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The Implementation of MOORA method in the Selection of Direct Cash Aid Recipients

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Abstract−This research aims to implement the Multi-Objective Optimization on The Basis of Ratio Analysis (MOORA) algorithm as a Decision Support System for selecting recipients of Direct Cash Assistance in Cempaka Putih village, Gorontalo. With a dataset of 112 prospectus recipients, the study focuses on developing an efficient approach to assist the village head in the beneficiary selection process. By combining multi-objective optimization and ratio analysis, the MOORA algorithm objectively evaluates and ranks recipients based on eligibility and suitability. The findings demonstrate the effectiveness of MOORA in streamlining the selection process, ensuring transparency and optimizing resource allocation for those most in need. This research contributes to decision support systems by showcasing the practical application of MOORA, enhancing assistance distribution, and improving community welfare. The results show that Alternative A1 receives the highest ranking, which is 1, with a Yi value of 1.32. Therefore, Alternative A1 is recommended as the best candidate to receive direct cash assistance in the Cempaka Putih village. The method has the capability to rank the top 12 suitable candidates who are eligible to obtain direct cash aid. However, there are instances where certain Yi values match, resulting in the same ranking for those alternatives. This similarity necessitates further observation and analysis.

Keywords: MOORA; Decision Support System; Direct Cash Aid Recepient

1. INTRODUCTION

The Village Fund Direct Cash Assistance (BLT-DD) is a form of financial aid provided to impoverished families in the village to alleviate the effects of the COVID-19 pandemic [1]. According to [2] Direct Cash Assistance (BLT) is a form of aid whose source of funding comes from the Village Budget Allocation (APB Desa) and village funds.

The eligibility criteria for potential recipients of BLT-DD include being a financially disadvantaged or disabled family residing in the respective village. Priority is given to extremely poor families, those who have lost their source of income, families with members vulnerable to chronic illnesses, impoverished families who are recipients of other social safety net programs that have been suspended, families affected by the COVID-19 pandemic and have not yet received any assistance, and households with elderly members living alone.

The distribution process of the Direct Cash Assistance in Cempaka Putih Village, Tolinggula Subdistrict, North Gorontalo Regency, Gorontalo Province begins with the registration of poor residents based on a decision reached through consultations between the village government and the Village Consultative Board (BPD). The names of potential recipients are determined based on the prevailing situation, conditions, and requirements set by the village government. Subsequently, the next stage involves collecting the required documents, such as national identification cards and family cards in hard copy format, which are submitted to the village as attachments to the list of names to be proposed to the village government for verification of eligibility. After the verification process by the village government, the final decision on the recipients of the direct cash assistance is made through a consultation meeting.

Some issues with the direct cash assistance process in Cempaka Putih Village, Tolinggula Subdistrict, include the following: Village officials often receive complaints from residents who previously received BLT assistance at the beginning of the year but are no longer eligible due to receiving assistance from other sources. It has become difficult to identify BLT-DD recipients as almost all residents have already received assistance from sources other than BLT-DD, and the data keeps changing. From the perspective of the community, they acknowledge that direct cash assistance is helpful but not accurately targeted. There are cases where some individuals who should receive BLT assistance have not received any assistance until now. Therefore, the community hopes that the government will be more selective in providing assistance, ensuring it is not dependent on local officials. They also expect the assistance to be distributed more evenly and accurately targeted.

In addressing and preventing these issues in the selection of direct cash assistance recipients, the author proposes a solution called "The Implementation of MOORA (Multi Objective Optimization on the Basis of Ratio Analysis) in the Selection of Direct Cash Aid Recipients in Tolinggula District, Gorontalo". This method will assist and facilitate village officials in making decisions regarding the selection of eligible recipients for BLT-DD.

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Decision Support System is a system that supports the work of decision-makers in solving semi-structured problems by providing information or alternative decisions to a particular issue [3]. Computer-based decision support systems are widely implemented in determining policies in various fields, such as in economics [4], industry [5] and education [6]. The literature concerning the application of Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method in various decision-making scenarios is diverse and expanding. Studies such as [1] and [8] have applied MOORA in selecting beneficiaries for direct cash assistance in villages, showcasing its utility in socio-economic contexts. Furthermore, works like [7], [11], and [12] have explored MOORA's efficacy in materials selection and manufacturing environments, demonstrating its versatility across industries. Additionally, MOORA's implementation in decision-making processes extends to various domains such as supplier selection ([9]), school selection ([15], [17]), credit allocation for small businesses ([16], [26]), and even in educational institutions for faculty and student selection ([23], [24]). These studies collectively emphasize the broad applicability of MOORA across different sectors, showcasing its potential as a decision-making tool in diverse real-world scenarios. Other research efforts highlight its use in geographic information systems ([13], [14]), spatial-based industry location determination ([20]), employee selection ([22], [25]), and promotion media selection for educational institutions ([19]). MOORA's versatility and effectiveness are evident in its application to diverse decision-making situations, establishing it as a valuable technique for informed decision-making ([3], [4], [5], [6], [10], [18], [21], [27]). In specific cases, it has been employed in fields like artificial intelligence development ([3]), where it aids in optimizing complex algorithms. Additionally, its utilization extends to enhancing economic prospects in small-scale industries ([4]) by streamlining resource allocation. Within manufacturing contexts, MOORA plays a pivotal role in facilitating efficient raw material procurement ([5]). Moreover, it has been instrumental in optimizing aid distribution in educational settings, such as selecting recipients for operational support in early childhood education ([6]) and aiding in decision-making for digital wallet application choices ([10]). In the realm of construction, MOORA assists in supplier selection for building materials ([18]). These diverse applications exemplify MOORA's adaptability and effectiveness across multiple domains, positioning it as a valuable and dependable technique for facilitating well-informed decision-making processes.

The novelty in this research lies in the implementation in the case study of selecting recipients for village fund assistance in the Cempaka Putih village. There hasn't been any related study that investigates the application of MOORA (Multi-Objective Optimization by Ratio Analysis) specifically for village aid recipients, especially within the Cempaka Putih village.

2. RESEARCH METHODOLOGY

The research begins by gaining a deep understanding of the issues related to selecting recipients for direct cash aid (BLT) in that area. The subsequent step involves collecting data related to the relevant criteria for selecting BLT recipients. Following that, the implementation of the decision support system based on MOORA are carried out. The stage of research is explained as follows:

1. Problem Identification
   Identifying a specific problem related to the selection of BLT recipients and understanding stakeholder needs.
2. Literature Review
   Conducting a literature review to understand the application of MOORA in the context of selecting direct cash aid recipients and its success in various decision-making domains.
3. Data Collection
   Gathering relevant data for the criteria in selecting BLT recipients in three villages within Tolinggula sub-district. This may involve demographic data, economic conditions, or other relevant factors.
4. Analysis and Implementations of MOORA method
   Using the collected data, implementing the MOORA method to develop the decision support system. This stage involves criteria modeling, weighting, ranking, and decision-making.
5. Report Writing and Conclusion: Compiling a final report encompassing findings, system evaluation results, conclusion

The research was conducted from October 6, 2022, until completion. The selection of these locations was based on the existence of issues in determining the recipients of the Direct Cash Aid (BLT). The chosen location (Cempaka Putih Village) is easily accessible and convenient for the researcher to gather the necessary data relevant to the research problem.

2.1 *Implementation of MOORA method*

The Multi-Objective Optimization on the Basis of Ratio Analysis Cis a multi-objective approach that deals with two or more conflicting attributes. MOORA optimizes these attributes by applying complex mathematical calculations, resulting in desired problem-solving outcomes [7]. The steps involved in the MOORA method consist of the following:

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1. Creating a decision matrix
   The decision matrix represents all available information for each attribute in matrix form. Figure 1 represents an Xmxn matrix, where Xij represents the performance measurement of the i-th alternative on the j-th attribute. Here, m is the number of alternatives, and n is the number of attributes/criteria.

$$Xij = \begin{matrix} X_{11} & X_{12} & X_{1n} \\ X_{21} & X_{21} & X_{2n} \\ X_{m1} & X_{m1} & X_{mn} \end{matrix}$$

   Next, a comparison is made between the performances of each alternative on the attribute, with the denominator representing all alternatives for that attribute. In determining the recipients of direct cash aid (BLT-DD) there are five criteria are employed. The main criteria and sub criteria is described in Table 1:

Table 1. The values of the sub-criteria in Cempaka Putih Village

Criteria	Sub Critera
(C1) Registered in the Integrated Database for Social Welfare but have not received social assistance (JPS)	Inclusion in DTKS and has never received social assistance. Inclusion in DTKS and has previously received social assistance. Inclusion in DTKS and currently receiving social assistance.
(C2) Registered in the Integrated Database for Social Welfare	Yes No Currently in the registration process.
(C3) Source of livelihood	Unemployed / not working. Farmer. Fisherman. Homemaker. Self-employed
(C4) Having chronic or long-term illness	Yes No
(C5) Poor/underprivileged families residing in the village without ID card/family card	Yes No

2. The values of the sub-criteria in Cempaka Putih Village are Normalization.
   This step is performed to obtain uniform values for the elements of the matrix by standardizing each element. Equation 1 is used to calculate the normalization matrix.

$$Xij = \frac{Xij}{\sqrt{[\sum_{i=1}^{m} \quad](j = 1,2,...n)}} \tag{1}$$

   Where :
   Xij: matrix of alternative j with criteria i
   i: 1, 2, 3, ..., n is the initialization of the sequence of criteria or attributes
   j: 1, 2, 3, ..., m is the initialization of the sequence of alternatives
3. Calculate Yi
   In this stage, there are two possible conditions, each has different calculations. These conditions are as follows:
   1. When there are no weight values assigned to attributes or criteria for each alternative. In this situation, the maximum and minimum values are reduced in each row. This is done to obtain rankings for each row. Equation (2) is used in this process.

$$Y_i = \sum_{j=1}^{g} X_{ij} - \sum_{j=g+1}^{n} X_{ij} \tag{2}$$

      Where:
      i: 1, 2, 3, ..., g represents the maximized criteria or attributes.
      j: g+1, g+2, g+3, ..., n represents the minimized criteria or attributes.
      Yj: Normalization matrix resulting from the subtraction of the maximized and minimized values for alternative j.
   2. When attributes or criteria for each alternative have assigned weight values. In this condition, the weight values are assigned according to the condition that the minimum weight value of the criteria should be smaller than the maximum weight value. Significance coefficients are assigned to more important attributes by multiplying the weight value with the coefficient. Equation (3) is used to calculate this part.

$$Y_i = \sum_{j=1}^{g} W_j X_{ij} - \sum_{j=g+1}^{n} W_j X_{ij} \tag{3}$$

      Where:

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i : 1, 2, 3, ..., g represents the maximized criteria or attributes.
j : g+1, g+2, g+3, ..., n represents the minimized criteria or attributes.
Wj : Weight value of alternative j.
Yi : Normalized evaluation value of alternative j for all attributes.

2.2 Ranking or prioritization

The total maximum value (benefit attribute) in a decision matrix can result in yi values being positive or negative. In this stage, ranking is performed on the yi values, where the highest yi value signifies the best alternative, while the alternative with the lowest yi value is considered the worst alternative.
Based on Table 1, there are 5 criteria used for selecting potential recipients of direct cash aid. The weight values for each criterion in each village are directly provided by the Head of Welfare Section of Cempaka Putih Village. Table 2 presents the weight values for the criteria in Cempaka Putih Village. The weight values are provided by the Head of Welfare Section of Cempaka Putih Village. The highest weight value of 5 is assigned to the first criterion.

3. RESULT AND DISCUSSION

Based on the regulations set by the Ministry of Home Affairs and the regulations of the Village Government, the criteria for determining the eligible recipients of direct cash aid are presented in the table 2.

Table 2. Criteria of recipients

Symbol	Quantity
C1	Registered in the Integrated Database for Social Welfare but have not received social assistance (JPS)
C2	Registered in the Integrated Database for Social Welfare
C3	Source of livelihood
C4	Having chronic or long-term illness
C5	Poor/underprivileged families residing in the village without ID card/family card

After establishing the criteria and their respective weights, the focus shifts to the sub-criteria and their corresponding values. It is noteworthy that the values assigned to each sub-criterion vary across the three villages. The allocation of values to the sub-criteria is carried out by the welfare officer. Table 3 illustrating the sub-criteria and their associated values.

Table 3 presents the breakdown of values for each sub-criterion in Cempaka Putih Village. The assignment of values to each sub-criterion is directly provided by the welfare officer in Cempaka Putih Village. For the first criterion, there are 3 sub-criteria. The highest weight of 5 is assigned to the sub-criterion "Eligible for Social Assistance and Previously Received," while the lowest weight of 3 is given to the sub-criterion "Eligible for Social Assistance and Currently Receiving."

Table 3. The Weight Values of Criteria in Cempaka Putih Village

Weight Value	Symbol	Quantity
5	C1	Registered in the Integrated Database for Social Welfare but have not received social assistance (JPS)
1	*C2*	Registered in the Integrated Database for Social Welfare
3	*C3*	Source of livelihood
4	*C4*	Having chronic or long-term illness
2	*C5*	Poor/underprivileged families residing in the village without ID card/family card

Tabel 4. The values of the sub-criteria in Cempaka Putih Village

Criteria	Sub Critera	Value
(C1) Registered in the Integrated Database for Social Welfare but have not received social assistance (JPS)	Inclusion in DTKS and has never received social assistance.	4
	Inclusion in DTKS and has previously received social assistance.	5
	Inclusion in DTKS and currently receiving social assistance.	3
(C2) Registered in the Integrated Database for Social Welfare	Yes	4
	No	1
	Currently in the registration process.	2
(C3) Source of livelihood	Unemployed / not working.	5

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	Farmer.	3
	Fisherman.	2
	Homemaker.	1
	Self-employed	4
(C4) Having chronic or long-term illness	Yes	2
	No	1
(C5) Poor/underprivileged families residing in the village without ID card/family card	Yes	4
	No	2

In the second criterion, there are 3 sub-criteria. The highest weight of 4 is assigned to the sub-criterion "Yes," while the lowest weight of 1 is assigned to the sub-criterion "No." The third criterion consists of 5 sub-criteria. The highest weight of 5 is assigned to the sub-criterion "Unemployed or Not Working," while the lowest weight of 1 is assigned to the sub-criterion "Household Chores." The fourth criterion only has 2 sub-criteria. The highest weight of 2 is assigned to the sub-criterion "Has Chronic Illness," while the lowest weight of 1 is assigned to the sub-criterion "Does not have Chronic Illness." Lastly, the fifth criterion has 2 sub-criteria. The highest weight of 4 is assigned to the sub-criterion "Yes" (Poor and Unable Families residing in the village without National Identification Number or Family Card). The lowest weight of 2 is assigned to the sub-criterion "No" (Poor and Unable Families residing in the village without National Identification Number or Family Card).

Table 5 represents the alternative values for each criterion. The table only display several sample alternative values for each criterion.

Tabel 5. The values of the sub-criteria in Cempaka Putih Village

Alternatif	Kriteria				
	C1	C2	C3	C4	C5
A1	4	4	1	1	4
A2	5	4	1	1	2
A3	3	4	1	1	4
A4	4	4	1	1	2
A5	4	4	1	1	2
A6	…….	……	……	……	……
A7	……	……..	…….	……	…..
A8	4	4	1	1	2
A9	5	4	3	1	2
A10	5	4	3	1	2
A11	5	4	3	1	2
A112	5	4	3	1	2

1. Decision Matrix
   A decision matrix namely decision matrixx 1 of candidate recipient is shown in below. The values for all the data are not fully presented here. All the numbers in the criteria values are used to form the decision matrix, where the placement of values should correspond to their respective row and column positions. Subsequently, normalization is performed on matrix in the next step.

$$x = \begin{bmatrix} 4 & 4 & 1 & 1 & 2 \\ 5 & 4 & 1 & 1 & 4 \\ 3 & 4 & 1 & 1 & 4 \\ 4 & 4 & 1 & 1 & 2 \\ 4 & 4 & 1 & 1 & 2 \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ 4 & 4 & 1 & 1 & 2 \\ 5 & 4 & 3 & 1 & 2 \\ 5 & 4 & 3 & 1 & 2 \\ 5 & 4 & 3 & 1 & 2 \\ 5 & 4 & 3 & 1 & 2 \end{bmatrix}$$

2. Normalization of Matrix
   Equation 1 is used to perform normalization of matrix. The normalization of decision matrix 1 is shown in below.

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$$\begin{bmatrix} 0.11 & 0.10 & 0.03 & 0.10 & 0.18 \\ 0.14 & 0.10 & 0.03 & 0.10 & 0.09 \\ 0.11 & 0.10 & 0.03 & 0.10 & 0.18 \\ 0.11 & 0.10 & 0.03 & 0.10 & 0.09 \\ 0.11 & 0.10 & 0.03 & 0.10 & 0.09 \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ 0.11 & 0.10 & 0.03 & 0.10 & 0.09 \\ 0.14 & 0.10 & 0.09 & 0.10 & 0.09 \\ 0.14 & 0.10 & 0.09 & 0.10 & 0.09 \\ 0.14 & 0.10 & 0.09 & 0.10 & 0.09 \\ 0.14 & 0.10 & 0.09 & 0.10 & 0.09 \end{bmatrix}$$

The subsequent stage after normalizing Matrix Xij is the weighting stage. The results normalization of Matrix X_{ij} with criterion weights is shown in below.

$$\begin{bmatrix} 0.55 & 0.10 & 0.09 & 0.40 & 0.37 \\ 0.69 & 0.10 & 0.09 & 0.40 & 0.18 \\ 0.42 & 0.10 & 0.09 & 0.40 & 0.37 \\ 0.55 & 0.10 & 0.09 & 0.40 & 0.18 \\ 0.55 & 0.10 & 0.09 & 0.40 & 0.18 \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ 0.55 & 0.10 & 0.09 & 0.40 & 0.18 \\ 0.69 & 0.10 & 0.28 & 0.40 & 0.18 \\ 0.69 & 0.10 & 0.28 & 0.40 & 0.18 \\ 0.69 & 0.10 & 0.28 & 0.40 & 0.18 \\ 0.69 & 0.10 & 0.28 & 0.40 & 0.18 \end{bmatrix}$$

After completing the third step in the MOORA method, which is the Normalization of Matrix X_{ij} with criterion weights, we proceed to the fourth step, which involves calculating the value of Y_i. To obtain the ranking values, we need to find the Y_i values by subtracting the *maximax* value from the *minimax* value. The criteria that belong to the benefit criteria are: "Not yet included in the DTKS but eligible for JPS" (C1), "Not yet listed in the DTKS" (C2), "Has chronic/long-term illness" (C4), and "Poor/financially incapable families residing in villages without NIK/KK" (C5). This is based on the criterion weights, where higher values indicate better outcomes. Criterion C3, which is "Livelihood," is considered a cost criterion because higher income reduces the chances of being selected as a recipient of direct cash assistance.

Table 5. Decision Table

Alternative	MAX C1+C2+C4+C5	MIN C3	Yi(MAX-MIN)
A1	1.41	0.09	1.32
A2	1.37	0.09	1.28
A3	1.28	0.09	1.18
A4	1.23	0.09	1.14
A5	1.23	0.09	1.14
A6	…..	…..	……
A7	…..	…..	……
A8	1.23	0.09	1.14
A9	1.37	0.28	1.09
A10	1.37	0.28	1.09
A11	1.37	0.28	1.09
A12	1.37	0.28	1.09

3. Calculation of Y_i

The Yi values are obtained by subtracting the maximax value from the minmax value. The *maximax* value is the total sum of the important benefit criteria (C1, C2, C4, C5). The *minmax* value is the total sum of the criteria considered as a cost, where lower values indicate better outcomes (C3). The determination of min and max values is based on the criterion weights, where cost criteria are assigned min and benefit criteria are assigned max. C1, C2, C4, and C5 are considered benefit values because higher values indicate better outcomes, while C3 is considered a cost value because lower or minimal values indicate better outcomes. The calculation of the Yi values can be seen in the table below.

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4. Ranking of Y_i
   Table 5 represents the ranking of Yi values for the Cempaka Putih village. Based on the calculation results using the MOORA method, it is determined that Alternative A1 receives the highest ranking, which is 1, with a Yi value of 1.32. Therefore, Alternative A1 is recommended as the best candidate to receive direct cash assistance in the Cempaka Putih village.

Table 6. The values of the sub-criteria in Cempaka Putih Village

Alternative	MAX C1+C2+C4+C5	MIN C3	Yi(MAX-MIN)	RANK
A1	1.41	0.09	1.32	1
A2	1.37	0.09	1.28	2
A3	1.28	0.09	1.18	3
A4	1.23	0.09	1.14	4
A5	1.23	0.09	1.14	4
A6	…..	…..	……	…..
A7	…..	…..	……	…..
A8	1.23	0.09	1.14	4
A9	1.37	0.28	1.09	5
A10	1.37	0.28	1.09	5
A11	1.37	0.28	1.09	5
A12	1.37	0.28	1.09	5

The findings in Table 7 indicate that Alternative A1 has attained the highest ranking, securing the top spot with a Yi value of 1.32. Consequently, Alternative A1 is suggested as the optimal choice for receiving direct cash assistance in the Cempaka Putih village. A1 has the highest ranking because it almost fulfills all the criteria and sub-criteria needed to qualify as a recipient of direct cash aid. The methodology can effectively rank the top 12 eligible candidates suitable for receiving direct cash aid. Nevertheless, there are instances where certain Yi values match, necessitating additional scrutiny by local authorities.

Table 7. The ranking Yi values

Alternative	MAX C1+C2+C4+C5	MIN C3	Yi(MAX-MIN)	RANK
A1	1.41	0.09	1.32	1
A2	1.37	0.09	1.28	2
A3	1.28	0.09	1.18	3
A4	1.23	0.09	1.14	4
A5	1.23	0.09	1.14	4
A6	…..	…..	……	…..
A7	…..	…..	……	…..
A8	1.23	0.09	1.14	4
A9	1.37	0.28	1.09	5
A10	1.37	0.28	1.09	5
A11	1.37	0.28	1.09	5
A12	1.37	0.28	1.09	5

4. CONCLUSION

This study aims to provide recommendations regarding potential recipients of direct cash assistance in Cempaka Putih village. A total of 112 data were analyzed using the MOORA method. The results indicate that Alternative A1 obtains the highest ranking as it fulfills all the criteria for receiving direct cash assistance. The methodology can effectively rank the top 12 eligible candidates suitable for receiving direct cash aid. Nevertheless, there are instances where certain Yi values match, necessitating additional scrutiny by local authorities. Nonetheless, the current implementation of this method relies on manual mathematical calculations, which highlights the need for the development of a computer program to streamline and expedite the computational process. In the future, it is anticipated that a computer program will be developed to further enhance the efficiency of the MOORA method in direct cash application study case.

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