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Decision Support System In Land Selection For Rubber Tree Planting Using The MOORA Method

Eliza Amanda
Department of Information System, STMIK KAPUTAMA Binjai

*Coresponding Author
Email : elizaamanda553@gmail.com

Abstract

Decision support system in the selection of land for rubber tree planting in order to minimize time and help PT GERGAS UTAMA to determine quality land so as to increase rubber productivity. This method also has a good level of selectivity because it can determine the purpose of conflicting criteria. Where the criteria can be profitable (benefit) or unfavorable (cost). The selection of the right rubber area will certainly affect the production of rubber plants. In the process of selecting the right rubber area, of course, there are several criteria that will determine whether or not a land is suitable for producing rubber plantations such as temperature, rainfall, drainage, soil texture and so on. PT GERGAS UTAMA has difficulty in the process of selecting this land because the selection process is still done manually which of course will take longer so that it becomes ineffective and affects the productivity of the rubber plant based on the description above, it is necessary to build a decision support system in the selection of land for rubber tree planting in order to minimize time and help PT GERGAS UTAMA to determine quality land so as to increase rubber productivity. In the development of this decision support system, the MOORA (Multi-Objective Optimization by Ratio Analysis) method is used, which is a method that has a level of flexibility and ease of understanding in separating the subjective part of an evaluation process into decision weight criteria with several decision-making attributes. The program used in the development of the Decision Support System is PHP for a web-based system and MySQL as a database management system. The results of this program indicate that the Decision Support System for the selection of land for planting rubber trees can be utilized by PT GERGAS UTAMA is the rubber plantation sector in selecting the best land for planting. The results of the ranking calculation from the MOORA (Multi-Objective Optimization by Ratio Analysis) method from a total of 10 rubber land planting locations with a value of 0.369, the result of the sum of the criteria weights being the highest. the best has the highest value of 0.369.

Keywords: Decision Support System, Land, Rubber Planting, MOORA

INTRODUCTION

Rubber is a hydrocarbon polymer formed from latex obtained from the sap of several types of rubber tree plants but can also be produced synthetically. Rubber is a plant that is easy to cultivate and can grow well in the tropics. Rubber plants are annual plants and can produce until they reach the age of 25-30 years. The main plant treatments such as fertilization or pest eradication are rarely carried out as a result of reduced rubber productivity (Iskandar, 2018).Land is an area on the earth's surface whose characteristics include all attributes that are quite stable or which can be assumed to be circular in nature from the biosphere, atmosphere, soil, geology, hydrology, plant and animal populations, as well as the results of past and present human activities. , as long as the identifier has a significant effect on current and future land use (Mokodompit, 2019).The growth of the rubber industry in Indonesia is quite good since the last decade has increased investor interest.

However, the availability of appropriate and quality land is the main problem that must be faced in the expansion of the rubber commodity business. Due to the results of rubber plants obtained from ordinary land and the right and quality land, it will be different and will certainly affect the production of the rubber business. PT GERGAS UTAMA is a private company engaged in rubber plantations which is located in Langkat Regency. PT GERGAS UTAMA is a private company engaged in rubber plantations which is located in Langkat Regency. The selection of the right rubber area will certainly affect the production of rubber plants. In the process of selecting the right rubber area, of course, there are several criteria that will determine whether or not a land is suitable for producing rubber plantations such as temperature, rainfall, drainage, soil texture and so on.

PT GERGAS UTAMA has difficulty in the process of selecting this land because the selection process is still done manually which of course will take longer so that it becomes ineffective and affects the productivity of the rubber plant. Based on the description above, it is necessary to build a decision support system in the selection of land for rubber tree planting in order to minimize time and help PT GERGAS UTAMA to determine quality land so as to increase rubber productivity. In the development of this decision support system, the MOORA (Multi-Objective Optimization by Ratio Analysis) method is used, which is a method that has a level of flexibility and ease of understanding in separating the subjective part of an evaluation process into decision weight criteria with several decision-making attributes. This method also has a good level of selectivity because it can determine the purpose of conflicting criteria. Where the criteria can be profitable (benefit) or unfavorable (cost).

The results of this program indicate that the Land Selection Decision Support System for Planting Pandanwangi Seeds can be used by the Department of Agriculture, namely the field of food crop production (rice plant section) and the sub-districts in Cianjur Regency in choosing the best land for planting Pandanwangi seedlings. This research is entitled "Decision support system for selecting the right agricultural land to increase chili yields using the MOORA method" (Kusnaidi, 2020).

RESEARCH METHODS

The problem solving method to improve the calculation results with the MOORA method is used for objective ranking of each decision maker involved based on their respective preference criteria. The Copeland Score method is used to accommodate the priority interests of the various decision makers involved by objectively aggregating the ranking results of the MOORA method of each decision maker involved based on their respective level of importance (L M. Fajar Israwan, 2021).

The MOORA method consists of five steps as follows:

Step 1: determine the objectives and identify the relevant evaluation attributes.

Step 2: display all available information for the attribute in the form of a decision matrix. X is the criterion value of each criterion which is represented as a matrix.

$$x = \begin{bmatrix} x_{11} & x_{12} & . & x_{1n} \\ x_{21} & x_{22} & . & x_{2n} \\ . & . & . & . \\ x_{m1} & x_{m2} & . & x_{mn} \end{bmatrix} \qquad \ldots(1)$$

Step 3: conclude that the denominator, the best choice of the square root of the sum of the squares of each alternative per attribute. This ratio can be expressed as follows:

$$X^*_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^2}} \qquad \ldots(2)$$

The ratio x_{ij} indicates the order to x_i of the alternative on the criterion to j, indicates the multiplicity of the number of alternatives and n indicates the number of criteria. concluded that for denominators, the best option of the square root of the sum of the squares of each alternative criterion.

Step 4: for multi-objective optimization, the result of normalization is the addition in terms of maximizing (from the beneficial attributes/benefit) and subtraction in terms of minimization (from the unfavorable attributes/cost). Then the optimization problem becomes:

$$y_1 = \sum_{j=1}^{g} x_{ij} - \sum_{j=g+1}^{n} x_{ij} \qquad \ldots(3)$$

Where g is the value of the criteria to be maximized, (n-g) is the value of the minimized criteria, and Yi is the value of the alternative normalization assessment of i for all attributes. In some cases, often observe some other more important criteria. Ordered to give more importance to the attribute, it was carried out with the appropriate weight (significant coefficient). When the weight of this criterion is considered, the Yi equation is as follows:

$$y_1 = \sum_{j=1}^{g} w_j x_{ij} - \sum_{j=g+1}^{n} w_j x_{ij} \qquad \ldots(4)$$

Where W_i is the weight of the attribute x_j.
Step 5: Y_i value can be positive or negative depending on the maximum (favorable criteria) and minimum (unfavorable criteria) in the decision matrix.

RESULTS AND DISCUSSION

Analysis And Design

The research methodology is a method used to obtain the truth by using a search with certain procedures in finding the truth, depending on the reality being studied.

Based on the picture above, it can be seen that there are several stages in conducting a research, namely:

1. Problem Identification
   This is the initial stage in research, namely by explaining the background of the problem, the purpose of the problem, the benefits of the research conducted by limiting the problem, the objectives and benefits of the research conducted by limiting the problem so that it does not get out of the focus of the discussion.
2. Theory Study

At this stage the researcher looks for information from sources related to the problems encountered with several library sources such as books, journals and the internet as a support and basis for writing a thesis.

3. Data Collection
   This stage is collecting the data needed in making the thesis such as interviews, observations which can then be processed to the next stage. For this research the author uses three ways in collecting data so that this thesis can be completed
4. Decision research (Library Research), which is taking the theory and necessary data from various libraries such as books, articles and other scientific works according to the discussion.
5. Observation, namely observing and researching the system running at PT GERGAS UTAMA.
6. Interview (Interview), namely conducting questions and answers with competent parties at PT GERGAS UTAMA to obtain information about the Selection of the Best Rubber Tree Planting Land.
7. Data Analysis
   At this stage the researcher manages data, descriptions and sources of more complete information, the authors collect data and manage it into and related to decision support system theory and the Multi-Objective Optimization method on the basis of Ratio Analysis (MOORA).
8. Testing And Implementation
   This process is done by making software programming (coding) and entering some sample data. Then test the application programmer before use.
9. Evaluation
   At this stage the researcher evaluates the existing system, whether the system is in accordance with what the user expects. Assess and evaluate the system output or results. Testing the process management input and system output.

Research Supporting Data

The Research Supporting Data are as follows:

Table.1 Research Supporting Data

No	Land Location	Temperature	Rainfall	Drainage	Soil Texture	Peat Soil Thickness	Nutrient Retention of Base Saturation	Sulfidic Depth	Erosion Danger
1	AFD I	28°C	2500 mm/Year	Good	Fine	50 cm	4,5 Ph	130 cm	30 cm
2	AFD II	25°C	2900 mm/Year	Keep	A Little Smooth	60 cm	4,35 Ph	150 cm	8 cm
3	AFD III	22°C	4000	Good	Fine	130 cm	4,75 Ph	180 cm	20 cm

			mm/Year						
4	AFD IV	35°C	2500 mm/Year	Slow Down	A Little Roug h	60 cm	6,5 Ph	100 cm	15 cm
5	AFD V	27°C	3000 mm/Year	Good	A Little Smoot h	110 cm	4,5 Ph	160 cm	23 cm
6	AFDVI	20°C	3600 mm/Year	Good	Fine	100 cm	5,75 Ph	135 cm	18 cm
7	AFD VII	34°C	2200 mm/Year	Slightly Hindered	Roug h	180 cm	6,5 Ph	95 cm	12 cm
8	AFD VIII	26°C	3000 mm/Year	Keep	A Little Smoot h	150 cm	5,65 Ph	165 cm	29 cm
9	AFD IX	23°C	3500 mm/Year	Good	Fine	90 cm	5,0 Ph	125 cm	30 cm
10	AFD X	30°C	2800 mm/Year	Keep	A Little Smoot h	75 cm	5,5 Ph	155 cm	16 cm

Application of the Method

The application of the MOORA method for a decision support system in the selection of land for planting rubber trees is as follows:

Step 1: determine the objectives and identify the relevant evaluation attributes.

This method has a good choice because it can determine the objectives of conflicting criteria. Where the criteria can be feasible (benefit) or unfavorable (cost). PT GERGAS UTAMA Land Location Data:

Table.2 Research Supporting Data

No	Land Location	Tem pera ture	Rainfall	Draina ge	Soil Texture	Peat Soil Thickn ess	Nutrient Retentio n of Base Saturati on	Sulfidic Depth	Erosion Danger
1	AFD I	28°C	2500 mm/Year	Good	Fine	50 cm	4,5 Ph	130 cm	30 cm
2	AFD II	25°C	2900 mm/Year	Keep	A Little Smooth	60 cm	4,35 Ph	150 cm	8 cm

3	AFD III	22°C	4000 mm/Year	Good	Fine	130 cm	4,75 Ph	180 cm	20 cm
4	AFD IV	35°C	2500 mm/Year	Slow Down	A Little Rough	60 cm	6,5 Ph	100 cm	15 cm
5	AFD V	27°C	3000 mm/Year	Good	A Little Smooth	110 cm	4,5 Ph	160 cm	23 cm
6	AFDVI	20°C	3600 mm/Year	Good	Fine	100 cm	5,75 Ph	135 cm	18 cm
7	AFD VII	34°C	2200 mm/Year	Slightly Hindere d	Rough	180 cm	6,5 Ph	95 cm	12 cm
8	AFD VIII	26°C	3000 mm/Year	Keep	A Little Smooth	150 cm	5,65 Ph	165 cm	29 cm
9	AFD IX	23°C	3500 mm/Year	Good	Fine	90 cm	5,0 Ph	125 cm	30 cm
10	AFD X	30°C	2800 mm/Year	Keep	A Little Smooth	75 cm	5,5 Ph	155 cm	16 cm

Table III.2 Criteria

Criteria	Information	Attribute	Weight
C1	Temperature	*Benefit*	15%
C2	Rainfall	*Benefit*	10%
C3	Drainage	*Benefit*	15%
C4	Soil Texture	*Cost*	20%
C5	Peat Soil Thickness	*Cost*	10%
C6	Nutrient Retention of Base Saturation	*Benefit*	5%
C7	Sulfidic Depth	*Benefit*	5%
C8	Erosion Danger	*Benefit*	20%
Amount			100%

The weighting of each criterion is as follows:

Table III.3 Weighting Temperature

Temperature	Variable	Score
31-34 ℃	Very Suitable	4
26-30 ℃	Appropriate	3
22-25 ℃	Not Suitable	2
>34 & <22 ℃	It Is Not Accordance With	1
Weight 15%		

Table III.4 Weighting Rainfall

Rainfall	Variable	Score
2000-3000 mm/Year	Very Suitable	4
3000-3500 mm/Year	Appropriate	3
3500-4000 mm/Year	Not Suitable	2
<1500 & >4000 mm/Year	It Is Not Accordance With	1
	Weight 10 %	

Table III.5 Drainage Weighting

Drainase	Variable	Score
Excellent	Appropriate	4
Good	Not Suitable	3
Good Enough	It Is Not Accordance With	2
Bad	Very Suitable	1
	Weight 15 %	

Table III.6 Weighting Soil Texture

Soil Texture	Variable	Score
Soft	Appropriate	4
Less Subtle	Not Suitable	3
Less Rude	It Is Not Accordance With	2
Rough	Very Suitable	1
	Weight 20 %	

Table III.7 Soil Texture Weighting

Peat Soil Thickness	Variable	Score
< 60 cm	Appropriate	4
60-140 cm	Not Suitable	3
141-200 cm	It Is Not Accordance With	2
> 200 cm	Very Suitable	1
	Weight 10 %	

Table III.8 Weighting Nutrient Retention of Base Saturation

Nutrient Retention of Base Saturation	Variable	Score
< 3,5 Ph	Appropriate	4
3,5-4,0 Ph	Not Suitable	3
4,1-5,0 Ph	It Is Not Accordance With	2
>5,0 Ph	Very Suitable	1
	Weight 5%	

Table III.9 Weighting Sulfidic Depth

Sulfidic Depth	**Variable**	**Score**
>175 cm	Appropriate	4
125-175 cm	Not Suitable	3
75-124 cm	It Is Not Accordance With	2
<75 cm	Very Suitable	1

Weight 5 %

Table III.10 Weighting Erosion Danger

Erosion Danger	**Variable**	**Score**
< 8 cm	Appropriate	4
8-16 cm	Not Suitable	3
17-45 cm	It Is Not Accordance With	2
>45 cm	Very Suitable	1

Weight 20 %

Step 2: display all available information for the attribute in the form of a decision matrix. X is the criterion value of each criterion which is represented as a matrix.

Based on the data from the existing criteria, a suitability rating for each alternative is generated, as shown in the following table:

Table III.11 Rating of Each Alternative

Alternative	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**
A1	3	4	2	3	3	1	2	2
A2	2	1	1	1	1	1	3	3
A3	1	1	3	4	2	3	2	2
A4	1	4	4	4	3	1	2	2
A5	1	1	1	2	1	2	3	3
A6	1	2	4	1	3	1	3	2
A7	1	1	3	4	1	1	2	2
A8	1	1	2	1	2	1	3	2
A9	1	4	4	3	3	1	3	2
A10	1	3	3	2	2	2	3	2

Step 3: conclude that the denominator, the best choice of the square root of the sum of the squares of each alternative per attribute.

Then normalization of the X matrix is carried out:

Then normalization of the matrix X is carried out :

C1 $= \sqrt{3^2 + 2^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2}$
C1 $= \sqrt{9 + 4 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1}$
= 4,582
A_1 = 3/4,582 = 0,654
A2 = 2/4,582 = 0,436
A3 = 1/4,582 = 0,218
A4 = 1/4,582 = 0,218
A5 = 1/4,582= 0,218
A6 = 1/4,582 = 0,218
A7 = 1/4,582 = 0,218
A8 = 1/4,582 = 0,218
A9 = 1/4,582= 0,218
A10 = 1/4,582 = 0,218

C2 $= \sqrt{4^2 + 1^2 + 1^2} + 4^2 + 1^2 + 2^2 + 1^2 + 1^2 + 4^2 + 3^2$
= 8,124
A1 = 4/8,124 = 0,492
A2 = 1/8,124 = 0,123
A3 = 1/8,124 = 0,123
A4 = 4/8,124 = 0,492
A5 = 1/8,124 = 0,123
A6 = 2/8,124 = 0,246
A7 = 1/8,124 = 0,123
A8 = 4/8,124 = 0,123
A9 = 3/8,124 = 0,492
A10 = 3/8,124 = 0,369

The result of the normalization of the X matrix is obtained by the $X *_{ij}$ matrix as shown below.

$X *_{ij}$ =

0,654	0,492	0,216	0,341	0,420	0,204	0,239	0,282
0,436	0,123	0,108	0,113	0,140	0,204	0,358	0,424
0,218	0,123	0,325	0,455	0,280	0,612	0,239	0,282
0,218	0,492	0,433	0,455	0,420	0,204	0,239	0,282
0,218	0,123	0,108	0,227	0,140	0,408	0,358	0,424
0,218	0,246	0,433	0,113	0,420	0,204	0,358	0,282
0,218	0,123	0,325	0,455	0,140	0,204	0,239	0,282

0,218	0,123	0,216	0,113	0,280	0,204	0,358	0,282
0,218	0,492	0,433	0,341	0,420	0,204	0,358	0,282
0,218	0,369	0,325	0,227	0,280	0,408	0,358	0,282

Step 4: for multi-objective optimization, the result of normalization is the addition in terms of maximizing (from the beneficial attributes/benefit) and subtraction in terms of minimization (from the unfavorable attributes/cost).

Optimizing attributes includes weights in normalized searches.

$X_{wj}. =$
Calculation of Optimization Value for Alternative 1
C1 = (0,654*0,15) + (0,492*0,10) + (0,216*0,15) + (0,341*0,20) + (0,420*0,10) + (0,204*0,05) + (0,239*0,05) + (0,282*0,20)
C1 = 0,369

Calculation of Optimization Value for Alternative 2
C2 = (0,436*0,15) + (0,123*0,10) + (0,108*0,15) + (0,113*0,20) + (0,140*0,10) + (0,204*0,05) + (0,358*0,05) + (0,424*0,20)
C2 = 0,243

The results of the multiplication with the weight of the criteria X, namely:

0,098	0,049	0,032	0,068	0,042	0,010	0,011	0,056
0,065	0,012	0,016	0,022	0,014	0,010	0,017	0,084
0,032	0,012	0,048	0,091	0,028	0,030	0,011	0,056
0,032	0,049	0,065	0,091	0,042	0,010	0,011	0,056
0,032	0,012	0,016	0,045	0,014	0,020	0,017	0,084
0,032	0,024	0,065	0,022	0,042	0,010	0,017	0,056
0,032	0,012	0,048	0,091	0,014	0,010	0,011	0,056
0,032	0,012	0,032	0,022	0,028	0,010	0,017	0,056
0,032	0,049	0,065	0,068	0,042	0,010	0,017	0,056
0,032	0,036	0,048	0,045	0,028	0,020	0,017	0,056

Step 5: Yi value can be positive or negative depending on the maximum (favorable criteria) and minimum (unfavorable criteria) in the decision matrix.

Table III.12 Yi List

Alternative	Maximum (C1 + ….C8)	Minimum	Yi = max – min
A1	0,369	0,010	0,359
A2	0,243	0,010	0,233
A3	0,312	0,011	0,301
A4	0,358	0,010	0,358
A5	0,244	0,012	0,232
A6	0,271	0,010	0,261
A7	0,277	0,010	0,267
A8	0,213	0,010	0,201
A9	0,342	0,010	0,332
A10	0,286	0,017	0,269

From the results above, it can be seen the ranking of each alternative in the following table:

Table III.13 Ranking Results

Alternative	Results	Ranking
A1	0,359	1
A4	0,358	2
A9	0,332	3
A3	0,301	4
A10	0,269	5
A7	0,267	6
A6	0,261	7
A2	0,233	8
A5	0,232	9
A8	0,201	10

The value of 0.369 is obtained from the sum of the weights of the criteria successfully being the highest. From the value above, it can be seen that the one who gets the first rank in the Selection of the best Rubber Tree Planting Land has the highest value, which is 0.369.

CONCLUSION

1. Decision support system with using the MOORA method for rubber land selection based on input criteria data and alternative assessments can be used as well decisions can be made from the data there is.
2. By applying the MOORA method to rubber selection at PT. GERGAS UTAMA then the selection process will be more objective, alternative with Rank number 1 is an alternative with a value of the highest calculation of the MOORA method.

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