Best Quality Tomato Selection by Supply Chain Strategy for Renewable Energy

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Abstract— World agriculture still faces challenges quite fundamental, it is about the quality issues and the increasing of competitiveness through productivity and the eficiency. This research focused on the criteria of best tomato types and how to apply the Simple Additive weighting method (SAW) into a Decision Support System (DSS) for election best quality tomato that can assist farmers in determining the best type of tomato for renewable energy and supply chain strategy, based on the criteria that have been chosen, such as: tomato size, tomato color, tomato shape and tomato disease. By using the application of Simple Additive weighting method into Decision Support Systems value, it can be concluded that V_5 is the best quality tomato and has a predicate value of 83.75 with the fragile values, as follows: 50-69 = Enough, 70-82 = Good, 83-100 = Best.

Keywords— *Decision Support System, Simple Additive Weighting, Tomato, renewable energy, Supply chain.*

1. Introduction

The One of horticultural products that is growing is tomato. Tomato is important to study because it has merit as food products, pharmaceuticals, renewable energy and has a promising market prospect. Population increase and improvement of income levels resulted in the demand for renewable energy increased. This leads to a need to increase competitiveness through improved the quality, productivity, and efficiency. The fulfillment of the needs of horticultural products for the public is very important, so the most important to be considered is not only the quantity but also the quality of the product.

Tomato is a vegetable crop that is essential for farmers, because the tomato can be easily sold in the market even though the price is very fluctuates based on the season. Tomato has an important role in the fulfillment of renewable energy. One of the efforts made to improve the quality and quantity of production of tomato is to fertilization. Tomato ability to produce fruit is highly dependent on the interaction between plant growth and environmental conditions. The other factor that led to the low yields of tomato is the use of fertilizers is not maximized and the cropping patterns have not been right. Overcoming these problems, it is important to repair the cultivation of tomato. For the technique, this study tried to use Simple Additive weighting method (SAW).

Some researchers have presented research related to tomato. According to Makalew [1], Determination of Minimum Data Set and Soil Quality Index are as the cornerstone of sustainable land management. The Dissertation of Doctoral Program of Agricultural Sciences conducts a research to characterize the landscape and identify a variety of rainfall in the area of research, evaluate the suitability of land for farming crops in the area of research and study the availability of water resources both ground water and surface water, and then determine the water needs of crops based index of the adequacy of the water, to determine the procedures for awarding irrigation water to reduce the crops failure and devise a plan for planting in dry soil [1]. El Hariri et al. [2,3] and El Bendary et al. [4] have presented machine learning approach for tomato ripeness. Sukur [5], in his research of Decision Support System to Determine Planting Strategy (Case Study of District Agriculture Office, Pemalang) has generated the application of decision support system to determine which plants are best suited to the climatic conditions, rainfall, water availability, and soil types so that it can optimize the functionality and productivity of the agricultural land which refers to the pattern of the processing of agricultural land sustainable. This system can determine what plants

are best suited by the rank of results ratio (profit), the ratio of production costs, the ratio of plant age, and the ratio of water demand.

This research present a case of finding the best solution to help make decisions cultivate the best quality tomato for renewable energy using SAW. This method was chosen because it is able to select the best quality tomato. The purpose of this research is to provide the information to the public in order to cultivate tomato plants right in home territory yard area so it might be able to minimize the failure of implantation.

2. Tomato

Tomato (Solanum lycopersicum) is a plant of the family Solanaceae, which is from Central America and South America [6], and then it is also from Mexico to Peru. Tomato has a short life cycle and has a height of between 1 and 3 meters. Tomato has benefits like preventing cancer because the color red tomato contains a lot of lycopene.

Meanwhile in Indonesia, the production of quality and quantity tomato is still low. This happen because of some problems, such as: the soil conditions, the system unbalanced fertilization, pests and pathogens, technical cultivation by farmers, and the influence of climate and weather of tomato plants. One of the conditions ideal of growing tomato is the rainfall 750-1250 mm/year and +/- 25% relative humidity.

Most tomato varieties can only grow in the highlands, but the Agency for Agricultural Research and the floating tomato varieties have been founded tomato plant for the lowlands, namely: Ratna, Diamonds, Pearls and several other varieties. But there is often occurs planting tomatoes regardless of its quality, so that the yield and fruit quality is very low. Therefore, it is needed a research which is directed to increase the yield and quality of tomato by planting improved varieties because the need of tomato is increase.

3. Simple Additive Weighting

Fuzzy Logic can handle problems with imprecise data and give more accurate results. Professor L.A. Zadeh introduced the concept of Fuzzy Logic [7]. Researchers used this theory for developing real applications [8,9] and new algorithms [10-16]. SAW method can help in the decision of a case, but calculations using SAW method is only to generate the greatest value that will be selected as the best alternative. The calculation will be in accordance with this method, if the selected alternatives have the criteria that have been specified. SAW method is more efficient because the time needed in a calculation is shorter.

Simple Additive Weighting method commonly known as the weighted summation method. The basic concept of SAW method (Simple Additive weighting) is looking for a weighted sum of the performance rating for each alternative on all attributes [17-24].

SAW method requires a process of normalizing the decision matrix (X) to a scale that can be compared with all the ratings of existing alternatives. This method is the most famous of method and the most method which is widely used in dealing with situations of Multiple Attribute Decision Making (MADM). There are some steps completions of SAW. First, Determine the criteria that will be used as a reference in the decision, namely Ci. Second, Determine the suitability rating of each alternative on each criterion. Third, Make a decision matrix based on criteria (Ci), then do matrix normalization by equations adjusted for the type attribute (or attributes attribute benefit costs) in order to Obtain the normalized matrix R. Fourth, The final result is Obtained from the rank process, that is the sum of the multiplication of normalization R matrix with the weight vector so that it will get the greatest value that selected as the best alternative (Ai).

$$r_{ij} = \begin{cases} \dfrac{X_{ij}}{\text{Max } X_{ij}} \\ \dfrac{\text{Min } X_{ij}}{X_{ij}} \end{cases} \quad (1)$$

Which:
r_{ij} = the value of normalized performance rating
X_{ij} = the value of attribute possessed of each criterion

Criteria:
Max X_{ij} = the greatest value of each criterion

Min X_{ij} = the smallest value of each criterion
Benefit = if the greatest value is the best value
Cost = if the smallest value is the best value

In which, rij is the normalization rating of alternative Ai on attribute Cj; i = 1,2 ..., m and j = 1,2 ..., n. Preference Value will to each alternative (Vi) is given as

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \quad (2)$$

Where:
V_i = rank for each alternative
W_j = weight value of each criterion
r_{ij} = value of performance rating of normalization

V_i is the larger value indicates that Ai alternative will prefer to be chosen.

4. Implementation

In this research, there are weights and criteria established in determining the best quality tomato. The criteria is shown in Table 1 below.

Table 1. The Criteria

Criteria	Description	Value
C1	Tomato size	25
C2	Tomato color	30
C3	Form of Tomato	25
C4	Tomato diseases	20
	Total	**100**

Alternative:
A1 = Ratna
A2 = Diamonds
A3 = Mutiara
A4 = Ranti
A5 = Apples

In the process of making the Decision Support System for the best quality tomato selection, the weighting of each criterion determined by decision-makers or experts in their field as shown in Table 2. There are four criteria for the best quality tomato selection that would be used that criterion C1 to C4 as shown in Table 3, Table 4, Table 5, and Table 6. The criterion could be shown in the table above. Decision Support System for the selection of best quality tomato is made to determine the best quality tomato in choosing the criteria that specified by the previous provisions. Data input that used to conduct decision-making process of some of these alternatives was done through the data entry process in the form of criteria for the best quality tomato selection that has been applied. Then the decision-making process would be carried out using Fuzzy Multi Attribute Decision Making (FMADM) using Simple Additive Weighting (SAW).
Data output generated from this system was an alternative data that used to determine the best quality tomato that has been ranked from highest value to the Lowest value. The final results released by the Decision Support System is derived from the value of each alternative criterion best quality tomato, because in each criterion has a different value. Based on the step-by-step problem-solving method using SAW that has been described previously, this section would discuss the process of the calculation and determination of the tomato the best quality output.

Table 2. Weight of Value

Weight	Value
Very Low (VL)	1
Low (L)	2
Enough (E)	3
Height (H)	4

Table 3. Size of Tomato (C1)

Tomato size	Weight	Value
Big	H	4
moderate	E	3
Small	L	2

Table 4. Color of Tomato (C2)

Tomato color	Weight	Value
Red	H	4
Yellow	E	3
Green	VL	1

Table 5. Form of Tomato (C3)

Tomato Form	Weight	Value
Oval	L	2
oval	E	3
Round	H	4

Table 6. Tomato Disease (C4)

Fruit weight	Weight	Value
There is disease	T	4
There is no disease	R	2

Based on the above data, the decision X matrix could be formed as shown in Table 7 below.

Table 7. Rating of compatibility alternatives

	Criteria			
	C1	C2	C3	C4
A1	4	3	2	2
A2	3	3	3	4
A3	4	3	3	2
A4	2	1	4	2
A5	3	4	4	2

Decision-making give weight based on the importance level of each criteria which was required, as follows:

The weight vector W = [25, 30, 25, 20]

Making a decision X matrix, it would be made match table, as follows:

$$X = \begin{Bmatrix} 4 & 3 & 2 & 2 \\ 3 & 3 & 3 & 4 \\ 4 & 3 & 3 & 2 \\ 2 & 1 & 4 & 2 \\ 3 & 4 & 4 & 2 \end{Bmatrix}$$

The normalization X matrix to calculate the value of each criterion based on predetermined criteria, namely:

- **A1**

$R_1 = \frac{4}{Max(4,3,4,2,3)} = \frac{4}{4} = 1$

$R_2 = \frac{3}{Max(4,3,4,1,4)} = \frac{3}{4} = 0,75$

$R_3 = \frac{2}{Max(2,3,3,4,4)} = \frac{2}{4} = 0,5$

$R_4 = \frac{2}{Max(2,4,2,2,2)} = \frac{2}{4} = 0,5$

- **A2**

$R_{21} = \frac{3}{Max(4,3,4,2,3)} = \frac{3}{4} = 0,75$

$R_{22} = \frac{3}{Max(3,3,4,1,4)} = \frac{3}{4} = 0,75$

$R_{23} = \frac{3}{Max(2,3,3,4,4)} = \frac{3}{4} = 0,75$

$R_{24} = \frac{4}{Max(2,4,2,2,2)} = \frac{4}{4} = 1$

- **A3**

$R_{31} = \frac{4}{Max(4,3,4,2,3)} = \frac{4}{4} = 1$

$R_{32} = \frac{3}{Max(3,3,4,1,4)} = \frac{3}{4} = 0,75$

$R_{33} = \frac{3}{Max(2,3,3,4,4)} = \frac{3}{4} = 0,75$

$R_{34} = \frac{2}{Max(2,4,2,2,2)} = \frac{2}{4} = 0,5$

- **A4**

$R_{41} = \frac{2}{Max(4,3,4,2,3)} = \frac{2}{4} = 0,5$

$R_{42} = \frac{1}{Max(3,3,4,1,4)} = \frac{1}{4} = 0,25$

$R_{43} = \frac{4}{Max(2,3,3,4,4)} = \frac{4}{4} = 1$

$R_{44} = \frac{2}{Max(2,4,2,2,2)} = \frac{2}{4} = 0,5$

- **A5**

$R_{51} = \frac{3}{Max(4,3,4,2,3)} = \frac{3}{4} = 0,75$

$R_{52} = \frac{4}{Max(3,3,4,1,4)} = \frac{4}{4} = 1$

$R_{53} = \frac{4}{Max(2,3,3,4,4)} = \frac{4}{4} = 1$

$R_{54} = \frac{2}{Max(2,4,2,2,2)} = \frac{2}{4} = 0,5$

From the calculation above, the matrix could be normalized, as follows:

R =

$$\begin{Bmatrix} 1 & 0,75 & 0,5 & 0,5 \\ 0,75 & 0,75 & 0,75 & 1 \\ 1 & 0,75 & 0,75 & 0,5 \\ 0,5 & 0,25 & 1 & 0,5 \\ 0,75 & 1 & 1 & 0,5 \end{Bmatrix}$$

It would be made the multiplication of W × R matrix and summing the results of multiplication to obtain the best alternative by doing the following rank of the greatest, as follows:

V_1= {(1×25)+(0,75×30)+(0,5×25)+(0,5×20)}
= (25 + 22,5 + 12,5 + 10)
= 70

V_2 = {(0,75×25)+(0,75×30)+(0,75×25)+(1×20)}
= (18,75 + 22,5 + 18,75 + 20)
= 80

V_3= {(1×25)+(0,75×30)+(0,75×25)+(0,5×20)}
= (25 + 22,5 + 18,75 + 10)
= 76,25

V_4= {(0,5×25)+(0,25×30)+(1×25)+(0,5×20)}
= (12,5 + 7,5 + 25 + 10)
= 55

V_5= {(0,75×25)+(1×30)+(1×25)+(0,5×20)}
= (18,75 + 30 + 25 + 10)
= 83,75

From the multiplication of W × R matrix, it could be obtained the results, as follows:

$V_1 = 70$
$V_2 = 80$
$V_3 = 76,25$
$V_4 = 55$
$V_5 = 83,75$

The greatest value of the sum of the above matrix is thus V_5. Thus, the alternative of A5 (tomato A5) is the best quality tomato because it has the best predicate or tomato with the highest weight value.

The criterion of best tomato is based on the following intervals:
- ✓ **50 – 69** = Enough
- ✓ **70 – 82** = Good

83 – 100 = Best

5. Conclusion

Decision Support System to determine the selection of the best quality tomato might help and facilitate the farmers in choosing a quality tomato based on the criteria that have been determined, such as: tomato size, tomato color, tomato form and tomato disease. Using the application of Simple Additive Weighting method into the decision support system

value results obtained from the application of the V_5 is the best quality tomato. Then, it has a value of 83.75. The researchers suggest that the data of tomato are expected to be developed with the new data cultivation tomato, more numerous and widespread so that the data of this tomato may really be used as one of an illustration in the decision-making selection of best quality tomato for renewable energy.

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