rice originating from the West Sumatra region, namely Harum Solok Rice, Padi Bujang Marantau Rice, Anak Daro Rice, Gadang Rumpun Kambayau Rice, Saganggam Panuah Rice, Sigudang Rice, Kuruik Kusuik Rice, Ceredek Merah Rice, Siarang Rice, and Ampek Angkek Rice. Information related to rice types was obtained through literature studies, including published articles and books, to gather the required data.

2. **Determining the criteria, types of criteria, and weights**

Rice quality is monitored based on several criteria, including milling degree, head grain, moisture content, broken grains, and groats. Rice quality is determined according to SNI 6128:2020 procedures [19].

3. **Construct Decision Matrix (X)**

The choice matrix is a numerical representation of each alternative's performance value in relation to each preset criterion [20]. The formula for determining the Decision Matrix can be seen in Equation (1) as follows:

$$X = \begin{bmatrix} X_{01} & \cdots & X_{0j} & \cdots & X_{On} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ X_{i1} & \cdots & X_{ij} & \cdots & X_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ X_{n1} & \cdots & X_{mj} & \cdots & X_{mn} \end{bmatrix} \quad (1)$$

The decision matrix X is a numerical representation of the performance values of each alternative with respect to the predetermined criteria. Each element X_{ij} in the decision matrix represents the value of the i-th alternative evaluated against

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the j-th criterion. In this matrix, the rows correspond to the number of alternatives (m), while the columns represent the number of criteria (n). Therefore, the decision matrix X has a dimension of $m x n$ and serves as the fundamental basis for the multi-criteria decision-making process [21].

4. Determining the Normalization of the Decision Matrix (R)

The formula for determining the normalization of the decision matrix is presented in Equation (2) as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{2}$$

The normalized value r_{ij} represents the result of normalizing the decision matrix R. This value is obtained by dividing the performance value of an alternative x_{ij} by the square root of the sum of squares of all alternatives for the same criterion. Through this normalization process, the values in the decision matrix are transformed into dimensionless numbers, allowing fair and consistent comparison among alternatives across different criteria [22].

5. Calculate the Weighted Normalized Decision Matrix (Y)

The formula for determining the value of the weighted normalized decision matrix can be seen in equation (3) as follows:

$$y_{ij} = w_i * r_{ij} \tag{3}$$

The weighted normalized decision matrix Y is obtained by multiplying each element of the normalized decision matrix r_{ij} by the corresponding weight of the criterion w_j. Each element y_{ij} represents the weighted performance value of the i-th alternative with respect to the j-th criterion. This step incorporates the relative importance of each criterion into the decision-making process, ensuring that criteria with higher weights have a greater influence on the final evaluation [23].

6. Determining the Ideal Positive (A+) and Negative (A-) Solution

The formula for determining positive and negative ideal solutions can be seen in equation (4) and (5) as follows:

$$A^+ = (y_1^+, y_2^+, y_n^+) \tag{4}$$
$$A^- = (y_1^-, y_2^-, y_n^-) \tag{5}$$

The ideal positive solution A^+ and the ideal negative solution A^- are determined based on the values in the weighted normalized decision matrix Y. For each criterion, the ideal positive value y_j+ is selected as the maximum value if the criterion is a benefit criterion, or the minimum value if it is a cost criterion. Conversely, the ideal negative value y_j- is selected as the minimum value for benefit criteria and the maximum value for cost criteria. These ideal solutions represent the best and worst possible performance levels for each criterion and serve as reference points in the TOPSIS evaluation process [24].

7. Calculate the Distance to the Ideal Positive Solution (D+) and Negative (D-)

The formula for determining the distance between positive and negative ideal solutions can be seen in equations (6) and (7) as follows:

$$D_i^+ = \sqrt{\sum_{j=1}^{m} \left(y_i^+ - y_{ij}\right)^2} \tag{6}$$

$$D_i^- = \sqrt{\sum_{j=1}^{m} \left(y_{ij} - y_i^-\right)^2} \tag{7}$$

The distance to the ideal positive solution D_i^+ represents the Euclidean distance between the weighted normalized performance of the i-th alternative and the ideal positive solution. Similarly, the distance to the ideal negative solution D_i^- represents the Euclidean distance between the weighted normalized performance of the i-th alternative and the ideal negative solution. These distance measures indicate how close each alternative is to the best possible condition and how far it is from the worst possible condition within the decision space [25].

8. Calculate the Preference Score (V)

The final ranking of each option is determined by calculating its preference score, which serves as a measure of how well that option compares to other options [26]. The formula for determining the preference value can be seen in equation (8) as follows:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \tag{8}$$

The preference score V_i is calculated to determine the final ranking of each alternative. This score is obtained by dividing the distance to the negative ideal solution D_i^- by the sum of the distances to both the positive and negative ideal solutions

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($D_i^+ D_i^-$). The resulting value reflects the relative closeness of each alternative to the ideal solution, where a higher preference score indicates a better-performing alternative and a higher priority in the ranking process [27].

2.3 Research Flow Diagram

The research stages for measuring rice quality using the TOPSIS method are illustrated in Figure 1 as follows.

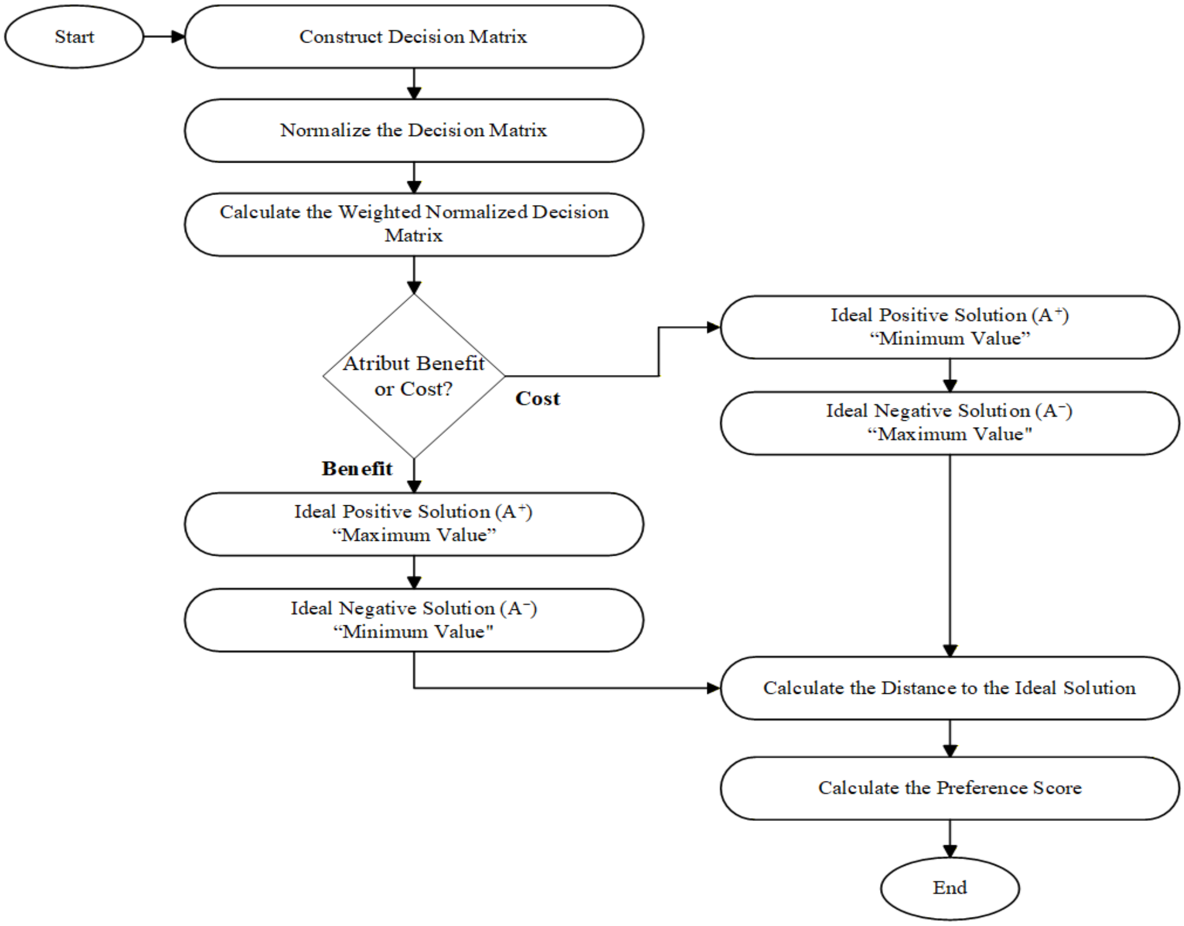

Figure 1. Research Flow Diagram

Figure 1 explains the stages of research carried out as follows: The first phase of decision-making analysis is referred to as the initiation phase. Create a Decision Matrix: Create a decision matrix (X) with all of the options and values for every criterion. Adjust the Decision Matrix to Normal: To keep the same scale (R), normalize every piece of data. Determine the Normalized Weighted Decision Matrix: Each criterion is multiplied by the normalized value (Y) after being weighted according to its significance. Point of Decision: Verify whether the criteria are cost-based or benefit-based. Find the Optimal Negative (A-) and Positive (A+) Solutions: The ideal negative value is the lowest value for each column, and the ideal positive value is the maximum value for each column if the criterion type is benefit. The ideal negative value is the highest value for each column, and the ideal positive value is the minimum value for each column if the criterion type is cost. Determine the distance to the ideal negative (D-) and positive (D+) solutions: Use the Euclidean Distance formula to determine each alternative's distance from A+ and A-. Determine the Preference Score (V): It is preferable to have a higher final preference score. Final Step: To determine the highest score, the preference scores are sorted.

3. RESULT AND DISCUSSION

In measuring the quality of rice, researchers used the TOPSIS method as a model. This chapter will implement calculations using TOPSIS, starting with determining alternative data(A), determine criteria (C), type of criteria and weight, Construct Decision Matrix (X), Normalize the Decision Matrix (R), Calculate the Weighted Normalized Decision Matrix (Y), Calculate the Distance to the Ideal Positive Solution (D+) and Negative (D), Calculate the Preference Score (V) and sort the preference values to get the best value.

3.1 Determining Alternative Data

Based on the data collection results, 10 types of rice originating from the West Sumatra region (alternatives) were selected for assessment, as recommended by the administration. The candidate's (alternative) data are shown in Table 1 as follows.

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Table 1. Alternative Data Candidate

Code	Alternative Data
A1	Harum Solok Rice
A2	Bujang Marantau Rice
A3	Anak Daro Rice
A4	Gadang Rumpun Kambayau Rice
A5	Saganggam Panuah Rice
A6	Sigudang Rice
A7	Kuruik Kusuik Rice
A8	Ceredek Merah Rice
A9	Siarang Rice
A10	Ampek Angkek Rice

3.2 Determine Criteria, Types, and Categories

A complete list of criteria, including their types and the interpretation of the assessment, is presented in Table 2 below.

Table 2. Criteria, Types, and Interpretation Scores

Code	Criteria	Types	Score 3 (Superior)	Score 2 (Good)	Score 1 (Not Good)
C1	Milling Degree	Benefit	95%-100%	90% - 94.9%	< 90%
C2	Head Grain	Benefit	≥ 95%	90% - < 95%	80% - < 90%
C3	Moisture Content	Cost	≤ 13%	13.1% - 14%	> 14%
C4	Broken Grain	Cost	≤ 5%	> 5% - 10%	> 10%-20%
C5	Grit Grain	Cost	≤ 0.5%	> 0.5% - 1%	> 1%

3.3 Determining the Weight of Each Criterion

The results of determining the weight of each criterion based on its level of importance are presented in Table 3 below.

Table 3. Criteria Weighting

Code	Criteria	Types	Weight
C1	Milling Degree	Benefit	0.30
C2	Head Grain	Benefit	0.25
C3	Moisture Content	Cost	0.20
C4	Broken Grain	Cost	0.15
C5	Grit Grain	Cost	0.10

Benefit and cost were the two groups into which the weighting findings for each criterion were separated in this study. The head grain was weighted at 25% because the percentage of intact grains is a significant determinant of rice quality; the milling degree was weighted at 30% because the milling level directly determines the physical and commercial quality of rice; the head grain retention rate is a physical quality indicator that affects appearance, cooking, and texture; the broken grain at 15% because the broken grain fraction frequently adversely affects sales value and appearance; the water content at 20% because it is given less priority than the two primary benefit criteria above because it is more of a manufacturing/warehousing quality control measure than direct consumer preference; and the grits at 10% have the lowest impact on overall final quality compared to other criteria.

3.4 Evaluation of Assessment Results

At this stage, the user evaluates the scoring of each alternative data and criterion. The results of the alternative evaluation for each criterion are shown in Table 4 as follows.

Table 4. Evaluation of Alternative Data Assessment

Code	Alternative Data	C1	C2	C3	C4	C5
A1	Harum Solok Rice	95%-100%	≥ 95%	13.1% - 14%	> 5% - 10%	> 1%
A2	Bujang Marantau Rice	90% - 94.9%	90% - < 95%	> 14%	> 5% - 10%	> 0.5% - 1%
A3	Anak Daro Rice	95%-100%	≥ 95%	13.1% - 14%	> 5% - 10%	> 0.5% - 1%
A4	Gadang Rumpun Kambayau Rice	95%-100%	90% - < 95%	13.1% - 14%	≤ 5%	> 0.5% - 1%
A5	Saganggam Panuah Rice	95%-100%	90% - < 95%	13.1% - 14%	> 5% - 10%	> 0.5% - 1%
A6	Sigudang Rice	95%-100%	90% - < 95%	13.1% - 14%	≤ 5%	> 0.5% - 1%
A7	Kuruik Kusuik Rice	95%-100%	≥ 95%	≤ 13%	> 5% - 10%	> 0.5% - 1%
A8	Ceredek Merah Rice	< 90%	80% - < 90%	13.1% - 14%	> 5% - 10%	> 1%
A9	Siarang Rice	90% - 94.9%	90% - < 95%	13.1% - 14%	≤ 5%	> 0.5% - 1%
A10	Ampek Angkek Rice	90% - 94.9%	≥ 95%	13.1% - 14%	> 10%-20%	> 0.5% - 1%

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3.5 Decision Matrix (X)

The decision matrix for evaluating alternative data assessment results is presented in Table 5 below.

Table 5. Decision Matrix

Code	Alternative Data	C1	C2	C3	C4	C5
A1	Harum Solok Rice	3	3	2	2	1
A2	Bujang Marantau Rice	2	2	3	2	2
A3	Anak Daro Rice	3	3	2	2	2
A4	Gadang Rumpun Kambayau Rice	3	2	2	3	2
A5	Saganggam Panuah Rice	3	2	2	2	2
A6	Sigudang Rice	3	2	2	3	2
A7	Kuruik Kusuik Rice	3	3	3	2	2
A8	Ceredek Merah Rice	1	1	2	2	1
A9	Siarang Rice	2	2	2	3	2
A10	Ampek Angkek Rice	2	3	2	1	2

3.6 Normalized Decision Matrix (R)

After obtaining the decision matrix, the next step is to calculate the normalized decision matrix as follows:

a. Calculating the Normalized Decision Matrix Criterion C1

$$r_{11} = \frac{3}{\sqrt{(3^2)+(2^2)+(3^2)+(3^2)+(3^2)+(3^2)+(3^2)+(1^2)+(2^2)+(2^2)}} = \frac{3}{\sqrt{67}} = \frac{3}{\sqrt{8.1854}} = 0.3665$$

$$r_{12} = \frac{2}{\sqrt{(3^2)+(2^2)+(3^2)+(3^2)+(3^2)+(3^2)+(3^2)+(1^2)+(2^2)+(2^2)}} = \frac{2}{\sqrt{67}} = \frac{2}{\sqrt{8.1854}} = 0.2443$$

$$r_{13} = \frac{3}{\sqrt{(3^2)+(2^2)+(3^2)+(3^2)+(3^2)+(3^2)+(3^2)+(1^2)+(2^2)+(2^2)}} = \frac{3}{\sqrt{67}} = \frac{3}{\sqrt{8.1854}} = 0.3665$$

$$r_{14} = \frac{3}{\sqrt{(3^2)+(2^2)+(3^2)+(3^2)+(3^2)+(3^2)+(3^2)+(1^2)+(2^2)+(2^2)}} = \frac{3}{\sqrt{67}} = \frac{3}{\sqrt{8.1854}} = 0.3665$$

$$r_{15} = \frac{3}{\sqrt{(3^2)+(2^2)+(3^2)+(3^2)+(3^2)+(3^2)+(3^2)+(1^2)+(2^2)+(2^2)}} = \frac{3}{\sqrt{67}} = \frac{3}{\sqrt{8.1854}} = 0.3665$$

$$r_{16} = \frac{3}{\sqrt{(3^2)+(2^2)+(3^2)+(3^2)+(3^2)+(3^2)+(3^2)+(1^2)+(2^2)+(2^2)}} = \frac{3}{\sqrt{67}} = \frac{3}{\sqrt{8.1854}} = 0.3665$$

$$r_{17} = \frac{3}{\sqrt{(3^2)+(2^2)+(3^2)+(3^2)+(3^2)+(3^2)+(3^2)+(1^2)+(2^2)+(2^2)}} = \frac{3}{\sqrt{67}} = \frac{3}{\sqrt{8.1854}} = 0.3665$$

$$r_{18} = \frac{1}{\sqrt{(3^2)+(2^2)+(3^2)+(3^2)+(3^2)+(3^2)+(3^2)+(1^2)+(2^2)+(2^2)}} = \frac{1}{\sqrt{67}} = \frac{1}{\sqrt{8.1854}} = 0.1221$$

$$r_{19} = \frac{2}{\sqrt{(3^2)+(2^2)+(3^2)+(3^2)+(3^2)+(3^2)+(3^2)+(1^2)+(2^2)+(2^2)}} = \frac{2}{\sqrt{67}} = \frac{2}{\sqrt{8.1854}} = 0.2443$$

$$r_{110} = \frac{2}{\sqrt{(3^2)+(2^2)+(3^2)+(3^2)+(3^2)+(3^2)+(3^2)+(1^2)+(2^2)+(2^2)}} = \frac{2}{\sqrt{67}} = \frac{2}{\sqrt{8.1854}} = 0.2443$$

b. Calculating the Normalized Decision Matrix Criterion C2

$$r_{21} = \frac{3}{\sqrt{(3^2)+(2^2)+(3^2)+(2^2)+(2^2)+(2^2)+(3^2)+(1^2)+(2^2)+(3^2)}} = \frac{3}{\sqrt{57}} = \frac{3}{\sqrt{7.5498}} = 0.3974$$

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$$r_{22} = \frac{2}{\sqrt{(3^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (3^2) + (1^2) + (2^2) + (3^2)}} = \frac{2}{\sqrt{57}} = \frac{2}{\sqrt{7.5498}} = 0.2649$$

$$r_{23} = \frac{3}{\sqrt{(3^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (3^2) + (1^2) + (2^2) + (3^2)}} = \frac{3}{\sqrt{57}} = \frac{3}{\sqrt{7.5498}} = 0.3974$$

$$r_{24} = \frac{2}{\sqrt{(3^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (3^2) + (1^2) + (2^2) + (3^2)}} = \frac{2}{\sqrt{57}} = \frac{2}{\sqrt{7.5498}} = 0.2649$$

$$r_{25} = \frac{2}{\sqrt{(3^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (3^2) + (1^2) + (2^2) + (3^2)}} = \frac{2}{\sqrt{57}} = \frac{2}{\sqrt{7.5498}} = 0.2649$$

$$r_{26} = \frac{2}{\sqrt{(3^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (3^2) + (1^2) + (2^2) + (3^2)}} = \frac{2}{\sqrt{57}} = \frac{2}{\sqrt{7.5498}} = 0.2649$$

$$r_{27} = \frac{2}{\sqrt{(3^2) + (2^2) + (3^2) + (3^2) + (3^2) + (3^2) + (3^2) + (1^2) + (2^2) + (2^2)}} = \frac{3}{\sqrt{57}} = \frac{3}{\sqrt{7.5498}} = 0.3974$$

$$r_{28} = \frac{1}{\sqrt{(3^2) + (2^2) + (3^2) + (3^2) + (3^2) + (3^2) + (3^2) + (1^2) + (2^2) + (2^2)}} = \frac{1}{\sqrt{57}} = \frac{1}{\sqrt{7.5498}} = 0.1325$$

$$r_{29} = \frac{2}{\sqrt{(3^2) + (2^2) + (3^2) + (3^2) + (3^2) + (3^2) + (3^2) + (1^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{57}} = \frac{2}{\sqrt{7.5498}} = 0.2649$$

$$r_{210} = \frac{3}{\sqrt{(3^2) + (2^2) + (3^2) + (3^2) + (3^2) + (3^2) + (3^2) + (1^2) + (2^2) + (2^2)}} = \frac{3}{\sqrt{57}} = \frac{3}{\sqrt{7.5498}} = 0.3974$$

c. Calculating the Normalized Decision Matrix Criterion C3

$$r_{31} = \frac{2}{\sqrt{(2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{50}} = \frac{2}{\sqrt{7.0711}} = 0.2828$$

$$r_{32} = \frac{3}{\sqrt{(2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2)}} = \frac{3}{\sqrt{50}} = \frac{3}{\sqrt{7.0711}} = 0.4243$$

$$r_{33} = \frac{2}{\sqrt{(2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{50}} = \frac{2}{\sqrt{7.0711}} = 0.2828$$

$$r_{34} = \frac{2}{\sqrt{(2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{50}} = \frac{2}{\sqrt{7.0711}} = 0.2828$$

$$r_{35} = \frac{2}{\sqrt{(2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{50}} = \frac{2}{\sqrt{7.0711}} = 0.2828$$

$$r_{36} = \frac{2}{\sqrt{(2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{50}} = \frac{2}{\sqrt{7.0711}} = 0.2828$$

$$r_{37} = \frac{3}{\sqrt{(2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2)}} = \frac{3}{\sqrt{50}} = \frac{3}{\sqrt{7.0711}} = 0.4243$$

$$r_{38} = \frac{2}{\sqrt{(2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{50}} = \frac{2}{\sqrt{7.0711}} = 0.2828$$

$$r_{39} = \frac{2}{\sqrt{(2^2) + (3^2) + (2^2) + (2^2) + (2^2) + (2^2) + (3^2) + (2^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{50}} = \frac{2}{\sqrt{7.0711}} = 0.2828$$

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$$r_{310} = \frac{2}{\sqrt{(2^2)+(3^2)+\ (2^2)+\ (2^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (2^2)}} = \frac{2}{\sqrt{50}} = \frac{2}{\sqrt{7.0711}} = 0.2828$$

d. Calculating the Normalized Decision Matrix Criterion C4

$$r_{41} = \frac{2}{\sqrt{(2^2)+(2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (1^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{7.2111} = 0.2774$$

$$r_{42} = \frac{2}{\sqrt{(2^2)+(2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (1^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{7.2111} = 0.2774$$

$$r_{43} = \frac{2}{\sqrt{(2^2)+(2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (1^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{7.2111} = 0.2774$$

$$r_{44} = \frac{3}{\sqrt{(2^2)+(2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (1^2)}} = \frac{3}{\sqrt{52}} = \frac{3}{7.2111} = 0.4160$$

$$r_{45} = \frac{2}{\sqrt{(2^2)+(2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (1^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{7.2111} = 0.2774$$

$$r_{46} = \frac{3}{\sqrt{(2^2)+(2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (1^2)}} = \frac{3}{\sqrt{52}} = \frac{3}{7.2111} = 0.4160$$

$$r_{47} = \frac{2}{\sqrt{(2^2)+(2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (1^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{7.2111} = 0.2774$$

$$r_{48} = \frac{2}{\sqrt{(2^2)+(2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (1^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{7.2111} = 0.2774$$

$$r_{49} = \frac{3}{\sqrt{(2^2)+(2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (1^2)}} = \frac{3}{\sqrt{52}} = \frac{3}{7.2111} = 0.4160$$

$$r_{410} = \frac{1}{\sqrt{(2^2)+(2^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (3^2)+\ (2^2)+\ (2^2)+\ (3^2)+\ (1^2)}} = \frac{1}{\sqrt{52}} = \frac{1}{7.2111} = 0.1387$$

e. Calculating the Normalized Decision Matrix Criterion C5

$$r_{51} = \frac{1}{\sqrt{(1^2)+(2^2)+\ (2^2)+\ (2^2)+\ (2^2)+\ (2)+\ (2^2)+\ (1^2)+\ (2^2)+\ (2^2)}} = \frac{1}{\sqrt{52}} = \frac{1}{5.8310} = 0.1715$$

$$r_{52} = \frac{2}{\sqrt{(1^2)+(2^2)+\ (2^2)+\ (2^2)+\ (2^2)+\ (2)+\ (2^2)+\ (1^2)+\ (2^2)+\ (2^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{5.8310} = 0.3430$$

$$r_{53} = \frac{2}{\sqrt{(1^2)+(2^2)+\ (2^2)+\ (2^2)+\ (2^2)+\ (2)+\ (2^2)+\ (1^2)+\ (2^2)+\ (2^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{5.8310} = 0.3430$$

$$r_{54} = \frac{2}{\sqrt{(1^2)+(2^2)+\ (2^2)+\ (2^2)+\ (2^2)+\ (2)+\ (2^2)+\ (1^2)+\ (2^2)+\ (2^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{5.8310} = 0.3430$$

$$r_{55} = \frac{2}{\sqrt{(1^2)+(2^2)+\ (2^2)+\ (2^2)+\ (2^2)+\ (2)+\ (2^2)+\ (1^2)+\ (2^2)+\ (2^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{5.8310} = 0.3430$$

$$r_{56} = \frac{2}{\sqrt{(1^2)+(2^2)+\ (2^2)+\ (2^2)+\ (2^2)+\ (2)+\ (2^2)+\ (1^2)+\ (2^2)+\ (2^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{5.8310} = 0.3430$$

$$r_{57} = \frac{2}{\sqrt{(1^2) + (2^2) + (2^2) + (2^2) + (2^2) + (2) + (2^2) + (1^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{5.8310} = 0.3430$$

$$r_{58} = \frac{1}{\sqrt{(1^2) + (2^2) + (2^2) + (2^2) + (2^2) + (2) + (2^2) + (1^2) + (2^2) + (2^2)}} = \frac{1}{\sqrt{52}} = \frac{1}{5.8310} = 0.1715$$

$$r_{59} = \frac{2}{\sqrt{(1^2) + (2^2) + (2^2) + (2^2) + (2^2) + (2) + (2^2) + (1^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{5.8310} = 0.3430$$

$$r_{510} = \frac{2}{\sqrt{(1^2) + (2^2) + (2^2) + (2^2) + (2^2) + (2) + (2^2) + (1^2) + (2^2) + (2^2)}} = \frac{2}{\sqrt{52}} = \frac{2}{5.8310} = 0.3430$$

The results of the normalized decision matrix calculations for each criterion are presented in Table 6 below.

Table 6. Normalized Decision Matrix

Code	Alternative Data	C1	C2	C3	C4	C5
A1	Harum Solok Rice	0.3665	0.3974	0.2828	0.2774	0.1715
A2	Bujang Marantau Rice	0.2443	0.2649	0.4243	0.2774	0.3430
A3	Anak Daro Rice	0.3665	0.3974	0.2828	0.2774	0.3430
A4	Gadang Rumpun Kambayau Rice	0.3665	0.2649	0.2828	0.4160	0.3430
A5	Saganggam Panuah Rice	0.3665	0.2649	0.2828	0.2774	0.3430
A6	Sigudang Rice	0.3665	0.2649	0.2828	0.4160	0.3430
A7	Kuruik Kusuik Rice	0.3665	0.3974	0.4243	0.2774	0.3430
A8	Ceredek Merah Rice	0.1222	0.1325	0.2828	0.2774	0.1715
A9	Siarang Rice	0.2443	0.2649	0.2828	0.4160	0.3430
A10	Ampek Angkek Rice	0.2443	0.3974	0.2828	0.1387	0.3430

3.7 Weighted Normalization Matrix (Y)

After obtaining the results of the matrix normalization, the weighted normalization matrix is calculated by multiplying the values in the normalized matrix by the weight values for each criterion as follows.

1. The result of multiplying the weight 0.30 on the C1 criterion by the Normalized Matrix
   $y_{11} = w_1 \times r_{11} = 0.30 \times 0.3665 = 0.1100$
   $y_{21} = w_1 \times r_{21} = 0.30 \times 0.2443 = 0.0733$
   $y_{31} = w_1 \times r_{31} = 0.30 \times 0.3665 = 0.1100$
   $y_{41} = w_1 \times r_{41} = 0.30 \times 0.3665 = 0.1100$
   $y_{51} = w_1 \times r_{51} = 0.30 \times 0.3665 = 0.1100$
   $y_{61} = w_1 \times r_{61} = 0.30 \times 0.3665 = 0.1100$
   $y_{71} = w_1 \times r_{71} = 0.30 \times 0.3665 = 0.1100$
   $y_{81} = w_1 \times r_{81} = 0.30 \times 0.1222 = 0.0367$
   $y_{91} = w_1 \times r_{91} = 0.30 \times 0.2443 = 0.0733$
   $y_{101} = w_1 \times r_{101} = 0.30 \times 0.2443 = 0.0733$

2. The result of multiplying the weight 0.25 on the C2 criterion by the Normalized Matrix
   $y_{12} = w_2 \times w_{12} = 0.25 \times 0.3974 = 0.0993$
   $y_{22} = w_2 \times r_{22} = 0.25 \times 0.2649 = 0.0662$
   $y_{32} = w_2 \times r_{32} = 0.25 \times 0.3974 = 0.0993$
   $y_{42} = w_2 \times r_{42} = 0.25 \times 0.2649 = 0.0662$
   $y_{52} = w_2 \times r_{52} = 0.25 \times 0.2649 = 0.0662$
   $y_{62} = w_2 \times r_{62} = 0.25 \times 0.2649 = 0.0662$
   $y_{72} = w_2 \times r_{72} = 0.25 \times 0.3974 = 0.0993$
   $y_{82} = w_2 \times r_{82} = 0.25 \times 0.1325 = 0.0331$
   $y_{92} = w_2 \times r_{92} = 0.25 \times 0.2649 = 0.0662$
   $y_{102} = w_2 \times r_{102} = 0.25 \times 0.3974 = 0.0993$

3. The result of multiplying the weight 0.20 on the C3 criterion by the Normalized Matrix
   $y_{13} = w_3 \times r_{13} = 0.20 \times 0.2828 = 0.0566$
   $y_{23} = w_3 \times r_{23} = 0.20 \times 0.4243 = 0.0849$
   $y_{33} = w_3 \times r_{33} = 0.20 \times 0.2828 = 0.0566$

$y_{43} = w_3 \text{ x } r_{43} = 0.20 \text{ x } 0.2828 = 0.0566$
$y_{53} = w_3 \text{ x } r_{53} = 0.20 \text{ x } 0.2828 = 0.0566$
$y_{63} = w_3 \text{ x } r_{63} = 0.20 \text{ x } 0.2828 = 0.0566$
$y_{73} = w_3 \text{ x } r_{73} = 0.20 \text{ x } 0.4243 = 0.0849$
$y_{83} = w_3 \text{ x } r_{83} = 0.20 \text{ x } 0.2828 = 0.0566$
$y_{93} = w_3 \text{ x } r_{93} = 0.20 \text{ x } 0.2828 = 0.0566$
$y_{103} = w_3 \text{ x } r_{103} = 0.20 \text{ x } 0.2828 = 0.0566$

4. The result of multiplying the weight 0.15 on the C4 criterion by the Normalized Matrix
$y_{14} = w_4 \text{ x } r_{14} = 0.15 \text{ x } 0.2774 = 0.0416$
$y_{24} = w_4 \text{ x } r_{24} = 0.15 \text{ x } 0.2774 = 0.0416$
$y_{34} = w_4 \text{ x } r_{34} = 0.15 \text{ x } 0.2774 = 0.0416$
$y_{44} = w_4 \text{ x } r_{44} = 0.15 \text{ x } 0.4160 = 0.0624$
$y_{54} = w_4 \text{ x } r_{54} = 0.15 \text{ x } 0.2774 = 0.0416$
$y_{64} = w_4 \text{ x } r_{64} = 0.15 \text{ x } 0.4160 = 0.0624$
$y_{74} = w_4 \text{ x } r_{74} = 0.15 \text{ x } 0.2774 = 0.0416$
$y_{84} = w_4 \text{ x } r_{84} = 0.15 \text{ x } 0.2774 = 0.0416$
$y_{94} = w_4 \text{ x } r_{94} = 0.15 \text{ x } 0.4160 = 0.0624$
$y_{104} = w_4 \text{ x } r_{104} = 0.15 \text{ x } 0.1387 = 0.0208$

5. The result of multiplying the weight 0.10 on the C5 criterion by the Normalized Matrix

$y_{15} = w_5 \text{ x } r_{15} = 0.10 \text{ x } 0.1715 = 0.0171$
$y_{25} = w_5 \text{ x } r_{25} = 0.10 \text{ x } 0.3430 = 0.0343$
$y_{35} = w_5 \text{ x } r_{35} = 0.10 \text{ x } 0.3430 = 0.0343$
$y_{45} = w_5 \text{ x } r_{45} = 0.10 \text{ x } 0.3430 = 0.0343$
$y_{55} = w_5 \text{ x } r_{55} = 0.10 \text{ x } 0.3430 = 0.0343$
$y_{65} = w_5 \text{ x } r_{65} = 0.10 \text{ x } 0.3430 = 0.0343$
$y_{75} = w_5 \text{ x } r_{75} = 0.10 \text{ x } 0.3430 = 0.0343$
$y_{85} = w_5 \text{ x } r_{85} = 0.10 \text{ x } 0.1715 = 0.0171$
$y_{95} = w_5 \text{ x } r_{95} = 0.10 \text{ x } 0.3430 = 0.0343$
$y_{105} = w_5 \text{ x } r_{105} = 0.10 \text{ x } 0.3430 = 0.0343$

Based on the overall calculations for each alternative, criteria and weight, the results of the weighted normalized decision matrix are obtained in Table 7 as follows.

Table 7. Weighted Normalized Decision Matrix

Code	Alternative Data	C1	C2	C3	C4	C5
A1	Harum Solok Rice	0.1100	0.0993	0.0566	0.0416	0.0171
A2	Bujang Marantau Rice	0.0733	0.0662	0.0849	0.0416	0.0343
A3	Anak Daro Rice	0.1100	0.0993	0.0566	0.0416	0.0343
A4	Gadang Rumpun Kambayau Rice	0.1100	0.0662	0.0566	0.0624	0.0343
A5	Saganggam Panuah Rice	0.1100	0.0662	0.0566	0.0416	0.0343
A6	Sigudang Rice	0.1100	0.0662	0.0566	0.0624	0.0343
A7	Kuruik Kusuik Rice	0.1100	0.0993	0.0849	0.0416	0.0343
A8	Ceredek Merah Rice	0.0367	0.0331	0.0566	0.0416	0.0171
A9	Siarang Rice	0.0733	0.0662	0.0566	0.0624	0.0343
A10	Ampek Angkek Rice	0.0733	0.0993	0.0566	0.0208	0.0343

3.8 Determining Positive (A+) and Negative (A-) Ideal Solutions

The determination of the positive and negative ideal solution matrices is obtained from the normalized weight matrix. The requirement is to be able to calculate the ideal solution value by first determining whether it is a benefit or a cost. In this study, the benefit criteria are C1 and C2, while the cost criteria are C3, C4, and C5. The results obtained in determining the positive and negative ideal solutions based on the type of criteria are presented in Table 8 below.

Table 8. Positive (A+) and Negative (A-) Ideal Solution Matrix

	Ideal Solution										Max (A+)	Min (A-)
Y1	0.1100	0.0733	0.1100	0.1100	0.1100	0.1100	0.1100	0.0367	0.0733	0.0733	**0.1100**	**0.0367**
Y2	0.0993	0.0662	0.0993	0.0662	0.0662	0.0662	0.0993	0.0331	0.0662	0.0993	**0.0993**	**0.0331**
Y3	0.0566	0.0849	0.0566	0.0566	0.0566	0.0566	0.0849	0.0566	0.0566	0.0566	**0.0566**	**0.0849**
Y4	0.0416	0.0416	0.0416	0.0624	0.0416	0.0624	0.0416	0.0416	0.0624	0.0208	**0.0208**	**0.0624**
Y5	0.0171	0.0343	0.0343	0.0343	0.0343	0.0343	0.0343	0.0171	0.0343	0.0343	**0.0171**	**0.0343**

3.9 Determining the Ideal Positive (D+) and Negative (D-) Distance

1. Positive Ideal Distance (D+)

$D_1+=$
$\sqrt{\{(0.1100 - 0.1100)^2 + (0.0993 - 0.0993)^2 + (0.0566 - 0.0566)^2 + (0.0416 - 0.0208)^2 + (0.0171 - 0.0171)^2\}}$

$= \sqrt{\{(0)^2 + (0)^2 + (0)^2 + (0.0208)^2 + (0)^2\}} = \sqrt{\{0.00043264\}} = 0.0208$

$D_2+=$
$\sqrt{\{(0.0733 - 0.1100)^2 + (0.0662 - 0.0993)^2 + (0.0849 - 0.0566)^2 + (0.0416 - 0.0208)^2 + (0.0343 - 0.0171)^2\}}$

$= \sqrt{\{(-0.367)^2 + (-0.0331)^2 + (0.0283)^2 + (0.0208)^2 + (0.0172)^2\}} = \sqrt{\{0.003973\}} = 0.0630$

$D_3+=$
$\sqrt{\{(0.1100 - 0.1100)^2 + (0.0993 - 0.0993)^2 + (0.0566 - 0.0566)^2 + (0.0416 - 0.0208)^2 + (0.0343 - 0.0171)^2\}}$

$= \sqrt{\{(0)^2 + (0)^2 + (0)^2 + (0.0208)^2 + (0.0172)^2\}} = \sqrt{\{0.00072848\}} = 0.0270$

$D_4+=$
$\sqrt{\{(0.1100 - 0.1100)^2 + (0.0662 - 0.0993)^2 + (0.0566 - 0.0566)^2 + (0.0624 - 0.0208)^2 + (0.0343 - 0.0171)^2\}}$

$= \sqrt{\{(0)^2 + (-0.0331)^2 + (0)^2 + (0.0416)^2 + (0.0172)^2\}} = \sqrt{\{0.00043264\}} = 0.0559$

$D_5+=$
$\sqrt{\{(0.1100 - 0.1100)^2 + (0.0662 - 0.0993)^2 + (0.0566 - 0.0566)^2 + (0.0416 - 0.0208)^2 + (0.0343 - 0.0171)^2\}}$

$= \sqrt{\{(0)^2 + (-0.0331)^2 + (0)^2 + (0.0208)^2 + (0.0172)^2\}} = \sqrt{\{0.001825\}} = 0.0427$

$D_6+=$
$\sqrt{\{(0.1100 - 0.1100)^2 + (0.0662 - 0.0993)^2 + (0.0566 - 0.0566)^2 + (0.0624 - 0.0208)^2 + (0.0343 - 0.0171)^2\}}$

$= \sqrt{\{(0)^2 + (-0.0331)^2 + (0)^2 + (0.0416)^2 + (0.0172)^2\}} = \sqrt{\{0.003122\}} = 0.0559$

$D_7+=$
$\sqrt{\{(0.1100 - 0.1100)^2 + (0.0993 - 0.0993)^2 + (0.0849 - 0.0566)^2 + (0.0416 - 0.0208)^2 + (0.0343 - 0.0171)^2\}}$

$= \sqrt{\{(0)^2 + (0)^2 + (0.0283)^2 + (0.0208)^2 + (0.0172)^2\}} = \sqrt{\{0.001530\}} = 0.0391$

$D_8+=$
$\sqrt{\{(0.0367 - 0.1100)^2 + (0.0331 - 0.0993)^2 + (0.0566 - 0.0566)^2 + (0.0416 - 0.0208)^2 + (0.0171 - 0.0171)^2\}}$

$= \sqrt{\{(-0.0733)^2 + (-0.0662)^2 + (0)^2 + (0.0208)^2 + (0)^2\}} = \sqrt{\{0.010188\}} = 0.0101$

$D_9+=$
$\sqrt{\{(0.0733 - 0.1100)^2 + (0.0662 - 0.0993)^2 + (0.0566 - 0.0566)^2 + (0.0624 - 0.0208)^2 + (0.0343 - 0.0171)^2\}}$

$= \sqrt{\{(-0.0367)^2 + (-0.0331)^2 + (0)^2 + (0.0416)^2 + (0.0172)^2\}} = \sqrt{\{0.004469\}} = 0.0668$

$D_{10}+=$
$\sqrt{\{(0.0733 - 0.1100)^2 + (0.0993 - 0.0993)^2 + (0.0566 - 0.0566)^2 + (0.0208 - 0.0208)^2 + (0.0343 - 0.0171)^2\}}$

$= \sqrt{\{(-0.0367)^2 + (0)^2 + (0)^2 + (0)^2 + (0.0172)^2\}} = \sqrt{\{0.001643\}} = 0.0405$

2. Negative Ideal Distance (D-)

$D_1-=$
$\sqrt{\{(0.1100 - 0.0367)^2 + (0.0993 - 0.0331)^2 + (0.0566 - 0.0849)^2 + (0.0416 - 0.0624)^2 + (0.0171 - 0.0343)^2\}}$

$= \sqrt{\{(0.0733)^2 + (0.0662)^2 + (-0.0283)^2 + (-0.0208)^2 + (-0.0172)^2\}} = \sqrt{\{0.0112847\}} = 0.1062$

$D_2-=$
$\sqrt{\{(0.0733 - 0.0367)^2 + (0.0662 - 0.0331)^2 + (0.0849 - 0.0849)^2 + (0.0416 - 0.0624)^2 + (0.0343 - 0.0343)^2\}}$

$= \sqrt{\{(-0.366)^2 + (-0.0331)^2 + (0)^2 + (-0.0208)^2 + (0)^2\}} = \sqrt{\{0.00286781\}} = 0.0536$

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$D_3 -=$
$\sqrt{\{(0.1100 - 0.0367)^2 + (0.0993 - 0.0331)^2 + (0.0566 - 0.0849)^2 + (0.0416 - 0.0624)^2 + (0.0343 - 0.0343)^2\}}$
$= \sqrt{\{(0.0733)^2 + (0.0662)^2 + (-0.0283)^2 + (-0.0208)^2 + (0)^2\}} = \sqrt{\{0.01098886\}} = 0.1048$

$D_4 -=$
$\sqrt{\{(0.1100 - 0.0367)^2 + (0.0662 - 0.0331)^2 + (0.0566 - 0.0849)^2 + (0.0624 - 0.0624)^2 + (0.0343 - 0.0343)^2\}}$
$= \sqrt{\{(0.0733)^2 + (0.0331)^2 + (-0.0283)^2 + (0)^2 + (0)^2\}} = \sqrt{\{0.00726939\}} = 0.0853$

$D_5 -=$
$\sqrt{\{(0.1100 - 0.0367)^2 + (0.0662 - 0.0331)^2 + (0.0566 - 0.0849)^2 + (0.0416 - 0.0624)^2 + (0.0343 - 0.0343)^2\}}$
$= \sqrt{\{(0.0733)^2 + (0.0331)^2 + (-0.0283)^2 + (-0.0208)^2 + (0)^2\}} = \sqrt{\{0.00770203\}} = 0.0878$

$D_6 -=$
$\sqrt{\{(0.1100 - 0.0367)^2 + (0.0662 - 0.0331)^2 + (0.0566 - 0.0849)^2 + (0.0624 - 0.0624)^2 + (0.0343 - 0.0343)^2\}}$
$= \sqrt{\{(0.0733)^2 + (0.0331)^2 + (-0.0283)^2 + (0)^2 + (0)^2\}} = \sqrt{\{0.00726939\}} = 0.0853$

$D_7 -=$
$\sqrt{\{(0.1100 - 0.0367)^2 + (0.0993 - 0.0331)^2 + (0.0849 - 0.0849)^2 + (0.0416 - 0.0624)^2 + (0.0343 - 0.0343)^2\}}$
$= \sqrt{\{(0.0733)^2 + (0.0662)^2 + (0)^2 + (-0.0208)^2 + (0)^2\}} = \sqrt{\{0.01018797\}} = 0.1010$

$D_8 -=$
$\sqrt{\{(0.0367 - 0.0367)^2 + (0.0331 - 0.0331)^2 + (0.0566 - 0.0849)^2 + (0.0416 - 0.0624)^2 + (0.0171 - 0.0343)^2\}}$
$= \sqrt{\{(0)^2 + (0)^2 + (-0.0283)^2 + (-0.0208)^2 + (-0.0172)^2\}} = \sqrt{\{0.00152937\}} = 0.0391$

$D_9 -=$
$\sqrt{\{(0.0733 - 0.0367)^2 + (0.0662 - 0.0331)^2 + (0.0566 - 0.0849)^2 + (0.0624 - 0.0624)^2 + (0.0343 - 0.0343)^2\}}$
$= \sqrt{\{(0.0366)^2 + (0.0331)^2 + (-0.0283)^2 + (0)^2 + (0)^2\}} = \sqrt{\{0.00323606\}} = 0.0569$

$D_{10} -=$
$\sqrt{\{(0.0733 - 0.0367)^2 + (0.0993 - 0.0331)^2 + (0.0566 - 0.0849)^2 + (0.0208 - 0.0624)^2 + (0.0343 - 0.0343)^2\}}$
$= \sqrt{\{(0.0366)^2 + (0.0662)^2 + (-0.0283)^2 + (-0.0416)^2 + (0)^2\}} = \sqrt{\{0.00825445\}} = 0.0909$

3.10 Calculate the Preference Score (V)

At this stage, the calculation is carried out by dividing the negative ideal distance value (D-) by the sum of the negative ideal distance value and the positive ideal distance value (D+). The results obtained in determining the preference value for each alternative can be seen as follows:

$$V_1 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.1062}{0.1062 + 0.0208} = \frac{0.1062}{0.127} = 0.8363$$

$$V_2 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.0536}{0.0536 + 0.0630} = \frac{0.0536}{0.1166} = 0.4597$$

$$V_3 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.1048}{0.1048 + 0.0270} = \frac{0.1048}{0.1318} = 0.7955$$

$$V_4 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.0853}{0.0853 + 0.0559} = \frac{0.0853}{0.1412} = 0.6041$$

$$V_5 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.0878}{0.0878 + 0.0427} = \frac{0.0878}{0.1305} = 0.6727$$

$$V_6 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.0853}{0.0853 + 0.0559} = \frac{0.0853}{0.1412} = 0.6041$$

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$$V_7 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.1010}{0.1010 + 0.0391} = \frac{0.1010}{0.1401} = 0.7210$$

$$V_8 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.0391}{0.0391 + 0.1010} = \frac{0.0391}{0.1401} = 0.2790$$

$$V_9 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.0569}{0.0569 + 0.0668} = \frac{0.0569}{0.1237} = 0.4600$$

$$V_{10} = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.0909}{0.0909 + 0.0405} = \frac{0.0909}{0.1314} = 0.6919$$

Based on the calculation of the preference value for each alternative, a ranking result was obtained, ranging from the highest to the lowest total value, and the order of ranking for rice with the best quality is presented in Table 9, as follows.

Table 9. Best Quality Rice Ranking Results

Code	Rice Name	Total	Score
A1	Harum Solok Rice	**0.8363**	**1**
A3	Anak Daro Rice	**0.7955**	**2**
A7	Kuruik Kusuik Rice	**0.7210**	**3**
A10	Ampek Angkek Rice	**0.6919**	**4**
A5	Saganggam Panuah Rice	**0.6727**	**5**
A6	Sigudang Rice	0.6041	6
A4	Gadang Rumpun Kambayau Rice	0.6041	6
A9	Siarang Rice	0.4600	8
A2	Padi Bujang Marantau Rice	0.4597	9
A8	Ceredek Merah Rice	0.2790	10

Table 9 shows that there are five types of rice with the highest scores, namely Harum Solok Rice (0.8363), Anak Daro Rice (0.7955), Kuruik Kusuik Rice (0.7210), Ampek Angkek Rice (0.6919), and Saganggam Panuah Rice (0.6727). Based on the ranking results, it can be concluded that measuring rice quality can be done using the TOPSIS method. The results obtained can be used as a reference in decision-making by interested parties.

4. CONCLUSION

According to the data, Milling Degree (C1) had the most weight and consistently distinguished the options, making it the most significant factor influencing the final ranking. Despite their importance, criteria such as Broken Grain (C4) and Grit Grain (C5) had a relatively reduced effect on the final preference values due to their lower weights. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approach has been used to create a decision support system for steaming high-quality rice. Ten different data sets and five primary criteria that were weighted based on significance were used in the study. Five rice varieties with the best scores—A1, A3, A7, A10, and A5—were successfully identified by the TOPSIS approach. Future research must address the limitations of this study, such as incorporating alternative data from locations other than West Sumatra. To get more precise findings, the criteria can be broadened, and the method of determining the weights for each criterion can be improved by involving a number of subject-matter experts. Additionally, creating a user-friendly.

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