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# Decision Support System for Recipients of Cash Social Assistance using the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) Method

**Ahmad Alfarisi Pasaribu[1], Imam Saputra[2,*], Abdul Karim[3]**

[1]Faculty of Computer Science and Information Technology, Informatics Engineering Study Program, Universitas Budi Darma, Medan, Indonesia
[2]Management Study Program, Sekolah Tinggi Ilmu Manajemen Sukma Medan, Medan, Indonesia
[3]Faculty of Science and Technology, Information Technology, Universitas Labuhanbatu, Rantauprapat, Indonesia
Email: [1]ahmadpasaribu090@gmail.com, [2,*]saputraimam69@gmail.com, [3]abdkarim6@gmail.com
Corresponding author: saputraimam69@gmail.com

**Abstract**−Cash Social Assistance (BST) is assistance in the form of money provided to poor, disadvantaged, and/or vulnerable families affected by the Corona Virus Disease 2019 (COVID-19) outbreak. The amount of Cash Social Assistance is IDR 600,000/family/month. This Cash Social Assistance is a social safety net program of the Ministry of Social Affairs intended for poor and vulnerable families affected by Covid-19. This program is a special assignment assistance from the President. Social assistance for areas outside Jabodetabek is provided in the form of money, while for the Jabodetabek area it is provided in the form of basic necessities. The provision of BST assistance does not include recipients of the Family Hope Program (PKH), Staple Food Cards, and Pre-Employment Cards. To obtain the Cash Social Assistance (BST) funds, the government has set several criteria for which families can be determined and are entitled to receive the Cash Social Assistance (BST). These criteria will later help government agencies in determining which residents can be selected to receive the Poor Family Assistance Fund. Therefore, a government agency must have a Decision Support System for Cash Social Assistance (BST) recommendations using the Multi Objective Optimization on the Basis of Ratio Analysis (MOORA) method, with the existence of a decision support system for determining Cash Social Assistance (BST) it is expected to run well, be on target, and be received by the entitled people. Thus, decision makers can compare the performance between the old system and the decision support system for determining BST funds using the Multi Objective Optimization On The Basis Of Ratio Analysis (MOORA) method without having to re-request data on families who will be given Cash Social Assistance (BST) funds.

**Keywords:** Decision Support System; BST Fund; Multi-Objective Optimization Based on Ratio Analysis

## 1. INTRODUCTION

The COVID-19 pandemic that struck the world, including Indonesia, has had a significant impact on various aspects of life, particularly in the economic and social welfare sectors. Restrictions on community activities imposed to curb the spread of the virus forced many businesses to cease operations, leading to rising unemployment rates and a drastic decline in household income. This situation caused a large portion of society, especially economically disadvantaged groups, to struggle in meeting their basic daily needs. As a response to this crisis, the Indonesian government implemented various strategic policies in the field of social protection, one of which was the implementation of the Cash Social Assistance Program (BST). This program was specifically designed to support poor and vulnerable households directly affected by the pandemic, with the primary aim of maintaining their purchasing power and ensuring that their basic needs were met during the crisis. Through this program, the government sought to mitigate the socio-economic impacts of the pandemic while maintaining social stability within society[1][2].

However, in its practical implementation, social assistance programs such as the Cash Social Assistance (BST) often face various challenges that hinder the achievement of the program's objectives optimally. One of the main issues frequently encountered is the inaccuracy in determining eligible recipients. Cases are often found where households that should rightfully receive assistance are not registered as beneficiaries, while individuals or families considered less deserving are included as recipients. Such disparities have the potential to create social jealousy and diminish public trust in government programs. Several factors contribute to these issues, including the continued reliance on manual selection processes that are vulnerable to subjectivity, the absence of a structured and data-driven decision-making system, and the lack of transparency and accountability in the processes of data collection and verification. Therefore, a more systematic, objective, and automated approach is needed to improve the accuracy and fairness in the selection of aid recipients.

To address these issues, an information technology–based approach is required that can provide systematic, fast, and accurate solutions. One potential solution is the development of a Decision Support System (DSS). A DSS is a computer-based system designed to assist decision-makers in formulating alternative solutions to problems, particularly those that are complex and require consideration of multiple criteria. In the context of cash social assistance distribution, a DSS can be utilized to help determine target households that are truly eligible to receive aid, based on relevant data and criteria such as income level, number of dependents, housing conditions, and other related factors[3][4][5].

One of the methods that can be applied in developing a Decision Support System (DSS) is the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA). MOORA is recognized as one of the multi-criteria decision-making (MCDM) approaches that excels in terms of implementation simplicity, computational

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efficiency, and the accuracy and reliability of its results. Another advantage of MOORA lies in its ability to perform weighting and ranking of alternatives objectively through ratio comparisons of each criterion value, whether classified as benefit or cost. This process enables each alternative to be evaluated fairly based on quantitative data and predetermined weights. In the context of determining recipients of the Cash Social Assistance (BST) program, the MOORA method is highly relevant, as the selection process often involves multiple criteria such as income, number of dependents, employment status, and education level [6][7][8]. By employing this approach, the decisions generated are not only more accurate and transparent but also assist the government or relevant institutions in distributing aid more effectively and in line with the actual conditions of the communities in need. This makes MOORA particularly relevant in ensuring fair and well-targeted outcomes in the selection of BST recipients.

By utilizing the MOORA method in a decision support system, the selection process for aid recipients is expected to be carried out with greater accuracy, objectivity, and efficiency. This method offers a quantitative approach capable of processing multiple criteria simultaneously, both benefit and cost types, so that the final ranking of each alternative reflects an objective value derived from all indicators used. In the context of aid distribution, this is crucial as it minimizes subjectivity and potential errors in the selection process, which have often been a point of public concern. Furthermore, the implementation of a MOORA-based decision support system provides added value in terms of transparency and accountability. Relevant agencies or institutions can use this system as a tool to store, document, and verify recipient data in a structured and well-documented manner. This not only facilitates evaluation and reporting processes but also strengthens public trust in government-run social assistance programs. Therefore, integrating the MOORA method into decision support systems represents a strategic step in enhancing the governance of aid distribution to be more targeted, fair, and data-driven.

Several previous studies have applied the MOORA method in decision support systems for various decision-making cases. Faqih Amsyari et al. (2024) developed a decision support system to determine the most popular tourist destinations in Buleleng Regency using the MOORA method. The results showed that Krisna Eco Village was identified as the most preferred alternative with a value of 0.3610, supported by the highest weight on the accessibility criterion of 29.17% [9]. A similar study was conducted by Aldo Eko Syaputra et al. (2024), who designed a decision support system for purchasing used motorcycles at MOKAS dealers using the MOORA approach. This study employed six criteria and identified Supra GTR as the most recommended alternative with a value of 0.3 [10]. Furthermore, Ade Rizka et al. (2023) applied the MOORA method in a decision support system for recommending university majors to vocational high school (SMK) students. Among 14 available majors, the results indicated that Law obtained the highest score of 31.2, making it the primary recommendation for students to pursue higher education [11]. Teddy Erlambang et al. (2023) also utilized the MOORA method combined with the ROC weighting method to determine the most suitable contraceptive method. In this study, the alternative Pill (A5) was identified as the best choice with the highest Yi value of 0.2249, based on seven predetermined criteria [12]. Finally, Muhammad Naufal Rifqi and Agus Iskandar (2023) implemented the MOORA method along with ROC weighting in a decision support system for selecting the best wedding organizer. Out of eight analyzed alternatives, four wedding organizers were recommended as the primary choices based on the highest values generated through MOORA and ROC calculations [13].

Based on this background, the authors consider it necessary to design and develop a decision support system using the MOORA method to assist relevant agencies or institutions in accurately identifying target households eligible to receive cash social assistance. This system is expected to serve as a practical solution in the recipient selection process, while also contributing to improving the efficiency and effectiveness of social welfare programs both at present and in the future.

# 2. RESEARCH METHODOLOGY

## 2.1 Research Stages

In conducting this study, several stages were carried out. These stages are illustrated in Figure 1.

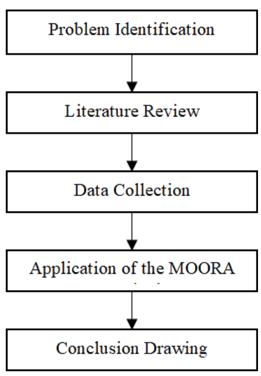


**Figure 1.** Research Stages

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Figure 1 presents the flow of the research stages, which will be explained in more detail in the following sections.

1. Problem Identification
   The first stage is problem identification, which involves formulating the main issues to be studied based on real conditions in the field. This identification serves as a crucial foundation for determining the direction and focus of the research.
2. Literature Review
   The next stage is a literature review, aimed at examining theories, methods, and relevant previous research. This stage helps establish a strong theoretical and methodological framework as the basis for designing the study.
3. Data Collection
   The subsequent stage is data collection, during which all required data are gathered using appropriate methods such as observation, interviews, questionnaires, or document analysis.
4. Application of the MOORA Method
   The collected data are then analyzed using the MOORA (Multi-Objective Optimization on the Basis of Ratio Analysis) method. This method serves as a decision-making tool by processing and evaluating alternatives based on specific criteria, both beneficial (benefit) and unfavorable (cost).
5. Conclusion Drawing
   The final stage of this study is conclusion drawing, conducted based on the results of the analysis of data processed using the MOORA method. The conclusions aim to answer the research questions formulated at the beginning of the study, while also providing relevant and applicable recommendations in line with the objectives of the research.

### 2.2 Decision Support System

A decision support system (DSS) is a component of a computer-based information system (including knowledge-based systems or knowledge management) that is used to support decision-making within an organization or company. It can also be defined as a computer system that processes data into information to support decisions in addressing specific semi-structured problems [14][15]. According to Keen and Scott Morton, a decision support system is the intellectual partnership between human resources and computer capabilities to improve decision-making. In other words, it is a computer-based support system designed for managers facing structured problems [16][17]. A DSS represents the integration of individual intelligence resources with computational capabilities to enhance the quality of decisions. The concept of decision support systems (DSS) began to be developed in the 1960s, but the term itself only appeared in 1971, introduced by G. Anthony Gorry and Michael S. Scott Morton, with the aim of creating a framework to guide the application of computers in managerial decision-making. A DSS is essentially a computer-based system intended to assist decision-makers by utilizing data and specific models to solve various unstructured problems. The term "decision support system" refers to systems that leverage computer support in the decision-making process [18][19][20].

### 2.3 Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA)

The MOORA (Multi-Objective Optimization on the Basis of Ratio Analysis) method is one of the multi-criteria decision-making approaches that offers a high degree of flexibility and is easy to understand. Its main advantage lies in its ability to minimize subjectivity in the evaluation process by transforming preferences or assessments of alternatives into quantitative values based on the weights of each criterion. The evaluation process in MOORA is carried out systematically by considering a number of decision-making attributes, both beneficial (benefit) and unfavorable (cost). This enables decision-makers to obtain results that are objective, measurable, and accountable. In addition, this method is advantageous in terms of computational efficiency and ease of interpreting the final results in the form of rankings for each alternative [21][22][23]. The following are the steps involved in solving decision-making problems using the MOORA method [24]:

1. Construct a Decision Matrix
   The first step is to construct a decision matrix, which represents the relationship between alternatives and the criteria used in the decision-making process. Each row corresponds to an alternative, while each column corresponds to a criterion, with the matrix elements containing the performance values of each alternative against the respective criteria.

$$X_{ij} = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1n} \\ X_{21} & X_{22} & \cdots & X_{2n} \\ \cdots & \cdots & \ldots & \ldots \\ X_{m1} & X_{m2} & \cdots & X_{mn} \end{bmatrix} \quad (1)$$

2. Calculate the Normalized Matrix
   In this step, the decision matrix is normalized in order to bring all criterion values into a comparable scale. Normalization is carried out by dividing each criterion value of an alternative by the square root of the sum of squares of all alternatives under the same criterion.

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$$X_{ij}^* = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \tag{2}$$

3. Calculate the Preference Value
   Next, the preference value for each alternative is calculated by considering both benefit and cost criteria. The weighted normalized values are summed for benefit criteria and subtracted for cost criteria, resulting in a final score that represents the overall performance of each alternative.

$$y_i^* = \sum_{j=1}^{g} w_j X_{ij}^* - \sum_{j=g+1}^{n} w_j X_{ij}^* \tag{3}$$

   In the MOORA method, several variables are applied to represent the components of the decision-making process. The symbol $X_{ij}$ denotes the performance value of alternative iii against criterion j. These values are organized into a decision matrix, which is then normalized to produce $X^*_{ij}$, ensuring that all criteria are comparable on the same scale. Each criterion is also assigned a weight, represented by $w_j$, which reflects its relative importance in the decision-making process. The preference value for each alternative, denoted as $y_i$, is calculated by summing the weighted normalized values of the benefit criteria and subtracting the weighted normalized values of the cost criteria. The final ranking is based on the preference values $y^*_i$, where a higher score indicates a better alternative.

# 3. RESULTS AND DISCUSSION

Based on the number of residents proposed as candidates for receiving Cash Social Assistance (BST), this study selected five residents as examples to apply the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method in determining eligibility for assistance. These five residents were treated as alternatives to be evaluated based on a set of predefined criteria. The information regarding the criteria and their respective weights is presented in Table 1 (Criteria Data), while the values of each alternative against every criterion are shown in Table 2 (Alternative Data). These data serve as the basis for the normalization and calculation stages to obtain the final value ($Y_i$), which determines the ranking and eligibility of each alternative.

**Table 1.** Criteria Data

| Criterion Code | Criterion Description | Criterion Weight | Criterion Type |
|---|---|---|---|
| C1 | Monthly Income | 50% | Cost |
| C2 | Number of Dependents | 20% | Benefit |
| C3 | Employment Status | 20% | Benefit |
| C4 | Last Education (High School) | 10% | Benefit |

Table 1 presents the criteria data used as the basis for assessment in the decision-making process using the MOORA method. There are four main criteria: C1 (Monthly Income), which carries the highest weight of 50% and is classified as a cost criterion, meaning that the lower the income value, the higher its priority in the evaluation. Meanwhile, C2 (Number of Dependents), C3 (Employment Status), and C4 (Last Education – High School) have weights of 20%, 20%, and 10% respectively, and are categorized as benefit criteria, indicating that the higher the value in these criteria, the better the alternative is considered. The assigned weights reflect the relative importance of each criterion toward the overall decision-making objective.

**Table 2.** Alternative Data

| Alternative Code | C1 | C2 | C3 | C4 |
|---|---|---|---|---|
| A1 | 1.500.000 | 2 | 60 | 50 |
| A2 | 2.000.000 | 3 | 60 | 65 |
| A3 | 1.500.000 | 4 | 100 | 80 |
| A4 | 1.000.000 | 2 | 50 | 85 |
| A5 | 1.500.000 | 2 | 50 | 60 |

Table 2 presents the alternative data to be evaluated based on the criteria defined in Table 1. There are five alternatives, namely A1 through A5, representing five individuals or entities to be analyzed. Each alternative is assessed against the established criteria: C1 represents monthly income in Indonesian Rupiah, C2 indicates the number of family dependents, C3 reflects the level of work activity or productivity, and C4 denotes the score of the most recent education equivalent to senior high school. These data serve as the input for the normalization and weighting process in the MOORA method, enabling the determination of rankings that reflect the best alternative based on all predefined criteria.

## 3.1 Application of the MOORA Method

The steps in applying the MOORA method are as follows:

1. Step 1. Constructing the Decision Matrix

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The decision matrix is constructed by arranging the alternatives (A1–A5) against the established criteria (C1–C4). Each row represents an alternative, while each column represents the value of a specific criterion.

$$X = \begin{bmatrix} 1500000 & 2 & 60 & 50 \\ 2000000 & 3 & 60 & 65 \\ 1500000 & 4 & 100 & 80 \\ 1000000 & 2 & 50 & 85 \\ 1500000 & 2 & 50 & 60 \end{bmatrix}$$

2. Step 2. Normalizing the Decision Matrix.
   Based on Equation (2), the normalization of matrix X is performed. The normalization process is carried out by dividing the value of each criterion for an alternative by the square root of the sum of squares of the corresponding criterion values across all alternatives. This step ensures that the criteria with different units of measurement can be compared on the same scale

$$C1 = \sqrt{1500000^2 + 2000000^2 + 1500000^2 + 1000000^2 + 1500000^2} = \sqrt{11750000000000} = 3427827$$

$$A11 = \frac{1500000}{3427827} = 0.437595$$

$$A21 = \frac{2000000}{3427827} = 0.58346$$

$$A31 = \frac{1500000}{3427827} = 0.437595$$

$$A41 = \frac{1000000}{3427827} = 0.29173$$

$$A51 = \frac{1500000}{3427827} = 0.437595$$

$$C2 = \sqrt{2^2 + 3^2 + 4^2 + 2^2 + 2^2} = \sqrt{37} = 6.083$$

$$A12 = \frac{2}{6.083} = 0.329$$

$$A22 = \frac{3}{6.083} = 0.493$$

$$A32 = \frac{4}{6.083} = 0.658$$

$$A42 = \frac{2}{6.083} = 0.329$$

$$A52 = \frac{2}{6.083} = 0.329$$

$$C3 = \sqrt{60^2 + 60^2 + 100^2 + 500^2 + 50^2} = \sqrt{22200} = 148{,}997$$

$$A13 = \frac{60}{148{,}997} = 0.403$$

$$A23 = \frac{60}{148{,}997} = 0.403$$

$$A33 = \frac{100}{148{,}997} = 0.671$$

$$A43 = \frac{50}{148{,}997} = 0.336$$

$$A53 = \frac{50}{148{,}997} = 0.336$$

$$C4 = \sqrt{50^2 + 65^2 + 80^2 + 85^2 + 60^2} = \sqrt{23950} = 154.758$$

$$A14 = \frac{50}{154.758} = 0.323$$

$$A24 = \frac{65}{154.758} = 0.420$$

$$A34 = \frac{80}{154.758} = 0.517$$

$$A44 = \frac{85}{154.758} = 0.549$$

$$A54 = \frac{60}{154.758} = 0.388$$

The result of the normalization of matrix X yields the following matrix:

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$$Xij = \begin{bmatrix} 0.437595 & 0.329 & 0.403 & 0.323 \\ 0.58346 & 0.493 & 0.403 & 0.420 \\ 0.437595 & 0.658 & 0.671 & 0.517 \\ 0.29173 & 0.329 & 0.336 & 0.549 \\ 0.437595 & 0.329 & 0.336 & 0.388 \end{bmatrix}$$

3. Optimizing the attributes by incorporating weights into the normalized values.

$$Xwj = \begin{bmatrix} 0.437595(0.5) & 0.329(0.2) & 0.403(0.2) & 0.323(0.1) \\ 0.58346(0.5) & 0.493(0.2) & 0.403(0.2) & 0.420(0.1) \\ 0.437595(0.5) & 0.658(0.2) & 0.671(0.2) & 0.517(0.1) \\ 0.29173(0.5) & 0.329(0.2) & 0.336(0.2) & 0.549(0.1) \\ 0.437595(0.5) & 0.329(0.2) & 0.336(0.2) & 0.388(0.1) \end{bmatrix}$$

The results of the multiplication with the criterion weights are as follows:

$$X = \begin{bmatrix} 0.219 & 0.066 & 0.081 & 0.032 \\ 0.292 & 0.099 & 0.081 & 0.042 \\ 0.219 & 0.132 & 0.134 & 0.052 \\ 0.146 & 0.066 & 0.067 & 0.055 \\ 0.219 & 0.066 & 0.067 & 0.039 \end{bmatrix}$$

The next step is to determine the Yi values for each alternative using Equation (3) above.

$$y_1^* = 0.066 + 0.081 + 0.032 - 0.179 - 0.219 = -0.040$$

$$y_2^* = 0.099 + 0.081 + 0.042 - 0.221 - 0.292 = -0.071$$

$$y_3^* = 0.132 + 0.134 + 0.052 - 0.318 - 0.219 = 0.099$$

$$y_4^* = 0.066 + 0.067 + 0.055 - 0.188 - 0.146 = 0.042$$

$$y_5^* = 0.066 + 0.067 + 0.039 - 0.172 - 0.219 = -0.047$$

After carrying out each step using the MOORA method, the final decision-making results determined based on the ranking of each data can be seen in Table 3 below.

**Table 3.** Presents the Yi values and the resulting ranking.

| Alternative Code | Yi Value | Ranking |
|---|---|---|
| A1 | -0.040 | 3 |
| A2 | -0.071 | 5 |
| A3 | 0.099 | 1 |
| A4 | 0.042 | 2 |
| A5 | -0.047 | 4 |

Table 3 presents the final results of the calculation using the MOORA method. The Max value represents the sum of the criteria classified as beneficial (benefit), while the Min value corresponds to the sum of the criteria classified as unfavorable (cost). The Yi value is obtained by subtracting the Min from the Max, which then serves as the basis for determining the ranking of each alternative. Based on the results, alternative A3 achieved the highest score (Yi = 0.099), placing it in the first rank. Alternative A4 secured the second position with a Yi value of 0.042, followed by A1 in third place, A5 in fourth place, and A2 in the last position. These findings indicate that A3 is the best alternative according to the criteria and calculations conducted using the MOORA method.

## 4. CONCLUSION

This study aimed to support a more systematic and objective decision-making process by applying the MOORA (Multi-Objective Optimization on the Basis of Ratio Analysis) method. The research was carried out through several stages, including problem identification, literature review, data collection, the application of the MOORA method, and drawing conclusions. Based on the data collected and analyzed, each alternative was evaluated against a set of criteria consisting of both beneficial (benefit) and unfavorable (cost) factors. The final score of each alternative was determined by calculating the difference between the maximum and minimum values for each case. The results indicated that alternative A3 achieved the highest Yi value of 0.099, placing it in the first rank. This finding demonstrates that A3 is the best alternative and most aligned with the criteria established in this study. Alternative A4 followed in second place with a Yi value of 0.042, while A1 ranked third with a Yi value of -0.040. Meanwhile, A5 and A2 occupied the fourth and fifth positions with Yi values of -0.047 and -0.071, respectively. These differences highlight the variation in eligibility levels among the alternatives, which may be further explored in practical implementation contexts. Overall, the findings suggest that the MOORA method provides a reliable quantitative approach for multi-criteria decision-making. Its strengths lie in the simplicity of processing data and its ability to deliver clear and easily interpretable ranking outcomes. Therefore, the MOORA method is highly suitable for application in decision support systems across various fields, including education, business, and public sectors, where the selection of the best alternative depends on complex and diverse criteria.

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