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DECISION SUPPORT SYSTEM USING THE COMPOSITE PERFORMANCE INDEX (CPI) FOR WIRELESS REPEATER SELECTION

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Abstract

To connect to the internet, a device must have an internet connection via an internet network, one of which is through a wireless network or what is called Wireless Fidelity (Wi-Fi). On a Wi-Fi network there is a Wi-Fi router that is used to provide a connection to the internet network, but the signal from the WI-FI router is limited. Then the Wi-Fi signal needs to be strengthened with a signal booster known as a Wi-Fi Repeater or Wi-Fi Extender. Wi-Fi Repeaters are important devices for individuals, agencies and companies so that the desired areas get internet connection. So, to make a purchase of this product, foresight is needed so that the device chosen is right and in accordance with the needs. The large selection of Wi-Fi Repeater products on the market results in a person having to find information in advance regarding the specifications of the Wi-Fi Repeater product to be purchased. This has an impact on the length of the process in making decisions. The purpose of this research is to implement the Composite Performance Index (CPI) method on a decision support system for choosing Wi-Fi Repeaters, so that it can make it easier for users to determine alternatives quickly and precisely. The CPI method is used to solve decision problems with a number of alternatives through a combined index to rank alternatives from several criteria. The results of the calculations in the case study produced the highest combined index value, namely the Asus N300 Range Extender (A2) getting a score of 125, then followed by Mercusys WiFi Extender (A1) getting a score of 92.5, Comfast WiFi Extender (A3) getting a score of 100 and Xiaomi Mi AC1200 (A4) get a value of 100. The calculation results of the CPI method obtained by the system obtain the same value as manual calculations, so the developed system is declared valid. In addition, based on tests using black-box testing, it shows that the system built can function as it should.

Keyword: *composite performance index, cpi, decision support system, wi-fi repeater, wireless.*

1. INTRODUCING

Currently the internet is a basic need for someone, this is because in all activities now requires the internet. The internet or short for Interconnection Networking can connect someone with other people easily and in a short time around the world without limits and can provide all the information needed and make it easier to work through the internet network [1]. To connect to the internet, a device must have an internet connection via an internet network, one of which is through a wireless network or what is called Wireless Fidelity (Wi-Fi). Currently, strategic areas or certain places have provided Wi-Fi networks so that devices such as smartphones, laptops and notebooks can connect to the internet. Wi-Fi can connect devices to an internet network without wire intermediaries or wirelessly [2]. To be able to build a Wi-Fi network, you need a Wi-Fi router to connect to the internet connection. A Wi-Fi router provides connectivity in the form of a Wi-Fi signal that can be picked up by other devices that want to connect to the internet. However, the Wi-Fi signal generated by the router has weaknesses and limitations for a certain distance or due to other interference factors. Then the Wi-Fi signal needs to be strengthened with a signal booster known as a Wi-Fi Repeater or Wi-Fi Extender. Wi-Fi Repeater has a function as a signal catcher from the router, then spreads the Wi-Fi signal to areas that are not covered by the main router [3]. Wi-Fi Repeaters are important devices for individuals, agencies and companies so that the desired areas get internet connection. So, to make a purchase of this product, foresight is needed so that the device chosen is right and as needed. However, not everyone has knowledge about the specifications of the Wi-Fi Repeaters on the market. The large selection of Wi-Fi Repeater products on the market results in a person having to find information in advance regarding the specifications of the Wi-Fi Repeater product to be purchased. This has an impact on the length of the process in making decisions. Therefore, it is necessary to solve the problem through a computerized system that can assist in determining

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the decision to choose a Wi-Fi Repeater.

Making a decision has the goal of making a choice to become a solution to a problem from several systematic solution options [4]. Decision Support Systems (DSS) provide solutions to solving decision problems by providing information, providing recommendations and supporting decision making in order to obtain the best solution based on rational decisions based on existing data and facts [5]. DSS is a computerized system that has the ability to support decision making that makes it easier for decision makers to solve semi-structured problems in order to recommend the best solution [6]. DSS offers a decision problem solving model using mathematical and statistical models [7]. In solving the problem of decision on DSS using several methods or approaches. Previous studies related to the selection of wireless-related devices have been carried out by several researchers. The first research concerns the development of a decision support system for choosing a wireless router by applying the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approach [8]. The approach applied can produce the best alternative based on the shortest and farthest distance between positive and negative ideal solutions. Subsequent research, regarding the development of a wireless router selection system using the Promethee approach [9]. In this research, the Promethee method makes decisions based on the dominance of the criteria used for ranking. Furthermore, research on the selection of Wireless Fidelity (Wi-Fi) service providers uses the Weighted Aggregated Sum Product Assessment (WASPAS) method [10]. This study uses the WASPAS method to find the best alternative by optimizing the assessment to get the highest score and the lowest score to get the best alternative.

The difference between this research and previous research is that this research focuses on choosing a Wi-Fi Repeater which is an important device in supporting Wi-Fi connections and the decision-solving method used is the Composite Performance Index (CPI). The criteria used for the selection of Wi-Fi Repeaters were sourced from an expert software engineer, namely Yosua Surojo, who was taken on a website page as a result of his review [11]. The criteria used include: price, standard speed, security system and power consumption. The Composite Performance Index (CPI) approach is used because it has advantages in transforming values into uniforms so as to obtain an effective value [12]. The CPI approach is also known as the combined index method which is used in determining the value and ranking of alternatives from a number of existing alternatives [13]. This approach is one of the decision-making method approaches whose calculations are based on performance indexes [14]. The CPI method has the ability to determine alternatives based on criteria that do not have uniformity, because the criteria used have positive and negative trends [15]. In addition, CPI can also be used to rank various alternatives based on several criteria [16]. Alternatives arranged sequentially based on ranking from highest to lowest value can make it easier for decision makers to choose the best alternative. Several studies implementing CPI in decision support systems have shown good results [17]–[19]. The CPI method is able to determine the best solution from a number of attributes with non-uniform criteria.

Based on the previous explanation, the purpose of this study is to implement the Composite Performance Index (CPI) method in a decision support system for choosing Wi-Fi Repeaters, so that it can make it easier for users to determine alternatives quickly and precisely. The CPI method is used to solve decision problems with a number of alternatives through a combined index to rank alternatives from several criteria. A decision support system developed based on a website for easy access.

2. RESEARCH METHODS

2.1 Research Stages

To make it easier to carry out research so that it can produce research that can solve problems appropriately, it is necessary to develop research stages that include a step-by-step process or research steps [20]. The stages in the research carried out are shown in Figure 1.

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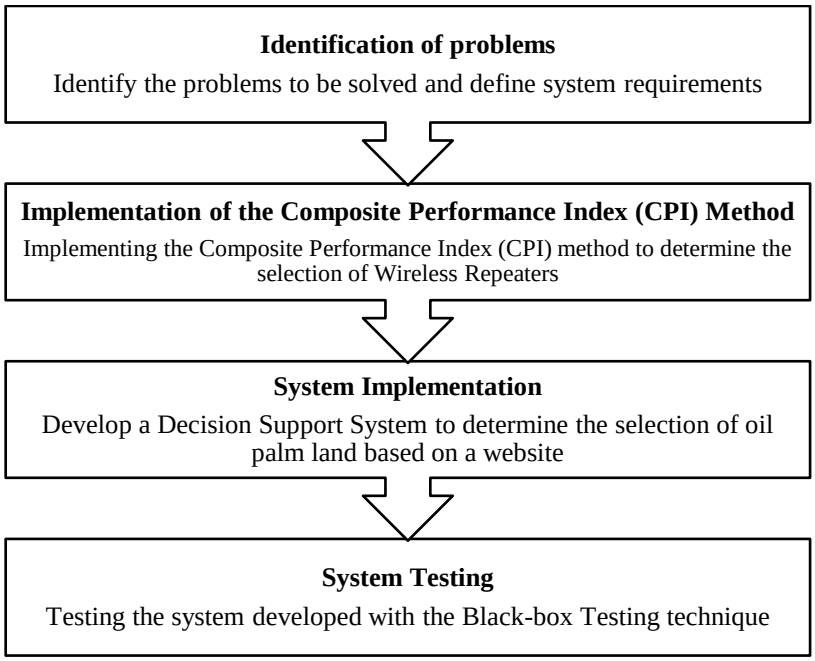

Figure 1. Research Stages

The following is a detailed explanation of the steps in the stages of the research carried out by the researchers depicted in Figure 1.

1) Problem Identification
   At this stage the researcher identifies the problems that will be solved, especially related to the obstacles faced by someone in selecting a Wi-Fi Repeater. The results of observations and interviews show that the main problem is that selecting a Wi-Fi Repeater requires time and effort because if someone is going to buy a Wi-Fi Repeater, they must first dig up information about the product to be purchased and compare it with the needs of the buyer.
   The next stage is to determine the needs through functional requirements analysis. This analysis contains the functional statements of the system in the form of services provided by the system. [21]. So, at this stage the features of the developed DSS will be determined.
2) Implementation of the Composite Performance Index (CPI) Method
   At this stage, the implementation of the Composite Performance Index (CPI) method was carried out in selecting Wi-Fi Repeaters. the website articles he wrote, the criteria used were: capacity, transfer speed, weight and price. The Composite Performance Index (CPI) method is used because this method has the advantage of transforming values into uniform so as to obtain an effective value [12]. The CPI method is a combined index that can be used to determine ratings or ratings of various alternatives based on several criteria [13].
3) System Implementation
   At this stage coding is done to build the system. Coding is the stage of converting the results of the design through a programming language that can be recognized by a computer to build a system [22], [23]. The system being developed is based on a website, the tool used for coding is Sublime Text and for data storage it uses a MySQL database.
4) System Testing
   The purpose of system testing is to enter the system that has been developed to work properly and is free from errors [24]. In addition, the testing phase can also be used to measure the performance of the model being built [25]. To test the system used a black-box testing approach. This approach tests the system based on the functionality or services provided on the system by ensuring that these features function properly.

2.2 Composite Performance Index (CPI) Method

The Composite Performance Index (CPI) approach is an approach that can search for the best alternative from several alternatives with a number of predetermined criteria. The CPI approach technique consists of a combined index that functions in determining value and ranking in order to obtain an ideal solution. The CPI method in obtaining the best

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alternative will involve a variety of criteria, namely positive trend criteria and negative trend criteria. For more details regarding the stages in making decisions using the Composite Performance Index (CPI) can be seen in the following steps.

1) Identification of trend criteria, namely positive and negative trends.
   The first step is to identify whether the criteria used are a positive trend or a negative trend. The positive trend is the criterion that seeks the highest value, while the negative trend is the criterion that seeks the lowest value.
2) Transformation of positive and negative trend values.
   In the positive trending criteria, the minimum value will be the divider for the other values in each criterion and then multiplied by one hundred. Conversely, for negative trending criteria, the minimum value will be divided by the other values for each criterion and then multiplied by one hundred. To obtain the transformation of positive trend values and negative trend values can be calculated using equations (1) and (2).

$$A_{ij} = \left(x_{ij}(min)/x_{ij}(min)\right) \times 100 \quad (1)$$

$$A_{(i+1.j)} = \left(x_{(i+1.j)}(min)/x_{ij}(min)\right) \times 100 \quad (2)$$

   where,
   A_{ij} : The value of the i-th alternative on the j-th criterion
   $x_{ij}(min)$: The value of the i-th alternative at the j-th minimum initial criterion
   $A_{(i+1.j)}$: The value of the i-th alternative in the j-th criterion
   $x_{(i+1.j)}$: The value of the i-th alternative in the j-th initial criterion
3) Calculating alternative index values
   The alternative index value is obtained from the multiplication of the criterion value with its weight as in equation (3).

$$I_{ij} = A_{ij} \times P_j \quad (3)$$

   where,
   A_{ij} : The value of the i-th alternative on the j-th criterion
   P_j : Weight for each criterion
   I_{ij} : Value for alternative index
4) Calculate the combined index value
   The combined index value is obtained from the number of alternative index values as in equation (4).

$$I_i = \sum_{i=1}^{n} I_{ij} \quad (4)$$

   where,
   I_{ij} : Value for alternative index
   I_i : The value for the combined index on each criterion

3. RESULT AND DISCUSSIONS

3.1 Implementation of the Composite Performance Index (CPI) Method

To determine a Wi-Fi Repeater, carefulness is needed in choosing the right product and according to your needs. However, not everyone has knowledge regarding the specifications of a Wi-Fi Repeater, so to make a selection, you must first find information about the specifications of the Wi-Fi Repeater product to be purchased. This has an impact on the length of the process in making decisions. To build a decision support system for choosing oil palm land, the Composite Performance Index (CPI) method is used. The criteria used for the selection of Wi-Fi Repeaters come from an expert software engineer, namely Yosua Surojo, who took the website page as a result of his review [11]. The criteria used include: price, standard speed, security system and power consumption. The first step in applying the CPI method is to determine the weight or level of importance for each criterion. Besides determining the criteria and their weights, the trend of the criteria used is also determined, whether the trend is positive or negative. In Table 1 below is a table containing the criteria, weights and trending criteria that have been determined by the decision maker for this case study.

Table 1. Table of Criteria, Weights and Trends of Criteria

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Code	Criteria	Criteria Trends	Weight
C1	Price	Negative Trends	25%
C2	Standard Speed	Positive Trend	30%
C3	Security System	Positive Trend	25%
C4	Power Consumption	Negative Trends	20%

Table 1 shows the criteria, trends in the criteria and the weights for each criterion. Then set the value of the criteria and conversion values for each criterion. For case studies, the value ranges and value conversions for each criterion used can be seen in Table 2.

Table 2. Range of Values and Conversion of Criteria Values

No.	Criteria Name	Value Range	Value Conversion
1	Price (C1)	< Rp. 200.00,-	1
		>= Rp. 200.00,- and <Rp. 400.00,-	2
		>= Rp. 400.00,- and <Rp. 800.00,-	3
		>= Rp. 800.00,-	4
2	Standard Speed (C2)	< 200Mbps	1
		>= 200 Mbps and < 400 Mbps	2
		>= 400 Mbps and < 800 Mbps	3
		>= 800Mbps	4
4	Security System (C3)	< 2 Security System	1
		>= 2 Security Systems and < 4 Security Systems	2
		>= 4 Security Systems and < 6 Security Systems	3
		>= 6 Security System	4
5	Power Consumption (C1)	< 0.3 A	1
		>= 0.3 A and < 0.6 A	2
		>= 0.6 A and < 1.2 A	3
		>= 1.2 A	4

The alternatives used for case studies for selecting Wi-Fi Repeaters include: Mercusys WiFi Extender (A1), Asus N300 Range Extender (A2), Comfast WiFi Extender (A3) and Xiaomi Mi AC1200 (A4). Furthermore, from these alternatives an assessment is carried out against predetermined criteria based on product specifications for each alternative. For the assessment of each alternative can be seen in Table 3.

Table 3. Value For Each Alternative

Kode Alternatif	Alternatif	Criteria			
		C1	C2	C3	C4
A1	Mercusys WiFi Extender	Rp. 280.000,-	430 Mbps	2 Security Systems	0.3 A
A2	Asus N300 Range Extender	Rp. 495.000,-	867 Mbps	5 Security Systems	0.6 A
A3	Comfast WiFi Extender	Rp. 215.000,-	300 Mbps	4 Security Systems	0.2 A
A4	Xiaomi Mi AC1200	Rp. 198.000,-	300 Mbps	2 Security Systems	0.05 A

Based on Table 3, then the existing values will be converted based on the conversion values in Table 1. The conversion criteria values for each alternative are presented in Table 4.

Table 4. Value Conversion Results

Alternative Code	Alternative	Criteria			
		C1	C2	C3	C4
A1	Mercusys WiFi Extender	2	3	2	2
A2	Asus N300 Range Extender	3	4	4	3
A3	Comfast WiFi Extender	2	2	3	1
A4	Xiaomi Mi AC1200	1	2	2	1

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After the values for each alternative have been converted as shown in Table 4 above, then calculations are carried out using the CPI method based on the stages discussed previously. To start the calculation begins with calculating the value of the positive trend and negative trend (A_{ij}) using equation (1) and equation (2). The criteria for Standard Speed (C2) and Security System (C3) are positive trend criteria, while the Price (C1) and Power Consumption criteria (C4) are negative criteria. The following is the process of calculating positive trends and negative trends (A_{ij}).

$$A_{11} = \left(\frac{1}{2}\right) \times 100 = 50$$
$$A_{21} = \left(\frac{1}{3}\right) \times 100 = 33.33$$
$$A_{31} = \left(\frac{1}{2}\right) \times 100 = 50$$
$$A_{41} = \left(\frac{1}{1}\right) \times 100 = 100$$

$$A_{12} = \left(\frac{3}{2}\right) \times 100 = 150$$
$$A_{22} = \left(\frac{4}{2}\right) \times 100 = 200$$
$$A_{32} = \left(\frac{2}{2}\right) \times 100 = 100$$
$$A_{42} = \left(\frac{2}{2}\right) \times 100 = 100$$

$$A_{13} = \left(\frac{2}{2}\right) \times 100 = 100$$
$$A_{23} = \left(\frac{4}{2}\right) \times 100 = 200$$
$$A_{33} = \left(\frac{3}{2}\right) \times 100 = 150$$
$$A_{43} = \left(\frac{2}{2}\right) \times 100 = 100$$

$$A_{14} = \left(\frac{1}{2}\right) \times 100 = 50$$
$$A_{24} = \left(\frac{1}{3}\right) \times 100 = 33.33$$
$$A_{34} = \left(\frac{1}{1}\right) \times 100 = 100$$
$$A_{44} = \left(\frac{1}{1}\right) \times 100 = 100$$

Based on the results of these calculations, the results of calculating positive trends and negative trends (A_{ij}) are presented in Table 5.

Table 5. Results of Positive Trend and Negative Trend Values (A_{ij})

Alternative Code	Alternative	Criteria			
		C1	C2	C3	C4
A1	Mercusys WiFi Extender	50	150	100	50
A2	Asus N300 Range Extender	33.33	200	200	33.33
A3	Comfast WiFi Extender	50	100	150	100
A4	Xiaomi Mi AC1200	100	100	100	100

The results of calculating the positive trend and negative trend (A_{ij}) that have been obtained in Table 5 will then be input for calculating alternative index (I_{ij}) values using equation (3). The alternative index value is obtained by multiplying

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the criterion value by its weight. The weight for each criterion is based on Table 1, namely: Price (C1) = 25% or 0.25; Standard Speed (C2) = 30% or 0.3; Security System (C3) = 25% or 0.25; Power Consumption (C4) = 20% or 0.2. The following is the alternative index calculation process (I_{ij}).

$I_{11} = 50 \times 0.25 = 12.5$
$I_{21} = 33.33 \times 0.25 = 8.33$
$I_{31} = 50 \times 0.25 = 12.5$
$I_{41} = 100 \times 0.25 = 25$

$I_{12} = 150 \times 0.3 = 45$
$I_{22} = 200 \times 0.3 = 60$
$I_{32} = 100 \times 0.3 = 30$
$I_{42} = 100 \times 0.3 = 30$

$I_{13} = 100 \times 0.25 = 25$
$I_{23} = 200 \times 0.25 = 50$
$I_{33} = 150 \times 0.25 = 37.5$
$I_{43} = 100 \times 0.25 = 25$

$I_{14} = 50 \times 0.2 = 10$
$I_{24} = 33.33 \times 0.2 = 6.67$
$I_{34} = 100 \times 0.2 = 20$
$I_{44} = 100 \times 0.2 = 20$

Based on the calculations that have been done, the alternative index (I_{ij}) can be seen in Table 6.

Table 6. Alternative Index (I_{ij}) Value Results

Alternative Code	Alternative	Criteria			
		C1	C2	C3	C4
A1	Mercusys WiFi Extender	12.5	45	25	10
A2	Asus N300 Range Extender	8.33	60	50	6.67
A3	Comfast WiFi Extender	12.5	30	37.5	20
A4	Xiaomi Mi AC1200	25	30	25	20

Based on Table 6, then these values will be calculated by the combined index (I_i) value using equation (4). The combined index value is obtained from the number of alternative index values. The following is the calculation process to get the combined index value.

$I_1 = 12.5 + 45 + 25 + 10 = 92.5$

$I_2 = 8.33 + 60 + 50 + 6.67 = 125$

$I_3 = 12.5 + 30 + 37.5 + 20 = 100$

$I_4 = 25 + 30 + 25 + 20 = 100$

Based on the calculation of the combined index (I_i) value it shows that Mercusys WiFi Extender (A1) gets a score of 92.5, Asus N300 Range Extender (A2) gets a score of 125, Comfast WiFi Extender (A3) gets a score of 100 and Xiaomi Mi AC1200 (A4) gets a score 100. The results are then ranked from the highest to the lowest combined index value. The results of ranking based on the combined index value can be seen in Table 7.

Table 7. Composite Index (I_i) Value Results

Alternative Code	Alternative	I_i Value	Rank
A2	Asus N300 Range Extender	125	1
A1	Mercusys WiFi Extender	92.5	2
A3	Comfast WiFi Extender	100	3

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A4	Xiaomi Mi AC1200	100	4

In the CPI method, the combined index value is the best alternative. So based on Table 7, for this case study the best alternative is the Asus N300 Range Extender (A2)

3.2 System Design

Furthermore, the CPI method is implemented in the DSS of website-based Wi-Fi Repeater selection. Prior to implementation, a system design is first made. The design used is a use case diagram. This diagram describes the relationship between the actor and the system which shows the functions that exist in the system [26]. Use case diagram on DSS for selecting Wi-Fi Repeater can be seen in Figure 2.

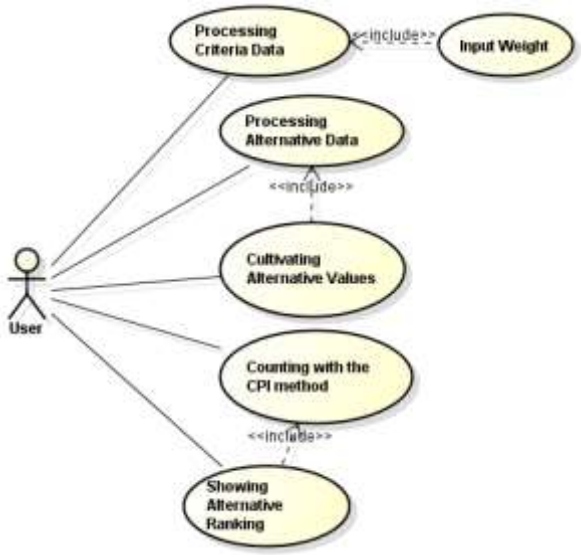

Figure 2. Use Case Diagram of a Decision Support System for Wi-Fi Repeater Selection

In Figure 2, it can be seen that users can manage criteria data, alternative data, assess alternatives, calculate using the CPI method and view ranking results.

3.3 System Implementation

The next step is to implement the CPI method into a website-based decision support system using Sublime Text and to store data using MySQL. The system being developed begins with the Login Menu, where the user to be able to access the system is required to log into the system by entering the username and password that was previously created on the system. If the user has entered the system, the Main Menu will appear. The Main Menu interface display on DSS for Wi-Fi Repeater selection is shown in Figure 3.

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Figure 3. Main Menu Interface on DSS for Wi-Fi Repeater Selection

In Figure 3, it can be seen that the Main Menu interface displays a graph of the results of the CPI method calculation and there are DSS system main menus for selecting Wi-Fi Repeater, namely: Criteria Menu, Alternative Menu, Alternative Value Menu, CPI Calculation Menu and User Menu. To start using DSS for Wi-Fi Repeater selection, the user must first enter the criteria in the Criteria feature. Figure 4 below is the Criteria Menu interface on the DSS system for selecting Wi-Fi Repeaters.

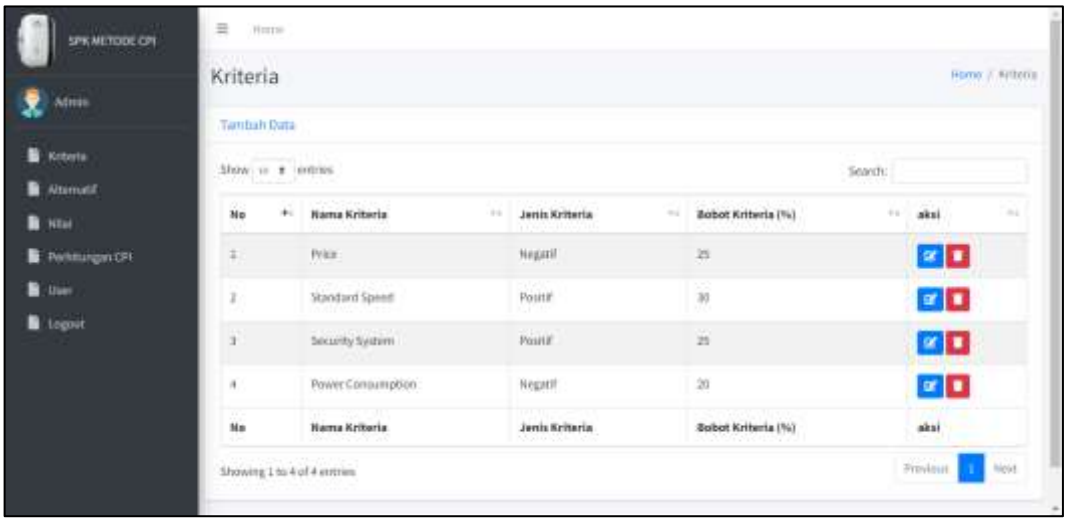

Figure 4. Criteria Menu Interface on DSS for Wi-Fi Repeater Selection

Figure 4 shows the Criteria Menu display, where on that menu the user can add, edit and delete criteria data. After the criteria data is added, the user can enter alternative data on the Alternative menu. In addition to adding data users can also change and delete alternative data. Furthermore, if the criteria and alternative data have been entered, the user can make an alternative assessment via the Value Menu. In this menu, the user can enter an alternative assessment of the criteria that have been set based on the specifications of the alternative product. Next, the user can perform the calculation process using the CPI method on the CPI Calculation Menu. This menu will display the stages in the complete CPI calculation. In addition, this menu will display the best alternative in the form of an alternative ranking. The interface for the CPI method calculation process generated by the system can be seen in Figure 4.

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Figure 5. CPI Method Calculation Interface on DSS for Wi-Fi Repeater Selection

Figure 4 shows the results of calculating the CPI method obtained by the system to obtain the same value as manual calculations. Thus, the implementation of the CPI method on the DSS for the selection of the Wi-Fi Repeater developed can be said to be valid.

3.4 System Testing

The next stage is to conduct testing to ensure that the developed system is free from errors or errors. For this reason, the black-box testing technique is used at the testing stage. In this test technique later the system that has been built will be tested based on its functionality whether it has been running according to predetermined requirements or not. The test results using black-box testing are presented in Table 8.

Table 8. Test Results with Black-box Testing

No	Test Cases	Functionality	Result
1	Login Menu	The user enters the username and password to enter the system and can enter the system by inputting the username and password.	Valid
2	Main Menu	Users can view the main menu by displaying a graph of the calculation of the CPI method and other main menus.	Valid
3	Criteria Menu	Users can process criteria data, including adding, changing and deleting criteria data.	Valid
4	Alternative Menu	Users can perform alternative data processing such as adding, changing and deleting alternative data.	Valid
5	Alternative Value Menu	Users can enter values for each alternative and can change and delete them.	Valid
6	CPI Method Calculation Menu	Users can see the process of calculating the selection of Wi-Fi Repeater using the CPI method and the system can display the best alternatives and alternative rankings.	Valid
7	User Menu	Users can add, modify and delete user data that will use the system.	Valid

In Table 8, it shows that from the test results through the black-box testing technique all test cases get "Valid" results. This means the system is free from errors or errors and can work properly.

4. CONCLUSION

This research has implemented the Composite Performance Index (CPI) method on a decision support system for selecting Wi-Fi Repeater. The CPI method is used to solve decision problems with a number of alternatives through a combined

index to rank alternatives from several criteria. The results of the calculations in the case study produced the highest combined index value, namely Asus N300 Range Extender (A2) getting a score of 125, followed by Mercusys WiFi Extender (A1) getting a score of 92.5, Comfast WiFi Extender (A3) getting a score of 100 and Xiaomi Mi AC1200 (A4) gets a value of 100. The calculation results of the CPI method obtained by the system obtain the same value as manual calculations. Thus, the implementation of the CPI method in the developed Wi-Fi Repeater selection DSS is declared valid. The DSS for selecting Wi-Fi Repeater is built on a website to make it easier to use and access. Based on tests using black-box testing, it shows that the system built can function properly.

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