MULTI-CRITERIA DECISION ANALYSIS USING COMPLEX PROPORTIONAL ASSESSMENTS AND RANK ORDER CENTROID METHODS IN THE SELECTION SYSTEM FOR TUTORING INSTITUTIONS

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Abstract

Tutoring can help increase students' self-confidence, reduce anxiety about tests or assignments, and overcome learning barriers. The large number of tutoring institutions that offer various programs makes parents or students have to be observant when choosing them. To choose a tutoring institution, parents or students must know all the profiles and programs of the institution to be selected. This creates a difficult and long time to come up with a choice. The purpose of this study is to use the Multi Criteria Decision Analysis (MCDA) approach through the Complex Proportional Assessment (COPRAS) method and the Rank Order Centroid (ROC) method to create a Decision Support System (DSS) that will make it easier to choose a tutoring institution. The ROC approach serves to determine the weight based on the order of importance of the criteria. The COPRAS method is used because this method takes utility into account by assessing the usefulness of each alternative. This research produced a web-based tutoring institution selection DSS that can provide alternative recommendations based on criteria determined by decision-makers. The results of system calculations and manual calculations do not show a different value, which shows that the system produces a valid COPRAS approach value. Based on the results of usability testing, the built DSS scored 89.17%; in other words, the system is feasible to use.

Keywords: *complex proportional assessments, decision support systems, multi-criteria decision analysis, rank order centroid, selection of tutoring institutions.*

1. INTRODUCTION

Education becomes a basic need for a person in living his life because, through education, the person can benefit himself or others. Education is obtained through learning at school, but to support learning at school, one can carry out education outside of school, one of which is through tutoring. Tutoring has a very important role in the process of education and student development. Through tutoring, students can get additional support and direction that can help them reach their full potential in learning [1]. Tutoring not only provides an in-depth understanding of the subject matter but also assists in building study skills, managing time, and developing effective strategies for dealing with academic challenges [2]. In addition, tutoring is also able to increase student self-confidence, reduce anxiety facing tests or assignments, and assist in overcoming learning obstacles that may be encountered [3]. Currently, there are many tutoring institutions that exist and offer a variety of programs. So, every parent and

student must be observant in choosing the right tutoring institution according to their wishes and needs. To choose a tutoring institution, parents or students must know, one by one, the profile and program of the institution. This makes it difficult and long to make a choice. Therefore, it is necessary to have a system that can help recommend tutoring institutions and make it easier to make the right choice.

Decision Support System (DSS) is a concept in the field of management and information technology that aims to assist more informed and structured decision making based on knowledge [4]. DSS uses a combination of data, analytical models, and algorithms to assist decision-makers in evaluating various alternatives and choosing the most optimal solution based on predetermined criteria [5]. DSS provides a framework for summarizing relevant data, analyzing situations, and producing measurable recommendations or solutions [6]. DSS development will relate to a variety of existing criteria and solutions, so to solve this, the Multi-Criteria Decision

Analysis (MCDA) approach is used. The MCDA approach is an analytical method used in decision-making to evaluate various alternatives based on several relevant criteria or factors [7]. The research conducted related to the selection of tutoring institutions has been reviewed in several previous studies by applying the MCDA approach through various methods. The first research is the development of a DSS for the selection of tutoring places by applying the Simple Additive Weighting (SAW) method [8]. This method can determine the best solution based on the value of each criterion, and the total score for each alternative is calculated by adding up the results of multiplying the criterion values with the appropriate weights. The next research is related to the determination of tutoring institutions by applying the Weighted Product (WP) approach [9]. In that study, the WP method was based on multiplication between attributes that had previously been raised to the power of their weights. Next, research related to the application of the Analytical Hierarchy Process (AHP) method in the development of DSS for selecting tutoring institutions in preparation for entering state universities [10]. In this study, the AHP approach obtained the best solution based on a hierarchy by comparing and measuring various alternatives based on a number of different criteria.

In decision problems, especially in the selection of tutoring institutions, decision makers will be faced with the level of usefulness of each different alternative, also known as utility. In addition, in producing the best alternative, determining the weight needs to be considered. The main difference between this study and others is that it uses the Complex Proportional Assessment (COPRAS) method to find the best solution and the Rank Order Centroid (ROC) method to find weights based on how important the criteria are. The Complex Proportional Assessment (COPRAS) method is a decision problem solving technique that involves a number of criteria by evaluating alternatives based on a number of relevant criteria and assigning utility values to rank alternatives [11]. The advantage of the COPRAS method is that it makes utility judgments based on the level of usefulness of each alternative for evaluation, so that this can increase accuracy in determining the best alternative [12]. The Rank Order Centroid (ROC) approach can be interpreted as a technique for determining the proper weight for a criterion used in decision making based on priority level [13]. By setting weights that take into account the order of importance of each criterion, the ROC method is easy to implement.

Based on the previous explanation, the purpose of this research is to implement the Complex Proportional Assessment (COPRAS) and Rank Order Centroid (ROC) approaches in making a Decision Support System (SPK) to choose a tutoring institution so that it provides convenience and does not take long. The development of this DSS is based on a website, so system users can easily use it and access it. The criteria for selecting tutoring institutions in this study include price, tutor experience, facility, and number of participants.

2. RESEARCH METHOD

To conduct research, it is necessary to compile a series of research steps to plan, carry out, and analyze a study. These stages help direct the research process to become more organized, systematic, and have results to achieve goals [14]. The research stages carried out in this study are visualized in Figure 1.
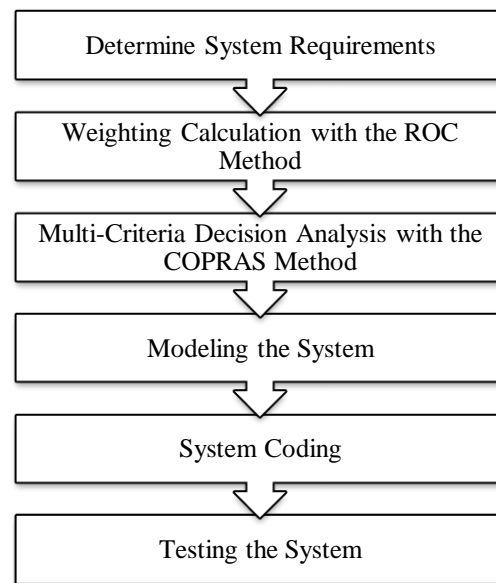
Figure 1. Research stages

Figure 1 shows the research stages of the system being built. In more detail on each phase as follows:

2.1. Determine System Requirements

Before determining the need, identify the problem first. In identification, we will explore the obstacles encountered in the case studies conducted [15]. If the main problem has been identified, then the next step is to determine the requirements through system requirements analysis. Then, at this stage, it will also identify the features, facilities, and output of the software being developed. In the needs analysis, it is necessary to explore what system requirements or features must exist in solving problems through functional requirements analysis. Thus, this analysis produces features or facilities that can be provided for access by users. So, at this stage, it produces a list of the features that exist in the system to overcome problems and meet user needs.

2.2. Weighting Calculation with the ROC Method

The Rank Order Centroid (ROC) approach is one of the techniques used to determine criteria

weights. This method performs weighting by considering the order of importance of each criterion [13]. The ROC method provides a more intuitive approach to determining criterion weights in multi-criteria analysis [16]. The way of determining the weighting using the ROC technique is through a ranking of importance or priority, where the order of criteria shows the level of importance [17]. The order of criteria shows the level of importance or priority of the criteria. The priority for each alternative is determined from the order; this means that criterion 1 (w_1) ≥ criterion 2 (w_2) ≥ criterion 3 (w_3) ≥ up to criterion n (w_n). So that the determination of the weight with the ROC approach is obtained through calculations based on equation (1).

$$w_k = \frac{1}{k}\sum_i^k = 1\left(\frac{1}{i}\right) \tag{1}$$

where w_k denotes the ratio of normalized weighted scale estimates, i indicates the total number of goals, and k denotes the priority of goals in i.

2.3. Multi-Criteria Decision Analysis with the COPRAS Method

Multi-Criteria Decision Analysis (MCDA) is an analytical method used in decision making to evaluate various alternatives based on several relevant criteria or factors [7]. In the MCDA approach, complex decisions are solved by considering more than one aspect that must be met [18]. One of the multi-criteria approaches that can be implemented in solving decision problems is the Complex Proportional Assessment (COPRAS) method. The COPRAS method is an approach to multi-criteria decision-making that overcomes complexity by dividing problems into smaller sub-problems, then assessing and comparing alternatives based on complex proportions of criteria [11]. In this method, each criterion is weighted based on its proportion and value relative to other criteria, which is then used to calculate alternative scores [19]. In addition, this approach takes into account the interdependence between criteria, which can make it more suitable for complex situations with interrelated criteria [20]. The COPRAS approach has the ability to address consistency with criteria and accommodate preferences that may not be fully consistent.

In the COPRAS method, different types of criteria can be resolved because they are completed separately. The criteria for the COPRAS approach are divided into two, namely the criteria for benefits (positive) and costs (negative). The type of benefit criteria aims to get the highest value, and the type of cost criteria aims to get the lowest value. The steps in completing the COPRAS approach are described in detail as follows:

1) Make the initial decision matrix.
Each alternative value on each criterion is converted into the initial decision matrix. The preparation of this decision matrix is based on equation (2).

$$D = \begin{bmatrix} x_{11} & x_{12} & x_{13} & x_{14} \\ x_{21} & x_{22} & x_{23} & x_{24} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & x_{m3} & x_{mn} \end{bmatrix} \tag{2}$$

2) Normalize the decision matrix.
From the initial decision matrix, matrix normalization is then carried out. To get the value of the normalized attribute, it is calculated by equation (3).

$$X\_ij = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \tag{3}$$

3) Make a weighted normalized matrix.
Based on the normalized matrix, then look for a weighted normalized matrix, meaning that the matrix will be multiplied by the weight value of the predetermined criteria. The matrix that has been normalized with its weight is calculated using equation (4).

$$D' = d_{ij} = X_{ij} \times W_{ij} \tag{4}$$

4) Get maximum and minimum index parameters.
The next step is to find the maximum and minimum index parameters. This process is sought in equations (5) and (6).

$$S_{+i} = \sum_{j=1}^{n} y_{+ij} \tag{5}$$

$$S_{-i} = \sum_{j=1}^{n} y_{-ij} \tag{6}$$

5) Look for relative weighting values.
Next is the stage of looking for relative weight values. To get the value of the relative weight, it is calculated through equation (7) or equation (8).

$$Q_i = S_{+i} \frac{S\sum_{i=1}^{m} S_{-i-min}}{S_{-i}\sum_{i=1}^{m} S_{-i}\left(\frac{Si_{min}}{S_{-i}}\right)} \tag{7}$$

$$Q\_i = S\_(+i) + \frac{\sum_{i=1}^{m} S_{-i}}{S_{-i}\sum_{i=1}^{m} S_{-i}\left(\frac{1}{S_i}\right)} \tag{8}$$

6) Get the alternative Utility value.
The final step is to perform utility judgments on each alternative. Furthermore, the highest utility value is the best alternative. The utility value can be calculated by equation (9).

$$U_i = \frac{Q_i}{Q_{max}} \tag{9}$$

2.4. Modeling the System

System modeling or system design can help identify how system components interact, how information flows within them, and how the system

responds to change. The main goal of system design is to create structures, components, and elements that work together to achieve the desired goals or functions [21]. This model serves as a tool to describe how system components interact and how the system responds to certain inputs or changes. In this study, we used case diagrams to design the system. A use case diagram is a type of diagram in UML (Unified Modeling Language) notation that is used to describe interactions between actors (external entities) and functionality that exists in software systems [22]. Thus, the design will produce use case diagrams that provide an overview of the actor's relationship with the services provided by the system.

2.5. System Coding

System coding relates to system implementation, where this process will change the system design or plan that has been made into a form that functions according to the desired needs and goals [23]. This stage involves the coding process, where programming code will be written that implements the various features, functions, and logic that have been planned beforehand. In the development of the DSS, the selection of tutoring institutions was made website-based with a programming language, namely PHP through the Notepad++ editor and MySQL for the database.

2.6. Testing the System

System testing is a critical stage in software development that is carried out before the system is declared ready to be used or implemented [24]. To prove that the developed software is feasible to use, the DSS is tested for usability. Usability testing is an evaluation method used to measure whether the system being built is effective, efficient, and satisfies users [25]. The usability aspects used are: understandability, learnability, operability and attractiveness.

3. RESULTS AND DISCUSSION

Implementing the Complex Proportional Assessment (COPRAS) method combined with the Rank Order Centroid (ROC) approach to solving the problem of choosing a tutoring institution begins with determining the criteria used. The criteria for selecting the tutoring institution used are: price, tutor experience, facility, and number of participants. If the criteria have been determined, then proceed with setting the range of criteria values and converting the values to make it easier to perform calculations. The determination of the range of criteria values and conversion values can be seen in Table 1.

Table 1. Criteria for Selection of Tutoring Institutions

Criteria	Value Range	Conversion Rate
Price (C1)	< 3,00,000	1
	>= 3,000,000 to < 5,000,000	2
	>= 5,000,000 to < 7,000,000	3
	> 7,000,000	4
Tutor Experience (C2)	< 3 Years	1
	>= 3 Years to < 6 Years	2
	>= 6 Years to < 9 Years	3
	> 9 Years	4
Facility (C3)	Very Complete	1
	Complete	2
	Quite complete	3
	Incomplete	4
Number of Participants (C4)	< 6 Participants	1
	>= 6 to < 12 Participants	2
	>= 12 to < 24 Participants	3
	> 24 Participants	4

To get weight values using the ROC approach, decision makers will determine the order of importance in each of the criteria used. For case studies in this research, the order of priority from the most prioritized criteria to the criteria that are not so prioritized includes: price (C1), tutor experience (C2), facility (C3), and number of participants (C4). After the ranking of the importance of the criteria has been determined, the weight values can be solved through equation (1). The calculation process to get the weight of each criterion by applying the ROC approach can be seen in the following discussion:

$$w_1 = \frac{1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4}}{4} = 0.5208$$

$$w_2 = \frac{0 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4}}{4} = 0.2708$$

$$w_3 = \frac{0 + 0 + \frac{1}{3} + \frac{1}{4}}{4} = 0.1458$$

$$w_4 = \frac{0 + 0 + 0 + \frac{1}{4}}{4} = 0.0626$$

The results of the weight values for each criterion using the ROC method are then converted into the percentages presented in Table 2.

Table 2. Criteria Weight

Criteria	Criteria Weight	Criteria Type
Price (C1)	52.08 %	Cost
Tutor Experience (C2)	27.08 %	Benefit
Facility (C3)	14.58%	Benefit
Number of Participants (C4)	6.26%	Cost

The next stage is to determine the alternative that is the solution for the election. For case studies in this study, there are four alternatives, namely: Primagama (A1), Salemba Group (A2), Neutrons (A3), and Zenius (A4). Of the alternatives that exist,

the user gives a value based on the profile of each alternative. Giving alternative values for each criterion is then included in Table 3.

Table 3. Value Given to Alternatives

Alternative	Criteria Value			
	C1	C2	C3	C4
Primagama (A1)	5.000.000	10 years	Very Complete	10 Participants
Salemba Group (A2)	3.850.000	8 years	Complete	5 Participants
Neutron (A3)	7.895.000	10 years	Very Complete	8 Participants
Zenius (A4)	3.500.000	7 years	Complete	12 Participants

Then, based on the alternative values in Table 3, the values will be converted with reference to the value conversions in Table 1. Based on the attribute values in Table 3, then the values are converted with reference to Table 1. The results of converting these values can be entered in Table 4.

Table 4. Conversion Value Given For Each Alternative

Alternative	Criteria Value			
	C1	C2	C3	C4
Primagama (A1)	3	4	4	2
Salemba Group (A2)	2	3	3	1
Neutron (A3)	4	4	4	2
Zenius (A4)	2	3	3	3

From these case studies, the best alternative was sought based on the COPRAS method. The calculation process using the COPRAS approach begins with creating an initial decision matrix through equation (2). The matrix is obtained based on the converted alternative values, which can be seen in Table 4. The following values for each attribute are arranged in the initial decision matrix:

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

Furthermore, matrix normalization is carried out from the initial decision matrix that has been determined. Calculations for each existing attribute for normalization use equation (3). To get the value of each attribute to form a normalized matrix, you can see the following process:

$$x_{11} = \frac{3}{3 + 2 + 4 + 2} = 0.2727$$

$$x_{21} = \frac{2}{3 + 2 + 4 + 2} = 0.1818$$

$$x_{31} = \frac{4}{3 + 2 + 4 + 2} = 0.3636$$

$$x_{41} = \frac{2}{3 + 2 + 4 + 2} = 0.1818$$

The calculation process is carried out on all attributes until all attributes are normalized, or up to attribute x_{44}. Furthermore, all normalized attributes are arranged into the matrix as follows:

$$X_{ij} = \begin{bmatrix} 0.2727 & 0.2857 & 0.2857 & 0.2500 \\ 0.1818 & 0.2142 & 0.2142 & 0.1250 \\ 0.3636 & 0.2857 & 0.2857 & 0.2500 \\ 0.1818 & 0.2142 & 0.2142 & 0.3750 \end{bmatrix}$$

Next, find the weighted normalized value through equation (4). The value of each attribute that has been weighted normalized will be arranged into a weighted normalized matrix. The weighted normalization process is based on the multiplication between the normalization value and the criterion weight. The criteria weights refer to the weight values in Table 2. The process for calculating each attribute to obtain a weighted normalized value is as follows:

$$d_{11} = 0.2727 \times 52.08\% = 0.1418$$

$$d_{21} = 0.1818 \times 27.08\% = 0.0945$$

$$d_{31} = 0.3636 \times 14.58\% = 0.1891$$

$$d_{41} = 0.1818 \times 06.26\% = 0.0945$$

The calculation process is carried out on all attributes until all attributes have been normalized with their weights, or up to attribute d_{44}. Furthermore, all weighted normalized attributes are arranged into a matrix as follows:

$$D_{ij} = \begin{bmatrix} 0.1418 & 0.0771 & 0.0429 & 0.0150 \\ 0.0945 & 0.0579 & 0.0321 & 0.0075 \\ 0.1891 & 0.0771 & 0.0429 & 0.0150 \\ 0.0945 & 0.0579 & 0.0321 & 0.0225 \end{bmatrix}$$

The process is continued by finding the maximum and minimum index values for each alternative using equations (5) and (6). Before carrying out the calculations, the type of criteria is first identified, which can be seen in Table 2. So that the criteria for benefits are tutor experience (C2) and facilities (C3), while the cost criteria are price (C1) and number of participants (C4). The following is the process for finding the maximum value (S_{+i}):

$$S_{+1} = 0.0771 + 0.0429 = 0.1200$$

$$S_{+2} = 0.0579 + 0.0321 = 0.0900$$

$$S_{+3} = 0.0771 + 0.0429 = 0.1200$$

$$S_{+4} = 0.0579 + 0.0321 = 0.0900$$

Then, the following is the process of calculating the minimum value (S_{-i}) for each alternative:

$$S_{-1} = 0.1418 + 0.0150 = 0.1568$$

$$S_{-2} = 0.0945 + 0.0075 = 0.1020$$

$$S_{-3} = 0.1891 + 0.0150 = 0.2041$$

$$S_{-4} = 0.0945 + 0.0225 = 0.1170$$

Furthermore, the results of the maximum and minimum values that have been obtained are useful for finding relative weight values. To get this value

can be calculated using equation (8). The process of finding relative weight values is as follows:

$$Q_1 = 0.1200 + \frac{0.5800}{4.6449} = 0.2449$$

$$Q_2 = 0.0900 + \frac{0.5800}{3.0226} = 0.2819$$

$$Q_1 = 0.1200 + \frac{0.5800}{6.0451} = 0.2159$$

$$Q_4 = 0.0900 + \frac{0.5800}{3.4669} = 0.2573$$

After the Q_i value has been obtained, proceed with calculating the utility value (U_i) for each alternative. The utility value (U_i) is obtained by calculating the equation (9). The calculation involves the Q_i value being divided by the Qmax value and multiplied by 100. Based on the Q_i calculation, it is found that the Q_{max} value is 0.2819. Thus, the process of calculating the value of U_i is as follows:

$$U_1 = \frac{0.2449}{0.2819} \times 100 = 86.8664$$

$$U_2 = \frac{0.2819}{0.2819} \times 100 = 100$$

$$U_3 = \frac{0.2159}{0.2819} \times 100 = 76.6061$$

$$U_4 = \frac{0.2573}{0.2819} \times 100 = 91.2761$$

The ranking then determines the results of the utility value (U_i). Based on the results of the calculations that have been obtained, they are then arranged in a ranking form from the largest to the smallest utility values presented in Table 5.

Table 5. Utility Values and Alternative Ratings

Alternative	Value Utility (Ui)	Ranking
Salemba Group (A2)	100	1
Zenius (A4)	91.2761	2
Primagama (A1)	86.8664	3
Neutron (A3)	76.6061	4

It can be seen in Table 5 that the largest utility value (U_i) is the Salemba Group (A2) with a value of 100, followed by Zenius (A4) with a value of 91.2761, Primagama (A1) with a value of 86.8664, and Neutron (A3) with a value of 76.6061. Based on these results, the best alternative is Salemba Group (A2).

Before building a decision support system for selecting tutoring institutions into software, it is necessary to identify functional requirements. The following are the results of the functional requirements analysis for the developed system:
1) Users can manage data on the selection criteria for tutoring institutions.
2) Users can manage alternative data for selecting tutoring institutions.
3) Users can manage research data on alternative selections of tutoring institutions.
4) Users can see the process of completing the COPRAS method.
5) Users can see the ranking results from the calculation of the COPRAS method.

Furthermore, the results of the analysis are converted into a design using a use case diagram. Use case diagrams for decision support systems for selecting tutoring institutions using the COPRAS method are presented in Figure 2.
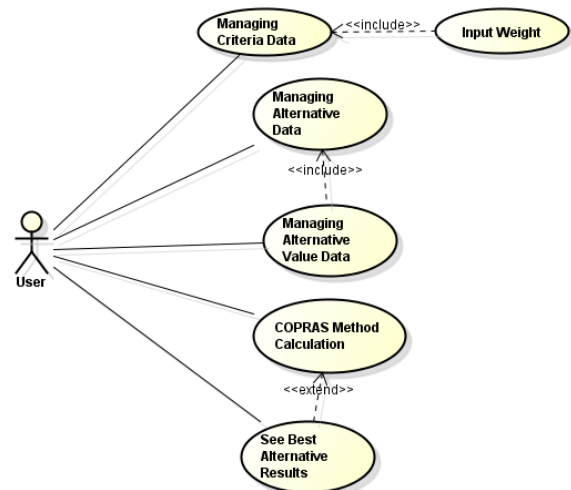

Figure 2. Use Case Diagram in DSS Selection of Tutoring Institutions

Based on the needs analysis and system design, it was realized into a decision support system. In the DSS, the selection of tutoring institutions is built on a website basis. To start operating the DSS for selecting tutoring institutions, it begins with the user entering the system via the login form. After the user has successfully logged in, the user enters the main menu interface. Main menu interface features on the system are presented in Figure 3.
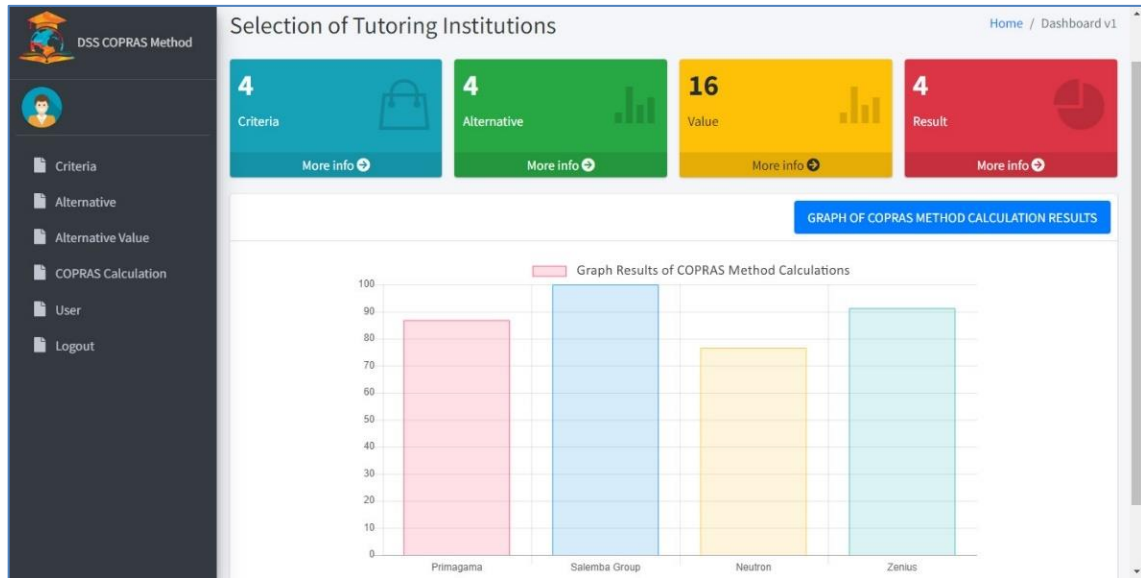
Figure 3. Main Menu Interface

Figure 3 displays the main menu interface for the SPK selection of tutoring institutions, which contains the main features of the system such as criteria, alternatives, alternative values, COPRAS method calculations, users, and graphics in the form of COPRAS method calculation results. Before the user selects a tutoring institution, the user needs to manage data such as criteria data, alternative data, and alternative value data. To manage criteria data, users can enter the criteria feature, where they can add, modify, and delete criteria data. After that, users can manage alternative data on alternative features. In this feature, users can add, delete, and change alternative data. The next step is that the user can perform alternative value management on alternative value features. In this feature, users can fill in alternative values based on the profile of each alternative. The interface for the alternative value input feature is presented in Figure 4.
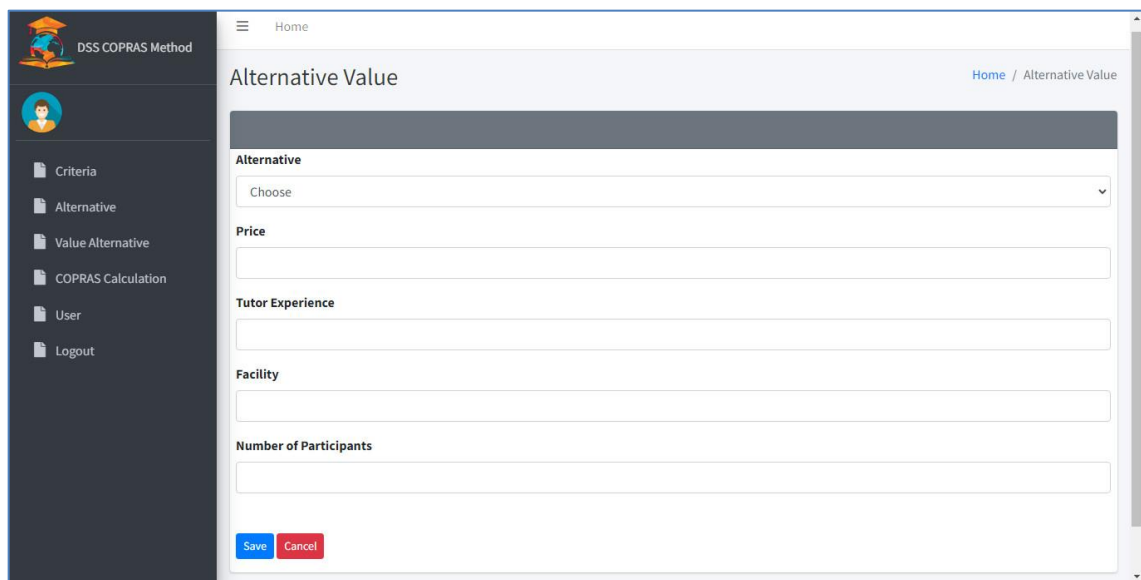

Figure 4. Display of Entering Alternative Values

After the criteria data, alternatives, and alternative values have been entered, the calculation of the COPRAS method to obtain the best alternative can be carried out. When the user selects the COPRAS calculation process feature, the system will display the COPRAS approach calculation process sequentially up to displaying an alternative ranking. The COPRAS calculation result interface displayed by the system can be seen in Figure 5.

Index Maximum and Minimum Value

No	Alternative	S_{+i}	S_{-i}
1	Primagama	0.12	0.156818181818
2	Salemba Group	0.0900000000001	0.102045454545
3	Neutron	0.12	0.204090909091
4	Zenius	0.0900000000001	0.117045454545

Quantitative Utility Value (U_i)

No	Alternative	U_i
1	Primagama	86.866369873
2	Salemba Group	100
3	Neutron	76.6061486418
4	Zenius	91.2761300435

Figure 5. Interface of COPRAS Method Calculation Results

Furthermore, the developed decision support system is tested to prove that the software is feasible to implement. To test it, a testing approach is used with usability testing. In usability testing, there are several aspects that are applied to carry out this test, including: understandability, learnability, operability and attractiveness. Based on these aspects, 10 (ten) questions were compiled which then became a questionnaire to be filled out by the respondents. In the choice of respondents' answers used the Guttman scale. This scale has the nature of extreme answers, where there are only 2 (two) statements, namely agree or disagree. The questionnaire was filled out by 30 people who would choose a tutoring institution. From filling out the questionnaire carried out by the respondents, the number of those who agreed and disagreed was calculated for each aspect and then the percentage of answers was calculated. The graph of the average percentage of respondents' answers is presented in Figure 6.
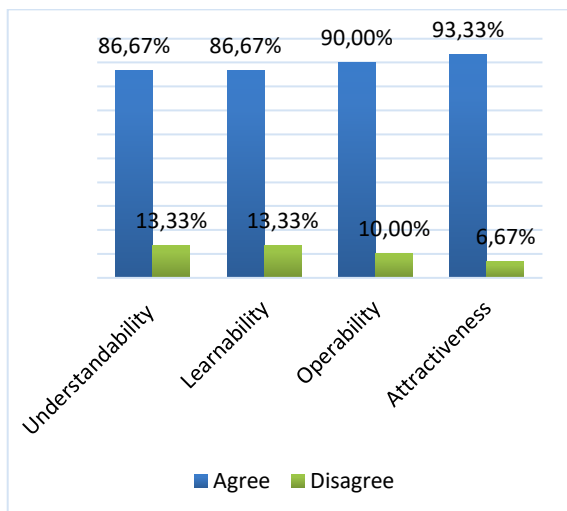

Figure 6. Acquired Value of Each Aspect

In Figure 6, shows a graph of the test results showing the percentage value of the respondents' answers. These results are then calculated for the average value for all aspects, so that a value of 89.17% is obtained. Then, this value is converted into criteria with the following guidelines: Good, has a value range of 76% -100%; Enough, has a value range of 56% - 75%; Not Good, has a value range of 40% - 55%, and Not Good, less than 40% [26]. Based on these guidelines, the DSS developed is in the good category. This shows that the system is feasible to use.

4. DISCUSSION

In the development of the DSS for the selection of tutoring institutions using the MCDA solution with the COPRAS method and ROC weighting. The process of determining the weights uses the ROC approach, with the weights being determined based on the order of the priority level. The level of importance is determined by the order of the criteria; for example, the criteria with the first order indicate that the criterion is more important than the second criterion, and so on. Thus, this method has the advantage of being able to handle situations where the criteria have unequal weight or have different rating scales. Based on the ROC approach in this study, it resulted in a weighting of the criteria, including: price (C1) of 52.08%; tutor experience (C2) of 27.08%; facility (C3) of 14.58%; and number of participants (C4) of 6.26%. These results indicate that decision-makers should give appropriate weight to the criteria that are considered more important. However, this approach shows a dominant weight for the criteria that have the first order. This means that ROC weighting has the weakness of being very sensitive to the weight given to each criterion and ignoring the interdependence or relationship between criteria.

In the application of the COPRAS method, this approach evaluates alternatives based on a number of criteria that are relevant to utility judgment to obtain alternative ratings. In Figure 4, the output of the system shows that the Salemba Group (A2) has the highest utility (Ui) value with a score of 100, followed by Zenius (A4) with a score of 91.2761, Primagama (A1) with a score of 86.8664, and Neutron (A3) with a score of 76.6061. The calculation results obtained from the DSS application that was built using manual calculations obtained no different results. So, the built-in DSS application has produced the right calculation. Based on the results of usability testing, it obtained a value of 89.17% and met the good criteria. So it can be said that the system built is easy and feasible to use.

So it can be said that the system is easy and suitable to use. This research shows that the Multi-Criteria Decision Analysis (MCDA) approach can solve decision-making problems with a number of criteria and alternatives. In previous research, namely regarding the selection of tutoring institutions using the Simple Additive Weighting (SAW) approach [8], certain weighting techniques were not used, and in this research, there were no measurements or tests of the system being built. Other research regarding the selection of tutoring institutions uses the weighted product (WP) approach [9], where in this research only black-box testing is carried out, so the usability of the system has not been tested. The next research regarding the selection of tutoring places for entering tertiary institutions uses the Analytical Hierarchy Process (AHP) approach [10]. The research also does not use certain weighting techniques in determining the weight of the criteria, and the system provided has not been tested. This research offers another, more representative approach by combining the Complex Proportional Assessment (COPRAS) approach and, to determine the weighting, the Rank Order Centroid (ROC) technique. Apart from that, in this research, the system developed was tested using usability testing.

5. CONCLUSION

In this research, the development of a DSS for selecting tutoring institutions using the MCDA approach uses the COPRAS method combined with weighting using the ROC method. The process of determining the weights uses the ROC approach, with the weights being determined based on the order of the priority level. Furthermore, the determination of alternatives is obtained using the COPRAS approach by evaluating alternatives based on a number of criteria relevant to utility assessment. This decision support system is built on a website and has features including managing criteria and alternative data, evaluating criteria, calculating the COPRAS method, and compiling alternative rankings. The best alternative results obtained from the built DSS application show the same value as the manual calculation shows, this shows that the calculation results are valid. Based on usability testing, a value of 89.17% was obtained and classified as good. This means that the SPK application that is built provides convenience and is feasible to use.

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