Comparison of MAGIQ, MABAC, MARCOS, and MOORA Methods in Multi-Criteria Problems

Gede Dharma Sahasra Muni[1), I Gede Iwan Sudipa[2)*] , Ni Putu Suci Meinarni[3)] , I Komang Arya Ganda Wiguna[4)] , I Made Subrata Sandhiyasa[5)]

[1,2,3,4,5)] Fakultas Teknologi dan Informatika, Program Studi Teknik Informatika, Institut Bisnis dan Teknologi Indonesia

[1)]dharma.a784@gmail.com, [2)]iwansudipa@instiki.ac.id,[3)]sucimeinarni@instiki.ac.id, [4)]kmaryagw@instiki.ac.id,[5)]subrata.sandhiyasa@instiki.ac.id

Abstract: Determining the best alternative from many criteria is one of the core problems in decision making, both routine and non-routine problems. One of them is in the problem of determining egg suppliers. Eggs are one of the basic needs of the community so that the demand for eggs is always increasing, this makes the emergence of many egg agents in distributing and fulfilling needs. Selective and careful selection is needed in order to get a supplier that meets the desired expectations. Problems then arise in the selection of egg suppliers that are not in accordance with the expectations of the manager. In determining egg suppliers that have been carried out by UD Taluh Subur, only by means of a simple comparison between several factors such as price, production quantity, and quality without considering other factors. In addition to this, business managers have limited knowledge in statistical and business decision making. To optimize the supplier selection process, a Decision Support System can be used to help provide recommendations for selecting prospective suppliers of fixed eggs. Based on the situation of decision makers who have limited knowledge in statistical decision making, the MAGIQ method is suitable for weighting. To provide a more accurate ranking, additional methods such as the MABAC, MARCOS, and MOORA methods are used. The purpose of this research is to focus on which method is most recommended for the case study faced in the research based on the analysis results of the sensitivity test. The results of the sensitivity test show that the MAGIQ-MABAC method has the highest value of 4.42737%, then the MAGIQ-MOORA method with a value of 2.34415% and the MAGIQ-MARCOS method with a value of 0.45729%.

Keywords: Method Comparison, Sensitivity Analysis, MADM Method, Multi-Criteria Problems

INTRODUCTION

Determining the best alternative from many criteria is one of the core problems in decision making, both routine and non-routine problems. One of them is the problem of determining egg suppliers. In determining the egg supplier decision, there are many criteria that must be considered, each of these criteria has a different weight and urgency, making the decision process complex (Kharisma, 2021; Putri et al., 2024; Sudipa et al., 2023). Eggs are one of the basic needs of the community that is rich in protein and nutrition. The benefits of eating eggs are that it can maintain eye health, improve brain function, prevent anemia, and strengthen immunity (Kementrian Kesehatan, 2023). In addition to daily consumption, eggs are also used for ceremonial needs, parties, and raw materials in making cakes and

*I Gede Iwan Sudipa
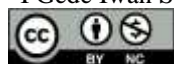
others. Aside from these needs, other factors such as price also make the demand for eggs in the community increase. This has led to the emergence of many egg agents. Egg agents have an important role in distributing and meeting market demand for eggs. The buying and selling activities carried out by agents cannot be separated from the role of suppliers in supplying egg stock (Sukma & Utami, 2022). Therefore, supplier selection is very important to do. Selective and careful selection is needed in order to get a supplier that meets the desired expectations.

UD Taluh Subur is one of the agents that plays a role in distributing and fulfilling the market for eggs in the Buleleng area. Apart from being an egg agent, UD Taluh Subur is also a laying hen farmer that has been established since 2018. UD Taluh Subur's business cannot be separated from the role of suppliers in providing egg stock. Problems then arise in the selection of egg suppliers that are not in accordance with the expectations of the manager. Based on the results of observations and initial interviews that have been conducted with the UD Taluh Subur business manager, that the determination of egg suppliers that has been carried out by UD Taluh Subur has only been carried out by means of a simple comparison between several factors such as price, production quantity, and quality without considering other factors. The results of this comparison make the manager get egg suppliers who have affordable prices but poor quality, good quality but expensive prices, affordable prices and good quality but small production quantities which are not in line with expectations. The obstacle faced by the manager of UD Taluh Subur is he has limited knowledge in statistical and business decision making. The manager's understanding is limited to using experience and business instincts. This makes supplier selection less than optimal. In order to get quality products at competitive prices, the manager must be selective in choosing potential suppliers of eggs. UD Taluh Subur is expected to be able to optimize the egg supplier selection process, Decision Support System (DSS) can be used to help provide recommendations for selecting prospective suppliers of eggs.

DSS is an effective system to address complex decision-making processes. It uses decision-making rules, model analysis, comprehensive databases, knowledge of decision makers, and a more structured approach (Mahendra & Nugraha, 2020; Sudipa et al., 2020). The DSS analysis carried out aims to recommend egg suppliers to decision makers at UD Taluh Subur. Effectiveness in DSS can be realized by applying calculations using methods contained in the realm of MCDM or MADM (Aristamy et al., 2021; Sudipa & Puspitayani, 2019). Methods that have been commonly used which are included in MCDM or MADM, such as AHP, ARAS, BWM, COPRAS, ELECTRE, MAGIQ, MABAC, MARCOS, MOORA, PROMETHEE, SAW, TOPSIS, VIKOR, WPM and others, have successfully solved various problems that produce recommendations. The problem that then arises with the many choices in determining the method, requires a study that is able to provide the right choice of method according to the case study raised. Based on the situation of decision makers who have limited knowledge in statistical decision making, the Multi-Attribute Global Inference of Quality (MAGIQ) method is suitable for use as a weighting. In the research conducted by Rahman et al.(2023) stated that when the MAGIQ method is compared with the AHP method, this method shows a high level of consistency in ranking, this shows that the MAGIQ method has reliability and effectiveness.

To provide a more accurate ranking, using additional methods such as the Multi-Attributive Border Approximation area Comparison (MABAC) method, this method has a simple calculation method so that in determining alternatives this method has a fairly good ability and has high precision (Hasudungan Lubis et al., 2023). Research conducted by Ismail & Hasanah, (2022) conducted accuracy testing which showed the accuracy of the MABAC method was 87.5%. Measurement of Alternatives and Ranking According to the Compromise Solution (MARCOS) method. This method provides a flexible ability to handle complex problems and produce optimal solutions from the available options. Research conducted by Sarja et al. (2021) conducted several tests on the combination of the BMW-MARCOS method, the results obtained were an accuracy value of 74.19%, precision of 81.25%, recall/sensitivity of 72.22% and specificity of 76.92%. Multi-Objective Optimazion method on the basis of Ratio Analysis (MOORA), this method is very simple and easy to implement. Research by Proboningrum & Sidauruk, (2021) conducted confusion matrix testing with an accuracy of 80%. The three methods proposed for ranking such as MABAC, MARCOS, and MOORA, are suitable for calculation and ranking in the case study that will be raised, namely, egg *supplier* recommendations at UD Taluh Subur.

*I Gede Iwan Sudipa

The purpose of this research is to focus on which method is most recommended for the case study faced in the study based on the analysis results of the sesnitivity test. As well as providing recommendations to UD Taluh Subur to choose prospective suppliers of fixed eggs. Sensitivity tests are carried out on a combination of MAGIQ-MABAC, MAGIQ-MARCOS and MAGIQ-MOORA methods, to see the extent to which changes in parameters or criteria can affect results or decisions.

Based on this explanation, it is necessary to compare the MAGIQ, MABAC, MARCOS, and MOORA methods in the Egg Supplier Recommendation Decision Support System. The results of this study aim to provide recommendations on which method is the best from the results of the sensitivity test and become a reference for further research, and provide supplier recommendations to UD Taluh Subur. The urgency of this research is that if this research is not realized, it will hinder the development and innovation in the field of DSS because of the use of methods that have often been used.

LITERATURE REVIEW

Decision Support System

Decision Support System (DSS) is an information system that can assist management in dealing with various semi-structured problems and unstructured situations by providing information, modeling, and data manipulation so as to produce various alternative decisions and answers (Rony et al., 2023; Sudipa et al., 2024). Good and high-quality data is very important in DSS calculations in order to produce accurate and relevant data. Selection of models or calculation methods that are in accordance with the characteristics of the problem.

Multi-Attribute Global Inference of Quality (MAGIQ) Method

MAGIQ was first introduced by James D. McCaffrey. The MAGIQ method is one of the MCDM methods that is quite simple and easy to understand in selecting alternatives.This method uses the same weighting concept as Rank Order Cendroid (ROC), namely giving value based on the priority order of the criteria. The MAGIQ method applies a ranking of criteria and sub-criteria that can speed up and simplify the weighting process compared to other weighting methods, which is what makes this method attractive for use in weighting criteria (Ambarsari et al., 2023; Rahman et al., 2023; Susanto Putro et al., 2019). The following is the MAGIQ method formula for weighting.

$$\left[\sum_{i=k}^{N}(1/i)\right]/N \tag{1}$$

Multi-Attributive Border Approximation Area Comparison (MABAC) Method

MABAC is a multicriteria comparison method that provides a consistent solution and this method is reliable in rational decision making. The main objective of this method is to assess the extent to which alternatives meet certain criteria with respect to the approximate boundary area. The advantage of the MABAC method is a simple way so that in determining alternatives this method has a fairly good ability and has high precision (Hasudungan Lubis et al., 2023; Sari & Oktavia, 2023). The steps of the MABAC method are as follows:
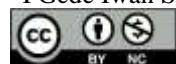
1) Form an initial decision matrix (X)

$$
X = \begin{matrix} & \begin{matrix} C_1 & C_2 & \cdots & C_n \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} & \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{matrix} \tag{2}
$$

2) Normalize the initial matrix (X)

$$
X = \begin{matrix} & \begin{matrix} C_1 & C_2 & \cdots & C_n \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} & \begin{bmatrix} n_{11} & n_{12} & \dots & n_{1n} \\ n_{21} & n_{22} & \cdots & n_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ n_{m1} & n_{m2} & \cdots & n_{mn} \end{bmatrix} \end{matrix} \tag{3}
$$

*I Gede Iwan Sudipa

The normalization matrix value (N) is obtained using the formula:

$$x^*_{ij} = \frac{x_{ij} - x_{ij}^-}{x_i^+ - x_i^-} \text{ for advantage/benefit criteria} \tag{4}$$

$$x^*_{ij} = \frac{x_{ij} - x_{ij}^+}{x_i^- - x_i^+} \text{ for cost criteria} \tag{5}$$

3) Weighted matrix calculation

$$V_{ij} = \left(w_i \times t_{ij}\right) + w_i \tag{6}$$

4) Border approximate area matrix determination (G_i)

$$G_i = \left[\prod_{j=1}^{m} V_{ij}\right]^{1/m} \tag{7}$$

5) Calculation of alternative distance matrix elements from the approximate border area

$$Q_{ij} = V_{ij} - G_i \tag{8}$$

6) Ranking of alternatives. Alternative ranking is done by adding each element of each alternative based on the alternative distance matrix from the border estimation area (Q).

$$S_i = \sum_{j=1}^{n} Q_m \tag{9}$$

Measurement of Alternatives and Ranking According to the Compromise Solution (MARCOS) Method

The MARCOS method basically defines the relationship between alternatives and reference values (ideal and anti-ideal alternatives) (Badi & Pamucar, 2020; Puška et al., 2020). The best alternative is the one that is closest to the ideal point and furthest from the anti-ideal point (Sarja et al., 2021; Stanković et al., 2020). In general, the MARCOS method is a method that provides good results when parameter considerations are in an uncertain environment, in this method effective decision making must consider the relationship between ideal and anti-ideal solutions (Mahendra, 2022). This method provides flexible capabilities in handling complex decision-making problems and generating optimal solutions among options. The following are the steps in calculating the MARCOS method.

1) Form the initial decision matrix.
2) Expanded form of the initial matrix.

$$X = \begin{array}{c} \\ AAI \\ A_1 \\ A_2 \\ \cdots \\ A_m \\ AI \end{array} \begin{array}{c} C_1 \quad C_2 \quad \cdots \quad C_n \\ \begin{bmatrix} x_{aa1} & x_{aa2} & \cdots & x_{aan} \\ x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \\ x_{ai1} & x_{ai2} & \cdots & x_{ain} \end{bmatrix} \end{array} \tag{10}$$

The anti-ideal solution (AAI) is the worst option, and the ideal solution (AI) is the best option. According to the nature of the criteria, AAI and AI are determined by applying formulas (11) and (12):

Criteria with *benefit* conditions:

$$AAI = {}^{min}_i x_{ij} ; AI = {}^{max}_i x_{ij} \tag{11}$$

Criteria with *cost/cost* conditions:

$$AAI = {}^{max}_i x_{ij} ; AI = {}^{min}_i x_{ij} \tag{12}$$

3) Normalize the initial expanded matrix (X).

$$n_{ij} = \frac{x_{ij}}{x_{ai}} ; \text{ if the criteria type is an advantage/benefit} \tag{13}$$

$$n_{ij} = \frac{x_{ai}}{x_{ij}} ; \text{ if the criteria type is } cost \tag{14}$$

4) Calculate the weighted normalization matrix (V).

$$v_{ij} = n_{ij} \times w_j \tag{15}$$

5) Calculation of alternative utility level (K_i), where (S_i) is the number of elements of the weighted normalization matrix. The utility value of alternatives in relation to anti-ideal and ideal solutions can be calculated by equations (14) and (15).

*I Gede Iwan Sudipa

$$S_i = \sum_{i=1}^{n} v_{ij} \tag{16}$$

$$K_i^- = \frac{S_i}{S_{aai}} \tag{17}$$

$$K_i^+ = \frac{S_i}{S_{ai}} \tag{18}$$

6) Determine the utility function of the substitution $f(K_i)$. The utility function is the compromise of the observed alternatives in relation to the ideal and anti-ideal solutions. $f(K_i^-)$ represents the utility function of the anti-ideal solution, and $f(K_i^+)$ represents the utility function of the ideal solution. The utility functions of the anti-ideal and ideal solutions can be calculated in formulas (20) and (21).

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + \frac{1 - f(K_i^+)}{f(K_i^+)} + \frac{1 - f(K_i^-)}{f(K_i^-)}} \tag{19}$$

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-} \tag{20}$$

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-} \tag{21}$$

7) Ranks the alternatives, with the highest value being the best recommendation.

Multi-Objective Optimazion on the basis of Ratio Analysis (MOORA) Method

The MOORA method was introduced by Brauers and Zavadskas in 2006. This method was first used by Brauers in 2004 for multi-criteria decision making. MOORA method is a multi-objective method that optimizes two or more conflicting attributes simultaneously within a constraint. This method has a minimum, stable and very simple calculation calculation, and the MOORA method has a level of flexibility and ease to separate the subjective evaluation process into decision weight criteria with decision-making attributes (Arisman et al., 2021; Mahendra et al., 2021; Proboningrum & Sidauruk, 2021). The following are the steps of the MOORA method.

1) Determine the decision matrix.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \tag{22}$$

2) Normalize the X matrix.

$$X^*_{ij} = \frac{X_{ij}}{\sqrt{\sum_{j=1}^{m} x^2_{ij}}} \tag{23}$$

3) Optimizing attributes (without using criteria weights).

$$Yi = \sum_{j=1}^{g} X^*_{ij} - \sum_{j=g+1}^{n} X^*_{ij} \tag{24}$$

If you include the criteria weights into the normalized search, then use the following equation.
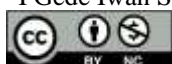
$$Yi = \sum_{j=1}^{g} W_j X^*_{ij} - \sum_{j=g+1}^{n} W_j X^*_{ij} \tag{25}$$

4) The value of Yi will be positive or negative depending on the number of maxima (benefits) and minima (costs) in the decision matrix.

$$Yi = \sum_{j=1}^{g} W_j X^*_{ij} - \sum_{j=g+1}^{n} W_j X^*_{ij} \tag{26}$$

Sensitivity Test

*I Gede Iwan Sudipa

Sensitivity testing in decision support systems (DSS) is a technique to test how much a change in the value of an attribute or ranking in an DSS model will affect the decision results. This test aims to determine how sensitive a method is when used to solve a problem. Methods that have a high sensitivity value or are sensitive to changes in rank will be increasingly chosen (Khasanah & Setiyadi, 2019; Sry Yunarti & Moeis, 2022). The following are the stages of conducting a sensitivity test.

1) Determine all attribute weights $W_j = 1$ (initial weights)
2) Change the weight of one criteria according to the expectations of the researcher with the condition that, the weight of the change $w > 0$ and the sum of the change weights $\sum w = 1$
3) Then, calculate the percentage change in rank by comparing the highest value obtained from each calculation to the initial weight condition.

METHOD

Decision Support System Model

The model used in the egg supplier recommendation decision support system is designed with a combination of MAGIQ-MABAC, MAGIQ-MARCOS, and MAGIQ-MOORA methods. The picture or flow can be seen in Figure 1 below.
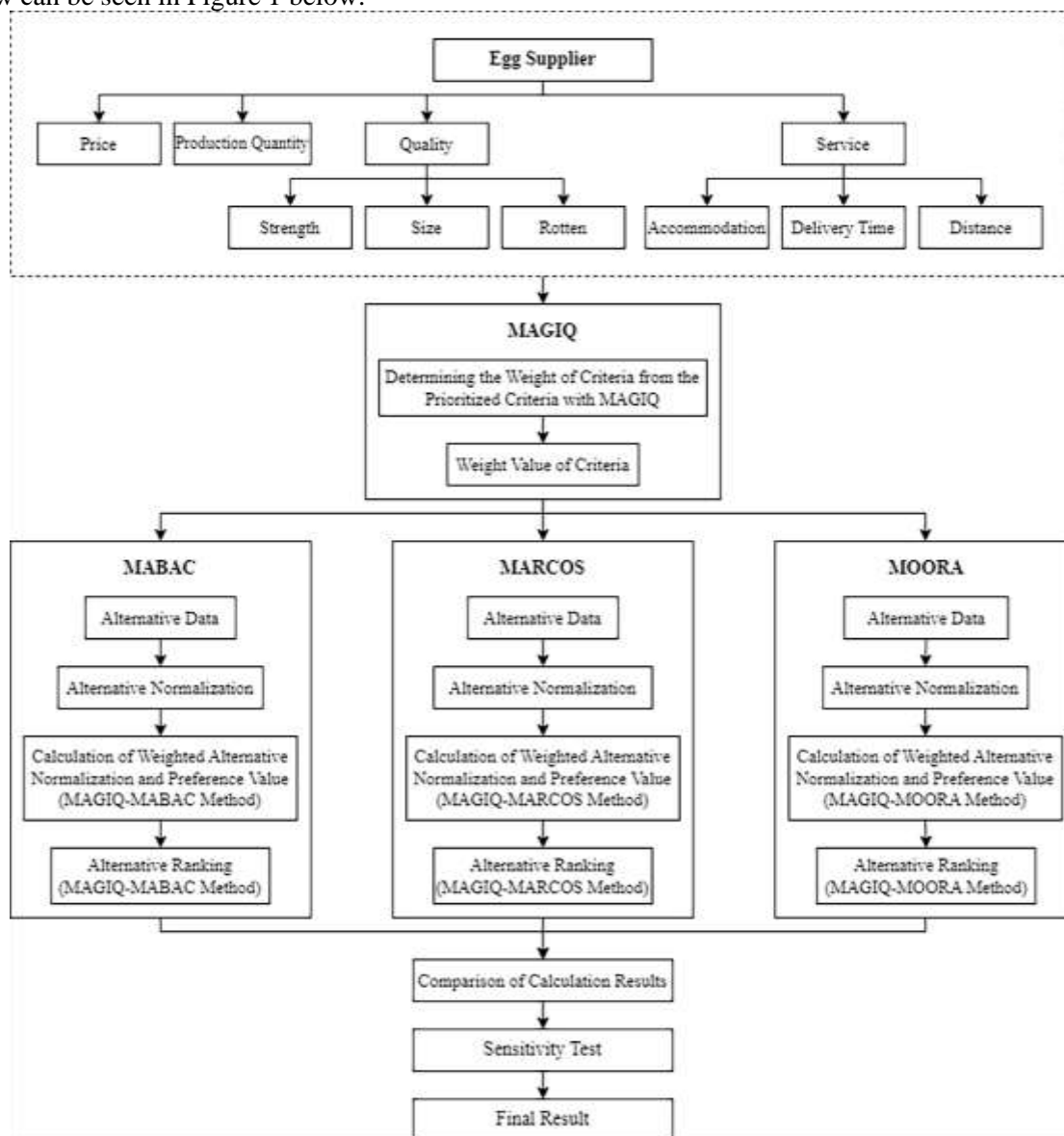

Fig. 1 Overview of the DSS Model for Determining Egg *Supplier* Recommendations

*I Gede Iwan Sudipa

Based on Figure 1 above, the weighting of criteria is carried out using the MAGIQ method. Weighting using this method is based on the most prioritized criteria. From the weighting carried out, the weighting based on the MAGIQ method is obtained as follows, Price (C1) > Quality (C3) > Service (C4) > Production Quantity (C2). For sub-criteria one as follows, Size (C3-2) > Strength (C3-1) > Rotten (C3-3), and sub-criteria two as follows, Delivery Time (C4-2) > Accommodation (C4-1) > Distance (C-3). After getting the weight value of the criteria, the next step is to enter the weight value of the criteria into the MABAC, MARCOS, and MOORA calculation methods.

In the calculation process of the MABAC, MARCOS, and MOORA methods, the initial stage of calculation of the three methods is to normalize alternative data. The next process in the MABAC method is to calculate the border approx and distance border before getting the preference value. In the MARCOS method, the next process is to calculate the ideal and anti-ideal distance values, then the alternative utility level, and the alternative utility function before getting the preference value. Unlike the two previous methods, the MOORA method only calculates the normalization of weighted alternatives and calculates the preference value to get the preference value. The results obtained from these calculations will produce data in the form of alternative recommendations based on the ranking carried out. Then the sensitivity test is carried out from the results obtained. This test is carried out in order to find out how effective and efficient the method is in calculating egg supplier recommendations.

RESULT

Alternative Analysis

Alternatives are one of the important requirements in performing calculations on a decision support system. Alternative data is obtained through interviews and observations. The following are the alternatives used.

Table 1.Alternative Data

Alternative Code (A)	Alternative Name
A1	Supplier 1
A2	Supplier 2
A3	Supplier 3
...	...
A11	Supplier 11

In table 1 above, it can be seen that there are 11 alternatives used in the calculation of decision support systems using a combination of MAGIQ-MABAC, MAGIQ-MARCOS and MAGIQ-MOORA methods in egg supplier recommendations.

Criteria Analysis

Criteria is also one of the important requirements in completing decision support system calculations. Criteria data can be seen in table 2 below.

Table 2.Criteria Data

Criteria Code (C)	Criteria Name	Attributes	Unit
C1	Price	Cost	Rupiah
C2	Production Quantity	Benefit	Egg Tray
C3	Quality	Benefit	
C3-1	Strength	Benefit	Likert Scale
C3-2	Size	Benefit	Likert Scale
C3-3	Rotten	Cost	Grain
C4	Services	Benefit	
C4-1	Accommodation	Cost	Rupiah
C4-2	Delivery Time	Benefit	Likert Scale
C4-3	Distance	Cost	Kilometers

*I Gede Iwan Sudipa

In table 2 above, it can be seen that there are 10 criteria used in supporting the calculations in this study, the following is an explanation of each of these criteria. Price Criteria (C1) is the purchase price of eggs from farmers. Production Quantity Criteria (C2) is the amount of egg production once taken to the breeder within a certain time frame, the unit used is a tray where in 1 tray there are 30 eggs. Quality Criteria (C3) is a criteria used to assess how good or feasible it is for eggs to be purchased from breeders so that this criteria is further divided into 3 sub-criteria, the first is the Strength criteria (C3-1) is a criteria that measures how strong the egg survives the shock of the trip when shipping from the breeder's place to the business location, then the Size criteria (C3-2) is a criteria that measures whether the eggs purchased have an average size that is large or small which can be seen when sorting is carried out, and the last is the rotten criteria (C3-3) this criteria is a criteria that calculates the number of rotten eggs during the purchase of eggs to breeders. Service Criteria (C4) is a criteria used to assess the service of breeders. This criteria is divided into 3, namely, the Accommodation criteria (C4-1) is a criteria that calculates how much cost is incurred in purchasing eggs starting from buying gasoline, food, and others, then the Delivery Time criteria (C4-2) is a criteria that measures how quickly the breeder delivers the eggs to the place agreed upon by the business and the breeder for the loading and unloading process, the Distance criteria (C4-3) is a criteria that measures the distance from the UD Taluh Subur business location to the place of purchase agreed upon by the business and the breeder. The criteria data that has been obtained is then weighted by the resource person based on the MAGIQ method weighting. The results of the weighting carried out obtained the following weighting, Price (C1) > Quality (C3) > Service (C4) > Production Quantity (C2). For the sub-criteria of criteria C3 as follows, Size (C3-2) > Strength (C3-1) > Rotten (C3-3), and for the sub-criteria of criteria C4 as follows, Delivery Time (C4-2) > Accommodation (C4-1) > Distance (C-3). Furthermore, determining the value for criteria using a Likert scale, which can be seen in table 3 below.

Table 3. Likert Scale Value

Scale Description			Value
Strength (C3-1)	Size (C3-2)	Deliver Time (C4-2)	
Very Strong	Very Large	Very Fast	5
Strong	Great	Fast	4
Strong enough	Large enough	Fast enough	3
Not Strong	Not Large	Not Fast	2
Not Very Strong	Very Not Large	Very Not Fast	1

After the Likert scale value is determined, the alternative value is obtained based on the predetermined criteria which can be seen in table 4 below.

Table 3. Alternative Value Based on Criteria

Alternative Code (A)	C1	C2	C3			C4		
			C3-1	C3-2	C3-3	C4-1	C4-2	C4-3
A1	51.000	550	3	5	1	200	5	52
A2	51.000	520	5	5	1	200	3	55
A3	50.000	520	4	3	1	200	5	52
A4	50.000	320	4	3	1	200	4	55
A5	52.000	450	3	4	1	150	4	50
A6	52.000	500	4	3	5	100	4	33
A7	53.000	500	3	3	2	50	4	20
A8	53.000	400	4	3	2	150	5	44
A9	53.000	200	4	4	1	100	5	23
A10	53.000	150	4	5	2	50	3	15
A11	53.000	300	4	3	1	150	4	40

Weighting Criteria and Sub-Criteria with MAGIQ Method

In order to perform calculations using a combination of MAGIQ-MABAC, MAGIQ-MARCOS, and MAGIQ-MOORA methods. Then the weighting of criteria and sub-criteria by the resource person was

*I Gede Iwan Sudipa
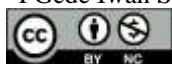
carried out previously. After knowing the weight of each criteria, then the calculation will be carried out using equation (1) in the MAGIQ method. The results of the calculation with the MAGIQ method can be seen in the hierarchical chart in Figure 2 below.
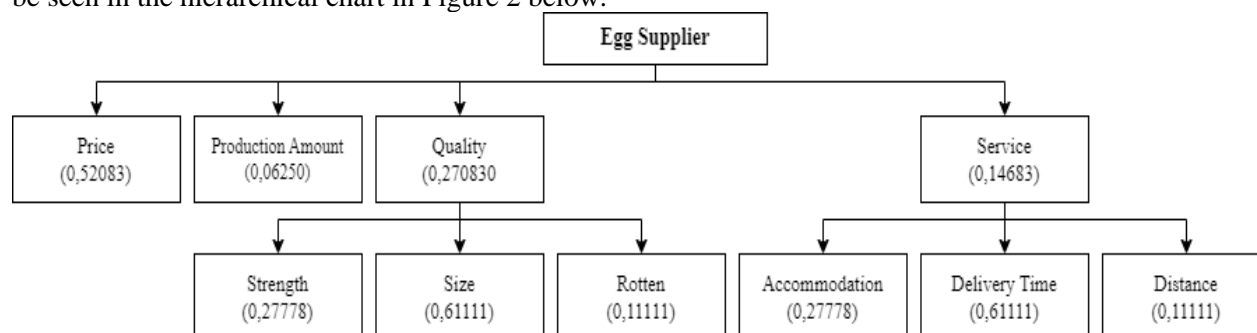

Fig. 2 Weighting Values With MAGIQ Method Hierarchy

MAGIQ-MABAC Method Calculation

After obtaining the weighting value of the criteria using the MAGIQ method, the next process is to calculate the MABAC method. The calculation begins by calculating the sub-criteria of criteria C3, namely C3-1, C3-2, and C3-3 and the sub-criteria of criteria C4, namely C4-1, C4-2 and C4-3 first. The results of the calculation of the two sub-criteria can be seen in table 4 below.

Table 4. C3 and C4 Criteria Values MAGIQ-MABAC Method

Alternative	C1	C2	C3	C4
A1	51.000	550	0,34334	0,15180
A2	51.000	520	0,62112	-0,46764
A3	50.000	520	-0,12888	0,15180
...	...	...	...	...
A11	53.000	300	-0,12888	-0,02783

In table 4 above, it can be seen that the values of criteria C3 and C4 are already known. The next process is to recalculate the criteria C1, C2, C3 and C4. Calculations with the MAGIQ-MABAC method have been successfully carried out, the results of these calculations can be seen in Figure 3 below.

Fig. 3 Graph of Preference Value for Egg Supplier Recommendations Using MAGIQ-MABAC

In Figure 3, it can be seen from the graph that alternative supplier 3 gets the highest value, with a value of 0.35686, in second place is supplier 1 with a value of 0.32746, while in third place is supplier 2 with a value of 0.30279, then followed by other suppliers.

MAGIQ-MARCOS Method Calculation

The next process is to calculate the MARCOS method. The calculation in the MARCOS method is also the same as the previous method which calculates the sub-criteria first. The calculation process follows the steps of the previously explained formula. The results of the calculation of the two sub-criteria can be seen in table 5 below.

Table 5. MAGIQ-MARCOS Method C3 and C4 Values

Alternative	C1	C2	C3	C4
A1	51.000	550	0,74172	0,62055
A2	51.000	520	0,83444	0,40616
A3	50.000	520	0,58411	0,62055
...	...	...	...	...
A11	53.000	300	0,58411	0,54265

In table 5 above, it can be seen that the values of C3 and C4 are already known. Then the C3 and C4 criteria will be recalculated along with the C1 and C2 criteria. The calculation of the MAGIQ-MARCOS method has been successfully carried out, the results of the calculation can be seen in Figure 4 below.
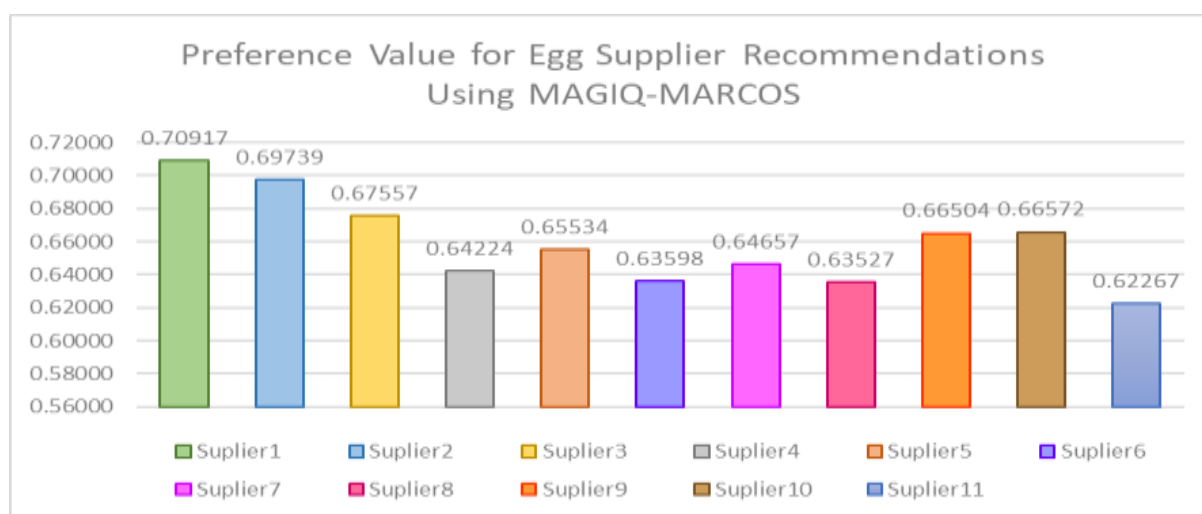

Fig. 4 Graph of Preference Value For Egg Supplier Recommendations Using MAGIQ-MARCOS

In Figure 4 it can be seen that supplier 1 gets the highest value with a value of 0.70917, in second place there is supplier 2 with a value of 0.69739, and in third place there is supplier 3 with a value of 0.67557 which is then followed by other suppliers.

MAGIQ-MOORA Method Calculation

The next process performs calculations with the MOORA method. The calculation in the MARCOS method also calculates the sub-criteria first. The calculation process follows the steps of the previously explained formula. The results of the calculation of the two sub-criteria can be seen in table 6 below.

Table 6. Likert Scale Value

Alternative	C1	C2	C3	C4
A1	51.000	550	0,28913	0,06546
A2	51.000	520	0,33252	-0,02377
A3	50.000	520	0,21450	0,06546
...	...	...	...	...
A11	53.000	300	0,21450	0,05916

In table 6, it can be seen that from the results of the calculation of sub-criteria, the values of criteria C3 and C4 are obtained. Then the criteria C1, C2, C3 and C4 will be calculated again with the MAGIQ-MOORA method. Calculations with this method have been successfully carried out, the results of these calculations can be seen in Figure 5 below.
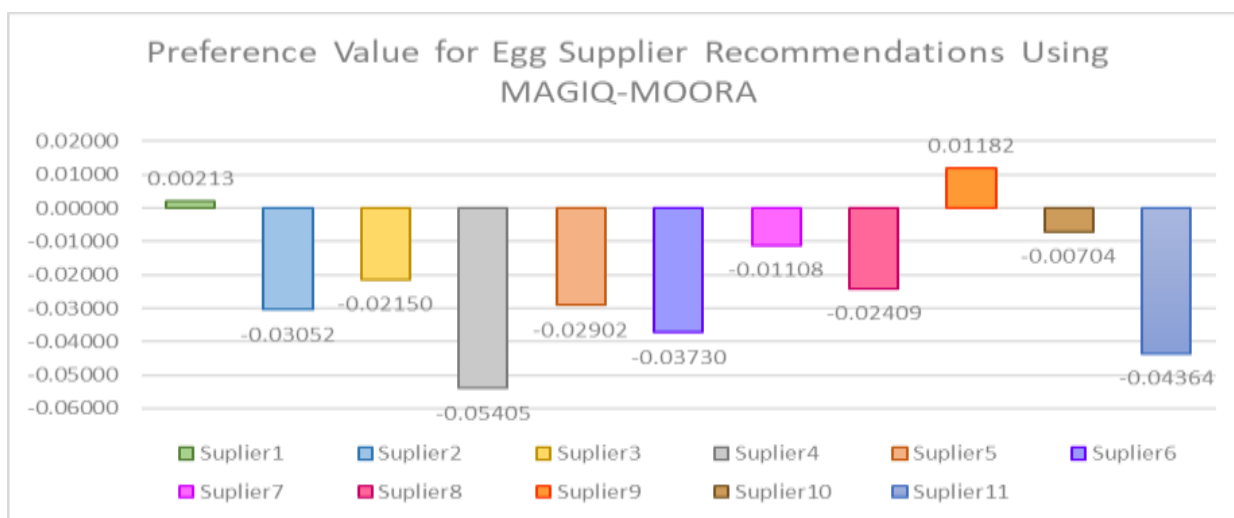
*I Gede Iwan Sudipa

Fig. 5 Graph of Preference Value For Egg Supplier Recommendations Using MAGIQ-MOORA

In Figure 5, it can be seen that the supplier with the highest value is supplier 9 with a value of 0.01182, in second place is supplier 1 with a value of 0.00213, then in third place is supplier 10 with a value of -0.00704, and followed by other suppliers.

Sensitivity Test

At this stage, testing of the results of the DSS calculation and the performance of the method used is carried out. Before testing, it is necessary to recheck the results of the calculations that have been carried out. Sensitivity analysis is used to compare which method has a high level of sensitivity to changes in the weight value of the criteria. Sensitivity testing is only carried out on criteria C1, C2, C3 and C4. Table 8 is the preference value data from the calculation results of the MAGIQ-MABAC, MAGIQ-MARCOS, and MAGIQ-MOORA methods.

Table 7
Calculation Results Data Using MAGIQ-MABAC, MAGIQ-MARCOS, and MAGIQ-MOORA Methods

Alternative	MAGIQ-MABAC	MAGIQ-MARCOS	MAGIQ-MOORA
A1	0,32746	0,70917	0,00213
A2	0,30279	0,69739	-0,03052
A3	0,35686	0,67557	-0,02150
A4	0,27390	0,64224	-0,05405
A5	0,01378	0,65534	-0,02902
A6	-0,03745	0,63598	-0,03730
A7	-0,20627	0,64657	-0,01108
A8	-0,17201	0,63527	-0,02409
A9	-0,07991	0,66504	0,01182
A10	-0,08742	0,66572	-0,00704
A11	-0,22794	0,62267	-0,04364
MAX	0,35686	0,70917	0,01182

The initial weights of the main criteria in the three combinations of methods are C1 = 0.52083, C2 = 0.0625, C3 = 0.27083, C4 = 0.14583. To conduct a sensitivity test, the initial weight of each criteria is increased from 0.25, 0.50, 0.75 to 1. Starting from criteria C1, the weight value is increased by 0.25 so that it becomes C1 = 0.77083, C2 = 0.0625, C3 = 0.27083, C4 = 0.14583. Then the calculation of each combination of these methods is carried out so as to produce a value that can be seen in the table below.
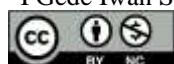
*I Gede Iwan Sudipa

Table 8. Sensitivity Test Results 1 MAGIQ-MABAC, MAGIQ-MARCOS and MAGIQ-MOORA Methods

Alternative	MAGIQ-MABAC	MAGIQ-MARCOS	MAGIQ-MOORA
A1	0.41624	0.70175	-0.07190
A2	0.39157	0.69251	-0.10456
A3	0.52897	0.67831	-0.09408
...	...	...	...
A11	-0.30582	0.62842	-0.12058
MAX	0.52897	0.70175	-0.06511
Change (%)	0,17211%	-0,00742%	-0,07693%

In table 9, it can be seen that there is a change value. The change value is obtained from the maximum test result compared the maximum initial value. Then increase the weight value of criteria C1 to 1 and do the same for the other criteria. So that you will get the sensitivity test results which can be seen in table 10.

Table 9. Sensitivity Test Results of MAGIQ-MABAC, MAGIQ-MARCOS and MAGIQ-MOORA Methods

Criteria	MAGIQ-MABAC	MAGIQ-MARCOS	MAGIQ-MOORA
Criteria 1 + (0.25)	0,17211%	-0,00742%	-0,07693%
Criteria 1 + (0.50)	0,34422%	-0,01236%	-0,15387%
Criteria 1 + (0.75)	0,51634%	-0,01589%	-0,23081%
Criteria 1 + (1)	0,68845%	-0,01852%	-0,30584%
Criteria 2 + (0.25)	0,08394%	0,04519%	0,08851%
Criteria 2 + (0.50)	0,17598%	0,07647%	0,18671%
Criteria 2 + (0.75)	0,27867%	0,09925%	0.28491%
Criteria 2 + (1)	0,38136%	0,11652%	0,38310%
Criteria 3 + (0.25)	0,11010%	0,01183%	0,08225%
Criteria 3 + (0.50)	0,27427%	0,02788%	0,17137%
Criteria 3 + (0.75)	0,43844%	0,03949%	0,26998%
Criteria 3 + (1)	0,60261%	0,04828%	0,37409%
Criteria 4 + (0.25)	0,03609%	-0,00059%	0,12708%
Criteria 4 + (0.50)	0,07218%	0,00214%	0,25414%
Criteria 4 + (0.75)	0,10826%	0,01575%	0,38120%
Criteria 4 + (1)	0,14435%	0,02927%	0,50826%
Total	4,42737%	0,45729%	2,34415%

Based on table 9, it can be explained that in the criteria column there is information about the criteria added (+) with a weight value from 0.25 to 1. Then in the MAGIQ-MABAC, MAGIQ-MARCOS and MAGIQ-MOORA columns contain the value of the calculation results by summing or increasing the weight value of the criteria. The total value is obtained by summing up all the values from the calculation results in one method combination.
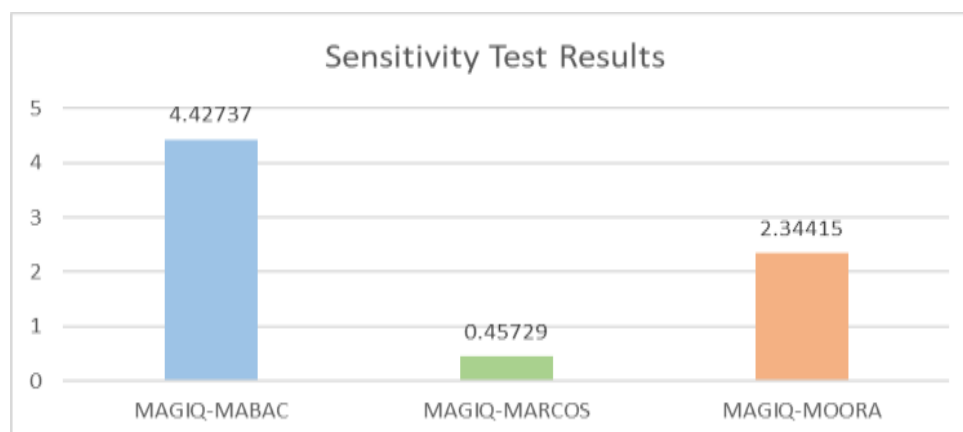
*I Gede Iwan Sudipa

Fig. 6 Sensitivity Test Results of MAGIQ-MABAC, MAGIQ-MARCOS and MAGIQ-MOORA Methods

Based on Figure 6 above, it can be explained that from the results of the sesnsitivity test conducted on the combination of the MAGIQ-MABAC, MAGIQ-MARCOS, and MAGIQ-MOORA methods, it shows that the MAGIQ-MABAC method has a change of 4.42737%, the MAGIQ-MARCOS method of 0.45729% and the MAGIQ-MOORA method of 2.34415%. The MAGIQ-MABAC method combination has the highest sensitivity value compared to other method combinations. Thus, the MAGIQ-MABAC method combination is the optimal method to be applied to the DSS for egg *supplier* recommendations.

DISCUSSIONS

Based on the results of the research that has been done, the application of the MAGIQ method as a weighting method in combination with the MABAC, MARCOS, and MOORA methods is successful. The results of the combination of these methods can be seen in Figures 3, 4 and 5. Then the results of the calculation of the combination of methods are carried out sensitivity tests to find out which method has a high level of sensitivity. The results show that the MAGIQ-MABAC method has the highest value. So that this method can be recommended to be applied in the calculation of the DSS egg supplier recommendations at UD Taluh Subur. After the calculation from the MAGIQ-MABAC method was applied to the UD Taluh Subur business, an interview was conducted with the business manager. The results of the calculations on the MAGIQ-MABAC method are well received because they can facilitate supplier selection when there are new suppliers and are able to provide better recommendation results.

CONCLUSION

This study shows that the application of the MAGIQ method as a weighting method in combination with the MABAC, MARCOS, and MOORA methods is able to solve the problem of egg supplier recommendations. In this calculation, the alternatives used amounted to eleven (11) suppliers and ten (10) criteria divided into six (6) sub-criteria and four (4) main criteria. Sensitivity testing was conducted in this study to determine which method has the highest sensitivity value of changes in weight values. The results show that the MAGIQ-MABAC method combination has the highest sensitivity value of 4.42737%, followed by the MAGIQ-MOORA method of 2.34415% and the MAGIQ-MARCOS method of 0.45729%. So that the recommended method to be applied in the calculation of the DSS egg supplier recommendations at UD Taluh Subur is the MAGIQ-MABAC method. The results of the calculation using the MAGIQ-MABAC method show that supplier 3 gets the highest value, with a value of 0.35686, in second place is supplier 1 with a value of 0.32746, while in third place is supplier 2 with a value of 0.30279, then followed by other suppliers. When the interview was conducted again to the business manager, the results of the calculation with the combination of these methods were well received because they could facilitate the selection of suppliers when there were new suppliers and were able to provide better recommendation results. In future research, it is hoped that combinations with MCDM or MADM methods with supplier recommendation case studies or other case studies, as well as conducting other tests to get maximum results.

*I Gede Iwan Sudipa

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*I Gede Iwan Sudipa