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MULTI-CRITERIA DECISION MAKING USING THE WASPAS METHOD FOR ONLINE ENGLISH COURSE SELECTION

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Abstract

English is an international language used in communication between countries. For this reason, the ability to speak English is of added value in entering the world of work. Because of how important English is, currently many course institutions offer English courses including online learning. With so many online English courses, it requires carefulness in choosing the right course and according to your needs. To find an online English course, you need to know one by one in advance about the programs and facilities offered. This study aims to implement the Multi-Criteria Decision Making (MCDM) approach with Weighted Aggregated Sum Product Assessment (WASPAS) in a decision support system for selecting online courses. The WASPAS method is used as a multi-criteria settlement model that can minimize errors and maximize the assessment for selecting the highest or lowest scores. Based on case studies conducted using the WASPAS method in decision making, it shows that the alternative with the highest score was obtained by the British Council (A5) with a value of 0.8927, followed by English Today (A2) with a value of 0.8311, Education First (A1) with a value of 0.8302, IELC English Campus (A4) with a score of 0.7859 and Engoo English Course (A3) with a score of 0.7823. In addition, the test results from black-box testing have a value of 100%, which means the system can work as it should.

Keyword: *decision support system, multi-criteria decision making, MCDM, online english course, weighted aggregated sum product assessment, WASPAS.*

1. INTRODUCING

English course is one of the activities outside of school which aims to improve students' ability to understand and practice English. English itself is an international language used in communication between countries. The ability to speak English is considered very important, this is because this ability can be of added value when entering the world of work [1]. Parents will also compete to send their children to English courses. Moreover, currently many institutions have offered English courses online. In the current post-pandemic period, many course providers are teaching online, with the hope of reaching a wider audience of students or students. However, this sometimes creates a dilemma for parents in choosing a place for English courses, especially courses that are held online. Choosing the right course is certainly expected to get the skills and knowledge that are in accordance with the wishes [2]. With the large number of online English courses, it is necessary to be careful in choosing the right course according to your needs. To find an online English course, you need to know one by one in advance about the programs and facilities offered. It takes a long time to make the selection. The current information system offers convenience, accuracy and speed in managing data into useful information [3]. For this reason, this problem requires a system that can recommend online English courses according to the user's wishes. Decision-making systems can be a solution to these problems.

Decision Support System (DSS) has a definition that is a computer-based system that is useful to assist in decision making that makes it easier for decision makers to solve semi-structured problems through recommendations for the best alternatives [4]. DSS can also be interpreted as a system that provides information, recommends and provides direction to decision makers to determine the best alternative by making rational decisions based on data and facts [5]. In addition, decision support systems provide information, models, and data processing that support decision making [6]. The selection of online English courses involves several criteria and alternatives, so this problem can be solved by using Multi-Criteria Decision Making (MCDM). The MCDM approach is a decision-making solution that aims to get the best alternative from

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a number of criteria [7]. One of the MCDM models is the Weighted Aggregated Sum Product Assessment (WASPAS) method. WASPAS is known as a method that combines the Weighted Product (WP) approach and the Simple Adaptive Weighting (SAW) approach [8]. The WASPAS method is a popular method for solving multi-criteria and evaluating several alternatives with a number of criteria [9]. WASPAS is an approach that can reduce errors or optimize the assessment in choosing the best alternative through weighting [10]. The WASPAS method is very efficient in complex decision-making situations and also results in very accurate models [9]. Previous research has shown that the application of the WASPAS method in the development of decision support systems can work well in assisting decision making. Research on the implementation of the WASPAS method on decision support systems for granting people's business loans [11]. In this study the WASPAS method was able to determine the best alternative from a number of criteria and alternatives. Subsequent research, related to the application of the WASPAS method for selecting student majors [12]. In this study the WASPAS method was able to provide decision recommendations in the form of rankings. Subsequent research regarding the development of a decision support system for selecting outstanding students using the WASPAS method. In this study the WASPAS method was able to produce the best decisions through the weighted quantity model and the weighted product model.

Based on the previous explanation, this study aims to implement the Multi-Criteria Decision Making (MCDM) approach with Weighted Aggregated Sum Product Assessment (WASPAS) in the decision support system for selecting online English courses, in order to get the best alternative that suits the needs of several alternatives. and existing criteria. The WASPAS method is used as a multi-criteria settlement model that can minimize errors and maximize the assessment for selecting the highest or lowest scores.

2. RESEARCH METHODS

2.1 Research Stages

To start research, it requires research stages that are used as a reference in carrying out research. The stages of the research contain the processes carried out to carry out research that is structured and planned so that the objectives can be achieved [13]. The applied research phase refers to the decision-making phase [14]. The stages of research conducted by researchers are shown in Figure 1.

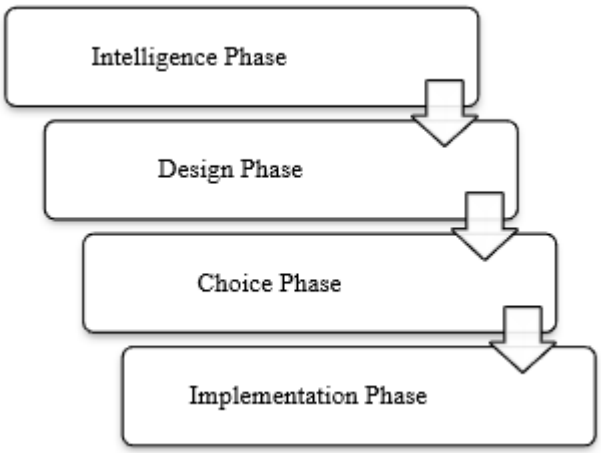

Figure 1. Research Stages

The explanation in Figure 1 regarding the steps at this research stage in detail is as follows:

1) Intelligence Phase
At this stage identification of problems will be carried out, collecting data and information. Problem identification includes analysis of facts that occur in the field so that existing problems can be identified.[15]. The output of this stage is a problem statement. The main problem of this research is how to build a system that can select online English courses. With so many online English courses, it requires carefulness in choosing the right course and according to your needs. To find an online English course, you need to know one by one in advance about the programs and facilities offered. It takes a long time to make the selection. For this reason, a system is needed that can recommend online English courses according to the user's wishes.

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2) Design Phase
The design stage is useful for illustrating the concept of the system to be built [16]. The design for modeling the system in this study uses use case diagrams. The diagram will describe the relationship between the actor and the system which shows the functions contained in the system [17]. Design using use case diagrams will show what functionality or facilities can be carried out by actors in the developed decision support system.
3) Choice Phase
At this stage it contains a series of activities to select from the available alternatives. This stage has an output in the form of a list of alternatives and criteria to be continued at the implementation stage. In this study, the choice stage will arrange criteria and alternatives as well as alternative values in the form of alternative value tables. From the table it will then be implemented using a particular model to solve the problem.
4) Implementation Phase
At this stage an assessment of the available options will be carried out. At this stage, a series of problem solving actions will be carried out to choose the best alternative. To determine alternatives, the Exponential Comparison Approach (MPE) method is used, which is one of several existing models in decision support systems that are used to determine the priority order of alternative decisions using multiple criteria. In addition, at this stage a decision support system will be developed, namely system coding, where in this step the process of changing the results of the analysis and design will be carried out into the form of an application or system through the use of a certain programming language [18]. The system to be developed is based on a website, so the coding process uses the PHP programming language and the Notepad++ text editor and MySQL is used for the database.

2.2 Metode *Weighted Aggregated Sum Product Assessment* (WASPAS)

To solve decision problems by selecting the best alternative obtained from a number of existing alternatives and based on a number of criteria, the Multi-Criteria Decision Making (MCDM) approach can be used. This method is a decision-making technique that involves several criteria that are used as a basis for making a decision, by giving subjective values to solve problems by providing an assessment of alternative performance [19]. One of the Multi-Criteria Decision Making (MCDM) solutions is the Weighted Aggregated Sum Product Assessment (WASPAS) method which can be used to evaluate several alternatives in several decision criteria. WASPAS is known as a method that combines the Weighted Product (WP) approach and the Simple Adaptive Weighting (SAW) approach [8]. The WASPAS method is a popular method for completing Multi-Criteria Decision Making (MCDM) in evaluating several alternatives with a number of criteria [9]. WASPAS is an approach that is able to minimize errors and maximize the assessment for the selection of the highest and lowest scores [10]. The WASPAS method is very efficient in complex decision-making situations and also results in very accurate models [12].

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

1) Compile a decision matrix (X)
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) Perform matrix normalization (X)
In order to normalize the matrix, the criteria used are first identified whether the criteria are benefit or cost criteria. The benefit criteria are the criteria that seek the highest value, whereas the cost criteria are the criteria that seek the lowest value. Matrix normalization for benefit criteria can be calculated using equation (2).

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

Meanwhile, the cost criteria is calculated using equation (3).

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

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

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

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

di mana, $x_{ij}w$ merupakan perkalian nilai x_{ij} dengan bobot atau w. Kemudian, $(x_{ij})^{w_j}$ merupakan nilai x_{ij} dipangkat dengan bobot atau w. Sedangkan Q_i merupakan nilai dari Q ke i.
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) Do ranking
Ranking is done by looking at the results of calculating the Q_i value. The largest value is determined to be the best alternative.

3. RESULT AND DISCUSSIONS

3.1 Implementation of the Weighted Aggregated Sum Product Assessment (WASPAS) Method

To implement the Multi-Criteria Decision Making (MCDM) approach with Weighted Aggregated Sum Product Assessment (WASPAS) in a decision support system for selecting online English courses, the first step is to determine the criteria. The set criteria are obtained from a decision maker. The criteria for selecting the online English course used included: Price, Duration, Learning Method and Learning Level. After the criteria have been determined, the next step is to determine the range of criteria values and conversion values for each of these criteria. The criteria values and conversion values for each criterion are presented in Table 1 below.

Table 1. Selection Criteria for Online English Courses

No.	Criteria Code	Criteria Name	Criteria Value	Conversion
1	C1	Price	< 500,000	1
			>= 500,000 and < 1,000,000	2
			>= 1,000,000 and 1,500,000	3
			>= 1,500,000 and < 2,000,000	4
			>= 2,000,000	5
2	C2	Duration	< 1 month	1
			>= 1 Month and < 3 Months	2
			>= 3 Months and < 6 Months	3
			>= 6 Months and < 8 Months	4
			>= 8 months	5
3	C1	Learning Method	Not Very Diverse	1
			Not Diverse	2
			Quite Diverse	3
			Various	4
			Very Diverse	5
4	C2	Learning Level	1 Levels	1
			2 Levels	2
			3 Levels	3
			4 Levels	4
			5 Levels	5

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After the criteria have been established, the next step is to determine the weight or level of importance of the criteria for each criterion. The decision maker will determine the priority level of the criteria or the weight of the criteria in the form of a percentage with the total weight of all criteria being 100%. In this case study, the weight of the predetermined criteria is presented in Table 2.

Table 2. Weight For Each Criterion

Criteria Code	Criteria Name	Weight
C1	Price	30%
C2	Duration	20%
C3	Learning Method	30%
C4	Learning Level	20%

In the case study of selecting online English courses in this study, the following alternatives were used: Education First (A1), English Today (A2), Engoo English Course (A3), IELC English Campus (A4) and British Council (A5). The next process is to determine the value of the criteria for each alternative. The results of the assessment of each alternative are presented in Table 3.

Table 3. Value for Each Alternative

Alternative Code	Alternative	Criteria			
		Price (C1)	Duration (C2)	Learning Method (C3)	Learning Level (C4)
A1	Education First	780,000	3 months	Quite Diverse	4 Levels
A2	English Today	1,800,000	4 months	Very Diverse	5 Levels
A3	Engoo English Course	500,000	6 months	Quite Diverse	4 Levels
A4	IELC English Campus	1,000,000	6 months	Various	5 Levels
A5	British Council	1,300,000	4 months	Very Diverse	5 Levels

Based on the alternative assessments in Table 3, then the value conversion is carried out using the reference in Table 1. The conversion criteria values for each alternative are presented in Table 4.

Table 4. Convert Value for Each Alternative

Alternative Code	Alternative	Criteria			
		Price (C1)	Duration (C2)	Learning Method (C3)	Learning Level (C4)
A1	Education First	2	3	3	4
A2	English Today	4	3	5	5
A3	Engoo English Course	2	4	3	4
A4	IELC English Campus	3	4	4	5
A5	British Council	3	3	5	5

The case study of selecting online English courses above was completed using the WASPAS approach through the following stages:

1) Compile a decision matrix (X)
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 (X) in this case.

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

2) Perform matrix normalization (X)
In order to normalize the matrix, the criteria used are first identified. In completing the case study for selecting online English courses, there are two cost criteria, namely: Price (C1) and Duration (C2). As for the benefit criteria, there

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are two criteria: Learning Method (C3) and Learning Level (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.

$$\bar{x}_{11} = \frac{\min\{2;4;2;3;3\}}{2} = \frac{2}{2} = 1$$
$$\bar{x}_{21} = \frac{\min\{2;4;2;3;3\}}{4} = \frac{2}{4} = 0.5$$
$$\bar{x}_{31} = \frac{\min\{2;4;2;3;3\}}{2} = \frac{2}{2} = 1$$
$$\bar{x}_{41} = \frac{\min\{2;4;2;3;3\}}{3} = \frac{2}{3} = 0.67$$
$$\bar{x}_{51} = \frac{\min\{2;4;2;3;3\}}{3} = \frac{2}{3} = 0.67$$

$$\bar{x}_{12} = \frac{\min\{3;3;4;4;3\}}{3} = \frac{3}{3} = 1$$
$$\bar{x}_{22} = \frac{\min\{3;3;4;4;3\}}{3} = \frac{3}{3} = 1$$
$$\bar{x}_{32} = \frac{\min\{3;3;4;4;3\}}{4} = \frac{3}{4} = 0.75$$
$$\bar{x}_{42} = \frac{\min\{3;3;4;4;3\}}{4} = \frac{3}{4} = 0.75$$
$$\bar{x}_{52} = \frac{\min\{3;3;4;4;3\}}{3} = \frac{3}{3} = 1$$

$$\bar{x}_{13} = \frac{3}{\max\{3;5;3;4;5\}} = \frac{3}{5} = 0.6$$
$$\bar{x}_{23} = \frac{5}{\max\{3;5;3;4;5\}} = \frac{5}{5} = 1$$
$$\bar{x}_{33} = \frac{3}{\max\{3;5;3;4;5\}} = \frac{3}{5} = 0.6$$
$$\bar{x}_{43} = \frac{4}{\max\{3;5;3;4;5\}} = \frac{4}{5} = 0.8$$
$$\bar{x}_{53} = \frac{5}{\max\{3;5;3;4;5\}} = \frac{5}{5} = 1$$

$$\bar{x}_{14} = \frac{4}{\max\{4;5;4;5;5\}} = \frac{4}{5} = 0.8$$
$$\bar{x}_{24} = \frac{5}{\max\{4;5;4;5;5\}} = \frac{5}{5} = 1$$
$$\bar{x}_{34} = \frac{4}{\max\{4;5;4;5;5\}} = \frac{4}{5} = 0.8$$
$$\bar{x}_{44} = \frac{5}{\max\{4;5;4;5;5\}} = \frac{5}{5} = 1$$
$$\bar{x}_{54} = \frac{5}{\max\{4;5;4;5;5\}} = \frac{5}{5} = 1$$

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

$$x = \begin{bmatrix} 1 & 1 & 0.6 & 0.8 \\ 0.5 & 1 & 1 & 1 \\ 1 & 0.75 & 0.6 & 0.8 \\ 0.67 & 0.75 & 0.8 & 1 \\ 0.67 & 1 & 1 & 1 \end{bmatrix}$$

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3) Calculating the $Q_i$value
The next stage is to calculate the preference value of each alternative or Q_i. To get the Q_i value, it can be calculated using equation (4). The weight value is obtained based on Table 2. The following is the calculation process to obtain the Q_i value.

$$Q_1 = 0.5 \times \big((1 \times 0.3) + (1 \times 0.2) + (0.6 \times 0.3) + (0.8 \times 0.2)\big) + 0.5 \times \big((1^{0.3}) \times (1^{0.2}) \times (0.6^{0.3}) \times (0.8^{0.2})\big) = 0.8302$$

$$Q_2 = 0.5 \times \big((0.5 \times 0.3) + (1 \times 0.2) + (1 \times 0.3) + (1 \times 0.2)\big) + 0.5 \times \big((0.5^{0.3}) \times (1^{0.2}) \times (1^{0.3}) \times (1^{0.2})\big) = 0.8311$$

$$Q_3 = 0.0.5 \times \big((1 \times 0.3) + (0.75 \times 0.2) + (0.6 \times 0.3) + (0.8 \times 0.2)\big) + 0.5 \times \big((1^{0.3}) \times (0.75^{0.2}) \times (0.6^{0.3}) \times (0.8^{0.2})\big) = 0.7823$$

$$Q_4 = 0.5 \times \big((0.67 \times 0.3) + (0.75 \times 0.2) + (0.8 \times 0.3) + (1 \times 0.2)\big) + 0.5 \times \big((0.67^{0.3}) \times (0.75^{0.2}) \times (0.8^{0.3}) \times (1^{0.2})\big) = 0.7859$$

$$Q_5 = 0.5 \times \big((0.67 \times 0.3) + (1 \times 0.2) + (1 \times 0.3) + (1 \times 0.2)\big) + 0.5 \times \big((0.67^{0.3}) \times (1^{0.2}) \times (1^{0.3}) \times (1^{0.2})\big) = 0.8927$$

4) Do ranking
Ranking is done by looking at the results of calculating the Q_i value. The largest value is determined to be the best alternative. For more details, the ranking results for selecting online English courses using the WASPAS method can be seen in Table 5 below.

Table 5. Alternative Ranking Results

Alternative Code	Alternative	Q_i Value	Rank
A2	British Council	0.8927	1
A1	English Today	0.8311	2
A3	Education First	0.8302	3
A4	IELC English Campus	0.7859	4
A5	Engoo English Course	0.7823	5

Based on Table 5, it shows that the alternative with the highest score was obtained by the British Council (A5) with a value of 0.8927, followed by English Today (A2) with a value of 0.8311, Education First (A1) with a value of 0.8302, IELC English Campus (A4) with a value 0.7859 and Engoo English Course (A3) with a score of 0.7823. This means that the best alternative from this case study is the British Council (A1) with a value of 0.8927.

3.2 System Design

Before the WASPAS method was implemented in decision support for selecting website-based online English courses, the system design was carried out beforehand. System design is useful to provide an overview of the system to be developed. The design used is a use case diagram, where this diagram provides an overview of the relationship between actors and the system which shows the functions that exist in the system. The use case diagram for the DSS for selecting online English courses can be seen in Figure 2.

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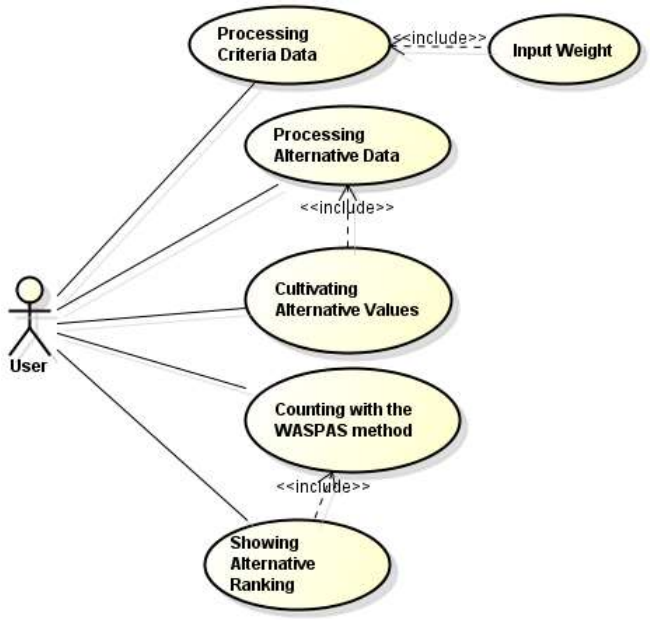

Figure 2. Use Case Diagram of Decision Support System for Selection of Online English Courses

Based on Figure 2, it can be seen that the functionality of the system developed between other users can manage criteria data, alternative data, assess alternatives, calculate using the WASPAS method and view ranking results.

3.3 System Implementation

System implementation is carried out by building a decision support system using the WASPAS method using the PHP programming language and the Notepad++ text editor and for databases using MySQL. The system begins with the Login menu, where the user will enter a username and password. If the username and password are correct, the user will enter the main menu interface of the online course selection decision support system. Figure 3 below is the main menu interface of the system being developed.

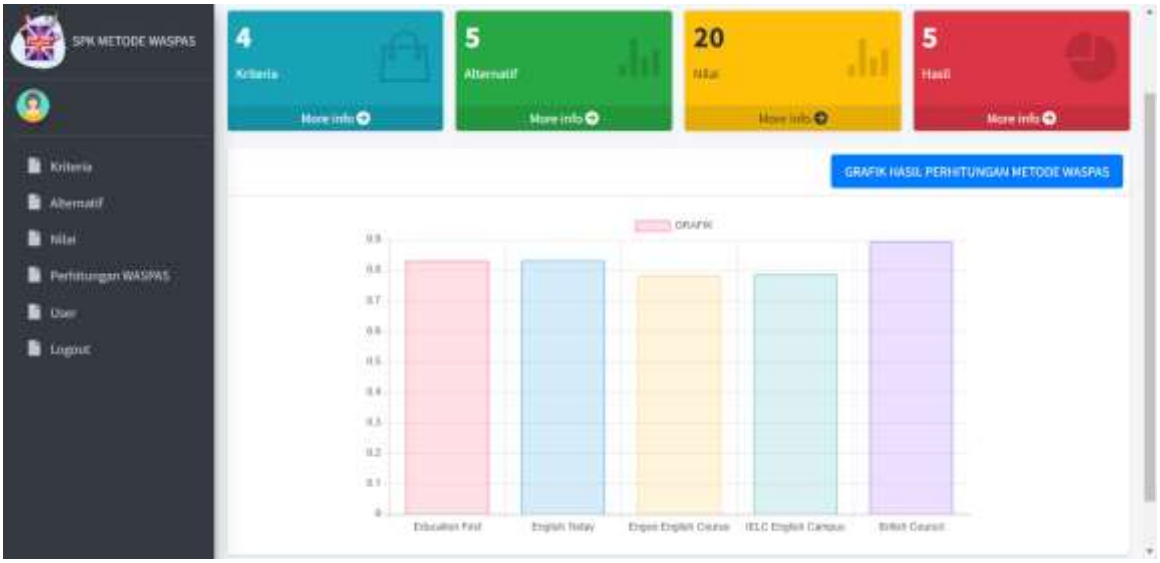

Figure 3. Main Menu Interface on DSS for Selection of Online English Courses

In Figure 3, it shows that after the user has successfully entered the main menu interface, there are features in the Online English course selection SPK. These features include: Dashboard, Alternative Data, Criteria Data, Alternative Assessments and WASPAS Calculations. The Dashboard feature or main menu can also be seen with a graph of the WASPAS calculation results. Furthermore, the user can manage the criteria data on the Criteria Data menu. In this form

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the user can add, edit and delete alternative data. The interface display for the Criteria Data feature can be seen in Figure 4.

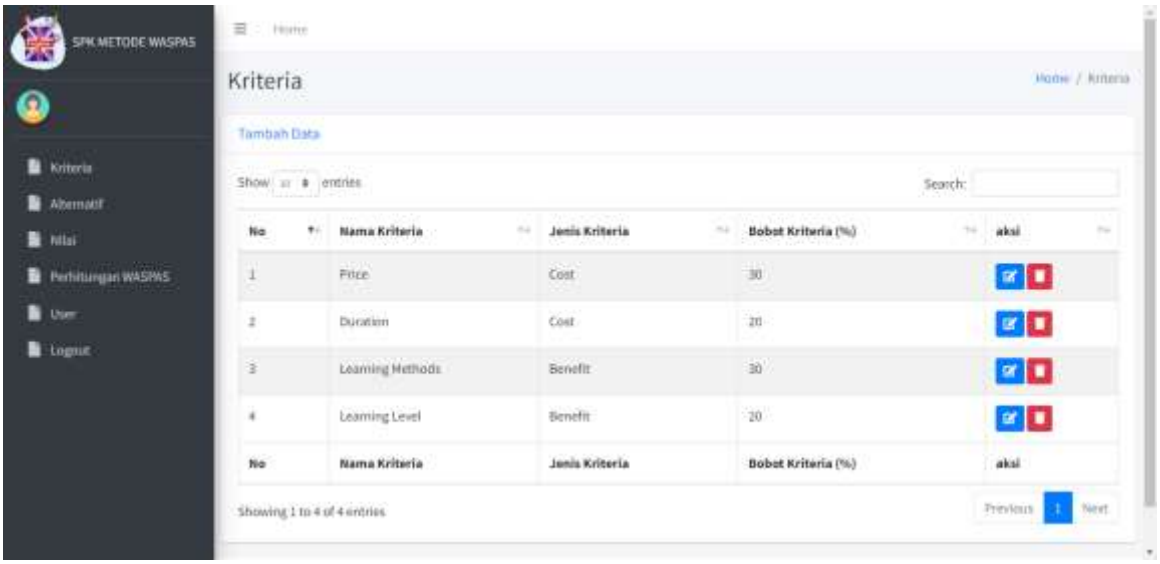

Figure 4. Criteria Data Menu Interface on DSS for Selection of Online English Courses

After, the user manages the next criterion data the user can manage alternative data on the Alternative Data menu. Through this feature users can add, edit and delete alternatives. Then, users can provide value to these alternatives through the Alternative Value feature. In this feature, the user will give a value to each online English course as an alternative based on predetermined criteria. After the user gives a value to each alternative against predetermined criteria, then the user can see the calculation process and recommendations generated by the WASPAS method through the WASPAS Calculation feature. In this feature, the calculation process will be displayed using WASPAS which is equipped with a score calculation and alternative rankings. Figure 5 below is a display of the calculation process using the WASPAS method.

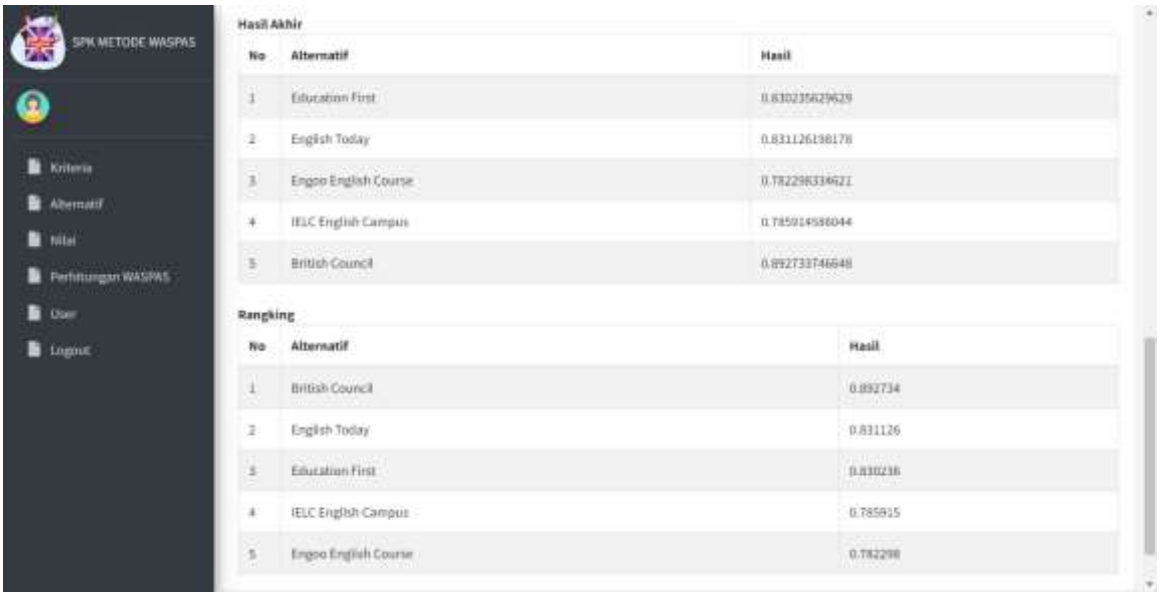

Figure 5. WASPAS Method Calculation Menu Interface on DSS for Selection of Online English Courses

Figure 4 shows the results of calculations using the WASPAS method. When compared the results of manual calculations with the results of calculations by the system get the same value. So, the implementation of the WASPAS method in the DSS for selecting online English courses developed can be said to be valid.

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3.4 System Testing

After the system is built, system testing will then be carried out. Testing can be used as a system evaluation, which at this stage aims to measure the performance of the system being built [20]. This stage is carried out to ensure that the system built is free from errors or errors. The test is carried out through black-box testing, a test based on the function of the system. The test results are shown in Table 6.

Table 6. Test Results with Black-box Testing

No	Test Cases	Functionality	Result
1	Login Menu	Users can enter the system by inputting a user name and password.	Successful
2	Main course	The system can display the main menu, dashboard and main SPK features for selecting online English courses.	Successful
3	Criteria Data	The system can manage criteria such as adding, changing and deleting criteria data.	Successful
4	Alternative Data	The system can manage alternatives such as adding, changing and deleting alternative data.	Successful
5	Alternative Value	The system can manage alternative values such as adding, changing and deleting alternative value data.	Successful
6	WASPAS calculation	The system displays the process of calculating the WASPAS method.	Successful
7	Ranking Results	The system displays the ranking results for selecting online English courses from the calculation results of the WASPAS method.	Successful
8	User Data	The system can add, change and delete user data.	Successful

Based on the test results in Table 6, it can be seen that, of the 8 test cases, 8 test cases obtained “Successful” results. This means that the test results using black-box testing have a value of 100%. This indicates that the system has been running well.

4. CONCLUSION

This research has implemented the Multi-Criteria Decision Making (MCDM) approach using Aggregated Sum Product Assessment (WASPAS) in a decision support system for selecting online English courses. The WASPAS method has the ability to solve multi-criteria problems by optimizing the assessment to select the highest and lowest values to get the best alternative. Based on case studies conducted using the WASPAS method in decision making, it shows that the alternative with the highest score was obtained by the British Council (A5) with a value of 0.8927, followed by English Today (A2) with a value of 0.8311, Education First (A1) with a value of 0.8302, IELC English Campus (A4) with a score of 0.7859 and Engoo English Course (A3) with a score of 0.7823. The SPK developed is built on a website basis, with the main features including managing criteria and weight data, alternative data, conducting alternative assessments, calculating the WASPAS method and displaying ranking results for each alternative. The results of manual calculations with the results obtained by the system show the same value, this means that the developed system can be said to be valid. In addition, testing using the black-box testing approach shows a success value of 100%, which means that the developed system is functioning properly.

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