Comparative Analysis of The MOORA Method for Evaluating The Effectiveness of Scholarship Acceptance

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1. Introduction

Every citizen will need education, because whether they realize it or not, education is the main source or benchmark for whether a country can prosper its people. Getting a good and decent education is a human right and is contained in the 1945 Constitution. Getting a good and decent education will open the door to a better life. The increasing cost of education will become an obstacle for less fortunate students, which can cause students to be forced to leave school due to lack of funds (Anindia Putra et al., 2020).

A school is a building or institution for learning and teaching as well as a place to receive and give lessons. In other words, a school is an educational institution where students receive or study. From this understanding, it is clear that the purpose of school is as a place for students to study. Students' obligations at school are to obey all school rules (I. N. T. A. Putra et al., 2022). All students at school must understand their position as part of the school. Of course, school students have some obligations to do well. By fulfilling their obligations, students receive their rights. This must be communicated by the school so that students can take responsibility and make decisions about their own behavior. Because of these students’ rights and obligations, government agencies provide...
financial assistance or what are usually called scholarships to talented and underprivileged students (Kartini & Putra, 2020).

Scholarships are income for students who receive them and the purpose of scholarships is to help ease the burden of educational costs on students who receive them. Several institutions distribute scholarships to help less fortunate people during their studies (Kurniawan et al., 2019). Scholarships provided by state institutions in the form of fees for one year of education are given to underprivileged students after a school selection decision. Manggis 1 Public High School is located in Karangasem Regency, Bali. This school is a high school that implements a scholarship program for its students.

In the selection process to determine students who are entitled to receive underprivileged scholarships, SMA Negeri 1 Manggis is still carrying out a selection process using the criteria used by the school which consists of KIS (Healthy Indonesia Card), parents' income, parents' employment, and the child's status is summarized using Microsoft Excel. SMA Negeri 1 Manggis is an educational institution that has not utilized the information system in Decision Support System (DSS), especially in supporting the educational scholarship selection process for its students. To be able to process data and search for scholarship recipient students more objectively, The aim of this research is to create a decision-making model by implementing a decision support system using the Multi-Objective Optimization On the Basis of Ratio Analysis (MOORA) method so that it can facilitate and assist SMA Negeri 1 Manggis in carrying out the scholarship acceptance process objectively and can be an alternative decision for decision makers (Lubis et al., 2020; Siregar et al., 2022).

Decision Support System is a computer-based system intended to assist decision making in utilizing certain data and models to solve various semi-structured problems such as in the process of determining scholarship selection (Ira Zulfa, Putra, 2018; Putri et al., 2024). Semi-structured are decisions that are partly programmable, partly repetitive and routine and partly unstructured. Unstructured, namely decisions that do not occur repeatedly and do not always occur. This decision occurs at the top level of management. Information for unstructured decision making is not easy to obtain and is not easily available and usually comes from the external environment (Sudipa et al., 2022). By utilizing the system, alternative data can be used in the selection process and determine the alternative with the highest results according to the assessment criteria (Prilantana et al., 2021). One of these information systems can be applied in a decision support system in an institution (Kadek et al., 2022). Decision support systems are intended to be tools for decision makers to expand their capabilities, but not to replace the decision maker's judgment (I. N. T. A. P. Putra et al., 2023). The applied MOORA comparative analysis DSS helps decision makers make objective decisions from the best alternatives.

2. Literature Review

A number of previous studies related to the Comparative Analysis of the MOORA Method in Decision Support Systems for Evaluating the Effectiveness of Scholarship Acceptance have provided important contributions in understanding the use of the MOORA method in this context. The first study examines the application of the MOORA method in a decision support system for evaluating scholarship admissions, highlighting the advantages and disadvantages of the method (Mardhiyyah et al., 2019). The second study conducted a critical analysis of the use of the MOORA method, highlighting aspects that need to be considered in its implementation. The third research conducted a comparative study on the use of the MOORA method (Marcheta et al., 2022; Utami & RUSKAN, 2020), comparing the resulting evaluation results with other methods. The fourth study explored various approaches to the MOORA method, trying to identify possible implementation variations. The fifth research focuses on comparative analysis of the performance of the MOORA method (Andani et al., 2019; Chakraborty et al., 2023), evaluating the efficiency and accuracy of the method.
compared with other approaches. Other research developed a scholarship acceptance evaluation model by comparing various implementations of the MOORA method in decision support systems, providing in-depth insight into the potential and limitations of using the method (Siregar et al., 2021). Through this study, a research gap is filled, namely the comparative MOORA approach in a decision support system with the selection of the best alternative from several criteria to improve process effectiveness and acceptance of scholarships procedure.

**Decision Support System**

Decision Support System (DSS) is an interactive information system that provides modeling information and data manipulation. The system is used to assist decision making in semi-structured situations and unstructured situations. Structured decisions are decisions that are repeated and routine, so they can be programmed. Semi-structured are decisions that are partly programmable, partly repetitive and routine and partly unstructured. Unstructured, namely decisions that do not occur repeatedly and do not always occur. This decision occurs at the top level of management (Putri et al., 2024; Sudipa et al., 2021).

**Scholarship**

Scholarships are income for those who receive them and the purpose of the scholarship is to help ease the burden of educational costs on students who receive them. Scholarships are distributed by several institutions to help someone who is less fortunate or has high achievements during their studies. Financial assistance given to individuals is intended to be used for the continuation of the education being pursued. Providing scholarships can be categorized as a work bond after completing education. The length of this service bond varies, depending on the institution that provides the scholarship in accordance with the regulations determined by the school to obtain a scholarship, so criteria are needed to determine who will be selected to receive the scholarship. The elementary school student scholarship program is a form of social responsibility to the Indonesian people in improving human resources, especially in the field of education (Ketut Sepdyana Kartini, I Nyoman Tri Anindia Putra, Nur Haliza Lukman, 2023). There are two types of elementary school scholarships, namely: achievement scholarships and underprivileged scholarships.

3. **Research Methods**

3.1 **Metode Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA)**

The MOORA method is one of the methods used in decision support systems (DSS) to evaluate decision alternatives that have several different criteria or objectives. The MOORA method allows users to compare decision alternatives by considering several predetermined criteria. This method converts each criterion into a ratio and then calculates the relative weight value for each criterion (Dong et al., 2019). After that, the MOORA method calculates the relative preference value for each decision alternative and determines the best alternative based on the highest preference value. The MOORA method has been widely used in various applications, including in the scholarship acceptance process, because it is able to provide accurate and efficient evaluation results. In the context of receiving scholarships, the MOORA method can help in evaluating applicant qualifications based on predetermined criteria (Siregar et al., 2022). Thus, the MOORA method can help improve the effectiveness of the scholarship acceptance process and ensure that scholarships are awarded to applicants who best meet the specified criteria. This relatively new method was first used in multi-criteria sampling (Rony et al., 2023). This method has a good level of selectivity because it can determine objectives from conflicting criteria. Where the criteria can be profitable (benefit) or unprofitable (cost) (Sahida et al., 2019).

The steps of the MOORA method can be seen as follows:

1) Inputting criteria values
2) Create a decision matrix
3) Normalization using the MOORA method. Normalization aims to unite each matrix element so that the elements in the matrix have uniform values. Normalization in MOORA can be calculated using the following equation

\[ X_{ij} = \frac{x_{ij}}{\sqrt[n]{\sum_{j=1}^{m} x_{ij}^2}} \]  

(1)

4) Optimize attributes, for multi-objective optimization, these normal performances are added in case of maximization (for favorable attributes) and subtracted in case of minimization (for unfavorable attributes). Then the optimization problem becomes:

\[ Y_{in} = \sum_{j=1}^{g} W_j X^n_{ij} - \sum_{j=g+1}^{n} W_j X^n_{ij} \]  

(2)

5) Reducing the maximum and minimum values to suddenly determine that an attribute is more important can be multiplied by the adjusted weight (significance coefficient) when the weight attribute is considered, calculated using the following equation:

\[ Y_{in} = \sum_{j=1}^{g} W_j X_{ij} - \sum_{j=g+1}^{n} W_j X_{ij} + 1 W_j W_{ij} \]  

(3)

4. Results and Discussions

4.1. Data Analysis

The Decision Support System for Determining Scholarship Recipients using the Moora Method for SMA Negeri 1 Manggis which will be designed must have the main function, namely being able to assist the School in making decisions to select students who are worthy of receiving scholarships in the categories of high achieving scholarships and underprivileged scholarships. In designing the Decision Support System for Determining Scholarship Recipients using the Moora Method for SMA Negeri 1 Manggis which will be created, the data required is the scholarship assessment criteria obtained from the interview process with the Decision Maker, so that there are 4 main criteria in determining the Decision.

<table>
<thead>
<tr>
<th>Criterion (C)</th>
<th>Subcriteria</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child status (C1)</td>
<td>Orphan</td>
<td>Benefits</td>
</tr>
<tr>
<td></td>
<td>Orphaned</td>
<td></td>
</tr>
<tr>
<td></td>
<td>complete parents</td>
<td></td>
</tr>
<tr>
<td>KIS (Healthy Indonesia Card)</td>
<td>Yes</td>
<td>Benefits</td>
</tr>
<tr>
<td>(C2)</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Parents' Occupation (C3)</td>
<td>Government employees</td>
<td>Benefits</td>
</tr>
<tr>
<td></td>
<td>Private employees</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Farmer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Doesn't work</td>
<td></td>
</tr>
<tr>
<td>Parents' Income (C4)</td>
<td>&gt; 1,600,000</td>
<td>Cost</td>
</tr>
<tr>
<td></td>
<td>1,100,000 – 1,600,00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>799,999 – 1,100,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt; 600,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No income</td>
<td></td>
</tr>
</tbody>
</table>

Based on the table below, the nim value of the matrix value is reduced by the highest minimum amount. The weight of the criteria is determined by the decision maker using manual weight determination, provided that the total weight value is equal to 1.
Table 2. Weight Values

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>0.25</td>
<td>Benefits</td>
</tr>
<tr>
<td>C2</td>
<td>0.35</td>
<td>Cost</td>
</tr>
<tr>
<td>C3</td>
<td>0.25</td>
<td>Benefits</td>
</tr>
<tr>
<td>C4</td>
<td>0.15</td>
<td>Benefits</td>
</tr>
</tbody>
</table>

Alternative Suitability Rating Value Against Criteria

Currently, there are multiple options available for each criterion, which have been derived from the process of collecting data. Each alternative value on the criteria has been transformed into a numerical value ranging from 1 to 5, with the purpose of simplifying the computation process.

Table 3. Compatibility Rating Table

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
</tr>
<tr>
<td>A1</td>
<td>1</td>
</tr>
<tr>
<td>A2</td>
<td>1</td>
</tr>
<tr>
<td>A3</td>
<td>2</td>
</tr>
<tr>
<td>A4</td>
<td>1</td>
</tr>
<tr>
<td>A5</td>
<td>2</td>
</tr>
<tr>
<td>A6</td>
<td>1</td>
</tr>
<tr>
<td>A7</td>
<td>1</td>
</tr>
<tr>
<td>A8</td>
<td>2</td>
</tr>
<tr>
<td>A9</td>
<td>2</td>
</tr>
<tr>
<td>A10</td>
<td>1</td>
</tr>
</tbody>
</table>

Procedure in preparing the decision matrix values x:

\[
X = \begin{bmatrix}
1 & 3 & 2 & 4 \\
1 & 4 & 3 & 2 \\
2 & 2 & 1 & 4 \\
1 & 5 & 4 & 2 \\
2 & 1 & 1 & 1 \\
1 & 5 & 4 & 3 \\
1 & 2 & 2 & 2 \\
2 & 4 & 3 & 4 \\
2 & 3 & 2 & 3 \\
1 & 1 & 1 & 2 \\
\end{bmatrix}
\]

The first is to prepare the value of the decision matrix, Then the procedure is to normalize the X matrix

\[
C1 = \sqrt{12+12+22+12+22+12+12+22+22+12} = \sqrt{22} = 4.6904
\]

\[
A_{1.1} = \frac{1}{4.6904} = 0.2132
\]

\[
A_{2.1} = \frac{1}{4.6904} = 0.2132
\]

\[
A_{3.1} = \frac{1}{4.6904} = 0.2132
\]

\[
A_{4.1} = \frac{1}{4.6904} = 0.2132
\]

\[
A_{5.1} = \frac{1}{4.6904} = 0.2132
\]
\[ A_{6.1} = \frac{1}{4.6904} = 0.2132 \]
\[ A_{7.1} = \frac{1}{4.6904} = 0.2132 \]
\[ A_{8.1} = \frac{4}{4.6904} = 0.4264 \]
\[ A_{9.1} = \frac{4}{4.6904} = 0.4264 \]
\[ A_{10.1} = \frac{1}{4.6904} = 0.2132 \]

\[ C_2 = \sqrt{32 + 42 + 22 + 52 + 12 + 52 + 22 + 42 + 32 + 12} = \sqrt{58} = 7.6157 \]
\[ A_{1.1} = \frac{3}{7.6157} = 0.286 \]
\[ A_{2.1} = \frac{7.6157}{2} = 3.814 \]
\[ A_{3.1} = \frac{7.6157}{5} = 0.1907 \]
\[ A_{4.1} = \frac{7.6157}{5} = 0.4767 \]
\[ A_{5.1} = \frac{7.6157}{5} = 0.0953 \]
\[ A_{6.1} = \frac{7.6157}{5} = 0.4767 \]
\[ A_{7.1} = \frac{7.6157}{5} = 0.1907 \]
\[ A_{8.1} = \frac{7.6157}{3} = 0.3814 \]
\[ A_{9.1} = \frac{7.6157}{3} = 0.286 \]
\[ A_{10.1} = \frac{1}{7.6157} = 0.0953 \]

\[ C_3 = \sqrt{22 + 32 + 12 + 42 + 12 + 42 + 22 + 42 + 32 + 12} = \sqrt{43} = 6.5574 \]
\[ A_{1.1} = \frac{2}{6.5574} = 0.3721 \]
\[ A_{2.1} = \frac{6.5574}{3} = 2.1851 \]
\[ A_{3.1} = \frac{6.5574}{4} = 1.6393 \]
\[ A_{4.1} = \frac{6.5574}{4} = 1.6393 \]
\[ A_{5.1} = \frac{6.5574}{4} = 1.6393 \]
\[ A_{6.1} = \frac{6.5574}{2} = 3.2787 \]
\[ A_{7.1} = \frac{6.5574}{2} = 3.2787 \]
\[ A_{8.1} = \frac{6.5574}{3} = 2.1851 \]
\[ A_{9.1} = \frac{6.5574}{3} = 2.1851 \]
\[ A_{10.1} = \frac{1}{6.5574} = 0.1531 \]

\[ C_4 = \sqrt{42 + 22 + 42 + 22 + 12 + 32 + 22 + 42 + 32 + 22} = \sqrt{53} = 7.2801 \]
\[ A_{1.1} = \frac{4}{7.2801} = 0.4391 \]
\[ A_{2.1} = \frac{7.2801}{2} = 3.6401 \]
\[ A_{3.1} = \frac{7.2801}{4} = 1.8201 \]
\[ A_{4.1} = \frac{7.2801}{4} = 1.8201 \]
\[ A_{5.1} = \frac{7.2801}{1} = 7.2801 \]
The results of normalizing matrix X obtained by matrix Xij below:

\[
\begin{array}{cccccc}
0.2132 & 0.286 & 0.2481 & 0.4391 \\
0.2132 & 0.3814 & 0.3721 & 0.2195 \\
0.4264 & 0.1907 & 0.124 & 0.4391 \\
0.2132 & 0.4767 & 0.4961 & 0.2195 \\
\end{array}
\]

Calculation of alternative optimization values for alternative 1: Calculation of optimization values for \(Y_i\) (Max – Min) is carried out. Formula:

\[Y_1 = (X_{1 \times 1} (\text{max}) \cdot W + X_{1 \times 2} (\text{max}) \cdot W + X_{1 \times 3} (\text{max}) \cdot W + X_{1 \times 5} (\text{max}) \cdot W) - (X_{1 \times 1} (\text{min}) \cdot W)
\]

Solution:

\[y_1 = ((0.2132 \cdot 0.25) + (0.2481 \cdot 0.025) + (0.4391 \cdot 0.15) - (0.286 \cdot 0.35)\]
\[y_1 = (0.0533 + 0.6202 + 0.0658 - (0.1001)) = 0.6393\]

\[y_2 = ((0.2132 \cdot 0.25) + (0.3721 \cdot 0.25) + (0.2195 \cdot 0.15) - (0.3814 \cdot 0.35)\]
\[y_2 = (0.0533 + 0.0930 + 0.0329 - (0.1334)) = 0.0457\]

\[y_3 = ((0.4264 \cdot 0.25) + (0.124 \cdot 0.25) + (0.4391 \cdot 0.15) - (0.1907 \cdot 0.35)\]
\[y_3 = (0.1066 + 0.031 + 0.0658 - (0.0667)) = 0.1367\]

\[y_4 = ((0.2132 \cdot 0.25) + (0.4961 \cdot 0.25) + (0.2159 \cdot 0.15) - (0.4767 \cdot 0.35)\]
\[y_4 = (0.0533 + 0.1240 + 0.0329 - (0.1668)) = 0.0434\]

\[y_5 = ((0.4264 \cdot 0.25) + (0.124 \cdot 0.25) + (0.1098 \cdot 0.15) - (0.0953 \cdot 0.35)\]
\[y_5 = (0.1066 + 0.031 + 0.0164 - (0.0333)) = 0.1207\]

\[y_6 = ((0.2132 \cdot 0.25) + (0.4961 \cdot 0.25) + (0.3293 \cdot 0.15) - (0.4767 \cdot 0.35)\]
\[y_6 = (0.0533 + 0.1240 + 0.0823 - (0.1668)) = 0.0928\]

\[y_7 = ((0.2132 \cdot 0.25) + (0.2481 \cdot 0.25) + (0.2195 \cdot 0.15) - (0.1907 \cdot 0.35)\]
\[y_7 = (0.0533 + 0.0620 + 0.0329 - (0.0667)) = 0.0815\]

\[y_8 = ((0.4264 \cdot 0.25) + (0.3727 \cdot 0.25) + (0.4391 \cdot 0.15) - (0.3814 \cdot 0.35)\]
\[y_8 = (0.1066 + 0.0930 + 0.0658 - (0.1334)) = 0.132\]

\[y_9 = ((0.4264 \cdot 0.25) + (0.2481 \cdot 0.25) + (0.3293 \cdot 0.15) - (0.286 \cdot 0.35)\]
\[y_9 = (0.1066 + 0.0620 + 0.0493 - (0.1001)) = 0.1179\]

\[y_{10} = ((0.2132 \cdot 0.25) + (0.124 \cdot 0.25) + (0.2195 \cdot 0.15) - (0.0953 \cdot 0.35)\]
\[y_{10} = (0.0533 + 0.031 + 0.0329 - (0.0333)) = 0.2163\]
a. The results of the optimization values are obtained:

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Student's name</th>
<th>Y = Max - Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Ni Kadek Diah Setiari</td>
<td>0.0811</td>
</tr>
<tr>
<td>A2</td>
<td>I Kadek Agus Widiantara</td>
<td>0.0457</td>
</tr>
<tr>
<td>A3</td>
<td>Ni Kadek Suarningsih</td>
<td>0.1368</td>
</tr>
<tr>
<td>A4</td>
<td>Ni Kadek Marta Yunita</td>
<td>0.0433</td>
</tr>
<tr>
<td>A5</td>
<td>I Nyoman Nova Aditya Wardana</td>
<td>0.1207</td>
</tr>
<tr>
<td>A6</td>
<td>Dewa Gede Adnyana</td>
<td>0.0598</td>
</tr>
<tr>
<td>A7</td>
<td>Ni Putu Nia Delivered</td>
<td>0.0815</td>
</tr>
<tr>
<td>A8</td>
<td>I Kadek Sudiantara</td>
<td>0.132</td>
</tr>
<tr>
<td>A9</td>
<td>Ni Luh Putri Fitriani</td>
<td>0.1179</td>
</tr>
<tr>
<td>A10</td>
<td>Dewa Ayu Apriani</td>
<td>0.132</td>
</tr>
</tbody>
</table>

b. The ranking can be seen as an alternative to calculating the criteria for female students:

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Student's name</th>
<th>Yi value</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>Ni Kadek Suarningsih</td>
<td>0.1368</td>
<td>1</td>
</tr>
<tr>
<td>A8</td>
<td>I Kadek Sudiantara</td>
<td>0.132</td>
<td>2</td>
</tr>
<tr>
<td>A5</td>
<td>I Nyoman Nova Aditya Wardana</td>
<td>0.1207</td>
<td>3</td>
</tr>
<tr>
<td>A9</td>
<td>Ni Luh Putri Fitriani</td>
<td>0.1179</td>
<td>4</td>
</tr>
<tr>
<td>A10</td>
<td>Dewa Ayu Apriani</td>
<td>0.0838</td>
<td>5</td>
</tr>
<tr>
<td>A7</td>
<td>Ni Putu Nia Delivered</td>
<td>0.0815</td>
<td>6</td>
</tr>
<tr>
<td>A1</td>
<td>Ni Kadek Diah Setiari</td>
<td>0.0811</td>
<td>7</td>
</tr>
<tr>
<td>A6</td>
<td>Dewa Gede Adnyana</td>
<td>0.0598</td>
<td>8</td>
</tr>
<tr>
<td>A2</td>
<td>I Kadek Agus Widiantara</td>
<td>0.0457</td>
<td>9</td>
</tr>
<tr>
<td>A4</td>
<td>Ni Kadek Marta Yunita</td>
<td>0.0433</td>
<td>10</td>
</tr>
</tbody>
</table>

The table above displays the final rankings of scholarship recipients using the MOORA approach. The selection procedure has identified 10 alternatives, and the MOORA method has determined the best beneficiaries among them. The ultimate outcome determines the ranking of the top three options who receive recommendations for becoming scholarship recipients. Based on the outcomes of this ranking, it can be demonstrated that the MOORA approach is capable of generating the most optimal alternative ranking, and each option has a distinct final value.

5. Conclusion

In conclusion, the purpose of developing the Decision Support System for Determining Scholarship Recipients with the Moora Method at SMA Negeri 1 Manggis was to aid educational institutions in the process of identifying deserving students for underprivileged and high-achieving scholarships. The design of this system is predicated on four primary criteria: parental income, KIS...
(Healthy Indonesia Card), employment status, and infant status. Scholarship applicants are selected using the MOORA method, which normalises the decision matrix and assigns weights to the factors in order to determine the most advantageous alternatives. The optimisation value for each student alternative is computed through the utilisation of a pre-established algorithm subsequent to normalisation. The computational outcomes present the \(Y_i\) (Max - Min) values for ten student alternatives. These values can subsequently be utilised to generate a final ranking of the most favourable alternatives, with scholarship recipients being advised on the three best alternatives. It is anticipated that by adopting the DSS methodology, SMA Negeri 1 Manggis will enhance the efficacy of scholarship recipient selection and provide decision makers with more viable options. Future research is encouraged to incorporate weighting methods, particularly surrogate weighting, which was utilised in this investigation, in order to generate optimal decisions.

References


Utami, A., & RUSKAN, E. L. (2020). Development of decision support system for selection of...