

## Application of Multi Attribute Utility Theory Method Recommendation of Types of Palm Oil Fertilizers to Farmers on Palm Oil Plantations in Pasir Tuntung Village, Kota Pinang District


Elvinawati Juliani<sup>1</sup>, Fatma Sari Hutagalung<sup>2</sup>

Department of Information Technology, University of Muhammadiyah Sumatera Utara, Indonesia

### ABSTRACT

This thesis research aims to provide recommendations for the best types of fertilizer to farmers on oil palm plantations in Desa Pasir Tuntung, Kecamatan Kota Pinang. The research method used is Multi Attribute Utility Theory and the data collection methods are literature study, observation and interviews. The results of the research show that the fertilizer selection system in Desa Pasir Tuntung, Kecamatan Kota Pinang still uses manual methods, so many farmers make mistakes in selecting and buying fertilizer that is suitable for their oil palm plants. In order to increase farmers' productivity results and help reduce the risk of choosing a type of fertilizer that is not in accordance with the needs of oil palm plants, a decision support system is needed to recommend types of oil palm fertilizer using the Multi Attribute Utility Theory method. By implementing this system, it is hoped that farmers in Desa Pasir Tuntung, Kecamatan Kota Pinang can ensure that oil palm plants receive proper and balanced nutrition for optimal growth and maximum yields.

**Keyword : Multi Attribute Utility Theory Decision Support System recommending fertilizer types**

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#### Corresponding Author:

Elvinawati Juliani  
Department of Information Technology  
Universitas Muhammadiyah Sumatera Utara  
Jl. Kapten Mukhtar Basri No 3 Medan, 20238, Indonesia.  
Email : elvinawatij@gmail.com

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### 1. INTRODUCTION

Oil palm is an industrial plantation plant that is useful as a producer of cooking oil, industrial oil, and fuel. Oil palm trees consist of two species, namely *Elaeis guineensis* and *Elaeis oleifera* which are used for commercial agriculture in the production of palm oil. The *Elaeis guineensis* oil palm tree, originates from West Africa between Angola and Gambia, the oil palm tree or *Elaeis oleifera*, originates from Central America and South America. Oil palm became popular after the industrial revolution in the late 19th century which caused high demand for vegetable oil for food and the soap industry (Efri Mardawati, et al. 2019).

In the oil palm plantation in Pasir Tuntung Village, Kota Pinang District, there are complex challenges in managing its oil palm plantation. The environment and unpredictable weather changes, give rise to the need for a more careful approach in selecting fertilizer types. Oil palm farmers in this area are also faced with cost efficiency pressures, while environmental sustainability is becoming increasingly important. Climate change and resource constraints such as limited budgets and the availability of certain fertilizers in the local market add to the complexity of making decisions related to fertilization. In this area, the majority of the community are farmers. They still use manual methods in 2 fertilizer selection, namely by asking the owner of a fertilizer sales business, following other people and sometimes still confused about which fertilizer is good to choose, so that this allows for an excess of the predetermined budget. This is because the determination of oil palm fertilizer must be in accordance with the needs of the plant. Criteria are needed in selecting the type of oil palm fertilizer to prevent failure in maintenance, as well as increase oil palm growth and save budget costs.

In order to increase farmer productivity and income, and consider environmental impacts, a systematic and informed approach is needed, therefore the author needs a system to recommend the best type of fertilizer. DSS is a decision support system that can help or support decision making, in DSS there is a Multy Attribute Utility Theory (MAUT) method that can carry out the process of finding the total weight of the values in each attribute that produces the final value with the highest value. The application of the Multy Attribute Utility Theory (MAUT) method can be an effective tool to support

better, relevant and robust decision making in recommending good types of fertilizer for oil palm plantations in Pasir Tuntung Village. This method is chosen so that decision makers give appropriate weight to each criterion and sub-criteria based on their preferences and can consider the relationship between existing criteria and sub-criteria.

## 2. RESEARCH METHOD/MATERIAL AND METHOD/LETERATURE REVIEW

### A. Palm Oil Fertilizer

Palm oil fertilizer is a fertilizer that is specifically designed to increase the productivity of oil palm plants, the type can be single fertilizer or compound fertilizer. When talking about the best oil palm fertilizer, it is a fertilizer that can be well absorbed by oil palm plants but at the same time can be applied effectively and efficiently.

Knowledge of the introduction of fertilizer types will help practitioners understand the characteristics of fertilizers, so that users do not make mistakes in determining the choice of fertilizer needed. Example: The target use of inorganic fertilizers is generally used to enrich nutrients in the soil in a short period of time. The use of this fertilizer is characterized by a relatively low dose (ku/ha units) per one planting season period (PT Saraswanti Anugreah Makmur Tbk, 2019).

### B. MAUT Method (Multi Attribute Utility Theory)

Multi Attribute Utility Theory (MAUT) is a quantitative comparison method that usually combines measurements of different risk costs and benefits. Each existing criterion has several alternatives that can provide solutions. To find an alternative that is close to the user's wishes, to identify it, a multiplication is carried out on the predetermined priority scale. So that the best and closest results from these alternatives will be taken as a solution (Ramadhani II, et al. 2021).

For the calculation, the formula for the MAUT method is as follows:

$$v(x) = \sum_{i=1}^n w_i v_i(x) \quad (1)$$

### C. Sublime Text

Sublime Text is a text editor software used to create or edit an application. Sublime Text has additional plugin features that make it easier for programmers. In addition, sublime text also has a simple and cool design, making sublime text look elegant for a syntax editor. In addition to being lightweight, this IDE has a fast file saving and opening process. It is no wonder that this IDE is the most widely used, especially among web-based programmers (Abdurahman Hidayat, et al. 2020).

### D. MySQL

MySQL is one type of database that is widely used to create dynamic web-based applications. MySQL is a popular database management system (DBMS) that functions as a relational database management system (RDBMS). In addition, MySQL software is an open source application. MySQL has very fast performance, is reliable, and easy to use and works with client server architecture or embedded systems (Herman Yuliansyah, 2014).

## 3. RESULTS AND DISCUSSION

### A. System Implementation

At this implementation stage, the results of the designed system will be displayed. The system can be accessed by 2 actors, namely admin and user, but both have significant differences, in the system, for admin, there are more pages in the system and the admin is the main holder of this system. The pages in the admin system start from the login page, then enter the home page or dashboard. The features in this system are managing user data, alternative data, criteria data, performing calculation processes, calculation results or rankings and printing reports. In the management feature there are forms such as from add data, from edit data and delete data forms. While the system for users only has a few pages and

user activity on the system is also limited. The features in the system for users are the main page, criteria data, alternative data and ranking results.

### B. Admin and User Login Page View

The login page is the first page that appears when the system is opened. The login display can be seen in Figure 1.

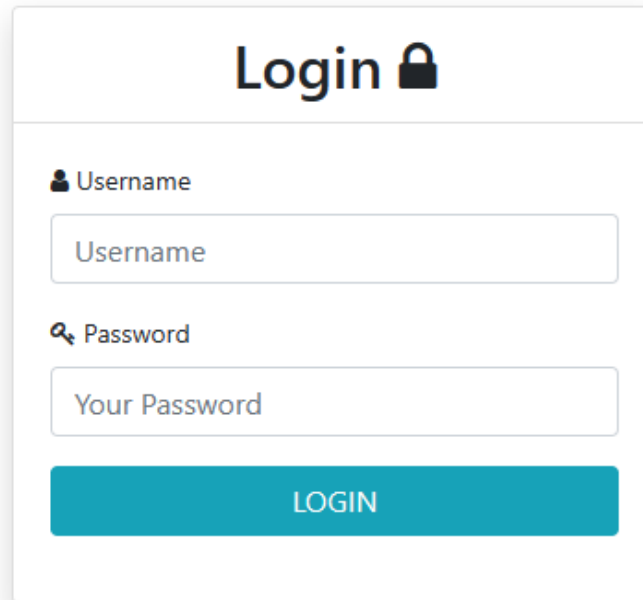


Figure 1. Login Page View

### C. Admin Dashboard Page View

The dashboard page is the page that will appear when the admin has successfully logged in. The admin dashboard page display can be seen in Figure 2.

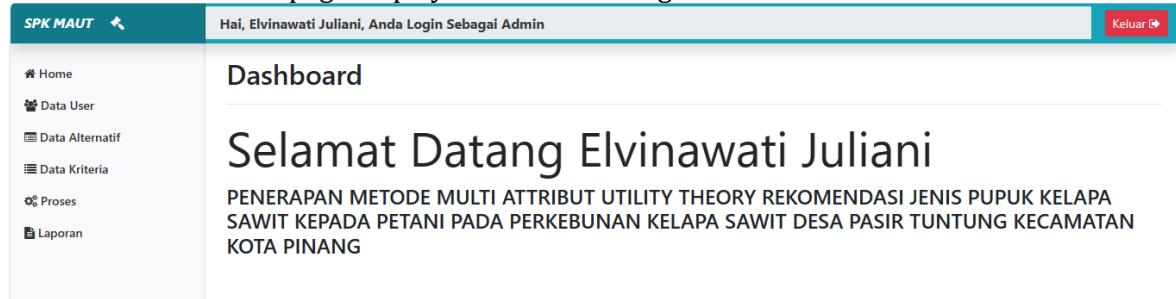


Figure 2. Admin Dashboard Page View

### D. User Dashboard Page View

On the user dashboard page, it is almost the same as the admin dashboard, only the features on the user dashboard have fewer menus, namely the alternative data menu, the criteria data menu. Users can only view alternative data, criteria data and print reports. The appearance of the user dashboard page can be seen in Figure 3.

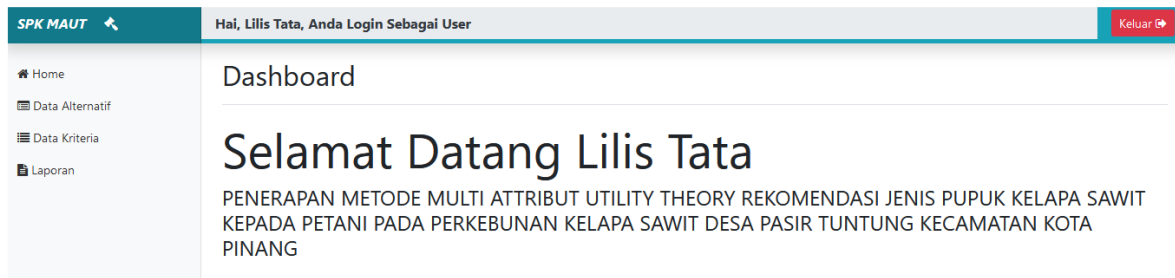


Figure 3. User Dashboard Page View

### E. User Data View

In the admin dashboard there is a user data menu. In this menu, several user names will be displayed who can access this system and see criteria, alternative and ranking data. Admin can also add user data according to the needs required. The user data page display can be seen in Figure 4.

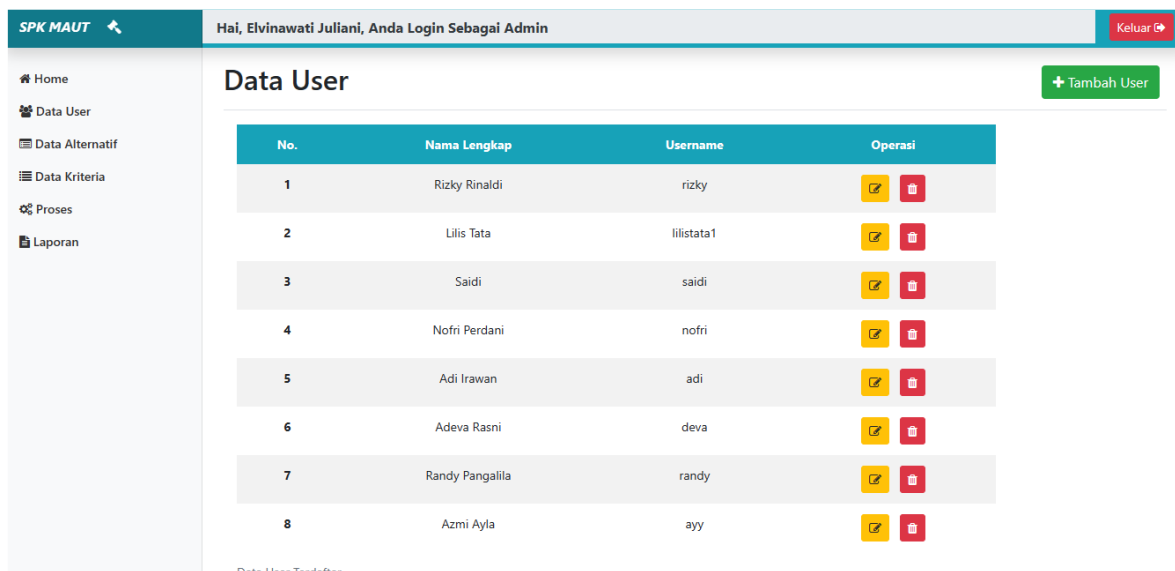


Figure 4. User Data Page View

### F. Alternative Data View

On the alternative data page there are alternative names, namely types of fertilizers with their respective criteria. In the alternative data, the admin can add alternative data, edit alternative data and delete alternative data. The appearance of the alternative data page can be seen in Figure 5.

No	Nama Pupuk	Harga	Mudah Dicari	Jenis Tanah	Kandungan Pupuk	Kualitas Pupuk	Menghemat Biaya	Aksi
V01	Npk	Rp. 520.000	Mudah	Basah	3 Unsur	Baik	Tidak Hemat	[Edit] [Delete]
V02	Urea	Rp. 355.000	Mudah	Kering	4 Unsur	Baik	Hemat	[Edit] [Delete]
V03	Tsp	Rp. 395.000	Mudah	Lembab	1 Unsur	Cukup	Hemat	[Edit] [Delete]
V04	Dolomite	Rp. 130.000	Sangat Mudah	Kering	2 Unsur	Baik	Hemat	[Edit] [Delete]
V05	Kcl	Rp. 375.000	Mudah	Lembab	1 Unsur	Baik	Hemat	[Edit] [Delete]
V06	Sp-36	Rp. 532.000	Mudah	Basah	1 Unsur	Cukup	Tidak Hemat	[Edit] [Delete]

Figure 5. Alternative Data Page View

### G. Criteria Data

In the criteria data there are 6 criteria names along with the code and weight of each criterion. Admin can only edit the criteria name and its weight. The appearance of the criteria data page can be seen in Figure 6.

No.	Kode Kriteria	Nama Kriteria	Bobot	Operasi
1	N1	Harga	0.3	[Edit]
2	N2	Mudah Dicari	0.15	[Edit]
3	N3	Jenis Tanah	0.1	[Edit]
4	N4	Kandungan Pupuk	0.2	[Edit]
5	N5	Kualitas Pupuk	0.15	[Edit]
6	N6	Hemat Biaya	0.1	[Edit]

Figure 6. Criteria Data Page View

### H. MAUT Calculation Process

In the process menu contained in the system will display the alternative data page menu, criteria data along with sub-criteria data. Where this calculation process is the initial stage of the calculation process carried out by the system using the Multi Attribute Utility Theory (MAUT) method to obtain the best fertilizer type recommendation results for farmers. The display of the MAUT calculation process page can be seen in Figure 7.

Alt.	Nama Pupuk	C1	C2	C3	C4	C5	C6
V01	Npk	520000	Mudah	Basah	3	Baik	Tidak Hema
V02	Urea	355000	Mudah	Kering	4	Baik	Hemat
V03	Tsp	395000	Mudah	Lembab	1	Cukup	Hemat
V04	Dolomite	130000	Sangat Muc	Kering	2	Baik	Hemat
V05	Kcl	375000	Mudah	Lembab	1	Baik	Hemat
V06	Sp-36	532000	Mudah	Basah	1	Cukup	Tidak Hema
V07	Kcf	435000	Tidak Muda	Kering	4	Baik	Hemat
V08	Kalsit	60000	Tidak Muda	Lembab	2	Cukup	Sangat Hem

Figure 7. Death Calculation Process Page View

After the process page displays alternative data and criteria, the system will then perform the calculation process using the Multi Attribute Utility Theory (MAUT) method, namely with the matrix normalization step. The display of the results page for processing matrix normalization data can be seen in Figure 8.

Alt.	Nama Pupuk	C1	C2	C3	C4	C5	C6
V01	Npk	5	4	3	4	5	2
V02	Urea	4	4	4	4	5	4
V03	Tsp	4	4	5	3	3	4
V04	Dolomite	4	5	4	3	5	4
V05	Kcl	4	4	5	3	5	4
V06	Sp-36	5	4	3	3	3	2
V07	Kcf	4	2	4	4	5	4
V08	Kalsit	3	2	5	3	3	5
V09	Mutiara	4	4	4	5	5	4
V10	Kalium Mega Sulfat	4	2	4	3	5	4

Figure 8. Matrix Normalization Data Page View

Next, after performing the matrix calculation, the system will display the results of the matrix normalization. The display of the matrix normalization results page can be seen in Figure 9.

Alt.	Nama Pupuk	C1	C2	C3	C4	C5	C6
V01	Npk	1.000	0.667	0.000	0.500	1.000	0.000
V02	Urea	0.500	0.667	0.500	0.500	1.000	0.667
V03	Tsp	0.500	0.667	1.000	0.000	0.000	0.667
V04	Dolomite	0.500	1.000	0.500	0.000	1.000	0.667
V05	Kcl	0.500	0.667	1.000	0.000	1.000	0.667
V06	Sp-36	1.000	0.667	0.000	0.000	0.000	0.000
V07	Kcf	0.500	0.000	0.500	0.500	1.000	0.667
V08	Kalsit	0.000	0.000	1.000	0.000	0.000	1.000
V09	Mutiara	0.500	0.667	0.500	1.000	1.000	0.667
V10	Kalium Mega Sulfat	0.500	0.000	0.500	0.000	1.000	0.667
V11	Petroganik	0.500	0.667	1.000	0.000	1.000	0.667

Figure 9. Matrix Normalization Result Data Page View


And the last is the process of calculating the  $V_i$  value ( $W_j \cdot X_{ij}$ ), where this calculation process is the last step in the calculation using the Multi Attribute Utility Theory (MAUT) method which will get the final result. The display of the  $V_i$  value calculation page ( $W_j \cdot X_{ij}$ ) can be seen in Figure 10.

Alt.	Nama Pupuk	C1	C2	C3	C4	C5	C6
V01	Npk	0.300	0.100	0.000	0.100	0.150	0.000
V02	Urea	0.150	0.100	0.050	0.100	0.150	0.067
V03	Tsp	0.150	0.100	0.100	0.000	0.000	0.067
V04	Dolomite	0.150	0.150	0.050	0.000	0.150	0.067
V05	Kcl	0.150	0.100	0.100	0.000	0.150	0.067
V06	Sp-36	0.300	0.100	0.000	0.000	0.000	0.000
V07	Kcf	0.150	0.000	0.050	0.100	0.150	0.067
V08	Kalsit	0.000	0.000	0.100	0.000	0.000	0.100
V09	Mutiara	0.150	0.100	0.050	0.200	0.150	0.067
V10	Kalium Mega Sulfat	0.150	0.000	0.050	0.000	0.150	0.067
V11	Petroganik	0.150	0.100	0.100	0.000	0.150	0.067

Figure 10. View the  $V_i$  Value Calculation Page ( $W_j \cdot X_{ij}$ )

## I. Ranking Results

The ranking result is the end of the purpose of this system being designed. This ranking has calculated all alternatives and the total number of scores obtained will be sorted from the largest to the smallest value. This result will show the recommendation of which type of fertilizer is best for farmers. The appearance of the ranking result page can be seen in Figure 11.



Alternatif	Nama Pupuk	Nilai UI	Peringkat
V09	Mutiara	0.717	1
V01	Npk	0.65	2
V02	Urea	0.617	3
V11	Petroganik	0.567	4
V05	Kcl	0.567	5
V04	Dolomite	0.567	6
V07	Kcf	0.517	7
V03	Tsp	0.417	8
V10	Kalium Mega Sulfat	0.417	9
V06	Sp-36	0.4	10

Figure 11. Ranking Results Page View

## J. Print Report

In this report print section, admin and user can print the report listed in the report menu, and the report print feature is located on the top right side of the report menu. The report will be downloaded in PDF format. The printed report results can be seen in Figure 12.

### Hasil Perhitungan Metode Maut

Penerapan Metode Multi Attribut Utility Theory Rekomendasi Jenis Pupuk Kelapa Sawit Kepada Petani Pada Perkebunan Kelapa Sawit Desa Pasir Tuntung Kecamatan Kota Pinang

Alternatif	Nama Pupuk	Nilai Vi	Peringkat
V09	Mutiara	0.717	1
V01	Npk	0.65	2
V02	Urea	0.617	3
V04	Dolomite	0.567	4
V05	Kcl	0.567	5
V07	Kcf	0.517	6
V10	Kalium Mega Sulfat	0.417	7
V03	Tsp	0.417	8
V06	Sp-36	0.4	9
V08	Kalsit	0.2	10

Figure 12. View Downloaded Report Results

## K. System Testing

The testing carried out at this stage is Blackbox testing. Blackbox testing is a test to determine whether the system's functionality can run as expected by its users. (Arfandi Ahmad & Yogie Indra Kurniawan, 2020). In addition, Box Testing or blackbox is also a method of testing software and various applications to determine whether the software and applications are operating properly and optimally or not.

The results of the Blackbox testing of the decision support system using the Multi Attribute Utility Theory (MAUT) method that has been created can be seen in table 1.

Table 1. Blackbox Testing Results

No	Feature	Input	Output	Status
1	Login	Enter the correct username and password	Login to the system or system dashboard	Valid
2	Login Failed	Entering the wrong username and password	System cannot be logged in and data not found	Valid
3	Manage User Data	Press the user data menu	Displays user data that can access the system	Valid
4	Manage Alternative Data	Press the alternative data menu	Displaying alternative data	Valid
5	Manage Criteria Data	Press the criteria data menu	Displaying criteria data	Valid
6	Calculation Process	Click or press the process menu	The system displays the Death calculation process	Valid
7	View Calculations	Click or press the calculation process menu under the process menu.	The system will display the calculation results	Valid
8	Ranking Results	Click or press the report menu	The system will display alternative ranking results	Valid
9	Add User Data	Click add user data, enter name, username and password then save.	User data will increase	Valid
10	Add Alternative Data	Click add data, fill in the data completely then save the data	The data entered will be saved by the system	Valid
11	Edit Alternative Data	Click add data, fill in the data	The system will update and save	Valid

		completely then save the data	data that has been changed or edited	
12	Delete Alternative Data	Click the delete symbol on the alternative data menu in the action section, delete the data you want to delete, if you are sure you want to delete it, click OK.	The system will delete the data, and the data will not appear in the alternative data	Valid
13	Edit Criteria Data	Click edit data on the criteria data menu. Select which data you want to edit, if so then click save data	The system will update and save the valid data that you want to edit, if so, click save the data that has been changed or edited	Valid
14	Print Report	Click print report at the top right of the report menu.	The report will automatically be downloaded in PDF format	Valid
15	Logut	Press the logout or exit button	Exit the system	Valid

This Blackbox testing is done by looking at the input and output of the system. If the output that comes out is in accordance with what is expected, then the function of the system is declared valid or appropriate. Based on the test results in table 1, it can be seen that all statuses contain valid, which means that the system has run as expected.

#### 4. CONCLUSION

Based on the results of the research that has been done, it can be concluded that the application of the Multi Attribute Utility Theory (MAUT) method can be an effective tool to support relevant decision making in recommending fertilizer types for oil palm plantations in Pasir Tuntung Village. This system is able to provide recommendations for the best fertilizer types by displaying fertilizer rankings from the highest to the lowest values.

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