

## DECISION SUPPORT SYSTEM FOR WI-FI MODEM SELECTION USING MULTIPLE ATTRIBUTE DECISION MAKING WITH TOPSIS

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### Abstract

The modem is a device that can connect mobile phones, PCs, or laptops to the internet network. The modem popular today is MiFi or Wi-Fi Modem, a portable modem that makes it easier for users to carry the device anywhere. Many Wi-Fi modems are circulating in the market with various brands with different specifications and capabilities. For this reason, people must be observant in choosing the right Wi-Fi Modem for their needs. Selection of the right Wi-Fi Modem will maximize the internet network's performance to facilitate internet use activities. This study aims to develop a decision support system by implementing the Multiple Attribute Decision Making (MADM) approach using the TOPSIS method for selecting a Wi-Fi Modem to facilitate the selection of the best Wi-Fi Modem according to user needs. Based on black-box testing, it shows that the system built can run well. In addition, the calculation results of the TOPSIS method generated by the system with manual calculations produce the same value.

Keywords: Decision support system; Wi-Fi Modem; MADM; TOPSIS

### Abstrak

Modem merupakan perangkat yang memiliki kemampuan untuk menghubungkan handphone, PC maupun laptop ke jaringan internet. Jenis modem yang populer saat ini adalah MiFi atau Modem Wi-Fi, yang merupakan modem portabel sehingga dapat memudahkan pengguna untuk membawa perangkat di mana saja. Saat ini Modem Wi-Fi telah banyak beredar dipasaran dengan berbagai merek dan brand yang memiliki spesifikasi dan kemampuan yang berbeda-beda. Untuk itu, masyarakat harus jeli untuk memilih Modem Wi-Fi yang tepat dengan kebutuhannya. Pemilihan Modem Wi-Fi yang tepat akan memaksimalkan kinerja jaringan internet sehingga memperlancar aktivitas dalam penggunaan internet. Tujuan dari penelitian ini adalah agar dapat mengembangkan sistem pendukung keputusan dengan mengimplementasikan pendekatan Multiple Attribute Decision Making (MADM) menggunakan metode TOPSIS untuk pemilihan Modem Wi-Fi, agar dapat mempermudah pemilihan Modem Wi-Fi yang terbaik dan sesuai kebutuhan pengguna. Berdasarkan black-box testing memperlihatkan bahwasanya sistem yang dibangun dapat berjalan dengan baik. Selain itu, hasil perhitungan metode TOPSIS yang dihasilkan oleh sistem dengan perhitungan manual menghasilkan nilai yang sama.

Kata kunci: Sistem pendukung keputusan; Modem Wi-Fi; MADM; TOPSIS

### INTRODUCTION

The internet has now become a necessity for humans in carrying out their activities. The internet is useful in almost all aspects of human life because it can connect and communicate, get information and knowledge, and learn, making it easier in business and entertainment (Walidaini & Muhammad Arifin, 2018). Connect the internet, and

a device requires an internet network, one of which is a modem. The type of modem that is popular today is MiFi or modem Wi-Fi, where this device is a portable modem that connects several devices to the internet at once (Badriansyah et al., 2021). Because this modem is portable, it makes it easier for users to carry this device everywhere. Many Wi-Fi modems are circulating in the market with various brands with different specifications and capabilities.

For this reason, people must be observant in choosing the right Wi-Fi modem for their needs. The selection of the right Wi-Fi modem will maximize the performance of the internet network to facilitate one's internet use activities. So, a solution is needed to solve the problem of selecting the right Wi-Fi modem device. The system that can provide recommendations in decision-making is a decision support system.

A decision support system, abbreviated as DSS, is a knowledge-based system that can assist in making decisions. DSS can help decision-makers solve semi-structured problems by recommending the best alternative or solution (Borman & Fauzi, 2018). In the case of the selection of a Wi-Fi Modem, it will involve several criteria and several options with subjective assessments. Therefore, the problem was solved using the Multiple Attribute Decision Making (MADM) approach. MADM is an approach to getting the best alternative from several alternatives based on several criteria (Jaya et al., 2020). One MADM approach that can be implemented is the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). TOPSIS is a method in which the best solution is obtained based on the shortest distance from the positive ideal solution and the farthest distance from the perfect negative solution to find the optimal solution (Nurelasari & Purwaningsih, 2020). The TOPSIS method has advantages. Namely, the method is practical, simple, and efficient in computation (Hertyana, 2019). Previous studies that applied the TOPSIS method had results with high accuracy, including research on the application of TOPSIS for the selection of tourist attractions (Paypas et al., 2019), which produces an accuracy value of 83.3%. Another study regarding the appointment of coffee beans with export quality using TOPSIS with an accuracy value of 84% (Borman, Megawaty, et al., 2020). Furthermore, research on applying TOPSIS to determine UKT waivers obtained an accuracy value of 87% (Ulloh et al., 2021).

This study aims to develop a decision support system through the Multiple Attribute Decision Making (MADM) approach using the TOPSIS method for selecting a Wi-Fi Modem to assist in choosing a Wi-Fi Modem that suits the needs and desires of the user. The difference between this study and previous research is that this research focuses on selecting a Wi-Fi Modem. In this study, the criteria were obtained from an expert whose sources were taken from the website (Faynilla, 2022). The system was developed based on a website to make it easier for users to use it anywhere and anytime. The criteria for selecting a

Wi-Fi Modem are price, battery capacity, type of sale, number of users, and speed.

## RESEARCH METHODS

This research develops a decision support system to choose the right Wi-Fi Modem. For this reason, the research stages refer to the system development method. The Extreme Programming (XP) system development approach is used in developing the system. This approach is a system development method that can be applied to build software on a small to medium scale, and this method can develop systems with changing needs (Borman, Priandika, et al., 2020). Figure 1 below is the stages of the research carried out.

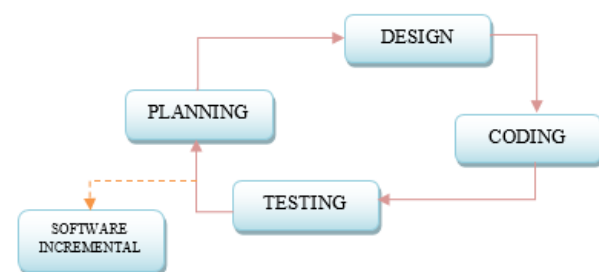


Figure 1. Research Stages

### Planning

Planning is the stage where the process of identifying problems and determining needs is carried out (Borman, Priandika, et al., 2020). The main problem in this study is to determine the Wi-Fi Modem according to the needs and criteria set by the user. It is an essential device for connecting to the internet. So, we need a system that can recommend the right Wi-Fi Modem. The system to be built requires functions such as managing data on criteria, alternatives, and weights and seeing the best alternative results from the system.

### Design

After determining the problems and system requirements, the next step is to design the system to simplify the implementation process. The design is based on user needs, and a framework is made for its implementation (Arifin et al., 2021). The plan will provide an overview of the system developed as a reference in the coding or implementation phase.

### Coding

The next stage is coding, where the results of the design in the previous stage will be implemented into the system through coding with a certain programming language (Rahmanto et al., 2021). In this study, a website-based decision

support system will be built so that for coding, the PHP programming language is used with the text editor Notepad++ and uses MySQL as the database.

### Testing

In the final stage, testing of the developed system is carried out. The testing phase ensures that the system developed can run well and is free from errors (Saputra & Borman, 2020). The testing method applied is black box testing. This testing technique is a test that focuses on the functionality of the system, whether it is to the specified requirements (Herdiansah et al., 2021).

## RESULTS AND DISCUSSION

Start developing a decision support system for selecting a Wi-Fi modem, and the first step is to determine the criteria. Wi-Fi Modem selection criteria used in this study include:

### 1. Price

The price criteria are based on the Wi-Fi Modem device's price, an alternative the user has determined.

### 2. Battery Capacity

The Wi-Fi modem is equipped with a battery to be used anywhere and anytime. So, battery capacity is a consideration for choosing a Wi-Fi Modem because a modem with a large battery capacity does not require repeated charging, especially when traveling.

### 3. Sales Type

In Indonesia, there are two types of Wi-Fi Modem sales: bundling and non-bundling. Bundling is a Wi-Fi Modem sale with internet packages from certain cellular operators. While the non-bundling is the sale of Wi-Fi Modems that only sells the device, users can buy their internet packages.

### 4. Number of Users

Each Wi-Fi Modem has several user capacities. The user capacity offered by the device is the maximum number of users that the Wi-Fi Modem can connect to.

### 5. Speed

Speed shows the maximum internet speed capacity that the Wi-Fi Modem can provide.

After the criteria have been determined, it is continued by assessing the value of the requirements and the conversion value. There are two types of criteria characteristics, namely benefits and costs. The alternative will be better if the value is higher for the benefit criteria type. On the contrary, for the cost criteria class, if the value is lower, the better. From the predetermined criteria, it is identified that the price criterion is a cost criterion, while the criteria for battery capacity, type of sale, number of users, and speed are benefit

criteria. Table 1 below shows the requirements and value conversions for each standard.

Table 1. Wi-Fi Modem Selection Criteria

Criteria	Criteria Value	Value Conversion
Price (C1)	< 500,000	5
	500,000 - 1,000,000	4
	1,000,000 - 1,500,000	3
	1,500,000 - 2,000,000	2
	> 2,000,000	1
Battery	< 1.500 mAh	1
Capacity (C2)	1.500 - 2.000 mAh	2
	2.000 - 2.500 mAh	3
	> 2.500 mAh	4
Sales	Bundling	1
Type (C3)	Non Bundling	2
Number of Users (C4)	< 10	1
	10 - 20	2
	20 - 30	3
	> 30	4
Speed (C5)	< 100 Mbps	1
	100 - 200 Mbps	2
	200 - 300 Mbps	3
	> 300 Mbps	4

Furthermore, the decision maker will assess each criterion's weight or level of importance. The level of importance or weight value will be given a value including Not Important with a value of 1; Enough with a value of 2; Fairly Important with a score of 3; Important with a value of 4; Very Important with a value of 4. As a case study, in Table 2, the following is the weight value of the decision maker.

Table 2. Weight of Each Criterion

C1	C2	C3	C4	C5
4	3	2	2	4

As a case study, for the selection of a Wi-Fi Modem using the alternative TOPSIS method used, including PROLiNK Smart 4G LTE (A1); Alcatel MiFi 4G LTE (A2); Moviemax Mobile Wi-Fi (A3); Bolt Modem Mifi Juno (A4). Each alternative will be assessed based on product specifications against predetermined criteria. Alternative assessments whose values have been converted are presented in Table 3.

Table 3. Value of Each Alternative That Has Been Converted

Alternative	C1	C2	C3	C4	C5
PROLiNK Smart 4G LTE (A1)	4	2	2	3	2
Alcatel MiFi 4G LTE (A2)	3	3	2	2	3

Moviemax Mobile Wi-Fi	4	4	1	2	2
(A3)					
Bolt Modem Mifi Juno	5	3	1	2	2
(A4)					

Based on the case study above, it can be solved using the TOPSIS method with the following stages.

#### 1. Determine the normalized decision matrix

The normalized decision matrix is used to determine the performance of each alternative. The normalized decision matrix for each criterion is denoted by  $x_{ij}$ , which is obtained from the sum of all alternatives, and each criterion will be divided by the total number of criteria. The calculation to get a normalized decision matrix is through equation (1) below.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad \dots\dots\dots (1)$$

where::

$r_{ij}$  = Result of normalized decision matrix (matrix R)  
 $i = 1, 2, 3, \dots, m$  and  $j = 1, 2, 3, \dots, n$

Based on the case study above, solving problems using the TOPSIS method begins with determining the normalized decision matrix using equation (1). The normalization decision matrix can be calculated as follows:

$$r_{11} = \frac{4}{\sqrt{4^2 + 3^2 + 4^2 + 5^2}} = \frac{4}{8.1240} = 0.4924$$

$$r_{21} = \frac{3}{\sqrt{4^2 + 3^2 + 4^2 + 5^2}} = \frac{3}{8.1240} = 0.3693$$

$$r_{11} = \frac{4}{\sqrt{4^2 + 3^2 + 4^2 + 5^2}} = \frac{4}{8.1240} = 0.4924$$

$$r_{11} = \frac{5}{\sqrt{4^2 + 3^2 + 4^2 + 5^2}} = \frac{5}{8.1240} = 0.6155$$

The calculation is carried out continuously until all alternative values in each criterion have been normalized. The calculation results for the entire  $r_{ij}$  value are then entered in the R matrix.

$$R = \begin{bmatrix} 0.4924 & 0.3244 & 0.6325 & 0.6547 & 0.4364 \\ 0.3693 & 0.4867 & 0.6325 & 0.4364 & 0.6547 \\ 0.4294 & 0.6489 & 0.3162 & 0.4364 & 0.4364 \\ 0.6155 & 0.4867 & 0.3162 & 0.4364 & 0.4364 \end{bmatrix}$$

#### 2. Determine the weighted normalized decision matrix

Before the weighted normalized matrix is used, the weight  $W = (w_1, w_2, \dots, w_n)$ , with equation (2) below:

$$y_{ij} = w_j \times r_{ij} \quad \dots\dots\dots (2)$$

Where:

$y_{ij}$  = The results of the weighted normalized decision matrix (matrix Y)

$i = 1, 2, 3, \dots, m$  and  $j = 1, 2, 3, \dots, n$

Based on Table 2, the weight of the criteria  $W = (4, 3, 2, 2, 4)$ , the weighted normalized matrix can be calculated using equation (2). The following is the calculation process:

$$y_{11} = w_j \times r = 4 \times 0.4924 = 1.9695$$

$$y_{21} = w_j \times r = 4 \times 0.3693 = 1.4771$$

$$y_{31} = w_j \times r = 4 \times 0.4924 = 1.9695$$

$$y_{41} = w_j \times r = 4 \times 0.6155 = 2.4618$$

The calculation is carried out continuously until all the values in the R matrix have been multiplied by the weights. Then, the results of the normalized decision matrix (Y) are obtained as follows:

$$Y = \begin{bmatrix} 1.9695 & 0.9773 & 1.2649 & 1.3093 & 1.7457 \\ 1.4771 & 1.4600 & 1.2649 & 0.8729 & 2.6186 \\ 1.9695 & 1.9467 & 0.6325 & 0.8729 & 1.7457 \\ 2.4618 & 1.4600 & 0.6325 & 0.8729 & 1.7457 \end{bmatrix}$$

#### 3. Determine the positive ideal solution matrix and negative ideal solution

The positive and negative ideal solution matrices are obtained from calculations using equations (3) and (4).

$$A^+ = y_1^+, y_2^+, y_3^+, \dots, y_n^+ \quad \dots\dots\dots (3)$$

$$A^- = y_1^-, y_2^-, y_3^-, \dots, y_n^- \quad \dots\dots\dots (4)$$

with,

$$Y_j^+ = \begin{cases} \max_i y_{ij}, & \text{if } j \text{ is a benefit attribute} \\ \min_i y_{ij}, & \text{if } j \text{ is a cost attribute} \end{cases} \quad \dots\dots\dots (5)$$

$$Y_j^- = \begin{cases} \min_i y_{ij}, & \text{if } j \text{ is a cost attribute} \\ \max_i y_{ij}, & \text{if } j \text{ is a benefit attribute} \end{cases} \quad \dots\dots\dots (6)$$



The following is the calculation process for the positive ideal solution.

$$\begin{aligned}y_1^+ &= \min \{1.9695; 1.4771; 1.9695; 2.4618\} = 1.4771 \\y_2^+ &= \max \{0.9733; 1.4600; 1.9467; 1.4600\} = 1.9467 \\y_3^+ &= \max \{1.2649; 1.2649; 0.6325; 0.6325\} = 1.2649 \\y_4^+ &= \max \{1.3093; 0.8729; 0.8729; 0.8729\} = 1.3093 \\y_5^+ &= \max \{1.7457; 2.6186; 1.7457; 1.7457\} = 2.6186 \\A^+ &= \{1.4771; 1.9467; 1.2649; 1.3093; 2.6186\}\end{aligned}$$

Calculating the negative ideal solution can be seen in the following calculations.

$$\begin{aligned}y_1^- &= \max \{1.9695; 1.4771; 1.9695; 2.4618\} = 2.4618 \\y_2^- &= \min \{0.9733; 1.4600; 1.9467; 1.4600\} = 0.9733 \\y_3^- &= \min \{1.2649; 1.2649; 0.6325; 0.6325\} = 0.6325 \\y_4^- &= \min \{1.3093; 0.8729; 0.8729; 0.8729\} = 0.8729 \\y_5^- &= \min \{1.7457; 2.6186; 1.7457; 1.7457\} = 1.7457 \\A^- &= \{2.4618; 0.9733; 0.6325; 0.8729; 1.7457\}\end{aligned}$$

- Determine the distance of each alternative through a positive and negative ideal solution matrix

The distance for each alternative through the positive ideal solution matrix and the negative ideal solution matrix can be calculated by equations (5) and (6).

$$D_i^+ = \sqrt{\sum_{j=1}^n (y_{ij} - y_j^+)^2} \dots\dots\dots(5)$$

$$D_i^- = \sqrt{\sum_{j=1}^n (y_{ij} - y_j^-)^2} \dots\dots\dots(6)$$

where,  $i = 1, 2, 3, \dots, m$

The following results from calculating the distance of the positive ideal solution ( $D^+$ ).

$$\begin{aligned}D_1^+ &= 1.3970; & D_2^+ &= 0.6537; & D_3^+ &= 1.2629; \\D_4^+ &= 1.5997\end{aligned}$$

While the following are the results of calculating the negative ideal solution distance ( $D^-$ ).

$$\begin{aligned}D_1^- &= 0.9126; & D_2^- &= 1.5390; & D_3^- &= 1.0908; \\D_4^- &= 0.4867\end{aligned}$$

- Calculating the preference value on each alternative

The last step is to find the preference value for each alternative. The result of the largest  $V_i$  is the best alternative. Calculating the preference value can apply the following equation (7).

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \dots\dots\dots(7)$$

where,  $i = 1, 2, 3, \dots, m$

Following are the calculation steps to get the preference value.

$$V_1 = \frac{0.9126}{0.9126 + 1.3970} = 0.3951$$

$$V_2 = \frac{1.5390}{1.3590 + 1.2629} = 0.7019$$

$$V_3 = \frac{1.0908}{1.0908 + 1.2629} = 0.4634$$

$$V_4 = \frac{0.4867}{0.4867 + 1.5997} = 0.2333$$

Based on the results of  $V_i$  or the reference value above, the one with the largest weight is the best alternative or solution. The results of the reference values for each alternative are presented in Table 4 below.

Table 4. Reference Value of Each Alternative

Alternative	Preference Value
PROLiNK Smart 4G LTE (A1)	0.3951
Alcatel MiFi 4G LTE (A2)	0.7019
Movimax Mobile Wi-Fi (A3)	0.4634
Bolt Modem Mifi Juno (A4)	0.2333

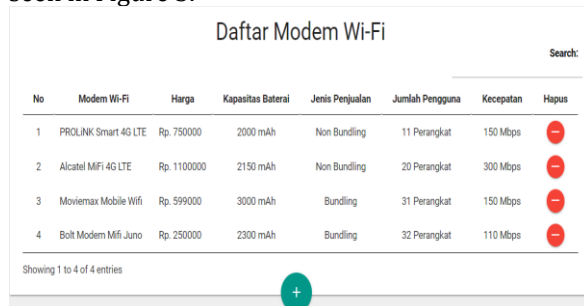
After the TOPSIS analysis has been carried out, the TOPSIS algorithm is applied in a decision support system to choose a Wi-Fi Modem with the PHP programming language Notepad++ and the database using MySQL. The interface display on the decision support system for selecting a Wi-Fi modem is presented in Figure 2.



Figure 2. System Main Menu Interface

The developed system has facilities such as alternative management, weights, inputting alternative values, performing TOPSIS calculations, and displaying the best alternative recommendations. Users can enter alternative data

and delete alternative data. After the main menu is accessed, the user can perform alternative management using the Wi-Fi Modem List feature. The interface of the Wi-Fi Modem List feature can be seen in Figure 3.



No	Modem Wi-Fi	Harga	Kapasitas Baterai	Jenis Penjualan	Jumlah Pengguna	Kecepatan	Hapus
1	PROLINK Smart 4G LTE	Rp. 750000	2000 mAh	Non Bundling	11 Perangkat	150 Mbps	⊖
2	Alcatel MIFI 4G LTE	Rp. 1100000	2150 mAh	Non Bundling	20 Perangkat	300 Mbps	⊖
3	Movimax Mobile Wifi	Rp. 599000	3000 mAh	Bundling	31 Perangkat	150 Mbps	⊖
4	Bolt Modem Mifi Juno	Rp. 250000	2300 mAh	Bundling	32 Perangkat	110 Mbps	⊖

Showing 1 to 4 of 4 entries

Figure 3. Wi-Fi modem list menu interface

After inputting the alternative data, system users can select a Wi-Fi Modem via the Recommendations menu. In this menu, system users will give weighting to each criterion. Then, the user can continue it by pressing the Calculate menu. The system will show the calculation process using the TOPSIS method in the calculate menu. In addition, the system also presents recommendations in the form of the best alternative results. Figure 4 below is a display of the TOPSIS calculation results.



Nilai Preferensi untuk Setiap alternatif (V)	
Nilai Preferensi "V"	Nilai
V1	0.39513335642536
V2	0.7018744014229
V3	0.46344054042571
V4	0.23327262269939

Nilai Preferensi tertinggi		
Nilai Preferensi tertinggi		Alternatif Modem Wi-Fi terpilih
V2	0.7018744014229	Alcatel MIFI 4G LTE

Figure 4. The Best Alternative Results Interface

Furthermore, the system will be tested to ensure that the system developed is error-free. The test technique used is the black-box testing method. Black-box testing will test the functionality of the developed software. The black-box testing carried out is presented in Table 5 below.

Table 5. Black-Box Testing Results

No.	Functionality	Expected Results	Results
1	Main Menu Interface	The Main Menu can appear when the system is accessed.	Valid
2	Managing Alternatives	Users can perform alternative management by adding or deleting data	Valid
3	Managing Weights	Users can provide a weighted value from predefined criteria	Valid
4	Recommendation	Users can select the Wi-Fi Modem by entering the desired weight	Valid
5	TOPSIS Calculation	The system will display the calculation of the TOPSIS method in the form of a detailed calculation process from start to finish.	Valid
6	Best Alternative Results	Users can see the best alternative results	Valid

Table 5 above shows that the system has been functioning properly. It is because, based on black-box testing, all test elements are valid. In addition, the calculation results issued by the system with conventional calculation results show the same results. It means that the TOPSIS method has worked well on the developed system.

## CONCLUSIONS AND SUGGESTIONS

### Conclusion

This study implements the Multiple Attribute Decision Making (MADM) approach using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) on a website-based Wi-Fi Modem selection system. The TOPSIS method can obtain the best alternative by calculating the shortest distance in the positive ideal solution and the farthest distance in the perfect negative solution. Developed facilities such as alternative management, weights, and entering alternative values can perform TOPSIS calculations and display the best alternative results. Based on black-box testing tests, it shows that the system built can run well. In addition, the calculation of the TOPSIS method generated by the system with manual calculations produces the same values and results.

### Suggestion

Several suggestions can be considered to improve further research, including developing an Android-based system so the system can be used on smartphones without the need to open a browser. In addition, it can develop using various methods to produce a more optimal system.

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