Applying the SMART methodology within decision support systems to evaluate the suitability of oil palm fruit for production

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ABSTRACT

"Palm oil holds a significant position within Indonesia's commodities sector due to the high economic value per hectare that oil palm plantations yield, making it one of the country's vital commodities. Evaluating the quality of oil palm fruits fit for production requires a precise mechanism. One effective approach is the application of the SMART method, which stands for Simple Multi-Attribute Technique. SMART is a model employed to identify the optimal alternative from a set of options based on specific criteria.The outcomes of this study indicate several key findings. Firstly, the decision support system developed accelerates data processing during the decision-making process to determine the suitability of oil palm fruit for production. Additionally, the application of this decision support system adapts to the dynamic nature of weight value determination, making it adjustable to varying needs in assessing the quality of oil palm fruit production. The SMART method proves to be highly suitable for decision-making, especially for rapidly and accurately determining the production-worthy quality of oil palm fruit. Notably, the test results using the SMART method yielded a remarkable accuracy rate of 100%."

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1. INTRODUCTION

Palm oil holds a pivotal position in Indonesia's commodities market, primarily due to its unmatched economic value per hectare compared to other oil and fat-producing plants worldwide. Oil extracted from oil palm fruit serves as a crucial ingredient in a wide range of food products, including butter, cooking oil, and various vegetable fatty acids. Additionally, palm oil serves as a key component in chocolate, ice cream, livestock feed, vanaspati, different types of fatty acids, and various snack items. Recognizing the current and future significance of oil palm cultivation, alongside the growing global demand for palm oil, it becomes imperative to consider initiatives aimed at improving both the quality and quantity of oil palm production accurately to achieve optimal targets. (Marakas, 2003)

Palm oil contributes significantly to the country's foreign exchange earnings. Akmad Mangga Barani, the Director General of Plantations at the Indonesian Ministry of Agriculture, has declared that Indonesia holds the position of being the world's largest palm oil producer. The projection is for palm oil production to continue its annual growth. In order to optimize palm oil output, there is a requirement for an assessment method to ascertain the quality deserving of production for every harvested palm oil fruit. To choose high-quality oil palm fruit, it is essential to pay close attention to fertilization and the care of oil palm trees to maintain the fruit's suitability for production. As a result, this method guarantees that oil palm fruit can produce the highest quality palm oil while preserving its overall excellence. (Burstein & Holsapple, 2008)

2. METHOD

A method represents a structured approach or technique utilized to address a particular scenario. Consequently, the author employs a range of approaches to acquire this, which encompass: 1.Field Investigation (Field Research) Field research serves as a method for data collection achieved through direct exploration of the production area, with the aim of attaining precise data associated with the decision support system. The author's data collection methodologies encompass: a. Interviews - Interviews involve direct inquiries posed to pertinent sources. The author directly engages with the production department through interviews. b. Observation - Observation stands as a highly effective approach for scrutinizing a system through firsthand monitoring of ongoing activities. c. Sampling - Sampling serves as a data collection technique involving the selection of specific samples or instances. The author scrutinizes available documents pertaining to the evaluation of oil palm fruit quality. 2. Literature Examination (Library Research) The author conducts a comprehensive examination of existing literature to gather relevant data for this research, drawing from diverse sources such as books, the internet, and other references. (Arnott & Pervan, 2015)

The SMART model serves as a comprehensive decision-making framework that considers both qualitative and quantitative factors. Essentially, the SMART decision-making model aims to overcome the limitations of previous non-computerized models.The steps for implementing the SMART method are as follows: 1. Identifying the decision problem. 2. Defining the criteria used in the decision-making process. 3. Identifying the alternatives for evaluation. 4. Ranking the criteria based on their importance. 5. Assigning weights to each criterion according to their significance for each alternative. 6. Normalizing the criterion weights by dividing each criterion's weight by the sum of all criterion weights. 7. Establishing single-attribute utilities that gauge the performance of each alternative across criteria. During this phase, an expert assesses each alternative's value on a scale of 0-100 for each criterion. 8. Calculating the utility score for each alternative.

9. Reaching a decision; utility scores for each alternative are computed, and if selecting a single alternative is necessary, choose the one with the highest utility score. The linear utility function model utilized by SMART is represented by Equation 1:

$$Maximize \sum_{j=1}^{k} wj.uij, \forall i = 1 \dots n$$

Here's the breakdown:

- Wj signifies the weight assigned to criterion j among the k criteria.
- Uij denotes the utility score of alternative i for criterion j.
- The decision-making process entails determining which of the n alternatives holds the highest function value.
- This function value can also serve as a basis for ranking the n alternatives. (Sauter, 2014) (Ginting et al., 2020)

3. RESULTS AND DISCUSSION

3.1. Criteria and Subcriteria

In this study, the author endeavors to implement the SMART method within the Decision Support System designed to assess the quality of oil palm fruits suitable for production. As an illustrative case in utilizing the SMART method for evaluating the production-worthy quality of oil palm fruits, the following procedural steps are employed: 1. Establishing the Quantity of Criteria and Sub-Criteria The criteria employed to assess the production-worthy quality of oil palm fruits can be referenced in Table 1. (Ginting, 2023)

Tabel 1. Criteria and Subcriteria

Criteria Names	Subcriteria
The Color of Oil Palm Fruit	Brilliant Red
	Redness
	Deep Red Black
	Intense Black
Maturation Quality	Ripe
	Less Ripe
	Raw
	Very Raw
The Weight of Oil Palm Fruit	More than 36 Kg
	Around 16 Kg - 35 Kg

	Around 3 Kg - 15 Kg
	Less than 3 Kg
The Size of Oil Palm Fruit	More than 5 Cm
	Approximately 3 cm – 5 cm
	Around 2 cm – 3 cm
	Less than 2 cm
Ripe Oil Palm Fruit	5 – 10 Fruit Bunches at the Edge
	0 Fruit Bunches at the Edge

3.2. The Weight of Each Criterion

Assigning Criterion Weights

Criterion weighting is performed by assigning values between 0-100 based on the importance of each criterion.

Tabel 2. The Weight of Each Criterion

Nama Kriteria	**Weight (w)**
The Color of Oil Palm Fruit	45
Maturation Quality	50
Weight of Oil Palm Fruit	35
Size of Oil Palm Fruit	35
Ripe Oil Palm Fruit	30
Total	**195**

Following the allocation of weights to criteria, the subsequent stage involves normalizing these criterion weights. This normalization process entails dividing the weight assigned to a specific criterion by the total weight of all criteria. The procedure for normalizing the weights of each criterion in evaluating the production-worthy quality of oil palm fruits unfolds as follows: (Ginting, Subhan Hafiz Nanda, Wayahdi, M.Rhifky, Guntur, 2022)

Tabel 3. Normalized Criterion Weight Results

Criterion Names	**Normalized Weight (wj)**
Color of Oil Palm Fruit	0.23
Maturation Quality	0.25
Weight of Oil Palm Fruit	0.18
Size of Oil Palm Fruit	0.18
Ripe Oil Palm Fruit	0.15
Total	**0.99**

Allocating Utility Scores for Each Respective Criterion

Following the definition of all established criteria, the subsequent phase entails an analysis to ascertain the utility values. These values will be assigned within a range of 0 to 100, where 0 signifies the minimum value, and 100 represents the maximum. (Muhammad Rhifky Wayahdi et al., 2021) (M Rhifky Wayahdi et al., 2020)

Tabel 4. Utility Values for Each Criterion

Criterion Names	**Subcriteria**	**Nilai *Utility***
Color of Oil Palm Fruit	Glossy Red	100
	Redness	75
	Deep Red Black	50
	Intense Black	25
Maturation QualityMaturation Quality	Ripe	100
	Less Ripe	75
	Raw	50
	Very Raw	25
Weight of Oil Palm Fruit	More than 36 Kg	100
	Around 16 Kg – 35 Kg	75
	Around 3 Kg – 15 Kg	50
	Less than 3 Kg	25
Size of Oil Palm Fruit	More than 5 Cm	100
	Around 3 Cm – 5 Cm	75
	Around 2 Cm – 3 Cm	50

	Less than 2 Cm	25
Ripe Oil Palm Fruit	5 – 10 Fruit Bunches at the Edge	100
	0 Fruit Bunches at the Edge"	50

Assigning Utility Scores to Each Respective Criterion After establishing all the criteria, the subsequent phase involves analysis to determine the utility scores. These scores will be allocated on a scale of 0 to 100, where 0 signifies the minimum value and 100 represents the maximum value. (Syahputra et al., 2020)

Tabel 5. Utility Scores for Each Criterion

Criterion Names	Subcriteria	Utility Values
The Color of Oil Palm Fruit	Glossy Red	100
	Redness	75
	Deep Red Black	50
	Intense Black	25
Maturation Quality	Ripe	100
	Less Ripe	75
	Raw	50
	Very Raw	25
Weight of Oil Palm Fruit	More than 36 Kg	100
	Around 16 Kg – 35 Kg	75
	Around 3 Kg – 15 Kg	50
	Less than 3 Kg	25
Size of Oil Palm Fruit	More than 5 Cm	100
	Around 3 Cm – 5 Cm	75
	Around 2 Cm – 3 Cm	50
	Less than 2 Cm	25
Ripe Oil Palm Fruit	5 – 10 Fruit Bunches at the Edge	100
	0 Fruit Bunches at the Edge	50

Calculating the Final Score
The process of calculating the final score for oil palm fruits is as follows:
Final Score = (normalized weight of fruit color * weight of fruit color utility) + (normalized weight of ripeness * weight of ripeness utility) + (normalized weight of fruit weight * weight of fruit weight utility) + (normalized weight of fruit size * weight of fruit size utility) + (normalized weight of ripe fruit * weight of ripe fruit utility).

Tabel 6. Decision Table

Values	Description
0 s/d 0.49	Oil Palm Fruits Unfit for Production
0.50 s/d 1	Oil Palm Fruits Fit for Production

The final score for the oil palm fruit is 0.87. Based on the decision table (Table III.7), the score falls between 0.50 and 1. Therefore, it can be concluded that the oil palm fruit with code P01 is suitable for production.

4. CONCLUSION

From the research conducted under the title "Utilization of the SMART Method in the Decision Support System for Assessing the Production-Worthy Quality of Oil Palm Fruits at PT. Perkebunan Nusantara II Kebun Bandar Klippa," the following key findings can be summarized: 1. The developed decision support system plays a pivotal role in streamlining data processing for the purpose of efficiently determining the suitability of oil palm fruits for production. 2. The user-friendly interface of the decision support system simplifies the process of generating reports related to the evaluation of oil palm fruit quality for production. 3. The SMART method emerges as a well-suited approach for decision-making that involves multiple options, particularly in the rapid and precise assessment of oil palm fruit quality. The results of SMART method testing demonstrate a remarkable accuracy rate of 100%. In light of the findings from this research, the author offers the following suggestions for future enhancements: At present, the system operates as a standalone application. It is advisable to explore the possibility of expanding the decision support system in the future to support client-server architecture or to adapt it for use on computers with internet connectivity. It is highly recommended to integrate data backup capabilities into the system. This measure would ensure that, in the event of server malfunctions, data remains protected against deletion. Prospective developments should encompass the addition of features tailored to specific application requirements, as well as the integration of antivirus measures to bolster system security and safeguard the data stored within the database. (Mughnyanti & Ginting, 2023)

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