Implementation of AHP and Topsis Methods to Determine the Ability of Farmer Groups

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Abstract- **Farmersmall in developing countries are besieged by many constraints such as constraints the yield of that crop low, limited access to credit and extension services, low capacity of farmers and slow transfer of technology and information (Markelova et al., 2009).Efforts to develop farmer groups in Indonesia have been going on since the Dutch colonial era. Meanwhile, the condition of the farmer groups from year to year can be said to have not experienced the development as expected or can be said to be stationary or even declining.From the problems of farmer groups, it is necessary to have a comprehensive evaluation of the development of farmer groups. Evaluation of the development of farmer groups is carried out based on the relevant group management criteria for a farmer group. The criteria for the ability class in farmer groups to be evaluated are (a) planning, (b) organizing, (c) implementation, (d) controlling and reporting, (e) developing farmer group leadership.To solve the problems mentioned above, you can use a mThe method that is often applied in decision support systems, namely AHP, various decision support systems have been widely applied in the industrial world. Basically it refers to the evaluation of a number of criteria, to evaluate a number of existing criteria the AHP method is used which is able to approach the assessment of qualitative criteria and quantitative criteria.The results of the evaluation phase are then prioritized. Prioritization is determined because of the large number of farmer groups in Indonesia and limited human resources in an effort to improve the quality of farmer groups. Priority determination is done by implementing the AHP and TOPSIS methods. The results of the calculation using this method will obtain the ranking of the performance / ability of farmer groups in managing their farmer groups. The priority for increasing the capacity of farmer groups is focused on farmer groups that have low scores. The existence of the SPK application makes it easier to determine the class of farmer groups quickly and better based on processed data.**

Keywords- AHP; TOPSIS; Decission Support System.

I. INTRODUCTION

Small farmers in developing countries are beset by many constraints such as low yields, limited access to credit and extension services, low farmer capacity and slow transfer of technology and information (Markelova et al., 2009). These constraints stimulate the interest of governments, development agencies and developing agribusiness companies to form farmer groups as an important step in facilitating effective and efficient smallholder participation in the agricultural food value chain, so as to improve rural development, reduce poverty, increase productivity and food security through their role (Verhofstadt and Maertens, 2014).

Efforts to develop farmer groups in Indonesia have been going on since the Dutch colonial era. At that time in West Java, for example, it was known as Rukun Tani, and in East Java Kring Tani. During the New Order era, the development of farmer groups was carried out intensively, so that the number of farmers continued to increase every year. In 1993 the farmer groups in the last four years there was an increase in the number of 89,139 (33.57%).

From the problems of farmer groups, it is necessary to have a comprehensive evaluation of the development of farmer groups. Evaluation of the development of farmer groups is a step in increasing the ability class of farmer groups. Evaluation of the development of farmer groups is carried out based on the relevant group management criteria for a farmer group. The criteria for the ability class of farmer groups to be evaluated are (a) planning, (b) organizing, (c) implementation, (d) controlling and reporting, (e) developing farmer group leadership.

The results of the evaluation phase are then prioritized. Prioritization is determined because of the large number of farmer groups in Indonesia and limited human resources in an effort to improve the quality of farmer groups. Priority determination is done by implementing the AHP and TOPSIS methods. The results of the calculation using this method will obtain the ranking of the performance / ability of farmer groups in managing their farmer groups. The priority for increasing the capacity of farmer groups is focused on farmer groups that have low scores.

II. THEORETICAL FRAMEWORK

A. Former Study

Research in evaluating performance using the Fuzzy AHP and TOPSIS methods was also conducted. The Turkish banking sector authorities carry out checks on the performance of commercial banks. The performance of these banks is evaluated against several matters related to financial and non-financial indicators. The integration of the Fuzzy AHP and TOPSIS methods is proposed in this evaluation. After the weight of each criterion is determined based on the opinion of experts using the Fuzzy AHP method, the weight is then input into the TOPSIS method for ranking. In order to obtain a ranking list of banks that need to be improved in performance (Secme et al., 2009).

Other research related to performance measurement was also carried out, which combined service quality in performance measurement by proposing a combined method, namely the FAHP, TOPSIS and DEA methods applied to the Turkish electricity distribution market. With the FAHP method, the relative importance of different quality indicators is determined. Meanwhile, the TOPSIS method is used to generate service quality variables. And finally this variable is used as output in the DEA stage, which displays the efficiency of electricity distribution (Celen and Yalcin, 2012).

B. Decision Support System

Decision Support Systems (DSS) are interactive computer-based systems that help decision makers use data and various models in solving semi-structured problems. DSS aims as a system to support managerial decisions in semi-structured decision situations. DSS is intended to be an adjunct for decision makers to expand decision-making capabilities, but not to replace the judgment of decision makers (Turban et al., 2007).

C. AHP Method

The AHP method allows the user to provide the relative weight value of a compound criterion or multiple alternatives to a criterion intuitively by performing pairwise comparisons. Saaty then determines a consistent way to convert pairwise comparisons into a set of numbers that represent the relative priority of each criterion and alternative.

Problem solving in decision making using the AHP method has several advantages, including:

1. Complexity: the AHP method combines deductive design and systems-driven design in solving complex problems.
2. Unity: the AHP method provides a single, easy-to-understand model for unstructured and semi-structured problems.
3. Interdependence: the AHP method can handle elements that are dependent on one another and does not impose linear equations.
4. Synthesis: the AHP method leads to a comprehensive assessment of the merits of each alternative.
5. Bargaining: the AHP method considers the relative priorities of various factors and allows decision-making to choose alternatives based on their individual objectives.

AHP Basic Principles

There are several principles that must be understood in solving problems using AHP, namely (Saaty, 1990):

1. Hierarchy Arrangement

   The problems to be resolved are broken down into their elements, namely criteria and alternatives, then arranged into a hierarchical structure, thus making it easier to make decisions to analyze and draw conclusions on these problems. The hierarchical structure can be shown in Figure 1.

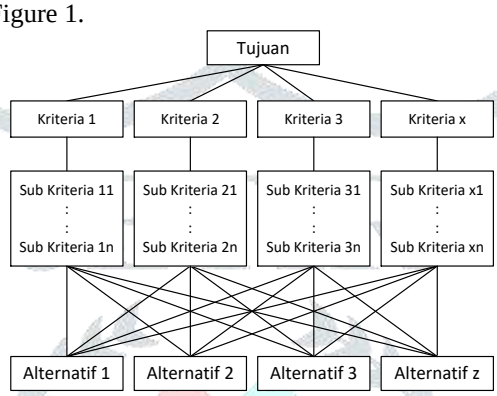

Figure 1 Hierarchical Structure

2. Assessment Criteria and Alternatives

   Criteria and alternatives are assessed through pairwise comparisons. For many problems, a scale of 1 to 9 is the best scale for expressing opinions. The values and quality opinion definitions of the Saaty comparison scale are shown in Table 1 below (Saaty, 1990):

TABEL 1
PAIRWISE COMPARISON SCALE

Level of Importance	Definition	Information
1	Just as important	Elements 1 and 2 are equally important
3	Quite important	Element 1 is quite important over Element 2
5	More important	Element 1 is more important than Element 2
7	Very important	Element 1 is very important over Element 2
9	Absolutes are more important	Element 1 is absolutely more important than Element 2
2,4,6,8	The values between two adjacent considerations	This value is given when there are two components between the two choices
The opposite	If for activity i gets one point compared to activity j, then j has the opposite value compared to i.	

Source: Saaty (1990)

The pairwise comparison process, starting from the top level of the hierarchy which is shown to select criteria, for example a, then takes the elements to be compared, for example a1, a2 and a3. Then the arrangement of the elements to be compared is as shown in Table 2 below:

TABEL 2
PAIRWISE COMPARISON MATRIX

	a_1	a_2	a_3	...	a_n
a_1	1	a_{12}	a_{13}	...	1 / a1n
a_2	$1 / a_{21}$	1	a_{23}	...	1 / a2n
a_3	1 / a31	1 / a32	1	...	1 / a3n
⋮	⋮	⋮	⋮	1	⋮
a_n	1 / an1	1 / an2	1 / an3	...	1

To determine the relative importance value between elements a number scale from 1 to 9 is used as shown in Table 2.2. This assessment is carried out by a decision maker who is an expert in the area of the problem being analyzed and has an interest in it (Kusumadewi, 2006).

When the element is compared to itself, it is given a value of 1. If element i is compared to element j gets a certain value, then element j compared to the value of i will get the opposite value.

3. Prioritization

   For each criterion and alternative it is necessary to make pairwise comparisons. The relative comparison values are then processed to determine the alternative rank of all alternatives. Considerations for pairwise comparisons are synthesized to obtain overall priority through the following stages:
   a. Sum the values for each column in the Pairwise Comparison Matrix.
   b. Divide the Aij value in each column by the number in the column in order to obtain a normalized matrix.
   c. Add the value for each row of the normalized matrix and divide by the number of elements per row. The results of the division show the overall priority value for each element.
4. Logical Consistency

   In making decisions, it is important to know how good the consistency is because we don't want decisions based on comparisons with low consistency. The things that are done in this step are:
   a. Multiply each value in the first column by the relative priority of the first element, the value in the second column by the relative priority of the second element and so on.
   b. Add up each row.
   c. The sum of the rows divided by the corresponding relative priority element.
   d. Adding the quotient by the number of elements present, the result is called λmaks with equation 2.1 below:

$$\lambda_{\text{maks}} = \sum_{j=i}^{n} \boldsymbol{a_{ij}} \frac{\boldsymbol{w_j}}{\boldsymbol{w_i}} \tag{2.1}$$

   where λmaks represents the largest eigenvalue of the n order of the matrix, wij represents the weight of the matrix and aij is the value (for i, j = 1,2,3, ..., n).
5. The largest eigenvalues are obtained by summing the multiplication of the number of columns with the eigenvector. The inconsistency limit is measured using the consistency ratio (CR), which is the comparison of the consistency index (CI) with the random consistency (IR) value of the consistency index. This value depends on the matrix order n.
6. Calculate the consistency index (CI) with equation 2.2. following:

$$CI = \frac{\lambda maks - n}{n-1} \tag{2.2}$$

   with CI stating the Consistency Index, *λmax*is the oxygen value and n represents the many elements.
7. Calculate the consistency ratio (CR) with the formula:

$$CR = \frac{CI}{IR} \tag{2.3}$$

   where CR stands for Consistency Ratio, CI represents Consistency Index and IR is *Index Random Consistency.*

   The Random Consistency Index value is an index issued to determine the IR value, for the table the value is obtained with IR = and determines the IR value according to the size of the respective matrix shown in Table 3 below:$\frac{1.98(n-2)}{n}$

TABEL 3
INDEX RANDOM CONSISTENCY

N	1	2	3	4	5	6	7	8	9	10	11	12	13
IR	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56

Source: Saaty (1990)

where N represents the number of dimensions and IR is *Index Random Consistency.*

8. Check hierarchy consistency

   Measuring consistency in making decisions is important to find out how good the consistency is because you don't want decisions based on considerations with low consistency. Due to low consistency, the judgment will appear random and inaccurate. Consistency is important for getting valid results in the real world. AHP measures the consistency of consideration with the consistency ratio.

D. Topsis Method

The TOPSIS method is an approach to solving multi-criteria problems. The TOPSIS method is based on the concept that the best chosen alternative not only has the shortest distance from the positive ideal solution but also has the longest distance from the negative ideal solution (Kusumadewi, 2006).

The TOPSIS method has the following steps:

1. Decision Matrix

   The decision matrix is a matrix whose side is the value of each criterion for each alternative. If A is an alternative and C is a defined criterion if X is an attribute of the criterion, then to represent the alternative decision the criteria are shown in Table 4.

TABEL 4
CRITERIA ALTERNATIVE DECISSION MATRIX TABLE

Alternative	Criteria					
	C1	C2	C3	....	Cj	Cn
A1	X1,1	X1,2	X1,3	....	X1, j	X1, n
A2	X2,1	X2,2	X2,3	....	X2, j	X2, n
:	:	:	:	:	:	:
:	:	:	:	:	:	:
Ai	Xi, 1	Xi, 2	Xi, 3	....	Xi, j	Xi, n
Am	Xm, 1	Xm, 2	Xm, 3	....	Xm, j	Xm, n

Information :

C_1 ..... Cn = Criteria

A_1 ..... Am = Alternative

The form of the decision from Table 5, namely:

TABEL 5
DECISSION MATRIX

		X1	X2	X3	....	Xj	Xn
X =	**a1**	X1,1	X1,2	X1,3	....	X1, j	X1, n
	a2	X2,1	X2,2	X2,3	....	X2, j	X2, n
	:	:	:	:	:	:	:
	:	:	:	:	:	:	:
	ai	Xi, 1	Xi, 2	Xi, 3	....	Xi, j	Xi, n
	am	Xm, 1	Xm, 2	Xm, 3	....	Xm, j	Xm, n

2. Determining the TOPSIS normalized decision matrix requires a performance ranking of each alternative Ai on each normalized Cj criterion which is calculated using the formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{2.4}$$

with rij stating the normalized performance rating value and xij is the value of each alternative on each criterion.

3. Calculates a weighted normalized decision matrix

$$Y_{ij} = W_i r_{ij} \tag{2.5}$$

where Wi states the weight value of each criterion, and rij is the normalized performance rating value.

4. Calculating a positive ideal solution matrix and a negative ideal solution matrix A + positive ideal solution and A- negative ideal solution can be determined based on the normalized weight rating (Yij).

$$A^{\pm} = (y_1^{\pm}, ...,); y_2^{\pm} y_n^{\pm} \tag{2.6}$$

by stating Maxyij if j is an advantage attributey_j^+(benefit), oil if j is a cost attribute. Meanwhile, declaring Min yij if j is a benefit attribute, Minyij if j is a cost attribute.y_j^-

5. Calculating the distance between the weighted value of each alternative to the positive ideal solution and the negative ideal solution.

The distance () between the alternative Ai and the positive ideal solution is formulated as follows:D_i^+

$$D_i^+ = \sqrt{\sum_{j=1}^{m} (y_i^+ - y_{ij}^+)\, 2} \tag{2.7}$$

The distance () between the alternative Ai and the negative ideal solution is formulated as follows:D_i^-

$$D_i^- = \sqrt{\sum_{j=1}^{m} (y_i^- - y_{ij}^-) 2} \tag{2.8}$$

6. Calculate the preference value for each alternative

The preference value for each alternative (Vi) is formulated as follows:

$$v_i = \frac{D_i^-}{D_i^- + D_i^+} \tag{2.9}$$

where i = 1, 2,…, m.

When the alternative has a preference value, then the alternative that has the greatest preference value is the best alternative. Thus the existing alternatives can be ranked based on the preference value of each alternative.

III. RESEARCH METHODS

A. *Materials and Tools*

This research requires data on the level of importance and data on the ability of farmer groups based on criteria. The criteria used are relevant criteria for farmer group coaching carried out by sub-district level agricultural extension agents based on the Minister of Agriculture Regulation No.67 of 2016 concerning Farmers' Institutional Development. These criteria includePlanning, Organizing, Implementing, Controlling and Reporting, Development of farmer group leadershipFrom the 5 criteria, each criterion has sub criteria which in total is 33 sub criteria. The research data was obtained through a questionnaire which was divided between expert respondents and performance evaluator respondents. Expert respondents from the Agricultural Human Resources Development and Extension Agency assessed the criteria by making a pairwise comparison between the criteria. While the performance appraiser respondents came from the Sub-district Level Agricultural Extension Center, the respondents who assessed the ability to evaluate the farmer groups.

The research tools used in this study consisted of hardware and software. The hardware (hardware) and software (software) used are as follows:

1. Hardware (hardware)
   The hardware used is in the form of a laptop unit that has the following specifications: core i7 processor, 4 GB memory, with 500 GB hard disk.
2. Software (software)
   The software used consists of: the Windows 8.1 operating system, the PHP programming language for designing and building systems, MySQL for managing databases and Microsoft Office 2013 for designing and compiling reports.

B. *Research procedure*

In an effort to obtain optimal results, the implementation of this research was carried out through stages as shown in Figure 2.

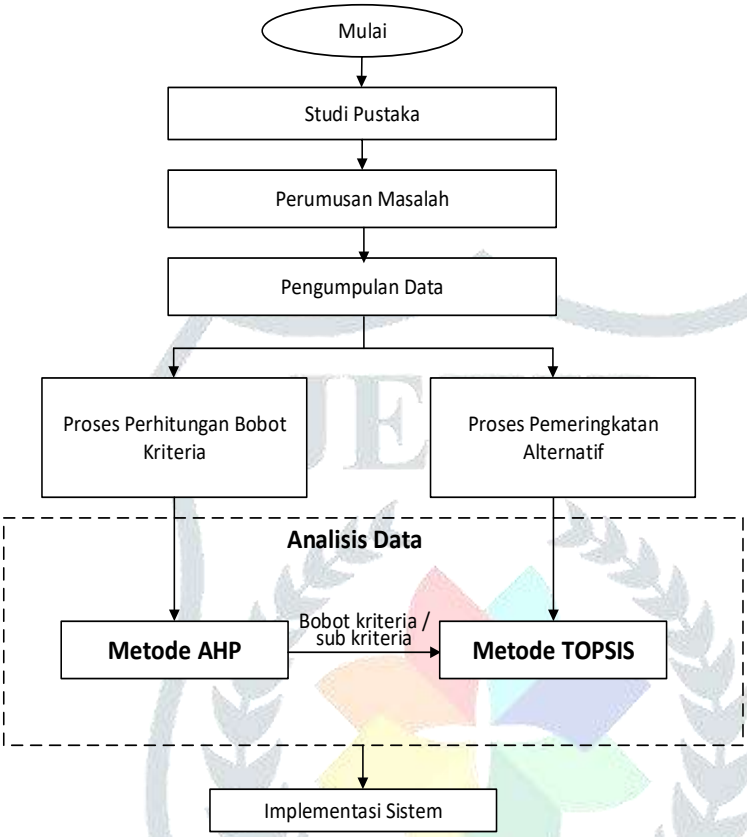

Figure 2 Research procedure

C. *Information Systems Framework*

The information system to be built is shown in Figure 3.

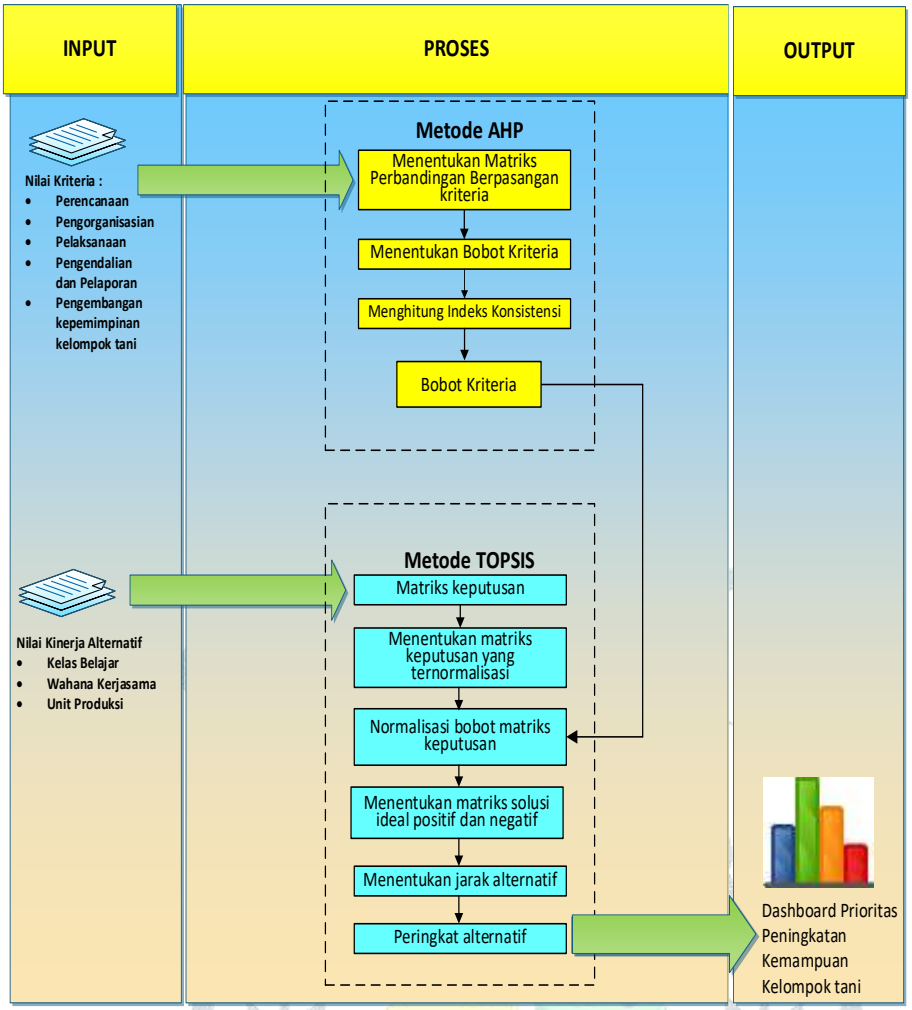

Figure 3 The design of the research information system framework

IV. Results and Discussion

4.1.1. Implementation

The system implementation stage is the process of building a system in accordance with the system design and design that has been previously made. This stage can be divided into several parts according to the functions created.

1. Admin Input Alternative

The main page when the application is run is the input page as follows:

Figure 4 Input page

2. **Admin Login Page**

The results page is a page to see the ranking results, here is a display of the results page:

Figure 5 Results page

4.2. Discussion

4.2.1. Analytical Hierarchy Process (AHP) Method

Determination of criteria is obtained from the existing criteria for farmer groups. Figure 6 shows the hierarchical structure of the problem to be studied, namely determining the best teacher based on several criteria.

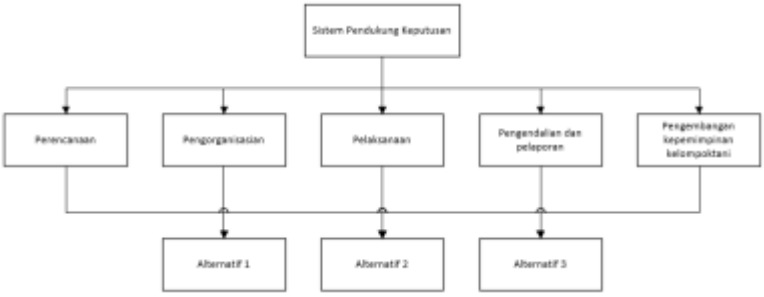

Figure 6 Hierarchical Structure of Farmer Groups

TABEL 6
RANDOM INDEX

Matrix Sequence	1	2	3	4	5	6	7	8	9	10
(RI)	0.00	0.01	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

CI = *Consistency Index*
RI = *Random Index*

With many criteria of 5, then RI = 1.12 (see table 2.3, p.)
Then, CR = 0.086 / 1.12 = 0.07

From the calculation, the CR value is 0.1. Comparative assessment is said to be consistent if the CR value is not greater than 0.1. So that the comparative assessment of the criteria for determining farmer groups does not need to be recalculated

4.2.2. TOPSIS method

In this TOPSIS method, there are two artificial alternatives which are hypothesized, one is the ideal solution, and the other is the negative ideal solution. The basic principle of the TOPSIS method is that the chosen alternative must have the closest distance from the positive ideal solution and the farthest distance from the negative ideal solution. The criteria for assessing camera selection are as follows:

C1 = Planning
C2 = Organizing
C3 = Implementation
C4 = Control and Reporting
C5 = Farmer Group Leadership Development

Rank the suitability of each alternative on each criterion, assessed from 0 to 100.The following table shows the suitability ranking of each alternative for each criterion:

TABEL 7
ALTERNATIVE MATCH RANKING

Alternative	C1	C2	C3	C4	C5
Cimangkok	89	100	270	90	137
Karya Mekar	185	100	400	145	155
Mikro Sejahtera	162	87	336	125	115

After the suitability ranking is filled in, then calculating the normalization of the matrix using equation 5.

$$r = \sqrt{80^2 + 90^2 + 90^2} = 150.33$$

Then count the rows up to row C5, and the results can be seen in the table below:

TABEL 8
RESULT OF SUM OF POWER ROOTS

Alternative	C1	C2	C3	C4	C5
r	261,5148179	166,039152	588,044216	211,541958	236,6833327

The normalization matrix is obtained from dividing table 7 with table 8.Examples of calculations are as follows:
Column value C1 row C1 = 80 / 150.33 = 0.532

TABEL 9
NORMALIZATION MATRIX

Alternative	C1	C2	C3	C4	C5
Cimangkok	0,340	0,602	0,459	0,425	0,579
Karya Mekar	0,707	0,602	0,680	0,685	0,655
Mikro Sejahtera	0,619	0,524	0,571	0,591	0,486

Furthermore, the normalized matrix will be made a weighted normalized matrix. The weighted normalized decision matrix is obtained from the multiplication of previously normalized matrices with quality preferences as in tables 6 and 9. The weighted normalized matrix calculation is as follows:

Column value C1 row C1 = 0.532 x 5.444 = 2.897

Next, calculate the overall value, and the results are as follows:

TABEL 10
WEIGHTED NORMALIZED MATRIX

Alternative	C1	C2	C3	C4	C5
Cimangkok	0,065	0,131	0,042	0,197	0,024
Karya Mekar	0,134	0,131	0,062	0,317	0,027
Mikro Sejahtera	0,118	0,114	0,052	0,273	0,020

Furthermore, from the results of the matrix above, it can be continued with the determination of the ideal solution to the negative and positive solutions. Before finding a solution to the ideal negative and positive solutions, one must determine the minimum and maximum values of each column.

TABEL 11
WEIGHTED NORMALIZED MATRIX

Alternative	C1	C2	C3	C4	C5
Cimangkok	0,065	0,131	0,042	0,197	0,024
Karya Mekar	0,134	0,131	0,062	0,317	0,027
Mikro Sejahtera	0,118	0,114	0,052	0,273	0,020
Max	0,134	0,131	0,062	0,317	0,027
Min	0,065	0,114	0,042	0,197	0,020

$$D + = \sqrt{((0.101 - 0.114)^2 + (0.121 - 0.134)^2 + (0.050 - 0.057)^2 + (0.252 - 0.280)^2 + (0.024 - 0.025)^2}$$
D + = 0.417
$$D - = \sqrt{((0.101 - 0.101)^2 + (0.121 - 0.121)^2 + (0.050 - 0.050)^2 + (0.252 - 0.252)^2 + (0.024 - 0.022)^2}$$
D - = 0.001

Next, calculate the overall value, and the results are as follows:

TABEL 12
ALTERNATIVE D+ AND D-

Alternative	D +	D-
Cimangkok	0,319	0,017
Karya Mekar	0,465	0,142
Mikro Sejahtera	0,416	0,094

Next is to find the final value or preference (vi) for each alternative using equation 13.
Final grade = $\frac{0.001}{0.001+0.417} = 0.003$
Next, calculate the overall value, and the results are as follows:

TABEL 13
THE FINAL RESULT

Alternative	Score	Rank
Alternative 1	0.003	3
Alternative 2	0.055	2
Alternative 3	0.065	1

So from the value obtained, the value of Alternative 3 is the largest value, so that Alternative 3 is chosen as the best farmer group.

CHAPTER V CONCLUSIONS AND SUGGESTIONS

Based on the results of the implementation and trials that have been carried out, it can be concluded that the results of this study are as follows:

1. The existence of the SPK application makes it easier to determine the class of farmer groups quickly and better based on processed data.
2. The Decision Support System (DSS) for determining the class of farmer groups using the AHP and TOPSIS methods has been successfully built to produce more objective decisions in the form of a list of the best alternative rankings.
3. It is easy to determine the Criteria Weight value, so that it is known which criteria are prioritized, and it can be seen that the advantages of each alternative are on certain criteria.

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