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Decision Support System for Choosing Online Learning Platforms Using the Complex Proportional Assessment Method

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Abstract−Online learning platforms can be an alternative to learning outside of school that can help improve student academic achievement. To determine the right online learning platform, decision makers must seek information one by one about the services provided by the platform as well as its weaknesses and strengths. This makes it difficult to make a choice and takes a long time. This research aims to build a Decision Support System (DSS) for choosing an online learning platform by applying the Complex Proportional Assessment (COPRAS) approach to get the right decision and not take long. The COPRAS approach can produce optimal alternatives based on alternative analysis using alternative assumptions by offering utility judgments so that the attributes of each alternative are sorted by interval. Based on the results of the case study, Zenius obtained the highest utility score with a score of 100, followed by Ruangguru with a score of 86.19, Pahamify with a score of 84.34, and Quipper with a score of 68.67. The calculation results obtained from a system built by calculating manually displays the same acquisition value, this means that the system has produced an accurate calculation. On the results of usability testing using aspects including understanding, learnability, operability and interesting, the average score is 91% and is in the good category. This demonstrates how user-friendly and implementable the created system is.

Keywords: Decision Support System; DSS; Complex Proportional Assessment; COPRAS; Online Learning Platforms

1. INTRODUCTION

The past Covid 19 pandemic demanded that the learning system be carried out online. This makes online learning technologies emerge which give birth to online learning platforms. Even though the pandemic has passed, it turns out that this online learning platform can be an alternative to learning outside of school that can help improve student academic achievement. As we know the educational process can be through formal or non-formal education, where formal education is obtained at school and non-formal education is obtained outside of school. However, there are institutions outside of schools that support additional learning to improve academic achievement, one of which is through applications or online learning platforms. This is supported by the Government because through these online learning platforms or applications it will improve the quality and quality of education. Because quality education will give birth to competent human resources so that they can support the development and development of the nation [1]. There are several advantages of learning activities outside of school such as tutoring or the use of learning applications, including students can have a deeper understanding of subjects that are considered difficult, can improve academic abilities and socialization with the environment, and academic achievement will be much better [2]. Online learning applications offer convenience in conducting learning because they are equipped with learning videos and exercises that can be done online which can be accessed via cellphones or laptops [3]. Online learning applications are increasingly in demand because they are considered cheaper than courses or tutoring places. Currently, there are many online learning platforms that offer various learning programs. So, carefulness is needed in choosing the right online tutoring platform and according to your needs. In order to determine the right online tutoring platform, parents and students must find information one by one about the services provided as well as their weaknesses and strengths. After getting the entire profile of the online learning platform, then comparing it with what is needed, then making a choice. This makes it difficult to make a choice and takes a long time. So, we need a software that makes it easy to help recommend the right online learning platforms and according to needs. Through a Decision Support System or abbreviated as DSS can be an alternative in overcoming these problems.

Knowledge-based software that can be used to support decision-making is referred to as a Decision Support System (DSS) [4]. The Decision Support System (DSS) is only a supporting tool for decision-making based on controlled facts through modeling in the form of math and statistics to get accurate and speedy results [5]. Typically, semi-structured or unstructured problems are solved with Decision Support Systems (DSS), which give information in the form of weighing the best option [6]. Research on the development of Decision Support Systems (DSS) relating to the selection of learning applications or platforms has been studied by several previous researchers using various decision-making methods. The first research is research on system development to determine the best learning media using the Simple Additive Weighting (SAW) approach [7]. The SAW approach calculates the optimum option by summing the performance weights for each solution. Subsequent research is related to developing a system for selecting online learning media by applying the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approach [8]. In this study, decision-making based on proximity to and distance from both positive and negative ideal solutions is addressed using the TOPSIS technique. The next research is research on system development for selecting online tutoring platforms through the implementation of the Analytical Hierarchy Process (AHP) approach [9]. By simultaneous qualitative and quantitative computations and thorough decision-making, the AHP technique can identify the optimum solution.

We must address this issue in order to clearly identify the greatest alternative since when making decisions, we frequently have to assess the utility of each individual choice, which is referred to as usefulness. Thus, the difference between the research conducted and the previous research is that this study uses an assessment of utility in obtaining optimal solutions through the Complex Proportional Assessment (COPRAS) approach. The COPRAS method is described as a methodology that evaluates alternatives that have different characteristics and assumes alternatives with utility judgment so that each alternative's features are grouped based on intervals to make the process more accurate and efficient [10]. This procedure is a way of decision-making that calculates links and forecasts the level of significance of alternative interests [11]. When there are criteria of the kind of benefit criterion (positive) and cost criteria (negative) that are handled individually to evaluate each alternative, the COPRAS approach can solve the problem of different criteria [12]. Because the COPRAS technique considers the assessment of utility, where the level of usefulness of each choice is evaluated, it has the advantages of superior precision and accuracy [13].

Based on the previous explanation, the aim of this research is to build a decision support system for selecting online learning platforms by implementing the Complex Proportional Assessment (COPRAS) approach to get the right decision and not take a long time. The COPRAS approach can generate the optimal alternative based on alternative analysis using alternative assumptions by offering utility assessments such that the attributes of each alternative are sorted based on intervals. This decision support system was created as a website, making it simple for users to use and access.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The stages in this study can be seen as a methodical strategy employed in the stages of research required so that research implementation can be carefully planned and arranged. The stages of research are procedures or stages that are methodically organized to accomplish the research's goals [14]. The stages used in this study are presented in Figure 1.

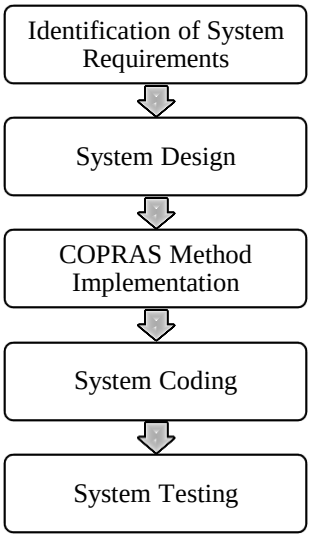


Figure 1. Research Stages

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) Identification of System Requirements
   First, a problem analysis is done in order to determine needs. The limitations discovered in the case study will be examined in the problem analysis [15]. After understanding the issue at hand, identify the needs of the system. To conduct a system requirements analysis, a requirement statement in the form of a functional requirements analysis is made [16]. An explanation of the system's capabilities and functions is the analysis's outcome.
2) System Design
   The process of assembling and modeling the system in a visual format to aid comprehension of software requirements is carried out during the subsequent stage of system design [17]. In order to generate a system design at this time that will subsequently be turned into software.
3) COPRAS Method Implementation
   By using the Complex Proportional Assessment (COPRAS) method, the decision-making process for the choice of online learning platforms in this study was completed. By assuming alternatives with utility judgment, the COPRAS approach is used to examine solutions with different characteristics and arrange the qualities of each alternative depending on intervals.

4) System Coding
The system's implementation or coding procedure takes place at this level. The process of system coding is completed by incorporating the findings of the analysis and design into the system [18]. Because the decision support system created is built on a website, PHP is used in the programming, and Visual Code Studio is used as the editor. Using MySQL for data storage.
5) System Testing
The system test serves to guarantee that the system can operate as it should and in accordance with user needs [19]. Tests conducted through usability testing, whose goal is to gauge users' level of comprehension, contentment, and operational simplicity when utilizing a built system [20]. This test is part of ISO 9126 regarding software quality assessment. The usability aspect used in this test has 4 (four) sub-criteria including: understandability, learnability, operability and attractiveness.

2.2 Complex Proportional Assessment (COPRAS) Method

The Complex Proportional Assessment method, or COPRAS as it is commonly known, is a model that analyzes alternatives that have dissimilar characteristics and assumes that each alternative has utility judgment. This causes the attributes of each alternative to be arranged based on intervals, making the process more accurate and efficient [10]. A decision-making strategy that evaluates interrelationships and forecasts the level of relevance of competing interests is the COPRAS approach [11]. Because the COPRAS technique takes into account an assessment of utility, where the level of usefulness of each alternative is assessed, it has the advantage of having good precision and accuracy [13].

When there are criteria that are positive (benefit) or negative (cost), which are addressed separately to evaluate each alternative, the COPRAS technique can tackle the problem of differences in criteria. The type of cost criteria is one that seeks a low value, as opposed to the type of benefit criteria, which is one that seeks a high value. The COPRAS technique is typically used in the calculating process to resolve decision problems through the steps below:

1) Prepare the initial decision matrix.
This process is carried out by entering all alternative values of the criteria into the matrix through equation (1).

$$D = \begin{bmatrix} x_{11} & x_{12} & x_{13} & x_{14} \\ x_{21} & x_{22} & x_{23} & x_{24} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & x_{m3} & x_{mn} \end{bmatrix} \quad (1)$$

2) Make a normalized matrix.
After obtaining the initial decision matrix, the matrix is then normalized through equation (2).

$$X_{ij} = \frac{X_{ij}}{\sum_{i=1}^{m} X_{ij}} \quad (2)$$

3) Arranging matrices that are normalized with their weights.
The next process is to calculate the normalized matrix by multiplying its weights to get a weighted normalized matrix. To calculate it using equation (3).

$$D^{'} = d_{ij} = X_{ij} \times W_{ij} \quad (3)$$

4) Get the maximum and minimum index values.
To obtain the maximum and minimum index values, you can calculate them through equation (4) and equation (5).

$$S_{+i} = \sum_{j=1}^{n} y_{+ij} \quad (4)$$

$$S_{-i} = \sum_{j=1}^{n} y_{-ij} \quad (5)$$

5) Calculating relative weight values.
Next is to do the calculations to get the relative weight or relative priority value of each alternative. In order to produce relative weight values, it can be calculated through equation (6) and equation (7).

$$Q_i = S_{+i} + \frac{S_{-\min} \sum_{i=1}^{m} S_{-i}}{S_{-i} \sum_{i=1}^{m} S_{-i} \left(S_{\min} / S_i \right)} \quad (6)$$

$$Q_i = S_{+i} + \frac{\sum_{i=1}^{m} S_{-i}}{S_{-i} \sum_{i=1}^{m} S_{-i}\left(1 / S_i\right)} \quad (7)$$

6) Calculating the utility value for each alternative.
Nilai Utilitas yang dinotasikan dengan U_i merupakan hasil akhir dalam perhitungan COPRAS. Nilai U_i tertinggilah menjadi alternatif terbaik. Untuk mendapatkan nilai U_i maka dapat dicari dengan perhitungan melalui persamaan (8).

$$U_i = \frac{Q_i}{Q_{\max}} \times 100\% \quad (8)$$

3. RESULT AND DISCUSSION

To develop a decision support system for selecting online learning platforms using the COPRAS method, the first thing to do is to determine the criteria. Find criteria. The criteria for choosing the platform in this case study include:

1) Complete Features
This criterion is a criterion related to the learning features offered by applications such as learning which are equipped with interactive learning materials, learning videos, practice questions and exam simulations as well as features that support online learning.
2) Teacher Experience
This criterion refers to the experience of teachers who teach on online learning platforms, where the experience of the teacher shows how long the teacher has been involved in the world of education or teaching.
3) Ease of Use
This criterion is a criterion related to the ability of an application to interact with its users or an application interface that can make it easier for users to understand and use the applications offered.
4) Platform Reputation
The platform's reputation is seen from the rating that has been given by previous users on Google Play. This rating shows the reputation that the platform is worth using.
5) Fees
This fee is the price charged by the user when accessing the online learning platform or subscribing to the learning programs offered.

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

Table 1. Criteria Used

No.	Criteria Name and Code	Rating Range	Value Conversion
1	Complete Features (C1)	Incomplete	1
		Quite complete	2
		Complete	3
		Very Complete	4
2	Teacher Experience (C2)	< 4 years	1
		>= 4 years to < 8 years	2
		>= 8 years to < 12 years	3
		> 12 Years	4
3	Ease of Use (C3)	Not easy	1
		Quite easy	2
		Easy	3
		Very easy	4
4	Platform Reputation (C4)	< 4.0	1
		>= 4.0 and < 4.3	2
		>= 4.3 and < 4.6	3
		>= 4.6	4
5	Fees (C5)	< 1,000,000	1
		>= 1,000,000 and < 2,000,000	2
		>= 2,000,000 and 3,000,000	3
		>= 3,000,000	4

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. So that the benefit criteria are Complete Features (C1), Ease of Use (C3) and Platform Reputation (C4), while the cost criteria are Fees (C5). 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 Name and Code	Criteria Type	Weight
Complete Features (C1)	Benefit	25 %
Teacher Experience (C2)	Benefit	20 %
Ease of Use (C3)	Benefit	20 %
Platform Reputation (C4)	Benefit	15 %
Fees (C5)	Cost	20 %

Decide which alternative will be chosen next. As a case study, there are 4 (four) alternatives to be selected, including: Pahamify (A1), Quipper (A2), Ruangguru (A3) and Zenius (A4). Based on the alternatives that have been determined then an assessment is given to the criteria that are adjusted to the existing alternative specifications. 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	C5
A1	Pahamify	Complete	10 years	Very Easy	4.7	1,300,000
A2	Quipper	Quite Complete	15 years	Easy	4.3	2,800,000
A3	Ruangguru	Very Complete	12 years	Very Easy	4.8	2,200,000
A4	Zenius	Complete	13 years	Easy	4.7	750,000

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 COPRAS 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	C5
A1	Pahamify	3	3	4	4	2
A2	Quipper	2	4	3	3	3
A3	Ruangguru	4	3	4	4	3
A4	Zenius	3	4	3	4	1

Based on the above case studies, a decision will be made by applying the COPRAS approach. To solve the decision-making problem through the COPRAS approach, it starts with making the initial decision matrix through equation (1). This matrix is obtained from each value in the converted alternatives contained in Table 4. So, the initial decision matrix is obtained as follows:

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

The next step is to make a normalized matrix, where the matrix is obtained through calculations with equation (2). The stages in obtaining the values in the normalized matrix are as follows:

$$x_{11} = \frac{3}{3+2+4+3} = 0.2500$$

$$x_{21} = \frac{2}{3+2+4+3} = 0.1667$$

$$x_{31} = \frac{4}{3+2+4+3} = 0.3333$$

$$x_{41} = \frac{3}{3+2+4+3} = 0.2500$$

To normalize all attributes, the computation process is completed for all attributes up to x_{45}. Following that, a matrix is created using the computation results for all normalized properties as follows:

$$X_{ij} = \begin{bmatrix} 0.2500 & 0.2143 & 0.2857 & 0.2667 & 0.2222 \\ 0.1667 & 0.2857 & 0.2143 & 0.2000 & 0.3333 \\ 0.3333 & 0.2143 & 0.2857 & 0.2667 & 0.3333 \\ 0.2500 & 0.2857 & 0.2143 & 0.2667 & 0.1111 \end{bmatrix}$$

Then the process is continued by obtaining the weighted normalized matrix values calculated through equation (3). The weighted normalization matrix is obtained from the multiplication of the values in the normalization matrix with the criteria weights referred to in Table 2, where the weight values for each criterion are as follows: Complete Features (C1) with a value of 25% or 0.25; Teacher Experience (C2) with a value of 20% or 0.2; Ease of Use (C3) with a value of 20% or 0.2; Platform Reputation (C4) with a value of 15% or 0.15; Fees (C5) with a value of 20% or 0.2. The following is the process of calculating the weighted normalized matrix values.

$$d_{11} = 0.2500 \times 0.25 = 0.0625$$

$$d_{21} = 0.1667 \times 0.25 = 0.0417$$

$$d_{31} = 0.3333 \times 0.25 = 0.0833$$

$$d_{41} = 0.2500 \times 0.25 = 0.0625$$

To ensure that all attributes have been standardized with their weights, the computation process is completed for all attributes up to d_{45}. After all attributes have been multiplied by their weights, the following weighted normalized matrix will be created:

$$D_{ij} = \begin{bmatrix} 0.0625 & 0.0429 & 0.0571 & 0.0400 & 0.0444 \\ 0.0417 & 0.0571 & 0.0429 & 0.0300 & 0.0667 \\ 0.0833 & 0.0429 & 0.0571 & 0.0400 & 0.0667 \\ 0.0625 & 0.0571 & 0.0429 & 0.0400 & 0.0222 \end{bmatrix}$$

The next process is to find the maximum and minimum index values for each alternative through calculations using equation (4) and equation (5). To obtain this value, the types of criteria are first identified based on Table 2. In this case study the types of benefit criteria are Complete Features (C1), Ease of Use (C3) and Platform Reputation (C4), while the cost criteria are Fees (C5). The process for finding S_{+i} (maximum value) is as follows:

$$S_{+1} = 0.0625 + 0.0429 + 0.0571 + 0.0400 = 0.2025$$

$$S_{+2} = 0.0417 + 0.0571 + 0.0429 + 0.0300 = 0.1717$$

$$S_{+3} = 0.0833 + 0.0429 + 0.0571 + 0.0400 = 0.2233$$

$$S_{+4} = 0.0625 + 0.0571 + 0.0429 + 0.0400 = 0.2025$$

Then, the process of finding S_{-i} (minimum value) for each alternative is as follows:

$$S_{-1} = 0.0444$$

$$S_{-2} = 0.0667$$

$$S_{-3} = 0.0667$$

$$S_{-4} = 0.0222$$

Furthermore, the results of the maximum and minimum values are used to calculate relative weight values or relative priorities. Relative weight values are obtained through calculations with equations (6) and (7). The following is the result of the calculation of the relative weight values:

$$Q_1 = 0.2025 + \frac{0.2000}{4.3333} = 0.2487$$

$$Q_2 = 0.1717 + \frac{0.2000}{6.5000} = 0.2024$$

$$Q_1 = 0.2233 + \frac{0.2000}{6.5000} = 0.2541$$

$$Q_4 = 0.2025 + \frac{0.2000}{2.1667} = 0.2948$$

The next process is to find the value of Utility (U_i) for each alternative. In order to get the value of Utility (U_i) is calculated using equation (8). Based on this equation, the (U_i) value is obtained from Q_i divided by the Q_{max} value then multiplied by 100. The Q_{max} value is 0.2948, then the utility value (U_i) can be calculated as follows:

$$U_1 = \frac{0.2487}{0.2948} \times 100 = 84.34$$

$$U_2 = \frac{0.2024}{0.2948} \times 100 = 68.67$$

$$U_3 = \frac{0.2541}{0.2948} \times 100 = 86.19$$

$$U_4 = \frac{0.2948}{0.2948} \times 100 = 100$$

Based on the value of Utility (U_i) that has been obtained then the ranking is determined, sorted by the alternative with the highest value to the lowest. The results of utility values and their rankings can be seen in Table 5.

Table 5. Results of Utility Values for Each Alternative

Alternative Name and Code	Utility Value	Ranking
Zenius (A4)	100	1
Ruangguru (A3)	86.19	2
Pahamify (A1)	84.34	3
Quipper (A2)	68.67	4

It can be seen in Table 5, it is found that the highest utility score is Zenius (A4) with a score of 100, followed by Ruangguru (A3) with a value of 86.19, Pahamify (A1) with a value of 84.34 and Quipper (A2) with a value of 68.67. So, the alternative Danamas Lender (A3) is the best alternative.

Then carry out the development of a decision support system by implementing the COPRAS method. A decision support system for selecting a web-based online learning platform written in PHP and using Microsoft Code Studio as its editor. Then, the data is stored in the MySQL database. Users must fill out a login form to access the online learning platform selection system to enter the system. The interface menu for the main form will appear if the user has logged in. The main form interface display can be seen in Figure 2.

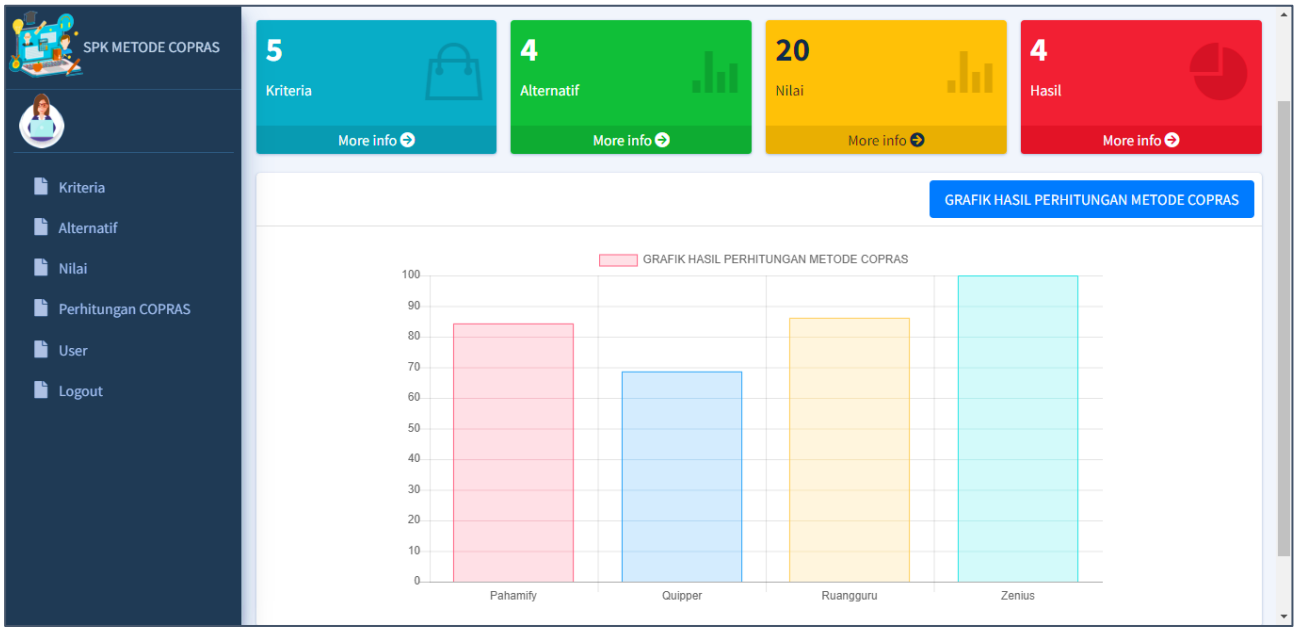


Figure 2. Decision Support System Main Form Interface for Selection of Online Learning Platforms

Figure 2 illustrates how the main form of the decision support system for selecting an online learning platform is displayed. This menu includes the main features including criteria, alternatives, values, and user menus in addition to a graph showing the calculation results of the COPRAS approach. Users must first handle criteria data before picking an online learning platform. The user can add, modify, and delete criteria data on the criteria menu. The user interface form data criteria are shown in Figure 3.

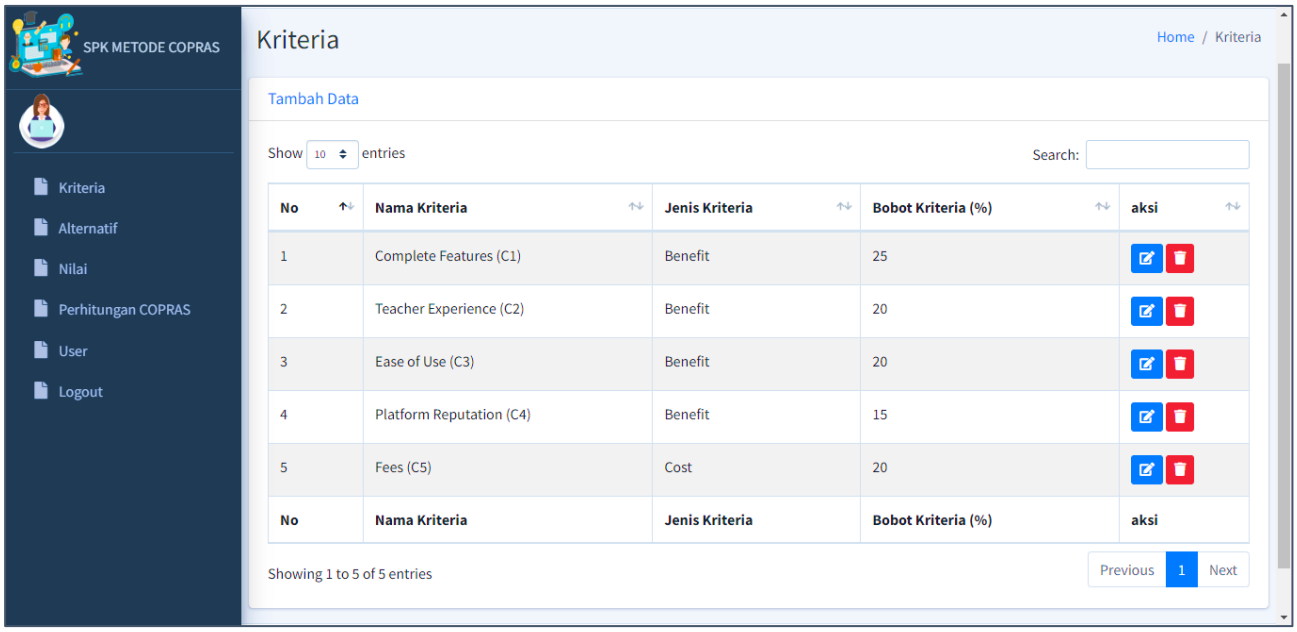


Figure 3. Criteria Data Form Interface

Figure 3 shows the criteria data form. After the form is filled, the user can then manage alternative data in alternative forms. In this form the user can add, change and delete alternative data. The form for alternative data input can be seen in Figure 4.

Figure 4. Alternative Data Input Form Interface

After alternative data has been inputted as shown in Figure 4, then the user can manage alternative value data. In the alternative value form the user can provide an assessment of the alternatives based on the specifications of each alternative against the existing criteria. If all alternative values for each criterion have been entered, the user can perform the COPRAS method calculation process to get the best alternative. In the COPRAS method calculation process form, the user will be shown step by step calculations on the COPRAS method. In addition, the user will also be shown the best alternative ranking results based on the COPRAS method. The COPRAS method calculation form interface is presented in Figure 5.

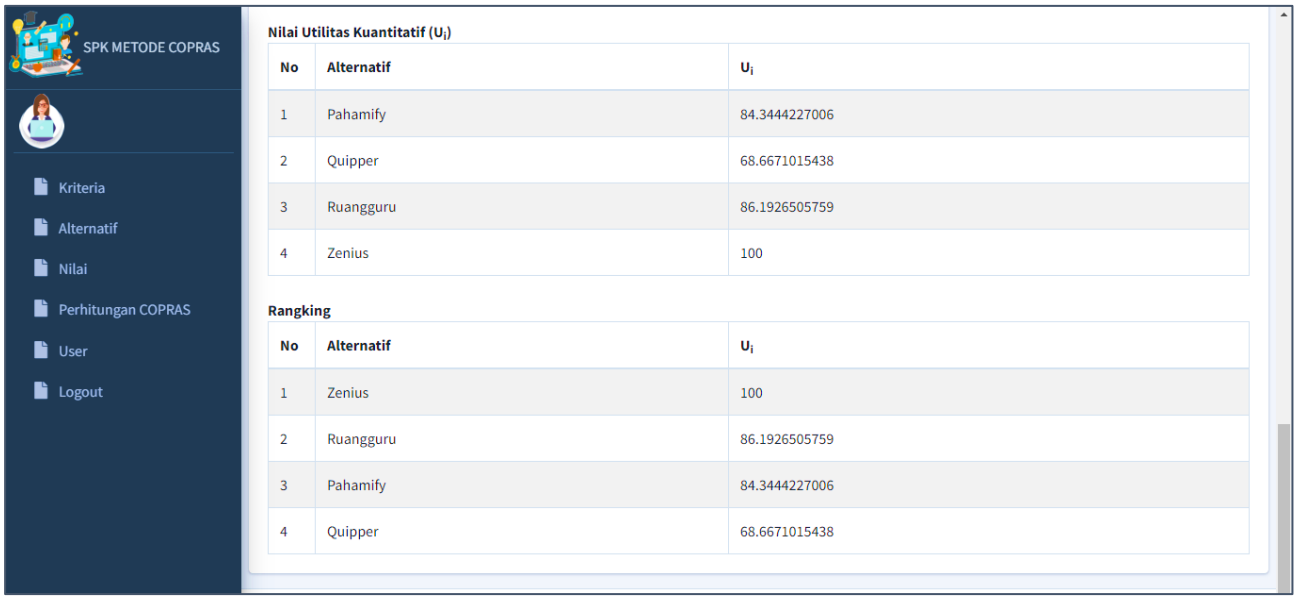
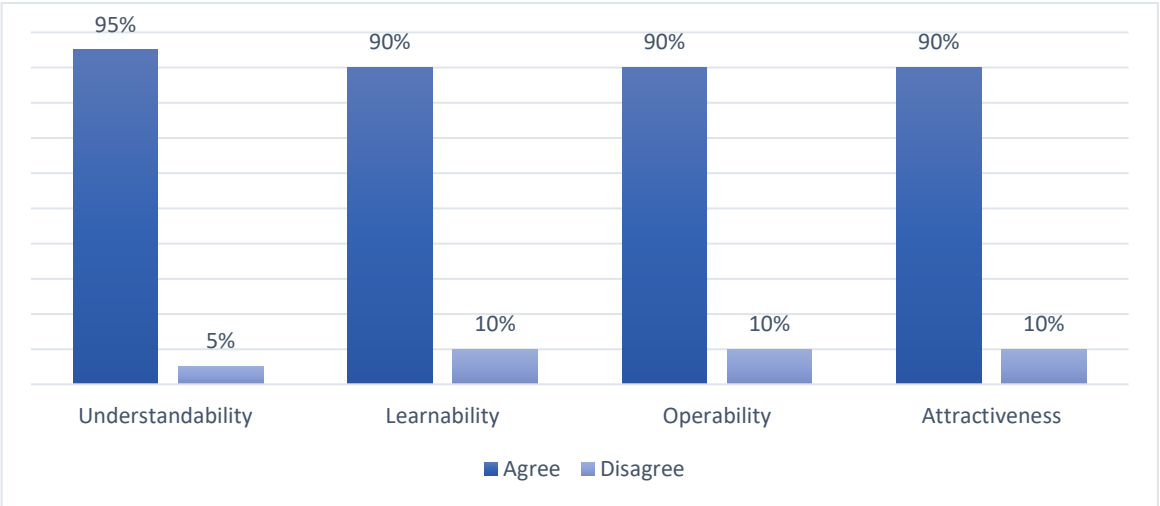


Figure 5. COPRAS Method Calculation Form Interface

Figure 5 shows the interface of the COPRAS method calculation form, where in this case study it was found that the highest Utility score was Zenius with a score of 100, then followed by Ruangguru with a value of 86.19, Pahamify with a value of 84.34 and Quipper with a value of 68.67. The calculation results obtained by the decision support system with manual calculations show the acquisition of the same value. This means that the decision support system built has produced valid calculations.

Also, the constructed decision support system is put to the test to make sure it can actually be used. Usability testing is the method utilized for the test. The usability aspects used include understandability, learnability, operability and attractiveness. From these aspects there are 10 questions which are then arranged into a questionnaire. The scale utilized for the questionnaire is the extreme Guttman scale, which has just two options for responses: agree and disagree. The questionnaire was distributed to 20 people who will choose an online learning platform. The results of usability testing are then calculated by the percentage of respondents who answer agree and disagree, then make it in graphical form as shown in Figure 6.



Gambar 6. Usability Testing Results

Figure 6 shows the graphical results of the percentage of respondents who answered agree, with the following value breakdown: the understandability aspect yields a value of 95%, learnability generates a value of 90%, operability generates a value of 90% and attractiveness generates a value of 90%. If the average value is calculated, the results of usability testing get a value of 91%. This value is then converted into criteria with the following guidelines: Good, if you get a score between 76% and 100%; Enough, if you get a score between 56% to 75%; Not Good, if you get a score between 40% to 55%, and Very Bad, if it's less than 40% [21]. Based on the conversion value reference, the decision support system for selecting this online learning platform is in the good category. This shows that the developed system is considered easy to use and feasible to implement.

4. CONCLUSION

This research has implemented the Complex Proportional Assessment (COPRAS) approach in a decision support system for choosing an online learning platform. The COPRAS approach is able to generate the optimal alternative based on alternative analysis, alternative assumptions, and utility evaluation, where the qualities of each alternative are grouped depending on intervals. The system built is website-based and has functions such as managing criteria data, alternative data, alternative value data, the COPRAS method calculation process and displaying alternative results through alternative rankings. Based on the results of the case study conducted, Zenius obtained the highest utility score with a score of 100, followed by Ruangguru with a score of 86.19, Pahamify with a score of 84.34 and Quipper with a score of 68.67. The calculation results obtained from a system built by calculating manually display the same acquisition value, this means that the system has produced an accurate calculation. On the results of usability testing using aspects including understanding, learnability, operability and interesting, the average score is 91% and is in the good category. This shows that the developed system is easy to use and feasible to implement.

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