The IJICS (International Journal of Informatics and Computer Science)
Vol 7 No 1, March 2023, Page 1−10
ISSN 2548-8384 (online), ISSN 2548-8449 (print)
Available Online at https://ejurnal.stmik-budidarma.ac.id/index.php/ijics/index
DOI 10.30865/ijics.v7i1.6001

Multi-Criteria Decision Making Using the WASPAS Method in Webcam Selection Decision Support Systems

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Submitted: **23/02/2023**; Accepted: **23/03/2023**; Published: **25/03/2023**

Abstract−To carry out all virtual or online activities, you need hardware that can support it, one of which is a webcam. Many webcam products issued by various electronics companies are compatible for laptops and computers. However, to make a webcam selection the user must know one by one the specifications of each webcam. This of course takes a long time to determine the right webcam. This study aims to implement the Multi-Criteria Decision Making (MCDM) approach with Aggregated Sum Product Assessment (WASPAS) on a webcam selection decision support system, in order to get the best, right and fast alternative. The WASPAS method can determine the best alternative through prioritization that is relevant to the weighting used. Based on the case studies conducted, the WASPAS method was able to determine the best webcam with the best alternative results, namely NYK Nemesis A96 with a value of 0.7053, followed by Aukey PC-LM7 with a value of 0.6826, JETE W2 with a value of 0.6799, Logitech C922 with a value of 0.6499 and Ausdom AF660 with a value 0.6271. Because the findings are identical to manual calculations, the created system generates legitimate WASPAS method calculations. Based on the tests carried out using the black-box testing approach, it shows that all the functions in the system can run as they should.

Keywords: Decision Support System; Multi-Criteria Decision Making; MCDM; Weighted Aggregated Sum Product Assessment; WASPAS

1. INTRODUCTION

The Covid-19 pandemic that has hit the world has resulted in change and requires people to innovate, one of which is by carrying out all activities online. This resulted in the emergence of platforms that facilitate online-based work such as teaching and learning, meetings, discussions and so on [1]. To carry out all virtual or online activities, you need software or hardware that supports its implementation. Hardware that supports virtual or online activities is a webcam. Webcam or short for web camera is a digital camera device to be connected to a computer or laptop [2]. Through a webcam, users can capture images or videos onto a computer or laptop. Currently, the need to use a webcam is increasing, this is due to the increase in virtual meeting activities, such as classes, meetings, and online conferences. Many webcam products issued by various electronics companies are compatible for laptops and computers. So, carefulness is needed in selecting a webcam in order to get the right product and according to your needs. However, to make a webcam selection the user must know one by one the specifications of each webcam to be selected, then compare it with what is needed. This of course takes a long time to determine the right webcam. For that we need a system that can help in recommending the best webcam that is fast and precise.

Decision Support System (DSS) is also known as knowledge-based software that is useful in solving decision problems or making a choice [3]. DSS is not completely absolute, but DSS is only software that supports making a decision based on data managed through modeling in the form of mathematics and statistics so as to produce the right and fast decisions [4]. DSS is usually used in solving problems that are semi-structured or unstructured by presenting information in the form of the best alternative recommendations [5]. Research on DSS development related to determining or choosing a webcam device does not yet exist, but there are several studies related to camera selection that have been carried out by several researchers with models and methods. Previous research regarding camera selection used the Simple Additive Weighting (SAW) approach in completing decision making [6]. The SAW method seeks a solution based on the weighted sum obtained through the performance rating of each alternative on all attributes. The next research, regarding the development of DSS to choose the best camera using the Simple Multi Attribute Technique (SMART) approach [7]. The approach used can determine the best solution through alternative research based on the weighting of each criterion, then a comparison is made and the importance of each criterion is described, how important it is to the other criteria. Subsequent research regarding the use of the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method in decision support systems for camera selection [8]. The TOPSIS approach in this study is used in solving decision-making based on distances that are near and far from positive and negative ideal solutions.

The difference between the previous research that has been described above and the research conducted is that in this research the solution to the Multi-Criteria Decision Making (MCDM) problem uses the Weighted Aggregated Sum Product Assessment (WASPAS) method, where this method has the ability to reduce errors or optimize in the assessment of choosing the best alternative through weighting. This is shown from previous research using the WASPAS method in developing a decision support system that is able to determine the best alternative out of a number of alternatives with several attributes, including research conducted by Icksan et al (2018) [9], research by Tundo and Kurniawan (2019) [10] and research by Harahap. et al (2021) [11]. In addition, this research focuses on solving webcam selection problems. The

criteria for selecting a webcam for this case study were taken from articles that had been validated by a gaming content creator practitioner, Faynilla (2023) [12]. The criteria used include: Camera Resolution, Frame Rate per Second (FPS), Viewing Angle and Price.

Based on the previous explanation, this study aims to implement the Multi-Criteria Decision Making (MCDM) approach with Weighted Aggregated Sum Product Assessment (WASPAS) on a webcam selection decision support system, in order to get the best alternative that suits the needs of several alternatives and certain criteria. The WASPAS method can determine the best alternative through prioritization that is relevant to the weighting used. The system built is made on a web-based basis, in order to make it easier to use and access it.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The stages in this research can be interpreted as a systematic approach that is used in the stages of research needed so that research implementation can be well planned and structured. The research stages contain processes or phases in research that are systematically arranged to achieve the objectives of the research [13]. These stages are presented in Figure 1.

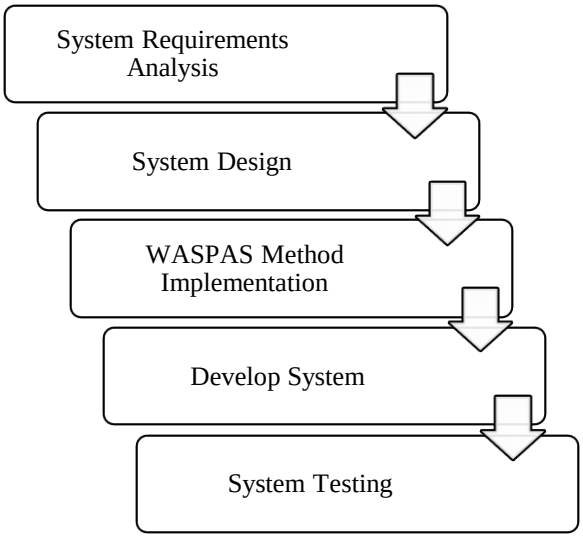


Figure 1. Research Stages

Based on Figure 1, you can see the phases in conducting the research. The following is a more detailed description of the stages of the research carried out:

1) System Requirements Analysis
   To carry out a needs analysis, previously identified the problem. In identifying the problem, the constraints encountered in the case study will be explored [14]. After knowing the problems to be solved then proceed with the analysis of system requirements. A requirement statement in the form of a functional requirements analysis is made to carry out a system requirements analysis [15]. The output of this analysis is a statement about the functions and what the system can do.
2) System Design
   The next stage is system design, where the process will be carried out in compiling and modeling the system in a visual form to facilitate understanding of software requirements. So that at this stage it will produce a system design which will later be converted into software.
3) WASPAS Method Implementation
   In completing the decision making for webcam selection in this study by applying the Weighted Aggregated Sum Product Assessment (WASPAS) approach. WASPAS is an approach that is able to minimize errors and maximize the assessment for the selection of the highest or lowest scores.
4) Develop System
   This stage is the process of system coding or system implementation. This implementation process is carried out by realizing the results of the analysis and design into the system [16]. The development of a webcam selection decision support system is built on a website, so that the programming language uses PHP using an editor, namely PHP Storm and data storage using MySQL.
5) System Testing
   The system test has a function so that it can be ensured that the system being built can work as it should and there are no functions that are not suitable if it is run [17]. Black-box testing is a tool for testing in this study. Black-box

testing is a testing technique based on system operation, which allows the program to be checked functionally to see if it is functioning as it should [18]. The output of this procedure consists of a set of test features and test results that can be used to determine if the system is functioning as planned.

2.2 Weighted Aggregated Sum Product Assessment (WASPAS) Method

The Multi-Criteria Decision Making (MCDM) approach can be used to handle choice problems by choosing the best alternative from a number of available alternatives and based on a number of criteria. The MCDM technique is a method for solving selection issues by employing alternative analysis while considering a number of underlying factors in judgments [19]. The Weighted Aggregated Sum Product Assessment (WASPAS) method, which may be used to evaluate a number of options in a number of choice criteria, is one of the Multi-Criteria Decision Making (MCDM) solutions. WASPAS is a combination of the Weighted Sum Model (WSM) and Weighted Product Model (WPM) approaches [20]. The WASPAS method is a popular method for completing Multi-Criteria Decision Making (MCDM) in evaluating several alternatives with a number of criteria [21]. An method called WASPAS can reduce errors and increase estimation when choosing the highest and lowest values [22]. The WASPAS method is very efficient in complex decision-making situations and also results in very accurate models [23].

The following are the stages in using the Weighted Aggregated Sum Product Assessment (WASPAS) approach:

1) Make a decision matrix
   Before compiling a decision matrix, the criteria (C) are first determined, then the weight values for the criteria (W) and alternatives (A) are determined. Next, arrange a decision matrix table using equation (1).

$$x = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m1} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

2) Finding the normalized matrix
   To normalize the matrix, it is first identified whether the criterion is a criterion of benefits or costs. The benefit criterion is a criterion that if the value is higher, the better, conversely, the cost criterion is a criterion, if the value is lower, the better. Matrix normalization for benefit criteria uses equation (2) and for cost criteria uses equation (3).

$$\bar{x}_{ij} = \frac{x_{ij}}{max_i\, x_{ij}} \quad (2)$$

$$\bar{x}_{ij} = \frac{min_i\, x_{ij}}{x_{ij}} \quad (3)$$

   where, x_{ij} is the performance value of alternative *i* on criterion *j*. While max_i is the alternative's largest value and min_i is the alternative's smallest value.

3) Perform calculations to get the *Qi* value
   The next stage is to calculate the preference value of each alternative or *Qi*. To get the *Qi* value, it can be calculated using equation (4).

$$Q_i = 0.5 \sum_{j=1}^{n} x_{ij} w + 0.5 \prod_{j=1}^{n} (x_{ij})^{w_j} \quad (4)$$

   where, $x_{ij}w$ is the multiplication of the x_{ij} value with the weight or w. Then, $(x_{ij})^{w_j}$ is the value of x_{ij} raised to the power of weight or w. While Q_i is the value from *Q* to *i*.

4) Compile alternative rankings
   The largest *Qi* value is determined to be the best alternative, and then arranged in the form of a ranking.

3. RESULT AND DISCUSSION

Finding the criterion first is the first step in applying the WASPAS approach to solve choice problems. The criteria for selecting a webcam for this case study were taken from articles that had been validated by a gaming content creator practitioner, Faynilla [12]. The following is an explanation for each criterion used:

1) Camera Resolution
   The resolution on a webcam camera shows the number of pixels that are arranged in a single image. Resolution can also be interpreted as the pixel density in an image and is composed of pixels. The resolution will determine the quality of an image, this means that the higher the resolution, the better the image quality.

2) Frame Rate per Second (FPS)
   A good webcam should be able to produce videos that look smooth. The level of video smoothness in the webcam is influenced by the value of the frame rate per second (FPS). The higher the frame rate, the smoother the resulting video will be.
3) Viewing Angle
   The viewing angle shows the area that can be reached by the webcam lens. The bigger the number, the wider the range that can be captured by the lens.
4) Price
   The price criterion is the price of the webcam product on the market.

Based on these criteria, the range of values and value conversions are then determined to make it easier to calculate. The results of determining the assessment range and the criteria conversion value are presented in Table 1.

Table 1. Criteria for Webcam Selection

No.	Criteria Kode	Criteria	Criteria Value	Value Conversion
1	C1	Camera Resolution	< 720p	1
			>= 720p and < 1,080p	2
			>= 1,080p and < 1,440p	3
			>= 1,440p and < 2,160p	4
			>2,160p	5
2	C2	Frame Rate per Second (FPS)	< 15fps	1
			>= 15fps and < 30fps	2
			>= 30fps and < 60fps	3
			>= 60fps and < 120fps	4
			>= 120fps	5
3	C3	Viewing Angle	< 40^o	1
			>= 40^o and < 70^o	2
			>= 70^o and < 100^o	3
			>= 100^o and < 130^o	4
			>= 130^o	5
4	C4	Price	< 200,000	1
			>= 200,000 and < 400,000	2
			>= 400,000 and 600,000	3
			>= 600,000 and 800,000	4
			>= 800,000	5

Based on Table 1, it can be seen that the criteria, assessment ranges and value conversions have been arranged. The next stage is to determine the level of importance of each criterion or usually referred to as the weight of the criteria. The weight of the criteria is adjusted according to the interests of the decision maker. But before the weight is determined, the type of criteria used is analyzed first. There are two types of criteria, namely positive or benefit criteria and negative or cost criteria. The type of benefit criteria is if the criterion seeks a high value, while for the type of cost criteria it is a criterion that seeks a low value. Based on the existing criteria, there are benefit criteria namely Camera Resolution (C1), Frame Rate per Second (FPS) (C2) and Viewing Angle (C3), while the cost criteria are Price (C4). The results of determining the weight of the criteria and the types of criteria are presented in Table 2.

Table 2. Types of Criteria and Their Weights

Criteria Code	Criteria	Criteria Type	Weight
C1	Camera Resolution	Benefit	35 %
C2	Frame Rate per Second (FPS)	Benefit	25 %
C3	Viewing Angle	Benefit	15 %
C4	Price	Cost	25 %

Solid Table 2, it can be seen the types of criteria and the weights for each criterion, where the weights are the level of importance that has been determined by the decision maker. The next process is to determine the alternative that will be selected, in this case, the webcam products that will be chosen by the decision maker. As a case study, there are 5 (five) alternatives to be selected, including: Aukey PC-LM7 (A1), NYK Nemesis A96 (A2), JETE W2 (A3), Logitech C922 (A4) and Ausdom AF660 (A5). Based on the alternatives that have been determined then an assessment is given to the criteria that are adjusted to the existing alternative specifications against the criteria that have been determined before. The results of the values for each alternative are presented in Table 3.

Table 3. Value of Each Alternative

Alternative Code	Alternative	Criteria			
		C1	C2	C3	C4
A1	Aukey PC-LM7	1,080p	30fps	85º	320,000
A2	NYK Nemesis A96	1,920p	50fps	100º	510,000
A3	JETE W2	720p	25fps	120º	188,000
A4	Logitech C922	1,080p	60fps	90	780,000
A5	Ausdom AF660	1,080p	60fps	75º	890,000

The alternative assessments in Table 3 will then be converted in value with the value conversion guidelines in Table 1. This is done to make it easier to calculate the WASPAS method. The results of the conversion of alternative values are presented in Table 4.

Table 4. Alternative Value Conversion Results

Alternative Code	Alternative	Criteria			
		C1	C2	C3	C4
A1	Aukey PC-LM7	3	3	3	2
A2	NYK Nemesis A96	4	3	3	3
A3	JETE W2	2	2	4	1
A4	Logitech C922	3	4	3	4
A5	Ausdom AF660	3	4	3	5

The webcam selection case study above was completed using the WASPAS approach through the following stages:

1) Make a decision matrix
The first step begins by loading the decision matrix using equation (1), based on the critical values for each alternative in Table 4. The following is the result of the decision matrix in this case.

$$x = \begin{bmatrix} 3 & 3 & 3 & 2 \\ 4 & 3 & 3 & 3 \\ 2 & 2 & 4 & 1 \\ 3 & 4 & 3 & 4 \\ 3 & 4 & 3 & 5 \end{bmatrix}$$

2) Finding the normalized matrix
In order to normalize the matrix, the criteria used are first identified. Based on the existing criteria, there are benefit criteria namely Camera Resolution (C1), Frame Rate per Second (FPS) (C2) and Viewing Angle (C3), while the cost criteria are Price (C4). To get the normalized value of the benefit criteria matrix using equation (2) and for cost criteria using equation (3). The following is the calculation process to get the matrix normalization value.

$$\bar{x}_{11} = \frac{3}{\max\{3;4;2;3;3\}} = \frac{3}{4} = 0.75$$
$$\bar{x}_{21} = \frac{4}{\max\{3;4;2;3;3\}} = \frac{4}{4} = 1$$
$$\bar{x}_{31} = \frac{2}{\max\{3;4;2;3;3\}} = \frac{2}{4} = 0.5$$
$$\bar{x}_{41} = \frac{3}{\max\{3;4;2;3;3\}} = \frac{3}{4} = 0.75$$
$$\bar{x}_{51} = \frac{3}{\max\{3;4;2;3;3\}} = \frac{3}{4} = 0.75$$

$$\bar{x}_{12} = \frac{3}{\max\{3;3;2;4;4\}} = \frac{3}{4} = 0.75$$
$$\bar{x}_{22} = \frac{3}{\max\{3;3;2;4;4\}} = \frac{3}{4} = 0.75$$
$$\bar{x}_{32} = \frac{2}{\max\{3;3;2;4;4\}} = \frac{2}{4} = 0.5$$
$$\bar{x}_{42} = \frac{4}{\max\{3;3;2;4;4\}} = \frac{4}{4} = 1$$

$$\bar{x}_{52} = \frac{4}{\max\{3;3;2;4;4\}} = \frac{4}{4} = 1$$

$$\bar{x}_{13} = \frac{3}{\max\{3;3;4;3;3\}} = \frac{3}{4} = 0.75$$
$$\bar{x}_{23} = \frac{3}{\max\{3;3;4;3;3\}} = \frac{3}{4} = 0.75$$
$$\bar{x}_{33} = \frac{4}{\max\{3;3;4;3;3\}} = \frac{4}{4} = 1$$
$$\bar{x}_{43} = \frac{3}{\max\{3;3;4;3;3\}} = \frac{3}{4} = 0.75$$
$$\bar{x}_{53} = \frac{3}{\max\{3;3;4;3;3\}} = \frac{3}{4} = 0.75$$

$$\bar{x}_{14} = \frac{\min\{2;3;1;4;5\}}{2} = \frac{1}{2} = 0.5$$
$$\bar{x}_{24} = \frac{\min\{2;3;1;4;5\}}{3} = \frac{1}{3} = 0.33$$
$$\bar{x}_{34} = \frac{\min\{2;3;1;4;5\}}{1} = \frac{1}{1} = 1$$
$$\bar{x}_{44} = \frac{\min\{2;3;1;4;5\}}{4} = \frac{1}{4} = 0.25$$
$$\bar{x}_{54} = \frac{\min\{2;3;1;4;5\}}{5} = \frac{1}{5} = 0.2$$

The following is the result of the matrix that has been normalized:

$$x = \begin{bmatrix} 0.75 & 0.75 & 0.75 & 0.5 \\ 1 & 0.75 & 0.75 & 0.33 \\ 0.5 & 0.5 & 1 & 1 \\ 0.75 & 1 & 0.75 & 0.25 \\ 0.75 & 1 & 0.75 & 0.2 \end{bmatrix}$$

3) Perform calculations to get the *Qi* value
The next stage is to calculate the preference value of each alternative or *Qi*. To get the *Qi* value, it can be calculated using equation (4). The weight values are obtained based on Table 2, where the criterion weight for C1 is 35% or 0.35; C2 is 25% or 0.25; C3 is 15% or 0.15 and C4 is 25% or 0.25. The following is the calculation process to get the *Qi* value.

$$\begin{aligned} Q_1 &= 0.5 \times \big((0.75 \times 0.35) + (0.75 \times 0.25) + (0.75 \times 0.15) + (0.5 \times 0.25)\big) + \\ &\quad 0.5 \times \big((0.75^{0.35}) \times (0.75^{0.25}) \times (0.75^{0.15}) \times (0.5^{0.25})\big) \\ &= 0.6826 \\ Q_2 &= 0.5 \times \big((1 \times 0.35) + (0.75 \times 0.25) + (0.75 \times 0.15) + (0.33 \times 0.25)\big) + \\ &\quad 0.5 \times \big((1^{0.35}) \times (0.75^{0.25}) \times (0.75^{0.15}) \times (0.33^{0.25})\big) \\ &= 0.7053 \\ Q_3 &= 0.5 \times \big((0.5 \times 0.35) + (0.5 \times 0.25) + (1 \times 0.15) + (1 \times 0.25)\big) + \\ &\quad 0.5 \times \big((0.5^{0.35}) \times (0.5^{0.25}) \times (1^{0.15}) \times (1^{0.25})\big) \\ &= 0.6799 \\ Q_4 &= 0.5 \times \big((0.75 \times 0.35) + (1 \times 0.25) + (0.75 \times 0.15) + (0.25 \times 0.25)\big) + \\ &\quad 0.5 \times \big((0.75^{0.35}) \times (1^{0.25}) \times (0.75^{0.15}) \times (0.25^{0.25})\big) \\ &= 0.6499 \\ Q_5 &= 0.5 \times \big((0.75 \times 0.35) + (1 \times 0.25) + (0.75 \times 0.15) + (0.2 \times 0.25)\big) + \\ &\quad 0.5 \times \big((0.75^{0.35}) \times (1^{0.25}) \times (0.75^{0.15}) \times (0.2^{0.25})\big) \\ &= 0.6271 \end{aligned}$$

4) Compile alternative rankings
Ranking is done by looking at the results of calculating the *Qi* value. The largest value is determined to be the best alternative. For more details, the ranking results for webcam selection use the WASPAS method, which are arranged from the highest to the lowest values, which are presented in Table 5.

Table 5. Alternative Ranking Results

Alternative Code	Alternative	Q_i Value	Ranking
A2	NYK Nemesis A96	0.7053	1
A1	Aukey PC-LM7	0.6826	2
A3	JETE W2	0.6799	3
A4	Logitech C922	0.6499	4
A5	Ausdom AF660	0.6271	5

It can be seen in Table 5, it was found that the highest Qi preference value was NYK Nemesis A96 (A2) with a value of 0.7053, followed by Aukey PC-LM7 (A1) with a value of 0.6826, JETE W2(A3) with a value of 0.6799, Logitech C922 (A4) with a value of 0.6499 and Ausdom AF660 (A5) with a value of 0.6271. So, the best alternative in this case study is NYK Nemesis A96 (A2).

After the analysis and implementation of the WASPAS approach has been carried out, then proceed with building decision support software. Web-based decision support system for choosing a webcam, so the programming language is PHP with the editor used is PHP Storm. Then, the MySQL database is used to store the data. To access the webcam selection system the first time the user must log in to the login form. If the user has entered into the system, the main menu user interface will be displayed. For the main menu user interface presented in Figure 2.

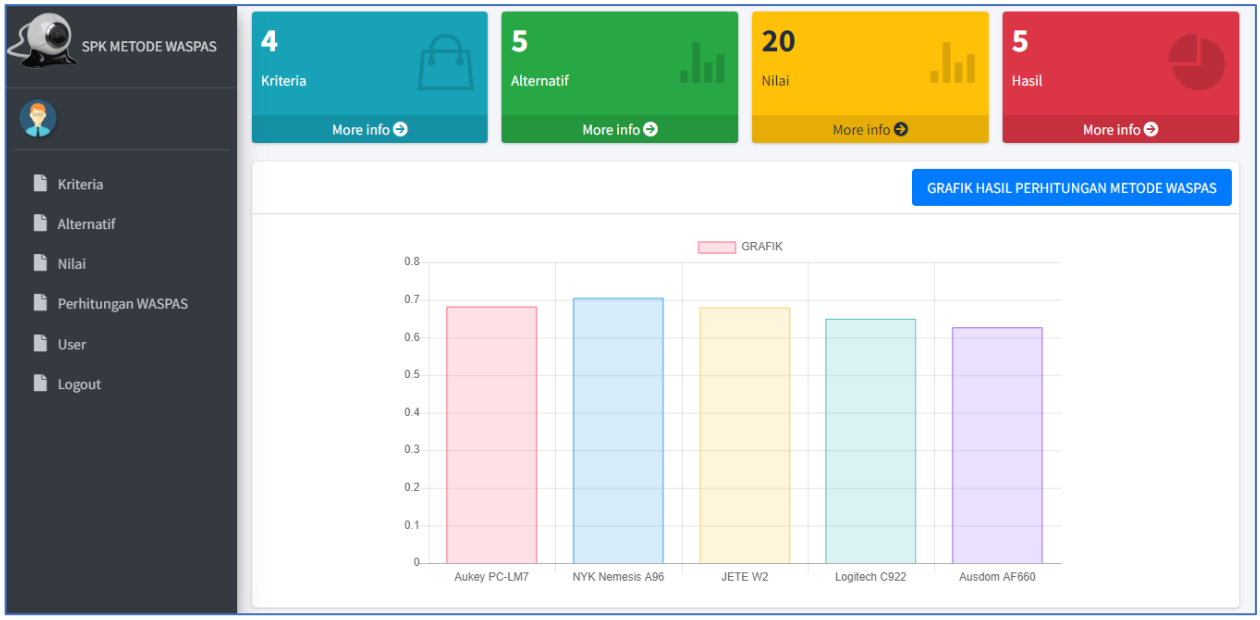


Figure 2. Main Menu Interface Display of Decision Support System for Webcam Selection

Figure 2 shows the main menu display for the decision support system for webcam selection, where this menu displays a graph of the calculation results of the WASPAS approach as well as the main features such as criteria, alternative, value and user menus. To start choosing a webcam, the user must first manage the criteria data through the criteria menu. On the criteria menu the user can add, change and delete criteria data. For the user interface the menu adds the criteria presented in Figure 3.

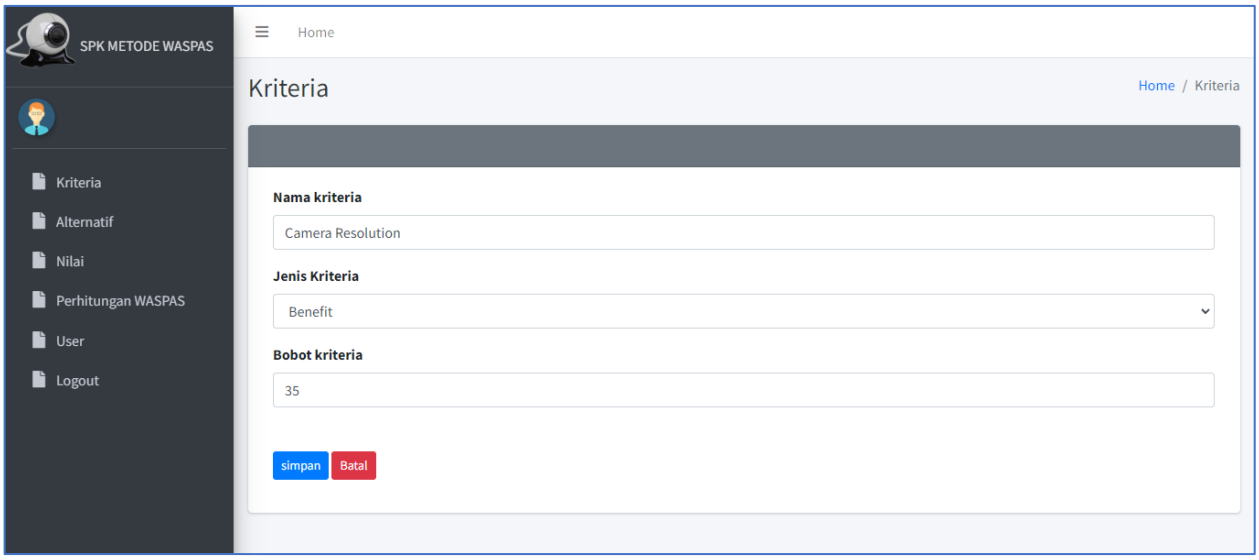


Figure 3. User Interface Menu Managing Criteria Data

Furthermore, the user can perform alternative data management on alternative menus. In this menu the user can add, change and delete alternative data. For the alternative menu user interface presented in Figure 4.

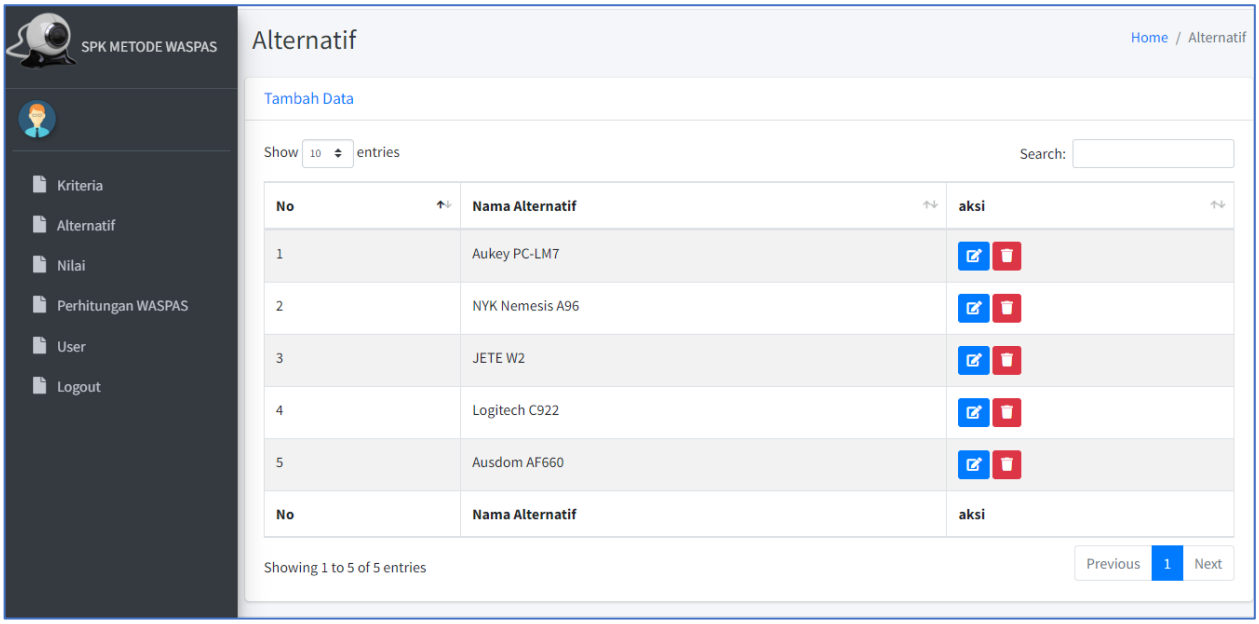
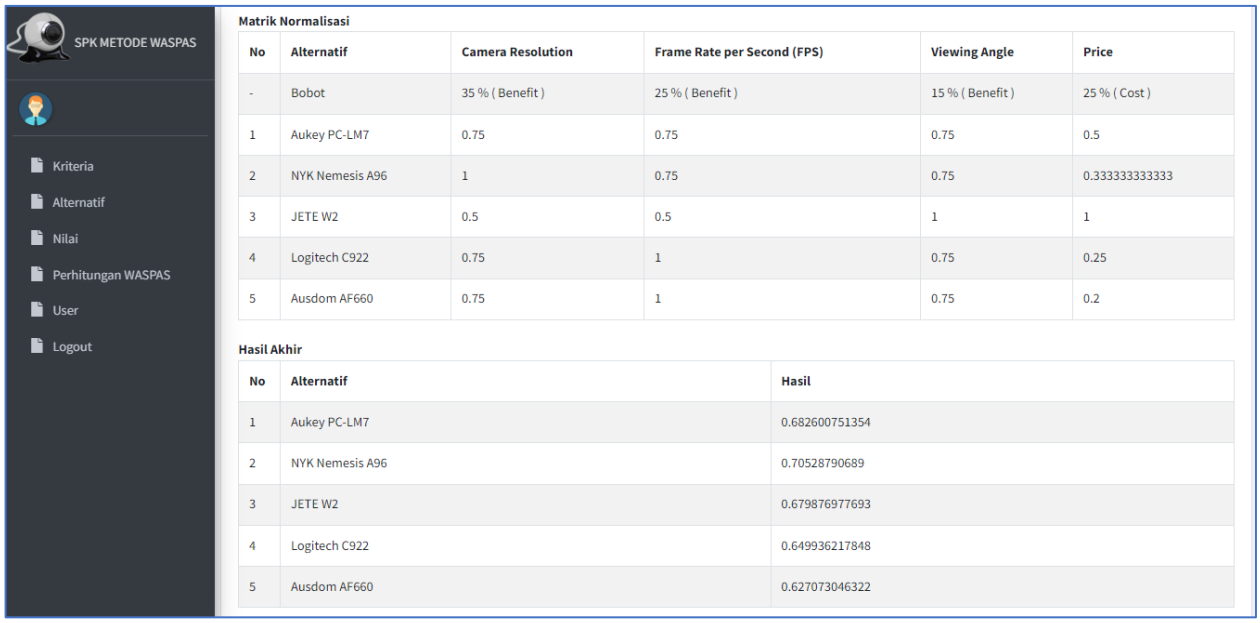


Figure 4. User Interface on Alternative Forms

After the alternative data is available as shown in Figure 4, then the user manages the alternative value data. On the value menu the user can provide an assessment of alternatives based on each of the criteria on the alternative webcam. If all alternative values for each criterion have been entered, the user can perform the WASPAS calculation process to get the best alternative. In the WASPAS calculation process menu the user will be shown step by step calculations on the WASPAS method. In addition, the user will also be shown the best alternative ranking results based on the WASPAS method. The user interface for the WASPAS calculation menu is presented in Figure 5.



No	Alternatif	Camera Resolution	Frame Rate per Second (FPS)	Viewing Angle	Price
-	Bobot	35 % (Benefit)	25 % (Benefit)	15 % (Benefit)	25 % (Cost)
1	Aukey PC-LM7	0.75	0.75	0.75	0.5
2	NYK Nemesis A96	1	0.75	0.75	0.333333333333
3	JETE W2	0.5	0.5	1	1
4	Logitech C922	0.75	1	0.75	0.25
5	Ausdom AF660	0.75	1	0.75	0.2

No	Alternatif	Hasil
1	Aukey PC-LM7	0.682600751354
2	NYK Nemesis A96	0.70528790689
3	JETE W2	0.679876977693
4	Logitech C922	0.649936217848
5	Ausdom AF660	0.627073046322

Figure 5. User Interface for WASPAS Method Calculation Results

In Figure 5 it can be seen that the results of system calculations using the WASPAS approach show that the highest score is NYK Nemesis A96 with a value of 0.7053, followed by Aukey PC-LM7 with a value of 0.6826, JETE W2 with a value of 0.6799, Logitech C922 with a value of 0.6499 and Ausdom AF660 with a value 0.6271. So, the NYK Nemesis A96 alternative is the best alternative. So, the calculation results obtained from the DSS that were built by manual calculations show the acquisition of the same value. This means that the system built has produced the right calculation.

Before the developed system is used by the general public, it must first be tested. This is done to ensure that the software built can work properly. The test technique applied is black-box testing, where in this test testing is based on the functionality of the software being built. The results of the tests performed are presented in Table 6.

Table 6. Test Results Using Black-box Testing

No	Test Cases	Expected Results	Conclusion
1	Main Menu Features	The system can display graphs of the best alternative results and the main features of the system.	Valid
2	Criteria Feature	The system is capable of adding, modifying, and deleting criteria data.	Valid
3	Alternative Features	The system is capable of managing alternative data, including its addition, modification, and deletion.	Valid
4	Alternative Value Features	The system is capable of managing alternative value data, including its entry, modification, and deletion.	Valid
5	WASPAS Method Calculation Features	The WASPAS algorithm computation procedure can be seen on the system.	Valid
6	Alternative Ranking Results	The best alternative ranking results are shown by the system.	Valid

Table 6 shows that all test cases produce "Valid" results. This shows that the webcam selection system that was built can run as it should.

4. CONCLUSION

This study implemented the Multi-Criteria Decision Making (MCDM) approach with Weighted Aggregated Sum Product Assessment (WASPAS) on a webcam selection decision support system. The WASPAS method is able to solve multi-attribute problems by optimizing the assessment to select the highest and lowest values to get the best alternative. Based on the case studies conducted, the WASPAS method was able to determine the best webcam with the best alternative results, namely NYK Nemesis A96 with a value of 0.7053, followed by Aukey PC-LM7 with a value of 0.6826, JETE W2 with a value of 0.6799, Logitech C922 with a value of 0.6499 and Ausdom AF660 with a value 0.6271. The developed system is made in the form of a website, with the main features including managing criteria data, alternative data, alternative values, calculating the WASPAS method and displaying the best alternative in the form of ranking. In addition, the developed system produces valid WASPAS method calculations, because the results are no different from manual

calculations. Based on the tests carried out using the black-box testing approach, it shows that the developed system has been running well.

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