Implementation of the TOPSIS Method for Analysis and Decision-Making in Selecting Goat Feed (Case Study at CV. Lamegogo)

Henri Afrizal, Zulham Sitorus

Abstract

The implementation of the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) technique in selecting goat feed is essential, as it assists farmers in making more objective and quantifiable selections. This study is to develop and execute a decision support system utilizing the TOPSIS approach to evaluate and identify the optimal feed alternatives for goat livestock at CV. Lamegogo. The evaluation criteria encompass nutritional content, feed cost, availability, palatability (livestock preference), and its effect on livestock growth. The research data was acquired via interviews with the proprietor. The digital decision support system for selecting goat feed at CV. Lamegogo facilitates multi-criteria decision-making, resulting in accurate information. The criteria for selecting optimal feed alternatives include availability, cost, nutritional value, knowledge, palatability, and impact on cattle growth. This strategy is expected to enhance feed cost efficiency and optimize goat production by rendering the decision-making process more systematic, transparent, and accountable.

Keywords: Digital, Decision Support System, Goat Farming, TOPSIS

Henri Afrizal[1]

[1]Master Student of Information Technology, Universitas Pembangunan Panca Budi, Indonesia e-mail: henribsi2010@yahoo.co.id[1]

Zulham Sitorus[2]

[2]Master of Information Technology, Universitas Pembangunan Panca Budi, Indonesia e-mail: zulhamsitorus@dosen.pancabudi.ac.id[2]

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Introduction

This research originates from the strategic significance of the livestock subsector in enhancing food security and bolstering the economy of rural communities. Goats are among the most often cultivated small ruminants due to their significant flexibility, minimal capital requirements, and favorable market potential as sources of meat, milk, and for the purposes of qurban and aqiqah. The production of goats is significantly affected by the quality of management techniques, with the provision of suitable, balanced, and sustainable feed being a crucial element. This prompts numerous inquiries concerning the government's capacity to make informed selections. Multi-Objective Optimization based on Ratio Analysis (MOORA) is a method frequently utilized in decision-making processes. This technique is favored because to its minimal implementation phases, enabling researchers to resolve issues expeditiously[1].

One solution is to employ a Decision Support System (DSS) [2]. This study use the TOPSIS approach to conduct calculations on the case at hand, utilizing established options and criteria to generate a proposal that aids the government in its decision-making process [3]. The scholarship recipient selection process at SMA Negeri 2 Mandau is being conducted manually by gathering data on pupils eligible for academic scholarships. An application is required to achieve expedited and efficient selection outcomes by assessing and calculating the criterion weights of scholarship candidates using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method [4].

Effective utilization of information enhances the efficiency of the decision-making process, since the necessary facts can be accessed directly. Moreover, the trustworthiness of the data increases, resulting in more precise decisions that may be made in a reduced timeframe. With technological advancement, computer-based decision support systems have proliferated, assisting individuals in acquiring the knowledge necessary for the decision-making process [5].

A Decision Support System (DSS) is a system designed to offer solutions to interactive problems, facilitating information provision, modeling, and information manipulation [6]. In practical applications, ascertaining feed for goats encompasses not only the availability of forage or concentrate but also various interconnected factors, including knowledge, nutritional quality (protein, energy, fiber), feed costs, feed availability, palatability (the extent of livestock preference for the feed), and its effects on livestock growth and health. Farmers frequently encounter several feed alternatives, including wild forage, farmed forage, agricultural byproducts, and commercial feed. This complexity necessitates a more rigorous and quantifiable decisionmaking methodology, rather than one that depends exclusively on intuition or routine. The establishment of priority scales for the advancement of spring potential can be executed utilizing the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) decision-making methodology [7].

Many livestock business operators, including CV. Lamegogo, continue to employ traditional methods for selecting feed combinations for their animals. Decisions sometimes rely on personal experience, advice from other farmers, or a singular factor like the lowest price, without doing a thorough investigation of feed quality and its effects on output performance. This may lead to inadequate feeding, suboptimal livestock development, inefficiently high feed costs, and potential long-term health issues for the animals. Erroneous feed selection can impede enhancements in productivity and profitability within the livestock industry. Goat farming is rather straightforward in Indonesia due to the plentiful availability of feed for this livestock across nearly all regions of the island. Alongside the sufficiency of feed supplies, the conditions of the natural habitat significantly facilitate the growth and development of livestock [8]. The community frequently neglects the management of goat feed, including the feeding schedule, the types of feed offered, and the quantity consumed as necessary [6].

With the advancement of information technology and multi-criteria decision-making methodologies, a decision support system is essential for assisting farmers in evaluating diverse feed alternatives according to established criteria. A prevalent strategy in multi-criteria

decisionmaking is the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The TOPSIS technique effectively evaluates the proximity of each option to the positive ideal solution and its separation from the negative ideal solution, resulting in a more objective and quantifiable ranking of alternatives based on the weights and values of each criterion.

Given these conditions, it is essential to undertake a study on the Application of the TOPSIS Method for Analyzing and Making Decisions Regarding Goat Feed Provision (Case Study: CV. Lamegogo). This research aims to develop and execute a decision support system that aids the management of CV. Lamegogo in identifying optimal feed choices based on the criteria of knowledge, nutrition, cost, availability, palatability, and their effects on livestock growth. This method is anticipated to render the decision-making process more structured, transparent, and responsible, thereby enhancing feed cost efficiency and maximizing goat productivity. Furthermore, the findings of this study are anticipated to provide a reference for other stakeholders in the cattle industry encountering analogous challenges in formulating their feed supply plans.

Literature Review 2.1 Decision Support System (DSS)

A Decision Support System (DSS) is a system engineered to assist in resolving both organized and unstructured situations. This approach is typically employed to facilitate decision-making in semi-structured and entirely unstructured contexts [9]. A Decision Support System (DSS) is defined as a system that facilitates ad hoc data analysis, enables modeling for decision-making, is geared towards decisions, aids in future planning, and is applicable in exceptional or non-routine circumstances. The primary aim of a DSS is to deliver pertinent information to users, enabling them to make decisions with greater accuracy and quality.The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method posits that the optimal alternative is characterized not only by its proximity to the positive ideal solution but also by its distance from the negative ideal solution [10]. The TOPSIS approach identifies the positive and negative ideal solutions [9].

2.2 TOPSIS

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is a multicriteria decision-making method initially proposed by Kwangsun Yoon and Hwang Ching-Lai in 1981. The decision-making process fundamentally relies on identifying the shortest Euclidean distance to the positive ideal solution and the longest Euclidean distance to the negative ideal solution. TOPSIS is extensively utilized because to its straightforward notion, computational efficiency, and capacity to quantitatively assess the relative performance of decision alternatives in a mathematically uncomplicated manner. This approach is extensively utilized to address practical decision-making challenges.The fundamental principle of TOPSIS is that the optimal alternative is the one nearest to the positive ideal solution and farthest from the negative ideal solution. The formula yields a preference value for each possibility, listed from highest to lowest [11].

The stages employed in the TOPSIS approach are as follows [12]:

1. Establishing the criteria and their weights, that is, defining the criteria that are used to choose the best teacher based on benefit features, giving each criterion a weight, and calculating the value of each option using teacher data. A Likert scale with a value range of 1 (one) to 5 (five) is used for the assessment.
2. Using the teacher assessment data that has been transformed into alternative values, calculating the value of each option for each criterion.
3. Applying the TOPSIS approach to the following steps of calculations [13]:
    a. Building the decision matrix and making it normal.

Xij

$$\text{Rij} \quad \frac{}{\sqrt{\sum \text{mi=1 x2ij}}}$$

is the normalized value of alternative $i$with respect to criterion j, where $i = 1,2,\ldots,m$and $j = 1,2,\ldots,n.$

$x_{ij}$is the value of alternative $i$with respect to criterion j, where $i = 1,2,\ldots,m$and $j = 1,2,\ldots,n.$

b. Calculating the weighted normalization to determine the weighted normalized matrix.

$$yij = wi\ rij$$

Where w_ii is the weighted normalized value, y_ijy_ij is the weighted normalized value, where r_ij is the normalized value of each alternative and w_i is the weight of each criterion. In this case, i=1, 2, ..., m and j=1, 2, ..., n.s are the weights of each criterion, and r_ij is the normalized value of each alternative in relation to criterion j. With i=1, 2, ..., m and j=1, 2, ..., n, r_ij is the normalized value of option i with regard to criterion j.

c. Applying the following formulas to find the Positive and Negative Ideal Solutions: Positive ideal solution: A+ = {v1+, v2+, v3+, …, vn+}
Negative ideal solution: A- = {v1-, v2-, v3-, …, vn-}

d. Separation is calculated by calculating the separation between each alternative's value and the positive and negative ideal solution matrices.

$$\text{(D+): } D_i^{+} \sqrt{\sum_{j=i}^{n}(vij - v_j^{+})}_2$$

$$\text{(D-): } D_i^{-} \sqrt{\sum_{j=i}^{n}(vij - v_j^{+})^{-2}}$$

e. Calculating the preference score to get the preferred value. When ranking all options, the preference value is the ultimate value that serves as a benchmark.

$$V_i \quad \frac{.}{Di- \; D+I- \; Di+}$$

Research Methodology

This study will examine a decision support system designed to aid CV. Lamegogo in selecting optimal feed for goats. The decision-making strategy employed for selecting goat feed is the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). This method is selected because TOPSIS is a decision support technique predicated on the principle that the optimal alternative is characterized not only by the minimal distance from the positive ideal solution but also by the maximal distance from the negative ideal solution. This context will offer ideas for choosing the optimal goat feed at CV. Lamegogo as anticipated.

3.1 Data Collection

Data collection yielded six criteria for evaluating the optimal goat feed utilizing the TOPSIS approach. Furthermore, data on eight varieties of goat feed were gathered to be evaluated and ranked in order to identify the optimal feed as the superior choice.

3.2 Problem Analysis

The selection of goat feed at CV. Lamegogo is now conducted manually and lacks a formalized approach. In practice, the proprietor and staff frequently encounter challenges in selecting the optimal goat feed that accurately aligns with the requirements of the livestock. Consequently, a decision support system utilizing the TOPSIS methodology is necessary. Prior to commencing the problem-solving phase, it is essential to establish a decision system that employs a database for the storage, management, and provision of input data.

Results

The steps in this research are as follows:

1. Identifying the criterion for selecting goat feed at CV. Lamegogo. This study identifies the criteria for goat feed selection as Knowledge, Nutritional Quality, Feed Cost, Feed Availability, Palatability, and Impact on Livestock Growth.
2. Evaluating the rating of each alternative for every criterion, measured on a scale from 1 to 5, where 1 denotes extremely low, 2 indicates low, 3 signifies moderate, 4 represents high, and 5 corresponds to very high.

Table 1. Criteria Score

Criteria	Preliminary Data	Ranking
Knowledge	0 - < = 50	1
	O = 51 - < = 60	2
	O = 61 - < = 70	3
	O = 71 - < = 80	4
	O = 81 - < = 100	5
Nutritional Quality	0 - < = 50	1
	O = 51 - < = 60	2
	O = 61 - < = 70	3
	O = 71 - < = 80	4
	O = 81 - < = 100	5
Feed Costs	0 - < = 50	1
	O = 51 - < = 60	2
	O = 61 - < = 70	3
	O = 71 - < = 80	4
	O = 81 - < = 100	5
Feed Availability	0 - < = 50	1
	O = 51 - < = 60	2
	O = 61 - < = 70	3
	O = 71 - < = 80	4
	O = 81 - < = 100	5

Palatability	0 - < = 50	1
	O = 51 - < = 60	2
	O = 61 - < = 70	3
	O = 71 - < = 80	4
	O = 81 - < = 100	5
Impact of livestock growth	0 - < = 50	1
	O = 51 - < = 60	2
	O = 61 - < = 70	3
	O = 71 - < = 80	4
	O = 81 - < = 100	5

3. Developing a decision matrix. In the decision matrix, the columns denote the qualities, specifically the established criteria, while the rows signify the alternatives, notably the feed options. The decision matrix pertains to m alternatives assessed according to n criteria.

Table 2. decision matrix

	Knowledge	**Nutritional Quality**	**Feed Costs**	**Feed Availability**	**Palatability**	**Impact of livestock growth**
A1	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}
A2	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	X_{26}
A3	X_{31}	X_{32}	X_{33}	X_{34}	X_{35}	X_{36}
A4	X_{41}	X_{42}	X_{43}	X_{44}	X_{45}	X_{46}
A5	X_{51}	X_{52}	X_{53}	X_{54}	X_{55}	X_{56}
A6	X_{61}	X_{62}	X_{63}	X_{64}	X_{65}	X_{66}

The notations X11 through X66 in the table above denote the performance values of each choice, represented as criterion scores based on the utilized criteria. Xij represents the performance value of the i-th choice concerning the j-th criterion. The symbol Ai (i = 1, 2, 3, …, m) denotes the set of alternatives under consideration, whereas Xj (j = 1, 2, 3, …, n) signifies the criteria employed to evaluate the performance of each alternative.
In this study, the values of j for each criterion are as follows
J = 1 Knowledge
J = 2 Nutritional Quality
J = 3 Feed Cost
J = 4 Feed Availability
J = 5 Palatability
J = 6 Impact on Livestock Growth

Utilizing the preliminary data table, the decision matrix for each choice is subsequently generated and can be illustrated as demonstrated in the following example.

Table 3. Decision Matrix Calculation Results

Animal feed	Knowledge	Nutritional Quality	Feed Costs	Feed Availability	Palatability	Impact of livestock growth
Feed 1	5	4	3	4	5	5
Feed 2	5	4	4	4	3	3
Feed 3	5	5	5	5	5	5
Feed 4	5	4	5	3	3	3
Feed 5	3	4	5	5	4	4
Feed 6	5	5	5	5	3	4

1. Determine the preference weight for each criterion.
   Weight for the Knowledge criterion:
   a. Very low = 0
   b. Low = 0.25
   c. Fair = 0.5
   d. High = 0.75
   e. Very high = 1
   Weight for the Nutritional Quality criterion:
   a. Very low = 0
   b. Low = 0.25
   c. Fair = 0.5
   d. High = 0.75
   e. Very high = 1
   Weight for the Feed Cost criterion:
   a. Very low = 0
   b. Low = 0.25
   c. Fair = 0.5
   d. High = 0.75
   e. Very high = 1

2. Following the establishment of the decision matrix and criterion weights, the subsequent step is to formulate the normalized decision matrix R, which serves to diminish the data range. The components of this matrix are ascertained using the subsequent formula:

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

Where:
rij is an element of the normalized decision matrix R, xij is an element of the decision matrix,i = 1, 2, 3, ..., m, j = 1, 2, 3, ..., n. The normalized decision matrix can be seen in the following solution:

$$r^{11} = \frac{x11}{\sqrt{x_{11} + x_{21} + x_{31} + x_{41} + x_{51}}}$$

Calculation of the knowledge criteria decision matrix

$$|X_1| = \sqrt{5+5+5+3+5} = 23$$

$$r^{11} = \frac{x_{11}}{x_1} = \frac{5}{23} = 0.217$$

$$r^{21} = \frac{x_{21}}{x_1} = \frac{5}{23} = 0.217$$

$$r^{31} = \frac{x_{31}}{x_1} = \frac{5}{23} = 0.217$$

$$r^{41} = \frac{x_{41}}{x_1} = \frac{3}{23} = 0.130$$

$$r^{51} = \frac{x_{51}}{x_1} = \frac{5}{23} = 0.217$$

Calculation of the decision matrix for Nutritional Quality criteria

$$|X_2| = \sqrt{4+4+5+4+5} = 22$$

$$r^{12} = \frac{x_{12}}{x_2} = \frac{4}{22} = 0.182$$

$$r^{22} = \frac{x_{22}}{x_2} = \frac{4}{22} = 0.182$$

$$r^{32} = \frac{x_{32}}{x_2} = \frac{5}{22} = 0.227$$

$$r_{42} = \frac{x_{42}}{x_2} = \frac{4}{22} = 0.182$$

$$r_{52} = \frac{x_{52}}{x_2} = \frac{5}{22} = 0.227$$

3. Subsequently, compute the alternative distances from the positive ideal solution (S+) and the alternative distances from the negative ideal solution (S−). Compute the different distances from the positive ideal solution (S+).
   The alternate positive ideal value a1 is as follows:

$$S_{+1} = \sqrt{(v_{11}-v_1)_2 + (v_{12}-v_2)_2 + (v_{13}+v_3)_2 + (v_{14}+v_4)_2 + (v_{15}+v_5)_2}$$

$$S^+_1 = \sqrt{(0.217-0.217)^2 + (0.136-0.227)^2 + (0.068+0.227)^2 + (0.143+0.238)^2 + (0.25+0.25)^2}$$

$S^+_1 = 0.748$

The alternative positive ideal value of a2 is:

$$S_{+2} = \sqrt{(v_{21}-v_1)_2 + (v_{22}-v_2)_2 + (v_{23}+v_3)_2 + (v_{24}+v_4)_2 + (v_{25}+v_5)_2}$$

$$S^+_2 = \sqrt{(0.217-0.217)^2 + (0.136-0.127)^2 + (0.137+0.227)^2 + (0.143+0.238)^2 + (0.075+0.25)^2}$$

$S^+_2 = 0.611$

The alternative positive ideal value of a3 is:

$S_{+3}=\sqrt{(v_{31}-v_1)_2+(v_{32}-v_2)_2+(v_{33}+v_3)_2+(v_{34}+v_4)_2+(v_{35}+v_5)_2}$

$S^{+}_{3}=\sqrt{(0.217-0.217)^2+(0.136-0.127)^2+(0.227+0.227)^2+(0.128+0.238)^2+(0.25+0.25)^2}$

$S^{+}_{3}=0.840$

The alternative positive ideal value of a4 is:

$S_{+4}=\sqrt{(v_{41}-v_1)_2+(v_{42}-v_2)_2+(v_{43}+v_3)_2+(v_{44}+v_4)_2+(v_{45}+v_5)_2}$

$S^{+}_{4}=\sqrt{(0.065-0.217)^2+(0.136-0.127)^2+(0.227+0.227)^2+(0.072+0.238)^2+(0.075+0.25)^2}$

$S^{+}_{4}=0.65$

The alternative positive ideal value of a5 is:

$S_{+5}=\sqrt{(v_{51}-v_1)_2+(v_{52}-v_2)_2+(v_{53}+v_3)_2+(v_{54}+v_4)_2+(v_{55}+v_5)_2}$

$S^{+}_{5}=\sqrt{(0.217-0.217)^2+(0.227-0.127)^2+(0.227+0.227)^2+(0.238+0.238)^2+(0.2+0.25)^2}$

$S^{+}_{5}=0.713$

Conclusion

This study demonstrates that the implementation of the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method serves as an excellent decision support system for selecting goat feed at CV. Lamegogo. The TOPSIS technique offers an objective and quantifiable rating of feed alternatives by evaluating several critical characteristics, including nutritional content, feed cost, availability, palatability, and influence on cattle growth. The data processing results demonstrate that the feed alternative exhibiting an optimal nutrient composition, costeffectiveness, year-round availability, excellent palatability for goats, and a beneficial impact on growth ranks top as the primary recommendation.

The application of the TOPSIS technique in this context enables the management of CV. Lamegogo to diminish its dependence on intuition and adopt a more methodical, transparent, and accountable decision-making process. The designed decision support system not only aids in selecting the optimal feed but also functions as a periodic assessment tool in response to fluctuations in price, composition, or feed availability in the field. Consequently, the implementation of TOPSIS may enhance feed management efficiency, bolster livestock health and production, and furnish a more logical foundation for decision-making in the advancement of the livestock enterprise at CV. Lamegogo.

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