Decision Support System for Selection of Productive Land in Corn Using the SMART Method

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Abstract—an Indonesia is one of the developing countries which has characteristics in one sector in agriculture, which is one source of income and improves the economy of farmers, but farmers in processing agricultural land are still not maximized as a means of productive plant land. This productive land requires a technology that can assist in land selection, the purpose of this research is to produce a Decision Support System for the Selection of Productive Land in Corn Plants Using a Web-Based Smart Method, and the author wants to implement the Smart method into the selection of productive land for corn plants that is safe in this system requires data that includes data criteria and alternatives. The results of the data are processed using intelligent methods so that it will produce alternative recommendations that have the highest value. So that research can help coordinators of agricultural extension centers assist farmers in managing land to be productive.

Keywords— Decision Support System, Smart, Land, Corn

I. INTRODUCTION

Indonesia is a country which has characteristics in one sector in agriculture and which is one source of income to improve the economy of farmers, but farmers in processing agricultural land are still not optimal as a means of productive land for food crops. Efforts need to be made to increase land productivity so that the productivity of agricultural products can increase. In land management activities, it is one of the activities carried out and plays a role in increasing productivity, and in agriculture a system is needed that can support the activities to be carried out, so that in its application in the agricultural sector it can obtain maximum results.factors that can affect agricultural production is one of the influencing factors is agricultural land that can be optimized land productivity is a priority in the development of food crop cultivation, stating that agricultural productivity is very important in creating food and land security.

One of the obstacles for these farmers is that farmers experience crop failure where the harvest is not yet productive, which has an impact on the quality of the farmers' crops, which is one of the factors is poor soil quality and less than optimal in the selection of land for crops, Therefore, in order to improve the quality of crop yields thus, a process in land management is needed that can increase and affect plant growth in order to increase yields and harvest quality.

Land is a soil medium where soil plays an important role in influencing the development of plants which will ultimately determine the productivity of the land, therefore land management is one of the important factors where soil is also a habitat for other organisms that also support soil fertility. Some of the plants that are cultivated in the Palaran area, one of which is corn, this corn plant has become one of the pagan crops.

Corn is the most important food commodity after rice and secondary crops. Corn plant products are used as raw materials for the food industry such as flour, milk, sugar, food (Riana, 2017), to get maximum corn production results, and it requires optimal land management and good land selection, so we need a technology that can solve the problem.

To be able to produce a good land selection system, the right decision support system can help for land selection in using a decision support system, it requires a modeling. The modeling used in making this decision is to use the SMART (Simple Multi Attribute Rating Technique) method.

SMART (Simple Multi Attribute Rating Technique) is a flexible decision-making method, this method is more widely used because of its simplicity in responding to the needs of decision makers and the way it analyzes responses. (Azhar, 2018). With a decision support system using the SMART method, it can be used as a medium for making a decision in determining productive land for corn cultivation by farmers or related agencies.

II. RESEARCH METHODS

A. Study Literature

In a study conducted by (Sibyan, 2020), the implementation of the smart method in a student admissions decision support system. Vocational School Gema Nusantara Wonosobo as an educational institution provides opportunities for its students to obtain school scholarships. The scholarships are given to students who meet the requirements based on parallel rankings, academic and non-academic achievements, economic conditions, and ability to memorize the Qur'an. Considering these requirements, the school makes a selection to determine which students will receive the school scholarship. However, in the selection process, the school found it difficult to determine scholarship recipients due to the many criteria or requirements and the very limited quota of scholarships.

Research conducted by (Pangaribuan, 2019), selection of cattle for beef cattle breeders using the smart method. The purpose of the study was to recommend the best type of cattle using the SMART method. Sources of data were obtained by interviewing and giving question to 25 beef cattle farmers at random. This study aims to make it easier for livestock owners to choose the best type of cattle for their business based on predetermined criteria. Based on the results of the study, it can be explained that the SMART method can applied to recommend the best type of cattle for beef cattle farming by considering several criteria, namely: Origin, Price, Age, Weight and Size.

Then the research conducted by (Andani, 2019), the application of the smart method in decision making for the recipients of the Amik Tunas Bangsa Foundation scholarship. Scholarships are the provision of assistance to individuals in the form of funds used for the continuation of education. At AMIK Tunas Bangsa, in addition to scholarships from the government, AMIK Tunas Bangsa Foundation scholarships are also given to students with high achievement and economically disadvantaged. Determination of foundation scholarship recipients is done selectively, but has not implemented a decision support system. So that the resulting output is less accurate.

And research conducted (Irwan, ukkas. Pratiwi, Henny. Purnamasari, 2014) a decision support system for determining suppliers of building materials using the smart method (simple multi attribute rating technique).Bintang Keramik Jaya Store is a building shop that sells building materials to customers and purchases building materials from suppliers. Fulfillment of building material inventory needs is carried out by ordering from various suppliers. Not all suppliers meet the criteria set by the Bintang Keramik Jaya Store, so a selection must be made and demand the purchasing department to determine the right supplier.

Research conducted by (Peace, 2020), Decision Support System for Selection Of Rubber Seeds Using The Web-Based Simple Additive Weighting (SAW) Method. Decision Support System is an interactive system that supports decisions in the decision-making process through alternatives obtained from the results of data processing, information and model design. Utilization of a decision support system using the Simple Additive Weighting (SAW) method is very appropriate if applied to this problem. This method was chosen because it is able to complete and provide the best results from a number of alternatives.

A. Decision support system

Decision support system is an application in the form of a Decision Support System (Decision Support System) which was developed in 1970. A Decision Support System (DSS) supported by a computer-based information system can assist a person in improving his performance in decision making. To provide a deeper understanding, several definitions of DSS developed by several experts, including by Man and Watson who provide the following definition, will be described, DSS is an interactive system, which helps decision making through the use of data and decision models for solve semi-structured and unstructured problems (E. Turban. & J.E. Aronson, 2001.) cited (Andani, 2019).

B. Simple Multi Attribute Rating Technique

The SMART method is a multi-criteria decision-making method developed by Edward in 1977. SMART is a multi-criteria decision-making technique based on the theory that each alternative consists of a number of criteria that have values and each criterion has a weight that describes how important it is compared to with other criteria. This weighting is used to assess each alternative in order to obtain the best alternative (Andani, 2019). The SMART method is more widely used because of its simplicity in responding to the needs of decision makers and the way it analyzes responses, each alternative consists of a set of attributes and each attribute has values, these values are averaged on a certain scale. Each attribute has a weight that describes how important it is compared to other attributes. With SMART attribute weighting is carried out in two steps, namely, sorting the importance of an attribute from the worst level to the best level, making a comparison of the importance of each attribute with other attributes. (Irwan, UKkas. Pratiwi, Heny. Purnamasari, 2014).

The order in using the SMART method is as follows:
1. Determines the number of criteria used.
2. Determine the weight of the criteria for each criterion by using an interval of 1-100 for each criterion with the most important priority.
3. Calculate the normalization of each criterion by comparing the value of the weight of the criteria with the total weight of the criteria. Using the formula:

Normalization: $\dfrac{w_j}{\sum w_j}$ (Andani, 2019).

Where w_j is the weighted value of a criterion

While $\sum W_j$ is the total of the total weights of all criteria.

4. Give the value of the criteria parameters on each criterion for each alternative.
5. Determine the utility value by converting the value of the criteria for each into standard data criteria, the utility value is obtained by using the formula Can be seen in (1).

$$u_i(ai) = 100 \frac{(C_{outi} - C_{min})}{(C_{max} - C_{min})}\%$$ (1)

Information (1)
ui(ai) : utility value of the 1st criterion for the i-th criterion
Cmax : maximum criterion value
Cmin : minimum criteria value
Cout i : the value of the i-th criterion

6. Determine the final value of each criterion by transferring the value obtained from normalization (Irwan, UKkas. Pratiwi, Heny. Purnamasari, 2014).

C. Land

Land resources are one of the factors that determine the success of an agricultural business system, because almost all agricultural businesses are based on land resources, but their role in the survival of life on earth is very important.
Soil is a medium for plant growth. Soil is also a habitat for various organisms that live in it. Soil has a main function as a place to grow and produce plants. The ability of the soil as a growing medium will be optimal if it is supported by good physical, chemical and biological properties, usually indicating the level of soil fertility (Harahap, R. R., Wahyuni, S., & Putri, D. R. (2021).
Soil productivity and fertility indicate the ability of the soil to produce plants that grow on it. Productivity is the ability or carrying capacity of agricultural land in producing crops. Productivity is the ability of the soil to produce certain crop production, the factors that affect land productivity, land area and soil acidity (Fauzi, 2019).

D. Cultivation of corn plants

Corn is the second important food crop after rice for the people of Indonesia. Besides being used as a staple food in some areas, corn is the main component in animal feed rations, the benefits of corn as a functional food because corn contains dietary fiber needed by the human body. To meet the needs of corn in the community, in meeting the needs of food and feed, efforts must be made to fulfill it through agricultural intensification in the cultivation of corn plants.
The stages in the cultivation of corn plants are selecting quality corn seeds and superior types so that they can grow well, the climate has direct sunlight intensity with open land that gets direct sunlight, this soil media has an important role in the development of a plant which must has good nutrient content, texture, and soil acidity. In corn plants, the pH of the soil is good around soil pH 5.5-7.5 (Hastini & Noviana, 2020).

III. RESEARCH METHODS

A. Research Procedure

The research procedure used in this study is as follows, which explains the stages of the research procedure can be seen in picture 1
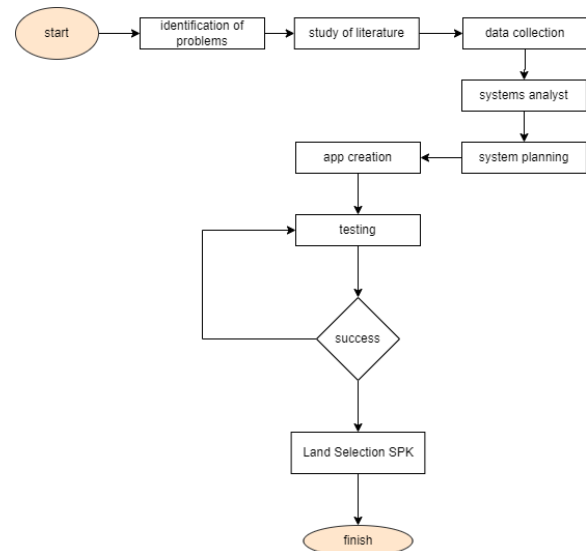
Picture 1. Research Steps

In the flowchart image, several stages in carrying out research procedures can be described as follows:
1. Identifying a problem which is an early stage in the Problem Identification is a stage to identify what problems are happening and how to solve problems that are happening and can provide solutions.
2. Literature study at this stage the author is looking for a literature study as a reference or guide for the author in his research and later in order to be able to build an application system.
3. This data collection is the stage where the author will need a data that can be used and applied to his system later so that the system created can be implemented properly in accordance with the purpose of making this system.
4. Analysis of this system is a technique for the process of forming a system to find out the system used can interact with each other and run well.
5. System Design is the activity of grouping the components of the system to be used and implemented into the system which aims to evaluate the system design that will be applied.
6. Making the application at this stage the author applies the system design into the programming

language so that the system can be used by the user. The stages of making the application include:
a. Installing the required software
b. Application creation
c. Internal testing

7. Testing at this stage the system will be tested, the goal is to ensure that all systems and features can be used by users properly without any errors. Success and if there is an error in the test, the application system will be made again so that it can be repaired and run properly, and if yes and successful in testing it will go to the next stage.

8. The land selection system is ready for use, after passing the testing phase, the land selection system is ready to be used.

A. *System Design*

This system analysis will what will be done by the system that will be built and who will interact with the system. The following is the login process design.

a) Use Case System

In the use case below, describing the system the admin interaction relationship to be able to process this system can be seen in Picture 2.
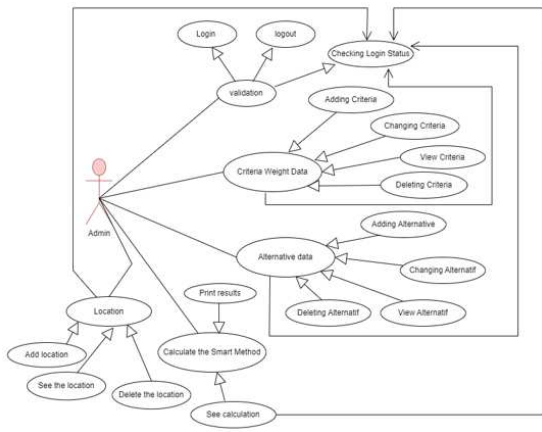
Picture 2. Use Case Diagram

b). *Sequence diagrams do the calculations*

In sequence diagrams analyze these results where all processes have been carried out, the admin will be able to analyze the results so that the final information can be seen in Picture3.
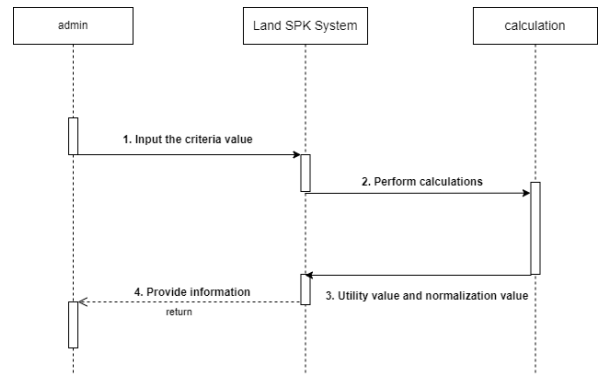
Picture 3. Sequence diagram

c). *Activity Diagram Assessment*

In the Activity Diagram, perform calculations using the smart method after the alternative data is inputted and the weight value data will then perform calculations on each alternative can be seen in Picture 4.
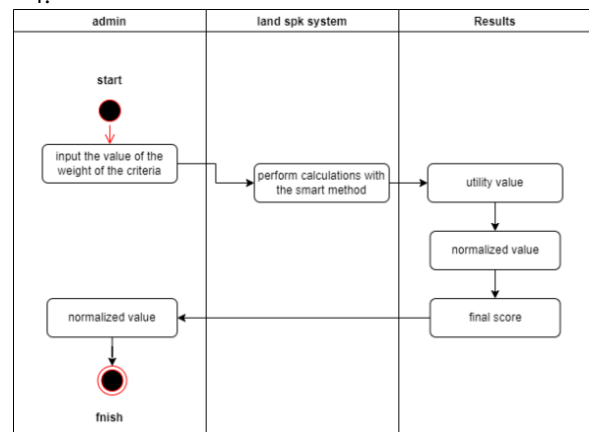
Picture 4. Activity diagram

B. System Modeling

In this modeling there are several stages of the smart method (Simple Multi Attribute Rating Technique) the formula used is the Benefit formula where the formula is and in each criterion, a greater value is desired in the form of profit.

The criteria contained in the table below are the criteria obtained from the selection of criteria where the criteria are obtained from the level of importance of the most important land criteria, so that these criteria are obtained with the value of each criterion.

The criteria used in the Decision Support System for Selection of Productive Land in Corn Plants Using the Smart Method are as follows:

This criterion displays the criteria data and the weight values for each criterion can be seen in Table 1.

Table 1. Criteria

#	Code	Criteria	weight	Value
1	C1	Land Area	30%	Benefit
2	C2	Soil Acidity	40%	Benefit
3	C3	Soil Type	20%	Benefit
4	C4	Planting Time	10%	Benefit

In the table of land area criteria where this criterion displays land area data and the value of each criterion can be seen in Table 2.

Table 2. Criteria for Land Area

#	Land Area Criteria (C1)		
#	Criteria	value	Weight
1	more than (>) 100000	100	
2	less than (<) 5000	80	30%
3	less than (<) 2500	20	

In this soil acidity criterion, there is data on soil acidity which is one of the criteria for productive land, which can be seen in Table 3.

Table 3. Soil Acidity Criteria

#	Soil Acidity Criteria (C2)		
#	Criteria	value	Weight
1	ph 4,5-5,5	30	
2	ph 5,6-6,5	70	40%
3	ph 6,6-6,7	100	

In this soil type criteria, the criteria that display the existing soil type data can be seen in Table 4.

Table 4. Soil Type Criteria

#	Soil Type Criteria (C3)		
#	Criteria	value	Weight
1	Humus Land	100	
2	Grumosol Land	50	20%
3	Latosol Land	30	
4	Podsolic Land	20	

On the criteria for the planting period where the data is the number of times the planting period of a land, the data can be seen in Table 5.

Table 5. Criteria for Planting Period

#	Planting Period Criteria (C4)		
#	Criteria	value	Weight
1	3 times planting	40	
2	2 times planting	60	10%
3	1 times planting	100	

Table 6. Normalization

#	Code	Criteria	Weight	Normalization
1	C1	Land Area	30%	0,3
2	C2	Soil Acidity	40%	0,4
3	C3	Soil Type	20%	0,2
4	C4	Planting Time	10%	0,1

Values are obtained from the main criteria and sub-criteria as follows:
1. Land area has a sub-criteria of more than (>) 10000 which has a value of 100, a sub-criteria of less than (<) 5000 which has a value of 80, less than (<) 2500 which has a value of 20.
2. Soil acidity has a sub-criteria of pH 4.5-5.5 which has a value of 30, a sub-criteria of pH 5.6-6.5 which has a value of 70, a sub-criteria of pH 6.6-6.7 which has a value of 100.
3. Soil type has sub-criteria Humus soil which has a value of 100, sub-criteria of Grumosol soil which has a value of 50, sub-criteria of Latosol soil which has a value of 30, sub-criteria of Pondzolic soil which has a value of 20.
4. Planting period has a sub-criteria of 3 times of planting which has a value of 40, a sub-criteria of 2 times of planting that has a value of 60, a sub-criteria of 1 time of planting which has a value of 100.

Normalization is obtained from:
1. The criteria for land area have weight 30%
2. The criteria for soil acidity have weight 40%
3. The criteria for the type of soil have weight 20%
4. The criteria for planting time have weight 10%

The normalization formula is:

$$\text{Normalization: } \frac{W_j}{\sum W_j}$$

Where W_J is the weighted value of a criterion.
While $\sum W_j$ is the total of the total weights of all criteria.
How to get the normalized value as follows:

1. $\text{Normalization} = \frac{30}{100} = 0.3$
   Information 30 is the weight value of the land area criteria.
   100 is the overall weighted value.
2. $\text{Normalization} = \frac{40}{100} = 0.4$
   Information 40 is the weight value of the soil acidity criteria.
   100 is the overall weighted value.
3. $\text{Normalization} = \frac{20}{100} = 0.2$
   Information 30 is the weight value of the soil type criteria.
   100 is the overall weighted value.
4. $\text{Normalization} = \frac{10}{100} = 0.1$

Information 10 is the weight value of the planting period criteria.
100 is the overall weighted value.

How to find the utility value is as follows:

$$u_i(a_i) = 100 \frac{(C_{outi} - C_{min})}{(C_{max} - C_{min})}\%$$

Information:
ui(ai) : utility value of the 1st criterion for the i-th criterion
Cmax : maximum criterion value
Cmin : minimum criteria value
Cout i : the value of the i-th criterion

Get the utility value as follows:
1. Case study 1
   In this case study 1, where land 1 gets a Cout , C1 80, C2 30, C3 30, C4 100.

Table 7. Find the value of land utility 1

	C1	C2	C3	C4
Land 1				
Cmax	100	100	100	100
Cmin	20	30	20	40
Cout	80	30	30	100
ui(ai)	**75**	**0**	**12.5**	**100**

After looking for the utility value and getting the ui(ai) value then wait for it to be multiplied by the normalized value can be seen in Table 8.

Table 8. Land final calculation 1

C1	C2	C3	C4	final calculation
Land 1				
22.5	0	2.5	10	35

2. Case study 2
   In this case study 2 where land 2 gets Cout C1 0, C2 70, C3 30, C4 60.

Table 9. Find the value of land utility 2

	C1	C2	C3	C4
Land 2				
Cmax	100	100	100	100
Cmin	20	30	20	40
Cout	20	70	30	60
ui(ai)	**0**	**57.1429**	**12.5**	**33.33333**

After looking for the utility value and getting the ui(ai) value then wait for it to be multiplied by the normalized value can be seen in Table 10.

Table 10. Land final calculation 2

| C1	C2	C3	C4	final calculation
Land 2				
0	22.8571	2.5	3.33333	28.69048

So from all the stages that have been carried out in the calculation process, the final value gets the result, namely the one who gets the highest value is land 1.

IV. RESULTS AND DISCUSSION

The following is a display of the Decision Support System for Sorting Productive Land in Corn Plants, this web is made in such a way as to be able to assist and support decision-making in order to choose a productive land selection for extension workers from the perennial agricultural center to be able to support land selection decisions productive maize.

1. Home Menu
   This is a login display where every admin will perform the system process will login first so that they can carry out the process by entering the registered Email and Password. It can be seen in Picture 5.
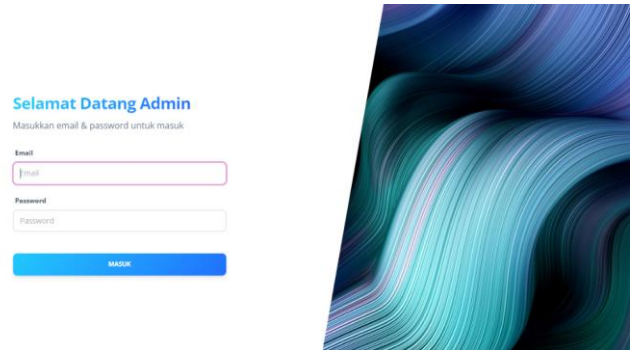
Picture 5. Home menu display

3. Brand Page Display
   Branda's display where this display displays a welcome greeting on the initial screen, this display can also directly input alternative data on the Click here Button. It can be seen in Picture 6.

Picture 6. Brand Page Display

3. Criteria Display
   It can be seen in the Criteria Menu where there is criteria data where there are Criteria Names and the Weight Values of each Criterion. It can be seen in Picture 7.

Picture 7. Criteria Display

4. Criteria Detail View

This criteria Details View displays a page that displays the criteria for productive land and has a weight in each criterion name, where there is also an Action button where you can later see the detailed criteria, edit the criteria and delete them, it can be seen in Picture 8.

Picture 8. Criteria Detail View

5. Alternative Views display

This is an Alternative Display where in this view the admin will input alternative data that has been obtained in accordance with the existing data added form, where at this stage the system will process the data so that it will produce utility values and normalization values and will then get final score, it can be seen in Picture 9.

Picture 9. Alternative Views display

6. Result display

Pictuere 10 shows, the Results Display where after the admin inputs data on the Alternative view, it will get the utility value in each criterion and normalization value, and the final value of each alternative data, and can view alternative data according to the location and location name and can also prints the results according to the region.

Picture 10. Result Display

7. Print view

Login view is a menu for admins who want to is the Print Result Display where this display can be printed after the system process has been carried out properly, the final result can be printed. It can be seen in Picture 11.

Picture 11. Print view

8. Master View

Is the Master Display which in this view, there is location data which will be able to add locations according to needs so that it can be inputted in an alternative display according to the selected area. It can be seen in Picture 12.

Picture 12. Master View

Black-Box Testing is a software testing In running this website using the Laravel framework, the author tested this system to check the features in this application system can run properly according to its function.The results of the system test can be seen in Table 11.

Table 11. System testing

#	Test	The resulting output	Result
1	Login Page	Displays the login form page, which contains email, password	succeeded
2	Brand Page	Show welcome greetings	succeeded
3	Criteria Page	Displaying criteria data and weight values	succeeded
4	Criteria Details Page	Displays criteria details, and displays sub-criteria data and weight values	succeeded
5	Alternative Page	Displays a form to input data from each alternative	succeeded
6	Results Page	Displays the results of the calculation of each alternative data	succeeded

V. CONCLUSIONS

The design and manufacture of a decision support system application system in the selection of productive land for corn plants using the Simple Multi Attribute Rating Technique (SMART) method, which has been carried out, can be concluded

That by using this smart method in its function it can support existing activities in agriculture, by using the Decision Support System application system in the selection of productive land in corn plants by using the Simple Multi Attribute Rating Technique (SMART) method.

So that it can improve the quality of land to be productive and can produce results, quality and increase economic results for farmers. And in the accuracy testing that has been done, manual testing and system testing get an accuracy value of 100%.

From this system, it is hoped that the selection of corn fields, it is hoped that this system can be developed by further research by combining it with other methods so that the results are more effective and accurate in the system.

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