Decision Support System Using a Combination of COPRAS and Rank Reciprocal Approaches to Select Accounting Software

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Abstract—Accounting software plays an important role in carrying out accounting processes that are fast, efficient, accurate and in accordance with applicable standards. With the emergence of various accounting software that offers a variety of features, users, both individuals and companies, often experience difficulty in determining the software that best suits their needs. The aim of this research is to develop a decision support system that makes it easier to choose accounting software through the application of the COPRAS approach and the Rank Reciprocal weighting technique. The Rank Reciprocal approach is used to rank or weight the criteria given by the decision-maker. The COPRAS (Complex Proportional Assessment) approach focuses on cognitive aspects so that it can accommodate the preferences and subjective assessments of decision-makers. Based on the case study that has been carried out, the highest to lowest utility value results are obtained, namely Zahir Online (A2), which obtained a score of 100. Since the decision support system's output yields a result that is identical to that of computations made by hand, it is deemed legitimate. Apart from that, the usability test obtained an average score of 91%, which proves that the system is in accordance with its usability and what is needed by its users.

Keywords: Accounting Software; Decision Support Systems; Complex Proportional Assessment; COPRAS; Rank Reciprocal

1. INTRODUCTION

In the era of globalization and Industrial Revolution 4.0, financial information management has become a key element in ensuring business continuity and progress. Companies are now faced with demands to carry out accounting processes that are not only fast and efficient but also accurate and in accordance with applicable standards [1]. This has driven an increase in demand for accounting software that is able to meet various specific company needs [2]. To get an accounting application that meets demand, of course, it will cost a lot of money and take a long development process. For this reason, many companies use accounting software that is already on the market. Currently, many accounting information system software products have emerged, offered by vendors or software developers offering a variety of features. Users, both individuals and companies, often have difficulty determining the software that best suits their needs. This happens because each application has its own advantages and disadvantages based on the software specifications offered. Plus, each entity's needs in terms of accounting can be very specific and varied. All of these factors add complexity to the process of selecting the right accounting application, which can have a direct impact on the operational efficiency and accuracy of an entity's financial reports. Therefore, the importance of developing an effective Decision Support System (DSS) for selecting accounting software becomes very relevant [3]. The Decision Support System (DSS) is a computer-based system that is able to provide assistance in complex and multi-criteria decision-making processes. In the context of selecting accounting software, DSS can be used to simplify the evaluation process by integrating various criteria needed by decision-makers in determining their decisions.

There is previous research regarding the selection of applications or software that helps and supports a company's business processes. There is research that has developed a decision support system for choosing business and financial management software by applying the SAW (Simple Additive Weighting) method [4]. This study demonstrates that the SAW technique can identify the optimal choice by calculating a weighted total of the alternatives' performance ratings. Furthermore, there is research on decision support systems to determine the best ERP (Enterprise Resource Planning) application through implementing the AHP (Analytical Hierarchy Process) approach [5]. To find the optimal option, this method compares and evaluates several criteria in a relative manner. The next research is about applying the MOORA approach to selecting digital wallet applications [6]. The MOORA approach aims to provide optimal solutions in a multi-criteria context by integrating the preferences and weights of each relevant criterion. Other research concerns systems that can assist in decision making in choosing an e-wallet application through the application of the Profile Matching approach [7]. This method compares the profiles or specifications of an entity through ranking based on the profile of the alternatives being assessed.

The difference between this research and the research previously described is that this research uses the Rank Sum approach to determine the weight values and uses the Complex Proportional Assessment (COPRAS) approach to determine the best alternative. Besides that, this research focuses on solving decision-making problems to recommend the best alternative in a case study of selecting accounting software. Criteria weights are necessary to determine the level of importance of each criterion in solving decision problems. The weight of these criteria is very influential in producing the best alternative. If the decision maker is unable to provide an explicit value to
determine the weight, an approach is needed to facilitate their determination of the criteria's weight. The Rank Reciprocal approach is used to assign weight to existing criteria based on their priority, which is assessed inversely [8]. Meanwhile, the COPRAS approach to finalizing decisions is based on proportional and complex comparative logic, which involves ranking alternatives based on quantified evidence. The COPRAS approach has the ability to calculate an effectiveness index that is directly proportional to the criteria that are considered to provide benefits and inversely proportional to the criteria that are considered to be costs [9].

So, the aim of this research is to implement the COPRAS approach and Rank Reciprocal weighting technique in a decision support system for choosing accounting software that can make it easier for users and produce fast decisions. To select accounting software in this research, the criteria used were based on reference articles from experts published on the MyBest website [10]. These criteria include: Completeness of Features, Price (Per Month), Storage Method and Customer Support. To make the created decision support system simpler for users to access and utilize, it is implemented on a website.

2. RESEARCH METHODOLOGY

2.1 Research Stages

Research stages are used to develop logical steps to facilitate the effective achievement of research objectives [11]. Thus, the research stages are not only formal steps but also an important instrument for achieving valid and reliable research results [12]. The steps in this research are visualized in Figure 1.

![Figure 1. Stages in Conducting Research](image)

A detailed explanation of the research steps depicted in Figure 1 is provided below:

1) Describe the Problem
   The main objective of this stage is to identify and formulate the problem to be investigated. This stage involves in-depth analysis of related literature, direct observation, or preliminary studies to identify areas where knowledge or understanding is still limited [13]. According to the findings of observations and interviews, there are main problems faced by someone who tries to decide on accounting software. The main problem in choosing accounting software is that each software has its own advantages and disadvantages, so in choosing it users must know all the specifications of the software offered. This of course takes time and creates difficulties in making a choice. Therefore, the importance of developing an effective Decision Support System (DSS) for selecting accounting software becomes very relevant.

2) Establish Criteria and Alternatives
   Setting criteria and alternatives is essential to solving choice problems when choosing accounting programs. The criteria employed in this research to choose the software accounting were based on expert reference articles that were posted on the MyBest website [10]. These criteria include: Completeness of Features, Price (Per Month), Storage Method, and Customer Support. Meanwhile, the alternatives used as case studies in this research include Zoho Books, Zahir Online, FreshBooks, Hashmicro, and Accurate.

3) Carrying out Criteria Weighting
The next stage is to use the Rank Reciprocal technique to calculate the weight of the criteria after they have been established. Weight determination is important because a mistake in weight determination will impact the correctness of the choice that follows [14]. The decision maker's criteria are ranked or weighted using the Rank Reciprocal method. The fundamental idea of rank reciprocal is to prioritize the option that receives the highest ranking by assigning weight values using an inverse procedure [15]. Thus, the weight of each criterion will be established during this phase.

4) Analysis of Decision Completion Using the COPRAS Method

One strategy employed by decision support systems to solve multi-criteria decision-making problems is the COPRAS (Complex Proportional Assessment) method. In order to take into account, the subjective judgments and preferences of decision makers, this approach was designed with an emphasis on cognitive elements [16]. When dealing with scenarios including a lot of interconnected factors that need for serious consideration, this method is frequently employed [17]. The ultimate outcome of this procedure is a ranking of the options that shows which is more important in relation to all the factors considered.

5) Building a Decision Support System

This step includes the coding stage, in which a software developer converts the specs or software design into computer code that a computer can run [18]. The decision support system was built based on a website using a code editor, namely Aptana Studio, and a database, namely MySQL.

6) Testing the System

To make sure the software operates in accordance with its requirements and specifications, testing is a crucial procedure [19], [20]. Before the program is released to consumers, this testing procedure aids guarantee its dependability and quality in addition to finding flaws or problems [21]. A The testing instrument of choice is a usability test, which is used to gauge how usable the program under development is [22]. This test is taken from the usability aspects of ISO 9126 which consist of sub-criteria including understandability, learnability, operability and attractiveness [23]. To gather information on the usability of the decision support system being developed, a questionnaire was created for this study and given to the user to complete.

2.2 Metode Rank Reciprocal

The Reciprocal Rank weighting method is an approach to ranking analysis used in the context of decision support systems [24]. This method is used to give weight to the ranking given to each alternative in a decision. The basic principle of Rank Reciprocal is to give increasingly higher weight values to lower rankings, emphasizing preference for the alternative that gets the best ranking [15]. In Rank Reciprocal, usually the weight value is given in reverse to the ranking [8]. This means that the alternative with the lowest ranking will get the highest weight, while the alternative with the highest ranking will get the lowest weight. This reflects the assumption that the higher the ranking, the lower the preference or performance of an alternative.

The Reciprocal Rank weighting process involves the inverse of the given ranking. For example, if there are five alternatives, the lowest rank (rank 1) will get the highest weight, rank 2 will get medium weight, and so on. With this approach, ranking analysis can provide more in-depth information about the relative preferences between alternatives. To carry out weighting calculations using the Rank Reciprocal approach, you can use equation (1).

\[ w_j = \frac{1/j}{\sum_{k=1}^{n} 1/k} \]  

(1)

where \( w_j \) refers to the weight value for each criterion, \( j \) shows the priority ranking of the criteria, and \( k \) refers to the order of the criteria.

2.3 Metode Complex Proportional Assessment dan Rank Reciprocal (COPRAS)

One multi-criteria assessment technique for handling difficult decision-making situations is the COPRAS (Complex Proportional Assessment) approach [25]. This approach compares options using pre-established criteria, each of which is assigned a weight depending on how important it is [26]. What makes COPRAS special is that it can compute an effectiveness index that is directly proportionate to the criteria that are thought to be beneficial and inversely proportional to the criteria that are thought to be costly [16]. The COPRAS method’s benefits include its versatility in adjusting criterion weights to account for changing circumstances or decision maker preferences, as well as its simplicity of processing a wide range of data kinds and scales[17]. The following steps may help you use the COPRAS approach to tackle decision-making problems:

1) Create a decision matrix from all existing attribute values.

Based on predetermined criteria, each option will be evaluated, and the results will be converted into a matrix.

The decision matrix of all attribute values is created using equation (1).

\[
D = \begin{bmatrix}
  x_{11} & x_{12} & x_{13} & x_{14} \\
  x_{21} & x_{22} & x_{23} & x_{24} \\
  \vdots & \vdots & \vdots & \vdots \\
  x_{m1} & x_{m2} & x_{m3} & x_{mn}
\end{bmatrix}
\]  

(2)
2) Search for normalization for each attribute. Based on the attribute values in the decision matrix in the previous step, then proceed by normalizing these values through equation (3).

\[ X_{ij} = \frac{x_{ij}}{\sum_{m=1}^{m} x_{ij}} \] (3)

3) Create attributes in weighted normalization. The following step involves obtaining a weighted normalization value, which is calculated by multiplying the normalized attribute's value by its weight. To obtain this value apply equation (4).

\[ D' = d_{ij} = X_{ij} \times W_{ij} \] (4)

4) Calculate the maximum and minimum index values. This phase is used to find the maximum and minimum values for each index. The maximum index value is calculated using equation (5), and the minimum index value is calculated using equation (6).

\[ S_{+i} = \sum_{j=1}^{n} y_{+ij} \] (5)

\[ S_{-i} = \sum_{j=1}^{n} y_{-ij} \] (6)

5) Calculate the relative weight value of each alternative. This relative weight value can be obtained through calculations guided by equation (7) and equation (8).

\[ Q_i = S_{+i} + \frac{s \sum_{m=1}^{m} S_{-i-min}}{s \sum_{m=1}^{m} S_{+i} - (S_{min}(3)} \] (7)

\[ Q_i = S_{+i} + \frac{\sum_{m=1}^{m} S_{-i}}{s \sum_{m=1}^{m} S_{+i} - (1/S_{i})} \] (8)

6) Find the utility value of each alternative. Each alternative’s performance value is determined by calculating its Utility Value, or \( U_i \). It follows that this option is the best one to choose if the utility value receives the highest value. Equation (9) may be used in order to get the value of utility.

\[ U_i = \frac{Q_i}{Q_{max}} \] (9)

### 3. RESULT AND DISCUSSION

To overcome decision-making problems in choosing accounting software, start by determining the criteria that are used as a reference in choosing the best option. To select accounting software in this research, the criteria used include: Completeness of Features, Price (Per Month), Storage Method and Customer Support [10]. After the criteria are determined, the next step is to determine the value range and conversion value for each criterion used, as presented in Table 1.

<table>
<thead>
<tr>
<th>Criteria Code</th>
<th>Criteria Code</th>
<th>Criteria</th>
<th>Criterion Value</th>
<th>Conversion Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2</td>
<td>C2</td>
<td>Completeness of Features</td>
<td>Incomplete</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quite Complete</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Complete</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Very Complete</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>C2</td>
<td>Price (Per Month)</td>
<td>&lt; 250,000</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt;= 250,000 dan &lt; 500,000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt;= 500,000 dan &lt; 750,000</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt;= 750,000</td>
<td>4</td>
</tr>
<tr>
<td>C1</td>
<td>Storage Method</td>
<td>Desktop Software</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cloud-Based Software</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>Customer Support</td>
<td>Not Good</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Good Enough</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Good</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very Good</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 includes a list of criteria, scale values and weights for each criterion. The next step is to determine the weight for each criterion, where it must also be determined whether the criterion is a benefit type (which requires a maximum value) or a cost type (which requires a minimum value). In determining these weights, the Rank Reciprocal method is used, where this approach is applied to classify or arrange criteria weights that are
adjusted to the decision maker's priorities. This technique utilizes the inverse principle, where an alternative with a higher ranking will be given a greater value, while an alternative with a lower ranking will receive a smaller value. In this decision-making process, priority values are given to each available alternative, with criteria that are considered more critical receiving higher priority. For the case of this research, the types of criteria and their priority order are shown in Table 2.

<table>
<thead>
<tr>
<th>Criteria Code</th>
<th>Criteria</th>
<th>Type Criteria</th>
<th>Order of Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Completeness of Features</td>
<td>Benefit</td>
<td>1</td>
</tr>
<tr>
<td>C2</td>
<td>Price (Per Month)</td>
<td>Cost</td>
<td>2</td>
</tr>
<tr>
<td>C3</td>
<td>Storage Method</td>
<td>Benefit</td>
<td>3</td>
</tr>
<tr>
<td>C4</td>
<td>Customer Support</td>
<td>Benefit</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2 lists each criterion's priority or degree of relevance. This information will be utilized as a guide for determining the weight value using the Rank Reciprocal method. Using equation (1), the values of each weight are determined. The following is the calculating procedure:

\[
\begin{align*}
   w_1 &= \frac{1/2}{(1/1)+1/2+(1/3)+1/4} = 0.48 \\
   w_2 &= \frac{1/2}{(1/1)+1/2+(1/3)+1/4} = 0.24 \\
   w_3 &= \frac{1/3}{(1/1)+1/2+(1/3)+1/4} = 0.16 \\
   w_4 &= \frac{1/4}{(1/1)+1/2+(1/3)+1/4} = 0.12
\end{align*}
\]

After the value of each weight is obtained, the next step is to compile all the weight values of the criteria into a table as in Table 3.

<table>
<thead>
<tr>
<th>Criteria Code</th>
<th>Criteria</th>
<th>Type Criteria</th>
<th>Order of Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Completeness of Features</td>
<td>Benefit</td>
<td>0.48</td>
</tr>
<tr>
<td>C2</td>
<td>Price (Per Month)</td>
<td>Benefit</td>
<td>0.24</td>
</tr>
<tr>
<td>C3</td>
<td>Storage Method</td>
<td>Cost</td>
<td>0.16</td>
</tr>
<tr>
<td>C4</td>
<td>Customer Support</td>
<td>Benefit</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Table 3. Results of Weight Values Using the Rank Reciprocal Approach

The values for each weight that were determined via Reciprocal Rank computations are shown in Table 3. Finding the option that will be used to choose the accounting program is the next stage. The following substitutes were used in this case study: Accurate (A5), FreshBooks (A3), Hashmicro (A4), Zahir Online (A2), and Zoho Books (A1). Next, a value is given to this option according to the specifications of each product according to the criteria. Table 4 displays the results that were obtained for each of the options in this case study.

<table>
<thead>
<tr>
<th>Alternative Code</th>
<th>Alternative</th>
<th>Criteria</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Zoho Books</td>
<td>Quite Complete</td>
<td>465,000</td>
<td></td>
<td>Cloud-Based</td>
<td>Very Good</td>
</tr>
<tr>
<td>A2</td>
<td>Zahir Online</td>
<td>Very Complete</td>
<td>1,500,000</td>
<td></td>
<td>Cloud-Based</td>
<td>Very Good</td>
</tr>
<tr>
<td>A3</td>
<td>FreshBooks</td>
<td>Very Complete</td>
<td>350,000</td>
<td></td>
<td>Cloud-Based</td>
<td>Good</td>
</tr>
<tr>
<td>A4</td>
<td>Xero</td>
<td>Quite complete</td>
<td>960,000</td>
<td></td>
<td>Cloud-Based</td>
<td>Good</td>
</tr>
<tr>
<td>A5</td>
<td>Accurate</td>
<td>Complete</td>
<td>300,000</td>
<td></td>
<td>Cloud-Based</td>
<td>Very Good</td>
</tr>
</tbody>
</table>

Accounting software product requirements, as shown in Table 4, are met by the results of assigning different values to the criteria. Additionally, based on Table 1, the evaluation findings are transformed into values to facilitate computations. Table 5 displays the values for each choice after the completion of the value conversion.

<table>
<thead>
<tr>
<th>Alternative Code</th>
<th>Alternative</th>
<th>Criteria</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Zoho Books</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>A2</td>
<td>Zahir Online</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>A3</td>
<td>FreshBooks</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>Xero</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>Accurate</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
Table 4 shows the value of each alternative whose value has been converted. To find the best alternative using the COPRAS approach, the first step is to create an initial decision matrix for all attributes. Each alternative will be given an assessment based on predetermined criteria, then these values are arranged into a matrix referring to equation (2). The following is the initial decision matrix for this case study:

\[
D = \begin{bmatrix}
2 & 2 & 4 \\
4 & 4 & 2 \\
4 & 2 & 2 \\
2 & 4 & 3 \\
3 & 2 & 4 \\
\end{bmatrix}
\]

After the initial decision matrix is formed, it is then continued by normalizing the values of the existing attributes. The normalized value for each attribute is obtained by calculating it using equation (3). The process for obtaining normalized values is explained as follows:

\[
X_{ij} = \frac{2 \times d_{ij}}{2 + 2 + 2 + 2 + 2} = 0.1333
\]

\[
X_{11} = \frac{2 + 4 + 4 + 2 + 3}{4} = 0.1333
\]

\[
X_{21} = \frac{2 + 4 + 4 + 2 + 3}{4} = 0.2667
\]

\[
X_{31} = \frac{2 + 4 + 4 + 2 + 3}{2} = 2.2667
\]

\[
X_{41} = \frac{2 + 4 + 4 + 2 + 3}{3} = 0.1333
\]

\[
X_{51} = \frac{2 + 4 + 4 + 2 + 3}{2} = 0.2000
\]

\[
X_{12} = \frac{2 + 4 + 4 + 2 + 4 + 2}{4} = 0.1429
\]

\[
X_{22} = \frac{2 + 4 + 4 + 2 + 4 + 2}{2} = 0.2857
\]

\[
X_{32} = \frac{2 + 4 + 4 + 2 + 4 + 2}{4} = 0.1429
\]

\[
X_{42} = \frac{2 + 4 + 4 + 2 + 4 + 2}{2} = 0.2857
\]

\[
X_{52} = \frac{2 + 4 + 4 + 2 + 4 + 2}{4} = 0.1429
\]

The following normalized matrix is then filled in with the outcomes of all normalized attribute values:

\[
X_{ij} = \begin{bmatrix}
0.1333 & 0.2667 & 0.2000 & 0.2222 \\
0.2667 & 0.2857 & 0.2000 & 0.2222 \\
0.2667 & 0.1429 & 0.2000 & 0.1667 \\
0.1333 & 0.2857 & 0.2000 & 0.1667 \\
0.2000 & 0.1429 & 0.2000 & 0.2222 \\
\end{bmatrix}
\]

The next process is to obtain a weighted normalization value, where the value of the normalized attribute is multiplied by its weight to obtain a weighted normalization value. To get the weighted normalization value, equation (4) is used. The weighting values used refer to the weighting results with Reciprocal Rank in Table 3.

The process for obtaining the weighted normalized value is as follows:

\[
d_{11} = 0.1333 \times 0.48 = 0.0640
\]

\[
d_{21} = 0.2667 \times 0.48 = 0.1280
\]

\[
d_{31} = 0.2667 \times 0.48 = 0.1280
\]

\[
d_{41} = 0.1333 \times 0.48 = 0.0640
\]

\[
d_{51} = 0.2000 \times 0.48 = 0.0960
\]

\[
d_{12} = 0.1429 \times 0.24 = 0.0343
\]

\[
d_{22} = 0.2857 \times 0.24 = 0.0686
\]

\[
d_{32} = 0.1429 \times 0.24 = 0.0343
\]

\[
d_{42} = 0.2857 \times 0.24 = 0.0686
\]

\[
d_{52} = 0.1429 \times 0.24 = 0.0343
\]

The results of all attribute values that have been normalized with their weights are then entered into the following weighted normalized matrix:

\[
D_{ij} = \begin{bmatrix}
0.0640 & 0.0343 & 0.0320 & 0.0267 \\
0.1280 & 0.0686 & 0.0320 & 0.0267 \\
0.1280 & 0.0343 & 0.0320 & 0.0200 \\
0.0640 & 0.0686 & 0.0320 & 0.0200 \\
0.0960 & 0.0343 & 0.0320 & 0.0267 \\
\end{bmatrix}
\]

The maximum and lowest index values will be sought for, taking into account the decision matrix values that have been normalized with respect to their weights. Equation (5) is used to compute the criteria if they are benefit criteria, while equation (6) is used to calculate the criteria if they are cost criteria. If you refer to Table 3,
the benefit criteria include C1, C3 and C4, while the cost criteria include C2. The following are the outcomes of the computation for the maximum value:

\[ A_{+1} = 0.0640 + 0.0320 + 0.0267 = 0.1227 \]
\[ A_{+2} = 0.1280 + 0.0320 + 0.0267 = 0.2210 \]
\[ A_{+3} = 0.1280 + 0.0320 + 0.0200 = 0.1800 \]
\[ A_{+4} = 0.0640 + 0.0320 + 0.0200 = 0.1503 \]
\[ A_{+5} = 0.0960 + 0.0320 + 0.0267 = 0.1547 \]

Meanwhile, the calculation results for the minimum value are as follows:

\[ A_{-1} = 0.0343 \]
\[ A_{-2} = 0.0686 \]
\[ A_{-3} = 0.0343 \]
\[ A_{-4} = 0.0686 \]
\[ A_{-5} = 0.0343 \]

The process continues by calculating the relative weight value which is calculated using equation (7) and equation (8). The calculation results in obtaining the relative weight values are as follows:

\[ Q_1 = 0.1227 + \frac{0.2400}{0.2400} = 0.1827 \]
\[ Q_2 = 0.2210 + \frac{0.0000}{0.2400} = 0.2510 \]
\[ Q_3 = 0.1800 + \frac{0.0000}{0.2400} = 0.2400 \]
\[ Q_4 = 0.1503 + \frac{0.0000}{0.2400} = 0.1803 \]
\[ Q_5 = 0.1547 + \frac{0.0000}{0.2400} = 0.2147 \]

The final step is to calculate the Utility or \( U_i \) value of the existing alternatives through equation (9). The highest Utility Value (\( U_i \)) is the most recommended choice. The following is the process to get the Utility value:

\[ U_1 = 0.1627 \times 100\% = 72.7894 \]
\[ U_2 = 0.2510 \times 100\% = 100 \]
\[ U_3 = 0.2400 \times 100\% = 95.6357 \]
\[ U_4 = 0.1803 \times 100\% = 71.8406 \]
\[ U_5 = 0.2147 \times 100\% = 85.5408 \]

After the Utility value (\( U_i \)) has been obtained, the values are sorted or arranged in ranking form from the largest value to the smallest value, as seen in Table 6.

<table>
<thead>
<tr>
<th>Alternative Code</th>
<th>Alternative</th>
<th>Utility Values (( U_i ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>Zahir Online</td>
<td>100</td>
</tr>
<tr>
<td>A3</td>
<td>FreshBooks</td>
<td>95.6357</td>
</tr>
<tr>
<td>A5</td>
<td>Accurate</td>
<td>85.5408</td>
</tr>
<tr>
<td>A1</td>
<td>Zoho Books</td>
<td>72.7894</td>
</tr>
<tr>
<td>A4</td>
<td>Xero</td>
<td>71.8406</td>
</tr>
</tbody>
</table>

It can be seen in Table 5 that the highest to lowest Utility (\( U_i \)) values are Zahir Online (A2) getting a score of 100, FreshBooks (A3) getting a score of 95.6357, Accurate (A5) getting a score of 85.5408, Zoho Books (A1) getting a score of 72.7894 and Xero (A4) obtained a score of 71.8406. This means that in this case study the recommended alternative is Mercusys Zahir Online (A2). After carrying out the system analysis and design, it is then continued by realizing it in the form of a decision support system through the system coding stage. The decision support system was built based on a website using a code editor, namely Aptana Studio, and a database, namely MySQL. To be able to access this software, users must log in first. If the user successfully logs in, the main menu interface or decision support system dashboard for selecting accounting software will be displayed. On the main menu, a dashboard will be displayed containing the main features of the system, and the results of previous decisions will also be displayed in graphical form. The DSS dashboard interface for selecting accounting software is presented in Figure 2.

Figure 2. Decision Support System User Interface Dashboard for Selecting Accounting Software
As can be seen in Figure 2, on the dashboard of the decision support system for selecting accounting software, there are the main features of the system, and the results of decisions that have been taken previously are also displayed in graphical form. The main features offered include features for managing criteria, alternatives, alternative values and carrying out calculations using the COPRAS approach. To be able to start getting the results of decisions on selecting accounting software in this system, users must first manage the criteria data in the criteria menu. In this feature, users can manage criteria data that will be used in making decisions. Management that can be carried out includes adding, changing data and deleting criteria data. After that, users can manage alternative data. In this feature, users can carry out management such as inputting, changing and deleting alternative data. The display for the alternative data addition feature is visualized in Figure 3.

![Figure 3. User Interface for Inputting Alternative Data](image)

Figure 3 shows the form interface for inputting alternative data, where the user can manage the alternatives to be selected. After the criteria data and alternative data are available, proceed with providing alternative values. In the alternative value menu, users can give a value to each alternative based on the criteria and specifications of the product. If alternative value data has been input, then the best alternative results can be seen in the COPRAS Calculation menu. This feature displays the step by step process of calculating the COPRAS approach. The output from this feature not only displays the COPRAS method calculation process, but also displays the recommendation results in the form of alternative rankings which are ordered from the highest value to the lowest. The output of the calculation results for this system is presented in Figure 4.

![Figure 4. Decision Recommendation Output Using the COPRAS Method](image)

Figure 4 shows the output of the calculation process using the COPRAS approach. This feature shows ranking results that can help users make their choices. It can be seen that the highest to lowest scores were obtained, namely Zahir Online (A2) got a score of 100, FreshBooks (A3) got a score of 95.6357, Accurate (A5) got a score of 85.5408, Zoho Books (A1) got a score of 72.7894 and Xero (A4) got a score of 71.8406. If you look at the output results of the COPRAS method calculations from the case studies that have been carried out, it produces values that are no different from the results of manual calculations. This means that the output produced by the system is valid.

The results of the implementation of the decision support system are then tested to ensure that the system is suitable for its use. Tests are carried out through usability testing so that the system can be evaluated to determine to what extent this decision support system can be used effectively and to meet the needs of its users. In this usability testing, four sub-criteria are used, consisting of understandability, learnability, operability, and attractiveness criteria. Based on these sub-criteria, a questionnaire was then prepared consisting of 10 questions. The scale used in the questionnaire uses the Guttman scale, so you can get an extreme response from the user, whether the user agrees or disagrees. The number of respondents was 25; these respondents were people who would choose accounting software. The results of the user responses are then calculated by the number of agreeing and disagreeing answers and created in the form of a percentage. The results of testing the usability of the decision support system for selecting accounting software are shown in Figure 5.
In this research, the COPRAS (Complex Proportional Assessment) and Rank Reciprocal approaches have been applied to decision support systems for selecting accounting software. From the case studies that have been completed, the highest to lowest utility values have been produced, namely Zahir Online (A2) obtained a score of 100, FreshBooks (A3) obtained a score of 95.6357, Accurate (A5) obtained a score of 85.5408, Zoho Books (A1) obtained a score of 72.7894, and Xero (A4) obtained a score of 71.8406. The output of the decision support system in the case study that has been carried out obtains the same value as manual calculations, so the system calculations can be said to be valid. Apart from that, the results of usability testing obtained a value of 89%. This means that the decision support system for selecting accounting software is appropriate for its use and function based on user responses. For further research, there are several suggestions that can be used as a reference for improvement. In this research, the determination of weights uses Rank Reciprocal, where this approach is vulnerable to a lack of resolution methods to obtain the most optimal approach in solving accounting software selection cases.

4. CONCLUSION

In this research, the COPRAS (Complex Proportional Assessment) and Rank Reciprocal approaches have been applied to decision support systems for selecting accounting software. From the case studies that have been completed, the highest to lowest utility values have been produced, namely Zahir Online (A2) obtained a score of 100, FreshBooks (A3) obtained a score of 95.6357, Accurate (A5) obtained a score of 85.5408, Zoho Books (A1) obtained a score of 72.7894, and Xero (A4) obtained a score of 71.8406. The output of the decision support system in the case study that has been carried out obtains the same value as manual calculations, so the system calculations can be said to be valid. Apart from that, the results of usability testing obtained a value of 89%. This means that the decision support system for selecting accounting software is appropriate for its use and function based on user responses. For further research, there are several suggestions that can be used as a reference for improvement. In this research, the determination of weights uses Rank Reciprocal, where this approach is vulnerable to a lack of resolution methods to obtain the most optimal approach in solving accounting software selection cases.

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