

Decision support system for determining chili land using weighted product method

by Ramadiani Ramadiani

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Ramadiani¹, Bayu Ramadhani², Zainal Arifin³, Muhammad Labib Jundillah⁴, Azainil Azainil⁵

^{1,2,3,4}Faculty of Computer Science and Information Technology, Universitas Mulawarman, Indonesia

⁵Faculty of Teacher Training and Education, Universitas Mulawarman, Indonesia

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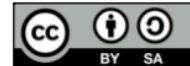
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ABSTRACT

Chili is one of the most consumed food commodities in Indonesia. Thus, chili is very influential to the economic, also inflation and deflation of an area. In order for the needs of chili to be fulfilled and to be able to export, the production must be increased with one consideration being the selection of the right land. The right land must meet the criteria agreed upon by experts, there is land height, soil pH, nutrient value and ambient temperature. This research aims to create a system to support the decision of chili crop land selection using the weighted product method. By entering land data according to the criteria, the user can easily find out which land has the potential to have a higher suitability for chili plants. The result of this system is in the form of land ranking that can help users decide which land to use for chili cultivation.

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Corresponding Author:

Ramadiani,
Faculty of Computer Science and Information Technology,
Mulawarman University,
Barong Tongkok Gunung Kelua, 75121, Samarinda, Indonesia.
Email: ilkom.ramadiani@gmail.com

1. INTRODUCTION

Economic stability needs to be maintained in a country, so the production and consumption activities in a region should be able to run together consistently so as to create a balance and economic progress in the area. But to maintain economic balance there are many problems that must be faced. One of them is the inflation factor caused by a commodity that is much in demand by Indonesian people, namely chili [1-7]. At certain times in the city of Samarinda, chili will experience an increase in demand on the day of celebration (Eid al-Fitr, Eid al-Adha, New Year, Ramadan and others), so that the supply of local chilies must be increased to maintain inflation stability in the area [3, 8]. When the supply of local chilies in Samarinda has not been able to meet the demands of the community to the maximum, the Government imported chili from outside, so that it had an impact on increasing inflation in Samarinda especially the prices of soaring chili [9].

In addition to the Government, chili farmers as executors who go directly to the field also play an important role in controlling the availability of chili [7-10]. For a more optimal effort for chili farmers, the subjects need a selection system that can be an alternative in facilitating the achievement of production [10]. With the best quality land and large area, it will have a significant impact on increasing the productivity of local chili farmers so that the supply of local chili is always reliable at all times. In addition, by increasing crop land quality selection, it is expected to minimize the use of fertilizers and losses caused by unfavorable land. In this study, we looked for sources to determine the criteria for chili

crop land in the Agricultural Technology Assessment Agency (BPTP) of East Kalimantan and chili crop land samples at the Agricultural Instructor Center (BPP) Suluh Manuntung.

2. RESEARCH METHOD

One of the previous research about decision support system using weighted product is "Decision Support Systems Selection of Soang Superior Brood Using Weighted Product (WP) and Simple Additive Weighting (SAW) Method" [11]. The results of the study can be concluded that the decision support system for selecting Gurami Soang sires using the WP and SAW method was successfully created. From the 10 alternative data of Gurame Soang sires obtained the results of testing using the Weighted Product method get an 80% accuracy value and Simple Additive weighting gets an accuracy value of 60%. The results showed that the accuracy of the two methods was obtained by the 4 best Gurame Soang broods [11].

Previous research related to this research namely "Decision Support System for Determining Chili Plantations Using Simple Additive Weighting Method" is the study that uses simple additive weighting method that can help chili farmers in supporting to determine the chili crop land, where the result is the highest recommended ranking value [3]. The research method used in this study is a qualitative descriptive method. This research is conducted aims to provide information to the farmer. The reason for using this method is because researchers gathered information from several previous studies which explained that the WP method is more accurate in some cases of decision support system research. Next, an analysis of criteria and weighting was carried out to support the experts' decision to select chili crop land. The data collected is processed according to research methods so as to produce conclusions that can be used as recommendations for farmers who want to add to their chili crop lands.

2.1. Interview

Interviews were conducted with informants in order to determine the criteria weight which would later be used as a basis for selecting chili crop land and obtaining land samples. The criteria and land samples offered by the two experts, the first is Mr. Wawan Banu Prasetyo as a researcher at BPTP East Kalimantan and the second is Ms. Lediana Helmi as instructor at the BPP Suluh Manuntung Lempake. Interviews were conducted on 7 February 2019 and 6 May 2019 at East Kalimantan BPTP.

2.2. Observation

The author will make direct observations when it has finished interviewing the interviewees from East Kalimantan BPTP. This observation was carried out to find values in the height criteria above sea level using the open camera application, while the other three criteria were immediately obtained during an interview with the second interviewees. Observations were made in three places recommended by BPP Suluh Manuntung, all in the Lempake area. The first land (Sumber Rejeki Farmer Group) is located on Jl. Muang In Gg. Puskesmas as shown in Figure 1, the second land (Bumi Putera Farmer Group) is located on Jl. Rejo Mulyo and the third land (Cahaya Baru Farmer Group) located on Jl. Muang In Gg. Thailand as shown in Figure 2. The following below are photos of direct observations to the land location.



Figure 1. Land of Sumber Rejeki Farmer (A1)



Figure 2. Land of Bumi Putera Farmer (A2)

2.3. Weighted product formula

Weighted Product (WP) is a multi-criteria decision analysis that is popular and is a method of multi criteria decision making [11]. Like all FMADM methods, WP is a finite set of decisions described in terms of some decision criteria [11-14]. Weighted product methods use multiplication to connect attributes, where the rating of each attribute should be advanced with the corresponding attribute weights [11-18]. This process is similar to the process of normalization. Weighted Product calculated based on the rate of interest. Product Weighted level of interest method, namely [11-18]:

- Very unimportant
- Not important
- Self-important
- Important
- Very important

The process of normalization criteria weight (W), $\Sigma W=1$ are:

$$W_j = \frac{w_j}{\Sigma w_j} \quad (1)$$

Description: W_j : Weight attribute

ΣW_j : The sum of the weights of attributes

Preference is given to alternatives:

$$S_i = \prod_{j=1}^n x_{ij}^{w_j} \quad (2)$$

Description:

S_i =Result decisions on the normalization alternative to -i

X_{ij} =Rating Alternatives per attributes

W_j =Weight attribute

i=Alternative

j=Attributes

$\prod_{j=1}^n X_{ij}$ =Multiplication alternative rating per attribute of $j=1-n$

In this alternative where $\Sigma W_j=1$.

W_j is the rank of positive value to attribute profits, and negative values to attribute costs.

Relative preference of each alternative (V), provided:

$$V_i = \frac{\prod_{j=1}^n x_{ij}^{w_j}}{\prod_{j=1}^n (x_j^w)^{w_j}} \quad (3)$$

Description:

V_i =Result alternate preference to - i

X_{ij} =Rating alternate per attribute

W_j =Weight attribute

i=Alternative

J=Attributes

$\prod_{j=1}^n X_{ij}$ =Multiplication alternative rating per attribute

$\prod_{j=1}^n (X_j^w)^{w_j}$ =the sum of the multiplication result per attribute alternative rating

3. RESULTS AND DISCUSSION

3.1. System description

Decision support system is a computer-based system that produces a variety of alternative decisions to assist management in dealing with various problems in a structured or unstructured using data and models. To produce a good decision in the decision support system, needs to be supported by quality information and facts, among others: completeness, accuracy, punctuality, Clarity and flexibility. This attribute is related to the degree of adaptation of the information produced to the needs of the various decisions to be taken and against a different group of decision makers [19-25],

3.2. System implementation

This decision support system for determining chili land uses the Weighted Product (WP) method. This decision support system is web-based, this system produces the highest to lowest value ranking which is used as a benchmark for selecting chili fields in Samarinda City. Users in this system or application are employees who work at Suluh Manuntung BPP, it is shown in Figure 3. On the calculation page, the thing to do is to press all the calculate buttons where the system will calculate the vector V value of the data. Users can also sort data on the sort button in each column heading. When the compute button has changed to all synchronous, it is time to sort the data according to the best value to worst with the sort button in the V (rank) vector value column as shown in Figure 4. In addition, there is an add data button to add data and a print button if you want to make a report regarding the results of the calculation of land data (the print button will only appear if all calculations have been completed as shown in Figure 5).

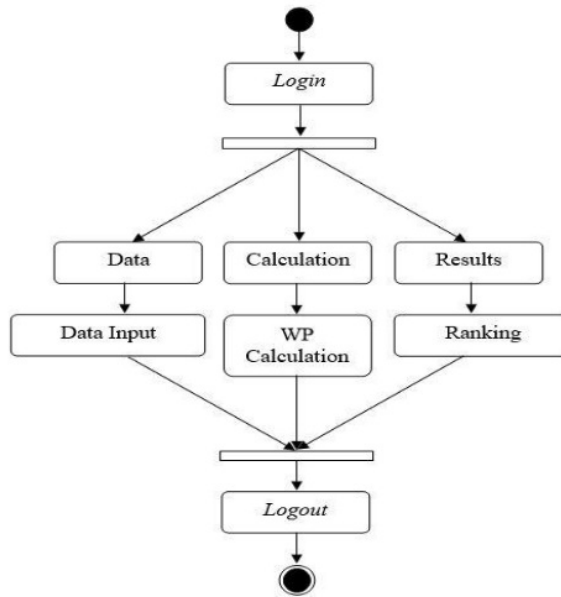


Figure 3. Activity diagram

DATA INPUT

Owner :

Identifikasi nama lahan :

Address :

Identifikasi alamat lahan :

Farmers Group :

- L2310122 - Jl. Bantabih
- L2310123 - Bantabih
- L2310124 - Bantabih
- L2310125 - Bantabih
- L2310126 - Bantabih
- L2310127 - Bantabih
- L2310128 - Bantabih
- L2310129 - Bantabih
- L2310130 - Bantabih
- L2310131 - Bantabih
- L2310132 - Bantabih
- L2310133 - Bantabih
- L2310134 - Bantabih
- L2310135 - Bantabih
- L2310136 - Bantabih
- L2310137 - Bantabih
- L2310138 - Bantabih
- L2310139 - Bantabih
- L2310140 - Bantabih

Instructor :

WSPP Sragen Sragen

Height (mas)	Soil pH	Nutrient Value	Ambient Temperature (°C)
>= 120	>= 6.2	<input type="radio"/> Excellent	>= 32
120 - 110	>= 6.1 - 6.2	<input type="radio"/> Good	29 - 31
110 - 104	>= 6.1 - 6.2	<input type="radio"/> Good	28 - 29
75 - 90	6	<input type="radio"/> Good	28 - 29
70 - 74	5.8 - 5.9	<input type="radio"/> Good	28 - 29
65 - 69	5.5 - 5.7	<input type="radio"/> Good	28 - 29
60 - 64	>= 5.2	<input type="radio"/> Good	28 - 29
55 - 59	>= 5.2	<input type="radio"/> Good	28 - 29

Buttons: Back

In farmland A data located on Jl. Muang In Gg. Puskesmas Kel. Lempake, note that:

MASL height = 50 - 74 meters so that it has a weight of 5
 Soil pH = 6 so it has a weight of 4
 Nutrient Value = Good so it has a weight of 3
 Ambient temperature = 26 - 28 ° C so it has a weight of 3

Then,

$$S = (C1 \wedge W1) \times (C2 \wedge W2) \times (C3 \wedge W3) \times (C4 \wedge W4)$$

$$C1 \wedge W1 = 5 \wedge 0.35 = 1.7768$$

$$C2 \wedge W2 = 4 \wedge 0.28 = 1.486$$

$$C3 \wedge W3 = 3 \wedge 0.21 = 1.4118$$

$$C4 \wedge W4 = 3 \wedge 0.14 = 1.2585$$

$$S = 1.7768 \times 1.486 \times 1.4118 \times 1.2585 = 3.9089$$

The above is done to find the S vector value for each land data, then to find the vector V value is:

$$V = S / \sum S$$

$$V = 0.3950$$

Buttons: Back

Figure 4. Data input

No.	Owner	Address	Farmers Group	Instructor	S Vector Value	V Vector Value
1	tani A	Jl. Muang Dalam Gg. Puskesmas Kel. Lempake	LEMPAKE - Sumber Rejeki	WKPP Muang Dalam	3.9089 meter	0.3950
2	tani C	Jl. Muang Dalam Gg. Thailand Kel. Lempake	LEMPAKE - Cahaya Baru	WKPP Muang Dalam	3.0261 meter	0.3058
3	tani B	Jl. Rejo Mulyo Kel. Lempake	LEMPAKE - Bumi Putra	WKPP Muang Dalam	2.9609 meter	0.2992

Admin : Sukardi, RE. SP.
Coordinator
BPP Suluh Manuntung

Figure 5. Calculation report

3.3. Manual calculation system testing

Trials are conducted to find out whether the application is made in accordance with the objectives. The trial was conducted using manual calculations. Trials were carried out on three chili crop land data which would be selected to determine the results of the land recommendations. It is known that there are three alternative land areas, namely:

A1=Sumber Rejeki Farmer Group

A2=Bumi Putera Farmers Group

A3=New Light Farmers Group

and four land criteria, namely:

C1=Altitude above sea level (meters)

C2=Soil pH

C3=Nutrient Value

C4=Ambient Temperature (Celsius)

The details are as follows:

1. Sumber Rejeki Farmer Group (A1)

C1 (4 samples)=63.8 m

C2=pH 6

C3=OK

C4=27 ° C

2. Bumi Putera Farmers Group

C1 (4 samples)=78.67 m

C2=pH 5.7

C3=OK

C4=28 ° C

3. Cahaya Baru Farmer Group

C1 (4 samples)=70.37 m

C2=pH 5.6

C3=OK

C4=29 ° C

The chili land data as shown in Table 1 was partially taken from the Agricultural Extension Center of Suluh Manuntung, one of the fields named Sumber Rejeki Farmers Group as an alternative A1 with an altitude of masl height of 63.8 meters at a preference weight of 5, a soil pH of 6 at a preference weight of 4, has a good nutrient value of the weighted preference value of 3 and environmental temperature 27 of the weighted preference value of 3. But before heading to the decision matrix, we determine the weighting of each criterion first.

Table 1. Land data table

Alternative	Criteria			
	C1	C2	C3	C4
A1	63.8 m	6	Good	27 °C
A2	78.67 m	5.7	Good	28 °C
A3	70.37 m	5.6	Good	29 °C

– Determination of weight

There are four criteria in this decision support system. The first criterion, height above sea level with weight=5. Second criterion, soil pH with weight=4. Third criterion, nutrient value with weight=3. The fourth criterion, ambient temperature with weight=2.

Criteria for weighting criteria:

$$W_j = \frac{w_j}{\sum w}$$

Total number of weights:

$$\begin{aligned}\sum w &= w_1 + w_2 + w_3 + w_4 \\ &= 5 + 4 + 3 + 2 \\ &= 14\end{aligned}$$

Calculate the value of criteria weights:

$$\begin{aligned}W_1 &= \frac{w_1}{\sum w} = \frac{5}{14} = 0,35 \\ W_2 &= \frac{w_2}{\sum w} = \frac{4}{14} = 0,28 \\ W_3 &= \frac{w_3}{\sum w} = \frac{3}{14} = 0,21 \\ W_4 &= \frac{w_4}{\sum w} = \frac{2}{14} = 0,14\end{aligned}$$

– Determine the value of the vector S

After determining the weights, the next step is to calculate the S vector value of each land data using the formula:

$$S_i = \prod_{j=1}^n x_{ij}^{w_j} ; \text{ with } i=1,2,\dots,m \quad (4)$$

$$\begin{aligned}S_1 &= (5^{0,35})(4^{0,28})(3^{0,21})(3^{0,14}) = 3,8037 \\ S_2 &= (4^{0,35})(2^{0,28})(3^{0,21})(3^{0,14}) = 2,8973 \\ S_3 &= (5^{0,35})(2^{0,28})(3^{0,21})(2^{0,14}) = 2,9598\end{aligned}$$

– Ranking by calculating the value of vector V

In this section the final value of a data will be calculated by calculating the value of the vector V of each land data using (5). The ranking of the best land from the best to the worst is presented in Table 2.

$$V_i = \frac{\prod_{j=1}^n x_{ij}^{w_j}}{\prod_{j=1}^n (x_j^w)^{w_j}} ; \text{ with } i=1,2,\dots,m \quad (5)$$

$$\begin{aligned}V_1 &= \frac{3,8037}{9,6608} = 0,3937 \\ V_2 &= \frac{2,8973}{9,6608} = 0,2999 \\ V_3 &= \frac{2,9598}{9,6608} = 0,3063\end{aligned}$$

Table 2. Ranking results

Alternative	Ranking
A1	1
A3	2
A2	3

3.4. Black box testing and comparison of calculation result

System testing is performed using the Black Box method and comparison of calculation results. Black Box testing focuses on the functional specifications of the software, the tester can define a set of input conditions and test the program's functional specifications. Stages of testing are carried out to ensure that the system being built is correct, as expected and to facilitate the users in operating it and there are no errors contained therein. Comparative testing of the results of calculations focuses on the accuracy of the results between calculations performed by the system (computer) and calculations manually [11, 19-25]. In this test will compare the results testing how accurate the results are between the two methods of calculation. Therefore, the accuracy between the system calculation and manual calculation of the vector S value is manual calculation as a denominator in Table 3 [11, 19-25]:

$$\frac{\text{Manual Calculation Results for Vector Value of S}}{\text{System Calculation Results for Vector Value of S}} \times 100\% = \text{Accuracy \%}$$

$$\frac{9,6608}{9,8959} \times 100\% = 97,6242\%$$

Table 3. Comparison of calculation results for vector value of S

Alternative	System calculation	Manual calculation
A1	3.9089	3.8037
A2	2.9609	2.8973
A3	3.0261	2.9598
Result	9.8959	9.6608

Therefore, the accuracy between the system calculation and manual calculation of the vector V value is manual calculation as a denominator in Table 4.

$$\frac{\text{Manual Calculation Results for Vector Value of S}}{\text{System Calculation Results for Vector Value of S}} \times 100\% = \text{Accuracy \%}$$

$$\frac{0,9999}{1,0000} \times 100\% = 99,99\%$$

Table 4. Comparison of calculation results for vector value of V

Alternative	System calculation	Manual calculation
A1	0.3950	0.3937
A2	0.2992	0.2999
A3	0.3058	0.3063
Result	1.0000	0.9999

Thus, the overall accuracy of the comparison of the results of the system calculations and manual calculations on the value of the vector S and the value of the vector V are:

$$\frac{\text{Accuracy of Vector Value of S}}{\text{Accuracy of Vector Value of V}} \times 100\% = \text{Accuracy Total \%}$$

$$\frac{97,6242}{99,99} \times 100\% = 97,6339\%$$

4. CONCLUSION

The process of making the Decision Support System for the Selection of Chili Plant Land can be carried out by the Weighted Product (WP) method with predetermined criteria and weights then processed by a web-based system so as to produce an output in the form of a list of the best chili crop land that can be sorted from highest value to value lowest and vice versa. The results of this study are that the chili plantations managed by Sumber Rejeki Farmers Group (A1) have the highest rank compared to two other lands, namely Bumi Putera Farmers Group (A2) and Cahaya Baru Farmers Group (A3). The order from best to worst based

on the final value of vector V is $A1=0.3950$, $A3=0.3058$ and $A2=0.2992$. Also, based on the results of testing the system calculation method Weighted Product (WP) with manual calculations, the final results obtained are more or less equal to the accuracy of 97.6%.

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BIOGRAPHIES OF AUTHORS

Ramadiani obtained her Ph.D in information system from Univesiti Putra Malaysia (UPM) in 2015. She received her first degree from Mulawarman University (1996), her M.Kom. in Computer Science from Gadjah Mada University (2006). Ramadiani currently works at the Department of Computer Science, Universitas Mulawarman. Ramadiani does research in software engineering, information systems and human-computer interaction. Her current project is 'e-Learning' and decision support system.



Bayu Ramadhani received his bachelor of computer science from Mulawarman University Samarinda Indonesia (2019). His research of interest is decision support system.



Zainal Arifin received his S.Kom from STMIK Widya Cipta Dharma (2003). He received his M.Kom. in Information System from Diponegoro University Semarang (2013). His areas of research interest is information system, decision support system and network security system.



Muhammad Labib Jundillah received his M.Kom. degree in Information System (2019) from Diponegoro University Semarang Indonesia. He obtained his S.Kom from Mulawarman University (2017) Samarinda. His research interests area in information system, decision support system, E-learning, and user statisfication.



Azainil received his first degree from Sriwijaya University (1990), his M.Si from Bogor Agricultural University (2003). He completed his Dr. in education management degree from Jakarta State University in 2012. Currently, he is a senior lecturer at Faculty of Teacher Training and Education, Mulawarman University. His research mainly focuses on education management, management information system, education quality management, information and communication technology, mathematics education.

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