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Decision Support System for Selecting Student Recipients of Single Tuition Fee (STF) Assistance using Multi-Objective Optimization on the Basis of Simple Ratio Analysis (MOOSRA) Method

Johannes Syahputra Sihombing[1], Dahner Junedi Naibaho[1], Mesran[2,*]

[1] Faculty of Computer Science and Information Technology, Informatics Engineering, Universitas Budi Darma, Medan, Indonesia
[2] Management, Sekolah Tinggi Ilmu Manajemen Sukma Medan, Medan, Indonesia
Email: [1]syahputrajohanes1@gmail.com, [2]dahnernaibaho211@gmail.com, [3,*]mesran.skom.mkom@gmail.com
Correspondence Author Email: mesran.skom.mkom@gmail.com

Abstract–Single Tuition Fee (STF) is a tuition fee borne by each prospective new student based on their economic capability. The process of determining the STF groups requires precision and time, as student data needs to be compared with the STF criteria one by one. The decision-making system in determining the STF groups that exist currently utilizes five criteria in assessing the parents' ability to pay for their child's education, namely: Parental Income, Possession of PKH Card, Document Completeness, Parental Dependents, and Academic Performance. Therefore, a decision support system is needed that applies the MOOSRA method to assist in determining the STF groups. There are five criteria used in this research: parental income, ownership of the PKH card, document completeness, parental dependents, and academic performance. The calculation results for several sample data yield the best final optimization value in the selection of students eligible for STF assistance, which is found in alternative A7 (Meli) with a total score of 0.863.

Keywords: Decision Support System; Single Tuition Tee; Moosra Method**;** Student Recipients; Selecting

1. INTRODUCTION

The Single Tuition Fee is an operational fund provided by the government to students who are under the auspices of the Ministry of Education, Culture, Research, and Technology (Kemendikbud Ristek). Under this new payment system, a cross-subsidy system has been implemented, wherein students can receive assistance based on their high and low economic status. This is aimed at helping students who are facing economic challenges. Based on the data from Kemendikbud Ristek, the fund assistance was distributed to all public and private universities with a total budget of IDR 745 billion in September 2021[1]–[5].

Although this assistance is provided to students in all universities, there are several criteria that can serve as a reference in the selection of Single Tuition Fee (STF) assistance. In the STF assistance selection process, there are certain requirements that must be fulfilled, namely: Parental Income, Possession of PKH Card, Document Completeness, Parental Dependents, and Academic Performance. Universities often face challenges in selecting deserving students to receive this assistance due to the large number of applicants and limited available slots. Therefore, a solution in the form of a decision support system is needed for the selection of eligible students to receive the STF.

Decision support system is a computerized system designed to address a problem and generate data used for making decisions[6]–[8]. Some methods within decision support systems include the Analytic Hierarchy Process (AHP), Simple Additive Weighting (SAW) Method, Weighted Product (WP) Method, Elimination And Choice Expressing Reality (ELECTRE) Method, and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) Method. In this research, the author was able to solve a problem using the Moosra method because the Moosra method is very simple, stable, and robust. Additionally, the Moosra method utilizes a simple ratio of the normalized performance values for beneficial criteria to the normalized performance values for non-beneficial criteria to avoid negative values and generate positive criterion values.

Based on related research previously conducted by other researchers, such as Asnita Susilawati Nadeak, the research focused on selecting the best cashier. To determine the selection of the best cashier, a decision support system is needed. The researcher designed the AHP and MOOSRA methods, and by utilizing both of these methods, they were able to generate the best alternative, which is alternative A1 with a Yi value of 44.9[9]. The research by Divya Febrina and Imam Saputra focuses on the selection of the best local content. To determine the selection of the best local content, a decision support system is necessary. The researchers designed the MOOSRA method, and by using this method, they were able to generate the best alternative, which is alternative A3, "METRO TV SUMUT (Wajah Sumut)," with a Yi value of 4.5815[10]. The research by Tri Hasanah, Bimastari Aviani, and Asep Toyib Hidayat focuses on the selection of recipients for the Single Tuition Fee. To determine the selection of Single Tuition Fee recipients, a decision support system is required. The researchers designed the WASPAS method, and by using this method, they were able to generate the best alternative, which is alternative M1, "Surya Putri," with a Qi value of 10.88[11]. The research by Ario Baskoro and Made Kamisutara focuses on the selection of recipients for the Single Tuition Fee assistance at universities. To determine the recipients of Single Tuition Fee assistance at universities, a decision support system is required. The researchers designed the AHP method, and by using this method, they were able to generate the best alternative, which is alternative 201701, "Dimas," with a Ci value of 0.1456[12].

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In this case, the author is finally interested in using the MOOSRA Method for the Selection of Students Receiving STF Assistance. The author conducted this research to calculate the criteria weighting and generate the reject rate as the primary criteria in selecting students eligible for STF Assistance. This way, the university will not face difficulties in choosing students for STF Assistance. The implementation of the MOOSRA method is expected to provide benefits by obtaining the best alternative optimally based on predefined criteria, making the selection of students for STF Assistance more efficient and effective.

2. RESEARCH METHODOLOGY

2.1 Research Stages

In creating this research, there are several stages undertaken by the author. Here is an explanation of the various research stages:

1. Literature Review
   This stage is used to ensure the author's understanding of Decision Support Systems (DSS) and the MOOSRA method by reading relevant journals and references related to the research.
2. Data Collection
   Conducting observations to understand the steps involved in selecting students for STF Assistance.
3. Problem Analysis
   Solving a problem and analyzing data as part of a study before designing or calculating.
4. Implementation of the MOOSRA Method
   Application of the MOOSRA method in the Decision Matrix process.
5. Drawing Conclusions
   In this stage, conclusions are drawn regarding the determination of the best alternative.

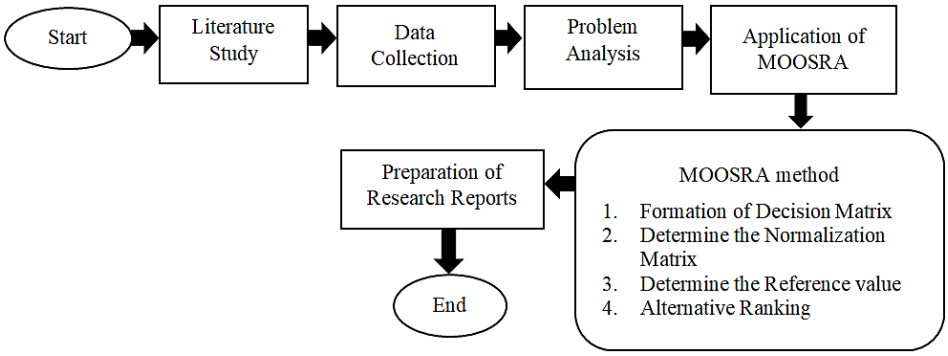

Figure 1. Research Stages

2.2 Decision Support System

Decision Support System (DSS) is a computer-based information system that generates various decision alternatives to assist management in addressing both structured and unstructured problems using data and models[13].

2.3 Single Tuition Fee (STF)

Single Tuition Fee is an operational fund provided by the government to students under the auspices of the Ministry of Education, Culture, Research, and Technology (Kemendikbud Ristek) [14],[15].

2.4 MOOSRA Method

The MOOSRA method is one of the multi-objective optimization methods. When compared to the MOORA method, negative performance scores do not appear in the MOOSRA method, and the MOOSRA method is less sensitive to significant variations in criteria values[16]–[18]. The MOOSRA method was first developed by Das et al. In general, the MOOSRA methodology begins with the formulation of a decision matrix, typically consisting of four parameters: alternatives, criteria or attributes, individual weights or coefficients of significance for each criterion, and measuring the performance of alternatives with respect to the criteria. The algorithms in solving Decision Support Systems (DSS) with the MOOSRA method include the following[19]–[22]:

1. The formation of the Decision Matrix in this methodology begins with defining a decision matrix where a number of criteria and alternatives are listed. The performance of each alternative with respect to each criterion is determined using the following equation:

$$X = \begin{bmatrix} x_{11} & x_{12} \cdots & x_{1n} \\ x_{21} & x_{22} \cdots & x_{2n} \\ \vdots & \vdots \ddots & \vdots \\ x_{m1} & x_{m2} \cdots & x_{mn} \end{bmatrix} \quad (1)$$

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Where the criteria are represented by: $x1$, $x2$, …., xn

2. Determining the Normalization Ratio Matrix Xij represents the size of alternative i on criterion j, and m indicates the number of criteria. Breauers et al. (2008) concluded that for the denominator, the best choice is the square root of the sum of squares for each alternative criterion. In the MOOSRA method, the normalized elements of the decision matrix are calculated using the following equation:

$$(x_{ij}^{*}) = \frac{x_{if}}{\sqrt{\sum_{i=1}^{m} x2_{if}}} \quad (2)$$

Where the value $X * ij$ represents the normalized performance of the ith alternative on the jth objective, with i= 1,2,3…..n and j= 1,2,3….m.

3. Determining the Preference Value Performance Score Yi for all alternatives is calculated as a simple ratio of the sum of beneficial criteria to the sum of non-beneficial criteria using the following equation:

$$(Y_i^{*}) = \frac{\sum_{j}^{g=1} w_j X_{*ij}}{\sum_{j}^{n=g+1} w_j X_{*ij}} \quad (3)$$

Where g is the number of attributes to be maximized, (n-g) is the number of attributes to be minimized, and w_j is the associated weight for the j^{th} attribute. In some cases, if we assume that the attributes are equally important, the optimization formula becomes as follows:

$$Y_i = \frac{\sum_{j}^{g=1} X_{*ij}}{\sum_{j}^{n=g+1} X_{*ij}} \quad (4)$$

4. Alternative Ranking
In this step, alternative ranking is performed, where they are arranged in descending order, and the best alternative is the one with the highest assessment value. It is advisable to have an ordinal ranking of Yi values to obtain the final preference for alternative candidates.

3. RESULTS AND DISCUSSION

The analysis in this results and discussion section is used to observe/examine the selection of students eligible for STF assistance, focusing on the quality and the recovery of scores concerning the predefined criteria by determining the alternatives, criteria, and weights.

3.1 Determination of Criteria and Weights

In making decisions regarding the selection of students eligible for Single Tuition Fee assistance, it is necessary to have data such as criteria data, weights, and alternatives. There are 5 (five) criteria used for this selection process. Various criteria have weight values that are determined using the Rank Order Centroid (ROC) method. The following Table 1 lists the criteria and weights used.

Table 1. Criteria and Weight

Criteria	Information	Weight	Type
C_1	Parents Income	0.456	Cost
C_2	PKH card holders	0.256	Benefit
C_3	File Completeness	0.156	Benefit
C_4	Parent's Liability	0.09	Benefit
C_5	Achievement Index	0.04	Benefit

Attribute description in table 1
Parents Income : Parents Monthly Income
PKH Card Holders : Priority to Recipient students or families of Family Hope Program (PKH) holders
File Completeness : Documents to be submitted must be complete
Parent's Liability : Number of children covered
Achievement Index : Performance in the academic/educational field

Table 2. Alternative To Criteria

Alternative	Parents Income	PKH Card Holders	File Completeness	Parent's Liability	Achievement Index
Josua(A_1)	Rp. 3.500.000	Yes	Very Complete	3 people	3,30
Jonathan(A_2)	Rp. 3.250.000	Yes	Complete	4 people	3,05
Samuel (A_3)	Rp. 4.000.000	Yes	Complete	2 people	3,20
Dewi (A_4)	Rp. 3.750.000	No	Very Complete	2 people	3.40
Sindy (A_5)	Rp. 3.900.000	No	Cukup Complete	5 people	3,25

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Alternative	Parents Income	PKH Card Holders	File Completeness	Parent's Liability	Achievement Index
John (A_6)	Rp. 4.500.000	No	Cukup Complete	2 people	3.60
Meli (A_7)	Rp. 3.200.000,	Yes	Very Complete	2 people	3,40

From the alternative data table for the criteria above, we need two weighting tables for criteria C_2 and C_3 as shown below.

Table 3. Criteria C_2 Value Weight

Information	Weight Value
Yes	2
No	1

Table 4. Criteria C_3 Value Weight

Information	Weight Value
Very Complete	3
Complete	2
Cukup Complete	1

Based on the two weighting tables in Table 3 and Table 4, we will obtain a table of compatibility ratings as follows.

Table 5. Match Rating Data

Alternative	C_1	C_2	C_3	C_4	C_5
A_1	3.500.000	2	3	3	3,30
A_2	3.250.000	2	2	4	3,05
A_3	4.000.000	2	2	2	3,20
A_4	3.750.000	1	3	2	4,40
A_5	3.900.000	1	1	5	3,25
A_6	4.500.000	1	1	2	2.60
A_7	3.200.000	2	3	2	3.40

3.2 Implementation of MOOSRA Method

The stages of the calculation process apply the methodMOOSRA is explained in detail in the process below:

1. Persiapkan Maktrik Keputusan berdasarkan data di atas yang telah diperoleh.

$$X_{if} = \begin{bmatrix} 3500000 & 2 & 3 & 3 & 3.00 \\ 3250000 & 2 & 2 & 4 & 3.75 \\ 4000000 & 2 & 2 & 2 & 3.80 \\ 3750000 & 1 & 3 & 2 & 4.00 \\ 3900000 & 1 & 1 & 5 & 3.00 \\ 4500000 & 1 & 1 & 2 & 2.90 \\ 3200000 & 3 & 3 & 2 & 3.90 \end{bmatrix}$$

2. Prepare a Decision Matrix based on the above data that has been obtained.
   For Criterion C1 (Parents Income)

$$x_{ij}^* = \frac{x_{if}}{\sqrt{\sum_{i=1}^{m} x2_{if}}}$$

$$x_{1,1}^* = \frac{3500000}{\sqrt{[\,3500000^2 + 3250000^2 + 4000000^2 + 3750000^2 + 3900000^2 + 4500000^2 + 3200000^2}} = \frac{3500000}{9928494.347} = 0.3525$$

$$x_{2,1}^* = \frac{3250000}{\sqrt{[\,3500000^2 + 3250000^2 + 4000000^2 + 3750000^2 + 3900000^2 + 4500000^2 + 3200000^2}} = \frac{3250000}{9928494.347} = 0.3273$$

$$x_{3,1}^* = \frac{4000000}{\sqrt{[\,3500000^2 + 3250000^2 + 4000000^2 + 3750000^2 + 3900000^2 + 4500000^2 + 3200000^2}} = \frac{4000000}{9928494.347} = 0.4029$$

$$x_{4,1}^* = \frac{3750000}{\sqrt{[\,3500000^2 + 3250000^2 + 4000000^2 + 3750000^2 + 3900000^2 + 4500000^2 + 3200000^2}} = \frac{3750000}{9928494.347} = 0.3777$$

$$x_{5,1}^* = \frac{3900000}{\sqrt{[\,3500000^2 + 3250000^2 + 4000000^2 + 3750000^2 + 3900000^2 + 4500000^2 + 3200000^2}} = \frac{3900000}{9928494.347} = 0.3928$$

$$x_{6,1}^* = \frac{4500000}{\sqrt{[\,3500000^2 + 3250000^2 + 4000000^2 + 3750000^2 + 3900000^2 + 4500000^2 + 3200000^2}} = \frac{4500000}{9928494.347} = 0.4532$$

$$x_{7,1}^* = \frac{3200000}{\sqrt{[\,3500000^2 + 3250000^2 + 4000000^2 + 3750000^2 + 3900000^2 + 4500000^2 + 3200000^2}} = \frac{3200000}{9928494.347} = 0.3223$$

For Criteria C2 (PKH Card Holder)

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$$x^*_{1,2} = \frac{2}{\sqrt{[\,2^2+2^2+2^2+1^2+1^2+1^2+3^2}} = \frac{2}{24} = 0.0833$$

$$x^*_{2,2} = \frac{2}{\sqrt{[\,2^2+2^2+2^2+1^2+1^2+1^2+9^2}} = \frac{2}{24} = 0.0833$$

$$x^*_{3,2} = \frac{2}{\sqrt{[\,2^2+2^2+2^2+1^2+1^2+1^2+9^2}} = \frac{2}{24} = 0.0833$$

$$x^*_{4,2} = \frac{1}{\sqrt{[\,2^2+2^2+2^2+1^2+1^2+1^2+9^2}} = \frac{1}{24} = 0.0416$$

$$x^*_{5,2} = \frac{1}{\sqrt{[\,2^2+2^2+2^2+1^2+1^2+1^2+9^2}} = \frac{1}{24} = 0.0416$$

$$x^*_{6,2} = \frac{1}{\sqrt{[\,2^2+2^2+2^2+1^2+1^2+1^2+9^2}} = \frac{1}{24} = 0.0416$$

$$x^*_{7,2} = \frac{9}{\sqrt{[\,2^2+2^2+2^2+1^2+1^2+1^2+9^2}} = \frac{9}{24} = 0.375$$

For Criteria C3 (File Completeness)

$$x^*_{1,3} = \frac{3}{\sqrt{[\,3^2+2^2+2^2+3^2+1^2+1^2+3^2}} = \frac{3}{37} = 0.0810$$

$$x^*_{2,3} = \frac{2}{\sqrt{[\,3^2+2^2+2^2+3^2+1^2+1^2+3^2}} = \frac{2}{37} = 0.0540$$

$$x^*_{3,3} = \frac{2}{\sqrt{[\,3^2+2^2+2^2+3^2+1^2+1^2+3^2}} = \frac{2}{37} = 0.0540$$

$$x^*_{4,3} = \frac{3}{\sqrt{[\,3^2+2^2+2^2+3^2+1^2+1^2+3^2}} = \frac{3}{37} = 0.0810$$

$$x^*_{5,3} = \frac{1}{\sqrt{[\,3^2+2^2+2^2+3^2+1^2+1^2+3^2}} = \frac{1}{37} = 0.0270$$

$$x^*_{6,3} = \frac{1}{\sqrt{[\,3^2+2^2+2^2+3^2+1^2+1^2+3^2}} = \frac{1}{37} = 0.0270$$

$$x^*_{7,3} = \frac{3}{\sqrt{[\,3^2+2^2+2^2+3^2+1^2+1^2+3^2}} = \frac{3}{37} = 0.0810$$

For Criteria C4 (Parents' Dependents)

$$x^*_{1,4} = \frac{3}{\sqrt{[\,3^2+4^2+2^2+2^2+5^2+2^2+2^2}} = \frac{3}{66} = 0.0454$$

$$x^*_{2,4} = \frac{4}{\sqrt{[\,3^2+4^2+2^2+2^2+5^2+2^2+2^2}} = \frac{4}{66} = 0.0606$$

$$x^*_{3,4} = \frac{2}{\sqrt{[\,3^2+4^2+2^2+2^2+5^2+2^2+2^2}} = \frac{2}{66} = 0.0303$$

$$x^*_{4,4} = \frac{2}{\sqrt{[\,3^2+4^2+2^2+2^2+5^2+2^2+2^2}} = \frac{2}{66} = 0.0303$$

$$x^*_{5,4} = \frac{5}{\sqrt{[\,3^2+4^2+2^2+2^2+5^2+2^2+2^2}} = \frac{5}{66} = 0.07575$$

$$x^*_{6,4} = \frac{2}{\sqrt{[\,3^2+4^2+2^2+2^2+5^2+2^2+2^2}} = \frac{2}{66} = 0.0303$$

$$x^*_{7,4} = \frac{2}{\sqrt{[\,3^2+4^2+2^2+2^2+5^2+2^2+2^2}} = \frac{2}{66} = 0.0303$$

For criteria C5 (Achievement Index)

$$x^*_{1,5} = \frac{3.30}{\sqrt{[\,3.30^2+3.05^2+3.20^2+3.40^2+3.25^2+3.60^2+3.40^2}} = \frac{3.30}{8.7792} = 0.3759$$

$$x^*_{2,5} = \frac{3.05}{\sqrt{[\,3.30^2+3.05^2+3.20^2+3.40^2+3.25^2+3.60^2+3.40^2}} = \frac{3.05}{8.7792} = 0.3474$$

$$x^*_{3,5} = \frac{3.20}{\sqrt{[\,3.30^2+3.05^2+3.20^2+3.40^2+3.25^2+3.60^2+3.40^2}} = \frac{3.20}{8.7792} = 0.3645$$

$$x^*_{4,5}) = \frac{3.40}{\sqrt{[\,3.30^2+3.05^2+3.20^2+3.40^2+3.25^2+3.60^2+3.40^2}} = \frac{3.40}{8.7792} = 0.3873$$

$$x^*_{5,5} = \frac{3.25}{\sqrt{[\,3.30^2+3.05^2+3.20^2+3.40^2+3.25^2+3.60^2+3.40^2}} = \frac{3.25}{8.7792} = 0.3702$$

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$$x^*_{6,5} = \frac{3.60}{\sqrt{[\,3.30^2 + 3.05^2 + 3.20^2 + 3.40^2 + 3.25^2 + 3.60^2 + 3.40^2}} = \frac{3.60}{8.7792} = 0.4101$$

$$x^*_{7,5} = \frac{3.40}{\sqrt{[\,3.30^2 + 3.05^2 + 3.20^2 + 3.40^2 + 3.25^2 + 3.60^2 + 3.40^2}} = \frac{3.40}{8.7792} = 0.3873$$

Based on the above calculations that have been carried out, obtain the matrix normalization values that are clearly visible, namely:

$$X_{if} = \begin{bmatrix} 0.3525 & 0.0833 & 0.0810 & 0.0454 & 0.3759 \\ 0.3273 & 0.0833 & 0.0540 & 0.0606 & 0.3474 \\ 0.4029 & 0.0833 & 0.0540 & 0.0303 & 0.3645 \\ 0.3777 & 0.0416 & 0.0810 & 0.0303 & 0.3873 \\ 0.3928 & 0.0416 & 0.0270 & 0.0757 & 0.3702 \\ 0.4532 & 0.0416 & 0.0270 & 0.0303 & 0.4101 \\ 0.3223 & 0.375 & 0.0810 & 0.0303 & 0.3873 \end{bmatrix}$$

3. Calculating the Optimization Value.

$$y^*_1 = \frac{(0.256 * 0.0833) + (0.156 * 0.0810) + (0.09 * 0.0454) + (0.04 * 0.3759)}{(0.456 * 0.3525)} = \frac{0.053}{0.160} = 0.331$$

$$y^*_2 = \frac{(0.256 * 0.0833) + (0.156 * 0.540) + (0.09 * 0.606) + (0.04 * 0.3474)}{(0.456 * 0.3273)} = \frac{0.049}{0.149} = 0.328$$

$$y^*_3 = \frac{(0.256 * 0.0833) + (0.156 * 0.0540) + (0.09 * 0.0303) + (0.04 * 0.3645)}{(0.456 * 0.4029)} = \frac{0.047}{0.183} = 0.256$$

$$y^*_4 = \frac{(0.256 * 0.0416) + (0.156 * 0.0810) + (0.09 * 0.0303) + (0.04 * 0.873)}{(0.456 * 0.3777)} = \frac{0.041}{0.172} = 0.238$$

$$y^*_5 = \frac{(0.256 * 0.416) + (0.156 * 0.0270) + (0.09 * 0.0757) + (0.04 * 0.3702)}{(0.456 * 0.3928)} = \frac{0.036}{0.179} = 0.201$$

$$y^*_6 = \frac{(0.256 * 0.0416) + (0.156 * 0.0270) + (0.09 * 0.0303) + (0.04 * 0.4101)}{(0.456 * 0.4532)} = \frac{0.033}{0.206} = 0.160$$

$$y^*_7 = \frac{(0.256 * 0.375) + (0.156 * 0.0810) + (0.09 * 0.0303) + (0.04 * 0.3873)}{(0.456 * 0.3223)} = \frac{0.126}{0.146} = 0{,}863$$

The results of searching for optimization values will get alternative rankings and then the results will be entered in the alternative ranking table. The following is a table of alternative ranking results: perangkingan Alternative. Berikut ini yeslah table hasil perankingan Alternative:

Table 6. Alternative Ranking

Alternative	Name	Y_i^*	Rank
A_1	Josua	0.331	2
A_2	Jonathan	0.328	3
A_3	Samuel	0.256	4
A_4	Dewi	0.238	5
A_5	Sindy	0.201	6
A_6	John	0.160	7
A_7	Meli	0.863	1

From the preference value above it is shown that 0.863 on behalf of Meli has the largest value, so it can be determined that the second alternative (A7) is a viable alternative to receive single tuition assistance (STF) which ranks first.

4. CONCLUSION

Based on the analysis and discussion conducted, conclusions can be drawn regarding the selection of students eligible for Single Tuition Fee assistance. To address this issue, this research presents several criteria organized using the Multiobjective Optimization on the Basis of Simple Ratio Analysis (MOOSRA) method, which can determine the best alternative choices. The best alternative in this research is Alternative A7, with Meli as the recipient, scoring a total of 0.863. The MOOSRA method can also assist in decision-making by selecting one or more alternatives to be chosen as the best student based on criteria. The development of this Decision Support System makes it easier for the program to make decisions in selecting the best students according to the specified criteria.

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