Decision Support System for Selecting Peer-to-Peer Lending Applications using ARAS and Rank Sum Approaches

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Abstract—The development of information technology has brought major changes to the world of finance, especially with the emergence of new business models such as Peer-to-Peer (P2P) lending. Even though the potential for high profits can be obtained through P2P lending platforms, the challenges faced by investors in choosing the right investment application are increasingly complex. With so many choices in P2P lending applications, decision-makers must be careful in making their choice. This creates problems if the decisions made are incorrect, resulting in financial losses. So, the aim of this research is to build a decision support system for choosing a Peer-to-Peer lending application by applying a combination of the Additive Ratio Assessment (ARAS) method and Rank Sum weighting to make it easier for users to determine their choice. Based on the case study, the utility value obtained is highest to lowest, namely: Amarta Microfinance (A3) got a score of 0.9034, Aseku (A4) got a score of 0.8954, KoinWorks (A5) got a score of 0.8640, Investree (A2) got a score of 0.8484, and Danamas Lender (A1) got a score of 0.8080. Besides that, the usability test got an average score of 88.75%, which means the system is appropriate for its use and function. The resulting decision support system has features that make it easier for decision makers to determine P2P lending applications because the system developed can display alternative rankings.

Keywords: Additive Ratio Assessment; ARAS; Decision Support Systems; Peer-to-Peer Lending Applications; Rank Sum

1. INTRODUCTION

The growth of the financial industry in the digital era has created various innovations, one of which is the Peer-to-Peer (P2P) lending system. Peer-to-Peer (P2P) lending is a lending model where borrowers can borrow funds directly from investors via an online platform without involving traditional financial institutions [1]. This business model provides easier access for borrowers who find it difficult to obtain loans from conventional financial institutions, while also providing attractive investment opportunities for lenders [2]. Investors face increasingly complex challenges in choosing the right investment application, despite the potential for high profits through P2P lending platforms [3].

Currently, to choose a P2P lending application, decision-makers must study the existing applications one by one by comparing what the application offers with their needs and risks. This, of course, takes a lot of time for decision-makers and makes it difficult to make decisions. So the impact if the decision to choose an inappropriate P2P lending application results in large financial losses. This means that the success of P2P lending really depends on choosing a P2P lending application that suits each individual’s needs and risk profile. Therefore, there is a need for a Decision Support System (DSS) that is able to provide convenience for borrowers and investors in determining the optimal P2P lending investment application. A Decision Support System (DSS) is an information system designed to assist decision-making in a business or organizational context [4]. The main goal of DSS is to provide computer-based support to decision-makers in analyzing information, evaluating various options, and selecting the best solution for a particular problem or decision [5].

Research related to the application of DSS in investment selection has been carried out by previous researchers using several approaches. There is research regarding the resolution of decisions to choose the best shares using the Simple Additive Weighting (SAW) method [6]. Other research is about a decision support system for choosing investments in the best shares through the use of the Weighted Product (WP) method [7]. This method obtains the best option by ranking alternatives by increasing their weight. The next research is to develop a DSS to determine investment instruments by applying the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) model [8]. This approach is able to obtain the best option by measuring performance based on the closest and farthest distance from the positive and negative ideal solutions. Then, there is research related to resolving decisions to choose stock investments using the Simple Multi-Attribute Rating Technique (SMART) method [9]. The SMART approach obtains the best option through comparing and describing the importance of each criterion regarding its weight and how important its influence is on other criteria.

This research is different from the research that has been described; the difference lies in the use of a combination of Rank Sum and ARAS (Additive Ratio Assessment) weighting methods, and the case study used is the selection of Peer-to-Peer lending applications. The Rank Sum approach is used to provide weighting based on the priority ranking of each criterion used [10]. This method is generally used in ranking analysis, where data are given an order or ranking relative to each other. Meanwhile, the ARAS approach solves decision problems by focusing on relative comparisons between alternatives using ratio comparisons [11]. The advantage of ARAS lies in its ability to handle situations where criteria have different weights and require precise comparisons [12]. This method allows users to overcome the complexity of decision making by paying special attention to the relative preferences between criteria.
This research was conducted with the aim of building a decision support system for choosing Peer-to-Peer (P2P) lending applications by applying a combination of the ARAS method and Rank Sum weighting in order to produce a system that makes it easier for users to determine their choice. The criteria used in this case study are guided by articles published on the MyBest website that have been reviewed by financial practitioners [13]. The criteria used are payment success rate, potential returns, ease of use, insurance protection and application ratings. To ensure easy access and usability for users, we built this decision support system as a website.

2. RESEARCH METHODOLOGY

2.1 Research Stages

Research stages are a series of steps designed to achieve research objectives in a structured and effective way [14]. The objectives of the research stages include the need to detail, plan, and carry out each step carefully in order to achieve valid and relevant research results [15]. The steps in carrying out this research are visualized in Figure 1.

![Figure 1. Research Stages](image)

It can be seen in Figure 1 regarding the stages of conducting research; for more details, they are explained as follows:

1) Identifying Problems

The main goal of problem identification is to clearly and systematically identify the sources or obstacles that cause a situation to not meet expectations or require improvement [16]. Through problem identification, we can detail the aspects that need to be improved or addressed to achieve an effective solution. Based on observations and interviews, the main problem in selecting P2P lending applications is that to make a selection, decision makers must study the existing applications one by one by comparing what the application offers with their needs and risks. This of course takes a lot of time for decision makers and makes it difficult to make decisions. Inappropriate investment decisions can result in significant financial losses. This means that the success of P2P lending really depends on choosing a P2P lending application that suits each individual’s needs and risk profile. Therefore, a Decision Support System (DSS) is needed that can help borrowers and investors in determining the optimal P2P lending investment application.

2) Determining Criteria Weighting

Criterion weight is the measure and level of importance of decision makers to the criteria used in making decisions [17]. Determining this weight is crucial because it serves as the basis for the decision-making approach to measuring alternative performance. The approach used in determining the weight of criteria in this research is Rank Sum. The Rank Sum approach is used to provide weighting based on the priority ranking of each criterion used [10]. The results of this approach are in the form of weight values for each criterion.

3) Solving Decision Problems

To solve decision problems by getting the best alternative, this research uses the ARAS (Additive Ratio Assessment) approach. The ARAS method is an approach in decision support systems that is used to evaluate and select alternatives based on their relative comparison [11]. The results of the ARAS approach are in the form of ranking alternatives by looking for the highest utility value. The highest utility value is the alternative with the best performance.
4) Implementing a Decision Support System

This stage involves the coding stage, where the software developer translates the software design or specifications into computer code that can be executed by a computer [18]. In developing a decision support system for choosing a P2P lending application, it was built based on a website using a code editor, namely Bluefish, and a database, namely MySQL.

5) Testing Decision Support Systems

Testing is an important process to ensure that the software works in line with its needs and specifications [19]. This testing process not only identifies bugs or errors but also helps ensure the quality and reliability of the software before it is rolled out to users. So, to ensure the quality of the software being built, usability testing is used. Usability testing evaluates and measures the effectiveness of implementing the system being built for its users [20]. This test is taken from the usability aspects of ISO 9126 which consist of sub-criteria including understandability, learnability, operability and attractiveness. In this research, a questionnaire was prepared, which was then filled out by users to assess the public complaints system in terms of usability.

2.2 Rank Sum Weighting Technique

The Rank Sum weighting method is a technique used in ranking analysis to assign a certain weight or value to each sorted data element [21]. In this method, we rank each data element relative to other elements. Each element’s ratings are then summed, and the results serve as a basis for weighting. This method involves ranking the criteria obtained based on the priority of each criterion, giving the highest ranking to the criteria considered most important by the decision-maker [22]. Next, we assign weights to each criterion based on their ranking, giving greater weight to higher-ranked criteria. The weight values produced using the Rank Sum approach can be obtained through equation (1).

\[
w_j = \frac{n-r_j+1}{\sum(n-r_k+1)}
\]

where \( w_j \) refers to the criteria weight value for parameter \( j \), \( n \) refers to the number of criteria used, \( r_j \) refers to the ranking position of the existing parameters, and \( r_k \) is the parameter used.

2.3 Additive Ratio Assessment (ARAS) Method

The ARAS (Additive Ratio Assessment) method, developed in 2010 by Zavadskas and Turskis, is a solution for solving multi-criteria decision problems [23]. The ARAS approach refers to an assessment method that combines additive and ratio aspects. In ARAS, assessment is carried out by adding the ratio values between pairs of criteria and alternatives, and weight is given to each criterion based on its contribution to the decision-making goal [24]. This approach allows stakeholders to assign preferences relative to each criterion, and automatically generates weights and rankings of alternatives. The main goal of ARAS is to simplify the complexity in multi-criteria decision making by systematically combining preferences. This method has the ability to provide consistent and measurable solutions, producing objective results in determining the best alternative. Completing the ARAS approach has several phases, here are the explanations:

1) Looking for the optimum value

For each existing attribute, the optimum value will be sought, where this value is obtained based on the nature of each criterion. If the type of criterion is benefit, the optimum value is obtained from the highest attribute value. On the other hand, if the type of criterion is cost, the optimum value is obtained from the attribute with the lowest value. So, the optimum value for the benefit criteria can use equation (2) and for the cost criteria use equation (3).

\[
x_{0j} = \frac{\text{Max}}{1}
\]

\[
x_{0j} = \frac{\text{Min}}{1}
\]

where, \( x_{0j} \) shows the optimum value for each attribute.

2) Create a decision matrix for all attributes

After the optimum value for each attribute is obtained, then proceed by entering all the attribute values into the decision matrix. The preparation of the decision matrix is guided by equation (4).

\[
X = \begin{bmatrix}
x_{01} & x_{0j} & \cdots & x_{0n} \\
x_{11} & x_{1j} & \cdots & x_{1n} \\
\vdots & \vdots & \ddots & \vdots \\
x_{m1} & x_{mj} & \cdots & x_{mn}
\end{bmatrix}
\]

where, \( m \) refers to the number of alternatives, \( n \) is the total criteria used, \( x_{ij} \) refers to the performance assessment of alternative \( i \) against criterion \( j \), and \( x_{0j} \) refers to the optimum value for each attribute.

3) Normalize attributes and arrange them in a normalized matrix

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Each attribute is normalized based on the nature of the criteria. After all the values in the matrix have been normalized, then rearrange them into a normalized matrix. To get the normalization value, if the criteria are benefit, use equation (5) and if the criteria are cost, use equation (6).

\[ x_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \]  
(5)

\[ x_{ij} = \frac{1}{k_{ij}} ; x_{ij}^* = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \]  
(6)

4) Calculates weighted normalized values

After normalization, the next step is to carry out weighted normalization by multiplying by the weight. The weighted normalization value for each attribute is obtained through equation (7).

\[ D_{ij} = x_{ij} \times w_{ij} \]  
(7)

5) Finding the value of the optimality function

Each existing alternative will be searched for and the value of the optimization function or \( S_i \) will be calculated. To get this value, it can be calculated using equation (8).

\[ S_i = \sum_{j=1}^{n} D_{ij} \]  
(8)

where, \( S_i \) shows the optimality function value of each alternative.

6) Determining utility value

The next phase is to determine the utility value \( K_i \) in order to obtain an assessment of the performance of each alternative. The highest utility value is the most recommended alternative. To get the utility value of each alternative, you can use equation (9).

\[ K_i = \frac{S_i}{S_0} \]  
(9)

where, \( S_i \) refers to the optimality function and \( S_0 \) refers to the number of optimal criteria, while \( K_i \) refers to the utility value of each alternative.

3. RESULT AND DISCUSSION

In providing solutions to decision-making problems for case studies selecting P2P lending applications, it begins with determining the criteria used in decision-making. The criteria used in this case study are guided by articles published on the MyBest website that have been reviewed by financial practitioners [13]. The criteria used are payment success rate, potential returns, ease of use, insurance protection, and application ratings. All criteria used are beneficial in nature because they prioritize the highest value. Next, the weight value for each criterion is determined from the predetermined criteria. The approach to determining the weight values applies the Rank Sum technique, where the weighting is obtained by ranking the criteria based on their priority and giving the highest ranking to the criteria considered most important by the decision maker. In this case study, the decision-maker determines the priority order presented in Table 1.

<table>
<thead>
<tr>
<th>Criteria Name</th>
<th>Type of Criteria</th>
<th>Order of Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment Success Rate</td>
<td>Benefit</td>
<td>1</td>
</tr>
<tr>
<td>Potential Returns</td>
<td>Benefit</td>
<td>2</td>
</tr>
<tr>
<td>Ease of Use</td>
<td>Benefit</td>
<td>3</td>
</tr>
<tr>
<td>Insurance Protection</td>
<td>Benefit</td>
<td>4</td>
</tr>
<tr>
<td>Application Ratings</td>
<td>Benefit</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 1 shows the priority order based on the importance of the criteria used. Based on the priority order, the weight value is determined through calculating the Rank Sum approach using equation (1). The calculation steps are as follows:

\[ w_1 = \frac{5-1+1}{(5-1+1)+(5-2+1)+(5-3+1)+(5-4+1)+(5-5+1)} = \frac{5}{15} = 0.3333 \]

\[ w_2 = \frac{5}{(5-1+1)+(5-2+1)+(5-3+1)} = \frac{4}{15} = 0.2667 \]

\[ w_3 = \frac{5}{(5-1+1)+(5-2+1)+5} = \frac{3}{15} = 0.2000 \]

\[ w_4 = \frac{5}{(5-1+1)+(5-2+1)+(5-3+1)+(5-4+1)+(5-5+1)} = \frac{1}{15} = 0.0667 \]
After calculating using the Rank Sum approach, these values are used as weights for each criterion. Table 2 presents the weight results for each criterion.

Table 2. Resulting Weight Values

<table>
<thead>
<tr>
<th>Criteria Code</th>
<th>Criterion Name</th>
<th>Type of Criteria</th>
<th>Value Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Payment Success Rate</td>
<td>Benefit</td>
<td>0.3333</td>
</tr>
<tr>
<td>C2</td>
<td>Potential Returns</td>
<td>Benefit</td>
<td>0.2667</td>
</tr>
<tr>
<td>C3</td>
<td>Ease of Use</td>
<td>Benefit</td>
<td>0.2000</td>
</tr>
<tr>
<td>C4</td>
<td>Insurance Protection</td>
<td>Benefit</td>
<td>0.1333</td>
</tr>
<tr>
<td>C5</td>
<td>Application Ratings</td>
<td>Benefit</td>
<td>0.0667</td>
</tr>
</tbody>
</table>

Table 2 shows the weights of the criteria that will be used in decision-making. The next step determines the value range and value conversion for each alternative. This is used to make calculations easier because there are several criteria that constitute qualitative data. The results of converting these values are then presented in Table 3.

Table 3. Conversion of Value for Each Criterion

<table>
<thead>
<tr>
<th>Code Criteria</th>
<th>Criterion Name</th>
<th>Value Range</th>
<th>Value Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Payment Success Rate</td>
<td>&lt; 90.00%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;= 90.00% dan &lt; 94.00%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;= 94.00% dan &lt; 98.00%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;= 98.00%</td>
<td>4</td>
</tr>
<tr>
<td>C2</td>
<td>Potential Returns</td>
<td>&lt; 8%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;= 8% dan &lt; 13%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;= 13% dan &lt; 18%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;= 18%</td>
<td>4</td>
</tr>
<tr>
<td>C3</td>
<td>Ease of Use</td>
<td>Not Easy</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quite Easy</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Easy</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very Easy</td>
<td>4</td>
</tr>
<tr>
<td>C4</td>
<td>Insurance Protection</td>
<td>Not Protected</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fairly Protected</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Protected</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Highly Protected</td>
<td>4</td>
</tr>
<tr>
<td>C5</td>
<td>Application Ratings</td>
<td>&lt; 3.5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;= 3.5 dan &lt; 4.0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;= 4.0 dan &lt; 4.5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;= 4.5</td>
<td>4</td>
</tr>
</tbody>
</table>

In Table 3, it can be seen that each criterion is given a conversion value because it makes calculations easier, and there are criteria with qualitative data. The process continues by determining the alternative that will be chosen by the decision-maker. For case studies, the P2P lending applications used as an alternative are as follows: Danamas Lender (A1), Investree (A2), Amartha Microfinance (A3), Asetku (A4), and KoinWorks (A5). Then, these options are given a value based on their characteristics against predetermined criteria. The valuation for each alternative in relation to the criteria is shown in Table 4.

Table 4. Value of the Option to be Selected

<table>
<thead>
<tr>
<th>Alternative Code</th>
<th>Alternative Name</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C1</td>
</tr>
<tr>
<td>A1</td>
<td>Danamas Lender</td>
<td>99.95%</td>
</tr>
<tr>
<td>A2</td>
<td>Investree</td>
<td>94.95%</td>
</tr>
<tr>
<td>A3</td>
<td>Amartha Microfinance</td>
<td>99.95%</td>
</tr>
<tr>
<td>A4</td>
<td>Asetku</td>
<td>99.00%</td>
</tr>
<tr>
<td>A5</td>
<td>KoinWorks</td>
<td>94.00%</td>
</tr>
</tbody>
</table>

Based on Table 4 which contains alternative assessments, the value will then be changed based on Table 3 which is used to carry out the value conversion.

Table 5. Obtained Conversion Value

<table>
<thead>
<tr>
<th>Alternative Code</th>
<th>Alternative Name</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C1</td>
</tr>
<tr>
<td>A1</td>
<td>Danamas Lender</td>
<td>4</td>
</tr>
</tbody>
</table>
Normalization is carried out for all attributes based on their values in the decision matrix. Because all attributes are beneficial, the normalization process uses equation (5). The following is the process of obtaining normalized attribute values:

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

Then all these values are entered into a matrix guided by equation (4). The following are the results of the decision matrix:

Table 5 presents alternative values for the criteria, which we have converted to facilitate the calculation process. The next step is to solve this decision problem using the ARAS approach in order to get the best option. This process begins by determining the optimum value \( X_0 \). Based on Table 2, it is shown that all the criteria used are benefit in nature, so that the optimum value \( X_0 \) obtained is: \( \{4; 4; 4; 4; 3\} \). Then all these values are entered into a matrix guided by equation (4). The following are the results of the decision matrix:

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

Normalization is carried out for all attributes based on their values in the decision matrix. Because all attributes are beneficial, the normalization process uses equation (5). The following is the process of obtaining normalized attribute values:

\[
X_{01} = \frac{4}{4+4+4+4+4+4} = 0.1818 \\
X_{11} = \frac{4}{4+4+4+4+4+4} = 0.1818 \\
X_{21} = \frac{4}{4+4+4+4+4+4} = 0.1364 \\
X_{31} = \frac{4}{4+4+4+4+4+4} = 0.1818 \\
X_{41} = \frac{4}{4+4+4+4+4+4} = 0.1818 \\
X_{51} = \frac{4}{4+4+4+4+4+4} = 0.2000 \\
X_{02} = \frac{4}{4+2+3+3+4+4} = 0.2000 \\
X_{12} = \frac{4}{4+2+3+3+4+4} = 0.1000 \\
X_{22} = \frac{4}{4+2+3+3+4+4} = 0.1500 \\
X_{32} = \frac{4}{4+2+3+3+4+4} = 0.1500 \\
X_{42} = \frac{4}{4+2+3+3+4+4} = 0.2000 \\
X_{52} = \frac{4}{4+2+3+3+4+4} = 0.2000 \\
X_{03} = \frac{4}{4+3+4+4+3+4} = 0.1818 \\
X_{13} = \frac{4}{4+3+4+4+3+4} = 0.1818 \\
X_{23} = \frac{4}{4+3+4+4+3+4} = 0.1818 \\
X_{33} = \frac{4}{4+3+4+4+3+4} = 0.1818 \\
X_{43} = \frac{4}{4+3+4+4+3+4} = 0.1364 \\
X_{53} = \frac{4}{4+3+4+4+3+4} = 0.1818 \\
X_{04} = \frac{4}{4+4+4+4+4+3} = 0.1818 \\
X_{14} = \frac{4}{4+4+4+4+4+4} = 0.1818 \\
X_{24} = \frac{4}{4+4+4+4+4+4} = 0.1818 \\
X_{34} = \frac{4}{4+4+4+4+4+4} = 0.1818 \\
X_{44} = \frac{4}{4+4+4+4+4+4} = 0.1818 \\
X_{54} = \frac{4}{4+4+4+4+4+4} = 0.2000 \\
X_{05} = \frac{4}{3+3+3+3+2+2} = 0.2000 \\
X_{15} = \frac{4}{3+3+3+3+2+2} = 0.2000 \\
X_{25} = \frac{4}{3+3+3+3+2+2} = 0.2000 \\
\]

The decision matrix can be rearranged as follows:

<table>
<thead>
<tr>
<th>Alternative Code</th>
<th>Alternative Name</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>Investree</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>A3</td>
<td>Amartha Microfinance</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>A4</td>
<td>Asetku</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>A5</td>
<td>KoinWorks</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
Next, arrange all normalized attribute values into a decision matrix using the following steps:

\[
X_{ij} = \begin{bmatrix}
0.1818 & 0.2000 & 0.1818 & 0.1818 & 0.2000 \\
0.1818 & 0.1000 & 0.1364 & 0.1818 & 0.2000 \\
0.1364 & 0.1500 & 0.1818 & 0.1818 & 0.2000 \\
0.1818 & 0.1500 & 0.1818 & 0.1818 & 0.1333 \\
0.1818 & 0.2000 & 0.1364 & 0.1364 & 0.1333 \\
0.1364 & 0.2000 & 0.1818 & 0.1364 & 0.1333 \\
\end{bmatrix}
\]

Based on the normalized matrix, a weighted normalized decision matrix is then prepared. The weighted normalization value is calculated using equation (7). Here's the calculation process:

\[
D_{01} = 0.3333 \times 0.1818 = 0.0900 \\
D_{11} = 0.3333 \times 0.1818 = 0.0675 \\
D_{21} = 0.3333 \times 0.1364 = 0.0900 \\
D_{31} = 0.3333 \times 0.1818 = 0.0675 \\
D_{41} = 0.3333 \times 0.1818 = 0.0900 \\
D_{51} = 0.3333 \times 0.1364 = 0.0450 \\
D_{02} = 0.2667 \times 0.2000 = 0.0900 \\
D_{12} = 0.2667 \times 0.1000 = 0.0675 \\
D_{22} = 0.2667 \times 0.1500 = 0.0900 \\
D_{32} = 0.2667 \times 0.1500 = 0.0675 \\
D_{42} = 0.2667 \times 0.2000 = 0.0900 \\
D_{52} = 0.2667 \times 0.2000 = 0.0450 \\
D_{03} = 0.2000 \times 0.1818 = 0.0900 \\
D_{13} = 0.2000 \times 0.1364 = 0.0675 \\
D_{23} = 0.2000 \times 0.1818 = 0.0900 \\
D_{33} = 0.2000 \times 0.1818 = 0.0675 \\
D_{43} = 0.2000 \times 0.1364 = 0.0900 \\
D_{53} = 0.2000 \times 0.1818 = 0.0450 \\
D_{04} = 0.1333 \times 0.1818 = 0.0900 \\
D_{14} = 0.1333 \times 0.1818 = 0.0675 \\
D_{24} = 0.1333 \times 0.1818 = 0.0900 \\
D_{34} = 0.1333 \times 0.1364 = 0.0450 \\
D_{44} = 0.1333 \times 0.1364 = 0.0900 \\
D_{54} = 0.1333 \times 0.1364 = 0.0450 \\
D_{05} = 0.0667 \times 0.2000 = 0.0900 \\
D_{15} = 0.0667 \times 0.2000 = 0.0675 \\
D_{25} = 0.0667 \times 0.2000 = 0.0900 \\
D_{35} = 0.0667 \times 0.1333 = 0.0675 \\
D_{45} = 0.0667 \times 0.1333 = 0.0900 \\
D_{55} = 0.0667 \times 0.1333 = 0.0450
\]

Arrange all weighted normalized attribute values into a weighted normalized decision matrix as follows:

\[
D_{ij} = \begin{bmatrix}
0.0600 & 0.0540 & 0.0364 & 0.0236 & 0.0140 \\
0.0600 & 0.0270 & 0.0273 & 0.0236 & 0.0140 \\
0.0450 & 0.0405 & 0.0364 & 0.0236 & 0.0140 \\
0.0600 & 0.0405 & 0.0364 & 0.0236 & 0.0093 \\
0.0600 & 0.0540 & 0.0273 & 0.0177 & 0.0093 \\
0.0450 & 0.0540 & 0.0364 & 0.0177 & 0.0093
\end{bmatrix}
\]

The next phase is to find the value of the optimization function \((S_\hat{i})\) using equation (8). Obtain the value of the optimization function by summing the weighted normalized attribute values for each alternative. The following is the process of obtaining the optimization function value:

\[
S_0 = 0.0600 + 0.0540 + 0.0364 + 0.0236 + 0.0140 = 0.1880 \\
S_1 = 0.0600 + 0.0270 + 0.0273 + 0.0236 + 0.0140 = 0.1519 \\
S_2 = 0.0450 + 0.0405 + 0.0364 + 0.0236 + 0.0140 = 0.1595 \\
S_3 = 0.0600 + 0.0405 + 0.0364 + 0.0236 + 0.0093 = 0.1698 \\
S_4 = 0.0600 + 0.0540 + 0.0273 + 0.0177 + 0.0093 = 0.1683
\]
After the optimization function value is obtained, proceed with finding the utility value ($K_i$) of the performance of each alternative using equation (9). The following process displays the results of these calculations:

$$S_x = 0.0450 + 0.0540 + 0.0364 + 0.0177 + 0.0093 = 0.1624$$

The utility value ($K_i$) guides the determination of the best option, with the highest utility value representing the best solution. Based on the utility calculations that have been obtained, they are sorted from the highest value to the lowest, as shown in Table 6.

<table>
<thead>
<tr>
<th>Alternative Code</th>
<th>Alternative Name</th>
<th>Utility Value</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>Amartha Microfinance</td>
<td>0.9034</td>
<td>1</td>
</tr>
<tr>
<td>A4</td>
<td>Asetku</td>
<td>0.8954</td>
<td>2</td>
</tr>
<tr>
<td>A5</td>
<td>KoinWorks</td>
<td>0.8640</td>
<td>3</td>
</tr>
<tr>
<td>A2</td>
<td>Investree</td>
<td>0.8484</td>
<td>4</td>
</tr>
<tr>
<td>A1</td>
<td>Danamas Lender</td>
<td>0.8080</td>
<td>5</td>
</tr>
</tbody>
</table>

In Table 6, the highest to lowest utility values are: Amartha Microfinance (A3) gets a score of 0.9034, Asetku (A4) gets a score of 0.8954, KoinWorks (A5) gets a score of 0.8640, Investree (A2) gets a score of 0.8484, and Danamas Lender (A1) gets a score of 0.8080. So, the Amartha Microfinance (A3) alternative is the best choice because it has the highest utility value.

After completing the analysis and modeling process, the next step involves realizing it in the form of a decision support system during the implementation stages. This stage involves the coding stage, where the software developer translates the software design or specifications into computer code that can be executed by a computer. The development of a decision support system for choosing a P2P lending application involved building it based on a website using a code editor, namely Bluefish, and a database, namely MySQL. The decision-support system for choosing a P2P lending application starts with the user accessing the application via a login form. After the user successfully logs in, the system displays the dashboard as the main menu. The dashboard contains the main features of the system and displays a graph of utility values using the ARAS approach. The main features of this system include managing criteria data, alternatives, alternative values, and ARAS calculations.
delete data. Once the criteria and alternative data have been added, the user can assign a value to each alternative in the alternative feature. In this feature, users provide alternative values based on specifications. The alternative value-added form is visualized in Figure 3.

![Figure 3. Interface Display Providing Alternative Values](image)

Figure 3 shows the alternative value data input interface. After the alternative value has been input, the user can perform automatic ARAS method calculations on the system via the ARAS calculation feature. This feature will display step-by-step instructions for calculating the ARAS approach. Apart from that, in this feature, the system will also display a ranking from highest to lowest utility value, making it easier for users to make decisions.

![Figure 4. ARAS Method Calculation Process Interface](image)

Figure 4 is the output of the decision support system developed, where the values obtained from the ARAS method calculation results are: Amartha Microfinance (A3) got a score of 0.9034, Asetku (A4) got a score of 0.8954, KoinWorks (A5) got a score of 0.8640, Investree (A2) got a score of 0.8484, and Danamas Lender (A1) got a score of 0.8080. The output results of the ARAS method calculations from the case studies that have been carried out produce values that are identical to the manual calculation results. The validity of the output produced by the system is confirmed. Based on the analysis of the results of the case study that has been carried out, it shows that the ARAS method is able to obtain the best alternative by providing a utility function value to take into account the ratio of different criteria in the assessment process, which is then compiled in the form of a performance ranking.
In order to ensure that the software being developed meets the user's wishes, the system is tested first. This testing process not only identifies bugs or errors but also helps ensure the quality and reliability of the software before it is released to users. So, in this research, usability testing is used, where this approach is applied so that it can be measured to what extent software is implemented effectively and efficiently by the end user. This test is taken from the usability aspects of ISO 9126, which consist of sub-criteria including understandability, learnability, operability, and attractiveness. Based on these criteria, a questionnaire was prepared using 10 questions that users had to answer using the Guttman scale. This scale is used because the aim of this measurement is to get firm answers, whereas on this scale there are only agree or disagree answers. This questionnaire will be filled out by 20 respondents who will select the P2P lending application. The results of this test are then presented in graphic form, as shown in Figure 5.

![Usability Test Percentage Gain Graph](image)

Based on the graphic results seen in Figure 5, it shows that respondents agree on the understandability sub-criteria with a score of 90.00%; learnability with a score of 85.00%; operability with a score of 95.00%; and attractiveness with a score of 85.00%. For the average of all criteria, a score of 88.75% was obtained. Then, the results are entered into an assessment category with the reference being: a score of 76% to 100% is in the "Good" category; a score of 56% to 75% falls into the "Fairly Good" category; a score of 40% to 55% falls into the "Poor" category; a score below 40% is included in the "Not Good" category [25]. So, the results of the usability test on the decision support system for selecting the P2P lending application that was built are in the "Good" category. So, it can be said that the system is appropriate for its use and function based on the response from the user.

### 4. CONCLUSION

This research develops a decision support system for selecting P2P lending applications by applying the ARAS method and Rank Sum approach. The Rank Sum approach in this research functions to deter disagree learnability. The method compares and ranks alternatives based on attribute utility performance to determine the best alternative. The resulting decision support system has features that make it easier for decision makers to determine P2P lending applications because the system developed can display a ranking of alternatives which are sorted based on the highest value. From the completed case studies, the highest to lowest utility values are: Amartaha Microfinance (A3) got a score of 0.9034, Asetku (A4) got a score of 0.8954, KoinWorks (A5) got a score of 0.8640, Investree (A2) got a score of 0.8484, and Danamas Lender (A1) got a score of 0.8484. Meanwhile, usability testing received an average score of 88.75%, which means the system was declared suitable for use. However, as a suggestion for future research, there are several things that need to be improved, namely that the Rank Sum weighting technique tends not to be objective in determining priorities, so it can use fuzzy logic to be able to reason logically. In addition, this research performs value transformation on qualitative data, which requires additional investigation into how to ensure that the values are truly representative.

### REFERENCES


