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Comparative Analysis of MCDM Methods in Employee Award Ranking

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A B S T R A C T

Awards are an important form of appreciation for outstanding employees, but the process of selecting recipients is often faced with various challenges, especially in assessing subjective aspects of performance. To overcome this, the Multi-Criteria Decision Making (MCDM) method can be an effective solution. MCDM offers a systematic framework for evaluating various alternatives (in this case, employees) based on a number of relevant criteria. By using the MCDM method, the process of selecting award recipients can be carried out more objectively and transparently. Some commonly used MCDM methods, such as MAUT, OCRA, and CoCoSo, have their own advantages and disadvantages. This study aims to compare the three methods specifically in the context of selecting employee award recipients. The final results obtained show that the best alternative is A6, where the results of the three methods look the same position or location in the ranking. After a comparative analysis of the three methods, it can be concluded that the OCRA method is the best method in terms of ranking consistency compared to the other two methods. Thus, it is hoped that recommendations for the most suitable MCDM method can be obtained to be applied in similar situations

1. INTRODUCTION

Giving awards to outstanding employees or known as awards is a way for companies to show appreciation and appreciate their contributions. This award is not only in the form of objects, but can also be in the form of recognition or opportunities for self-development. Nonetheless, assessing employee performance to determine who deserves an award is often a challenge. Every company has a different way of judging, and this appraisal often involves an element of subjectivity. Some aspects of performance that are difficult to measure, such as creativity or the ability to work together, are also obstacles in the assessment process. This problem can be overcome by utilizing ranking techniques in making a decision known as MCDM. Multi-Criteria Decision Making (MCDM) is a method used to make complex decisions by considering many factors or criteria. In our daily lives as well as in the business world, we are often faced with situations where we have to choose one option from several alternatives. Each alternative has different advantages and disadvantages, making the decision-making process difficult.

In MCDM, there are many methods that can be used, including VIKOR, OCRA, CoCoSo, MOORA, MOOSRA, TOPSIS, WP, MAUT, AHP, WASPAS, SAW, and many other methods[1]–[7]. The MCDM method offers a flexible framework for addressing complex decision-making problems. There are many variations of MCDM methods, each with unique characteristics. While each method has its advantages, none of them are always the best option. The selection of the right method largely depends on the concrete situation, the number of criteria used, and the preferences of the decision-maker. Therefore, comparing different MCDM methods is very important to choose the most appropriate method in ranking employee award recipients[8]–[10]. In this study, a comparison of three MCDM methods will be carried out, including the MAUT method, the OCRA method and the CoCoSo method.

MAUT is a very useful method for decision-making because of its comprehensive, quantitative, flexible, transparent, consistent, and efficient nature. This method allows decision-makers to systematically consider various factors and reach better decisions. Meanwhile, the Operational Competitive Analysis (OCRA) method is a practical and effective method to evaluate various situations. Its advantage lies in its simplicity of use, so it can be applied in a variety of contexts. Additionally, OCRA is able to generate trusted ratings, making it a valuable tool in objective decision-making. The Combine Compromise Solution (CoCoSo) method is a very useful tool in decision-making, especially when we are faced with complex situations and involve many criteria. This method helps us to find the best solution that can be accepted by all interested parties[11]–[17].

Through the comparison of several MCDM methods, this study aims to develop a more accurate and fair performance evaluation system. The results of this study are expected to be a guideline for companies in choosing the most appropriate MCDM method to be applied according to their specific needs. In a previous study in 2023, Aldinugroho and Aldisa emphasized the crucial role of the Decision Support System (SPK) in the recruitment process for warehouse heads. The conventional recruitment process, which often involves many criteria, can make potential applicants feel overwhelmed and HRD has difficulty finding suitable candidates. SPK offers an innovative solution by

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helping HRD identify and systematically evaluate the criteria required for the position. Through the application of the Multi-Attribute Utility Theory (MAUT) method and Rank Order Centroid (ROC) weighting, this study successfully identified "Dindin Samsudin" as the strongest candidate with the highest utility value (Ui = 0.761), showing its most optimal fit for the position of warehouse head[18].

Ida Mayanju Pandiangan and several other research colleagues conducted research in 2023. The study said that the optimal placement of a minimarket is crucial for its success and growth. Selecting a suitable location requires careful consideration to avoid detrimental consequences. A common challenge faced by businesses is the difficulty in choosing among various potential locations, each with its own strengths and weaknesses. This can lead to time-consuming analysis and indecision. To address this issue, a decision support system was developed. This system utilizes the ROC method for weighting criteria and the OCRA method to generate decisions. By analyzing different locations based on various factors, the system provides objective and definitive recommendations. The ROC method assigns weights to conflicting criteria, while the OCRA method efficiently calculates and ranks alternatives. The application of this system in Lubuk Pakam led to the identification of the most suitable location with a preference value of 0.673[19].

A study conducted by A. Ferico Octaviansyah Pasaribu and his team in 2023 tested the effectiveness of the Combined Compromise Solution method in selecting the best interns. This method proved to be capable of producing decisions, but was considered inadequate in evaluating students' skills in the actual work environment. The final results showed that a student named Jonathan, with the highest score of 5.7874, was selected as the most suitable intern[20]. Tb Ai Munandar conducted research in 2023. In the research, it is said that traditional employee rankings for year-end bonuses often rely solely on performance metrics like targets and achievements. However, other factors, such as attendance, discipline, communication, cooperation, and initiative, can also significantly contribute to overall employee value. This research proposes a multi-attribute decision-making (MADM) approach, specifically the ELECTRE technique, to rank employees more comprehensively. By considering a wider range of attributes, this method provides a more nuanced assessment. The study analyzed ten employees and identified four top candidates based on their aggregate scores. Alternative 6 was consistently ranked highest, demonstrating superior performance across multiple dimensions. The remaining top three alternatives were ranked in order of 5, 7, and 8. These recommendations can inform decision-makers when considering year-end bonus allocations[21].

2. RESEARCH METHODOLOGY

2.1 Research Stages

The research stage is a series of activities carried out by researchers to obtain new knowledge. This research stage usually begins with problem identification, followed by data collection, data analysis, and conclusion drawn. The following stages of research can be seen in Figure 1 below.

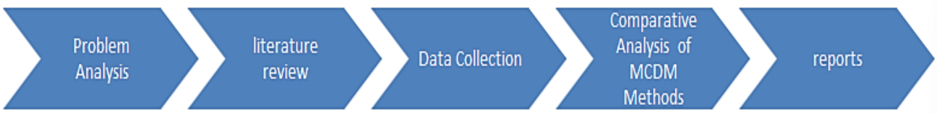

Figure 1. Research Stages

Based on Figure 1 above, the explanation of the stages above including Problem Analysis is a systematic process to understand in depth a problem. Literature review is an activity that involves the analysis, evaluation, and synthesis of various literature sources relevant to a particular research topic. Data collection is a systematic process of obtaining relevant information to answer a research question or achieve a specific goal. This data can be numbers, words, or even pictures, and is collected from a variety of sources. Comparative analysis of MCDM method is a process of comparing and evaluating various different Multi-Criteria Decision Making (MCDM) methods. A report is a written or oral delivery of information that contains the results of certain observations, research, or activities.

2.2 Multi-Criteria Decision Making (MCDM)

MCDM is a method or technique used to make decisions when we are faced with several alternative options that need to be evaluated based on a variety of different criteria. Simply put, MCDM helps us choose the best option from several options available by considering many factors simultaneously. There are many MCDM methods that can be used based on each problem faced, the MCDM methods include the SAW, ARAS, WP, GADA, WASPAS, OCRA, TOPSIS, MOORA, MAUT, MOOSRA, CoCoSo, PSI, AHP, ROC, EDAS, and many more methods[1]–[7], [22]–[24].

2.3 Method MAUT

The Multi-Attribute Utility Theory (MAUT) method is a decision-making method that compares alternatives based on several criteria. Each criterion has a weight that indicates its level of importance. The utility value of each alternative is calculated by multiplying the weight by the relevant criterion value. The alternative with the highest utility value is the one that best suits the user's wishes. The weights are calculated on a scale of 0-1, where 0 indicates an unimportant criterion and 1 indicates a very important criterion. The utility values of each alternative can be compared head-to-head. The utility value of each alternative is calculated by multiplying the weight by the relevant criterion value. Utility value

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is a value that indicates how well an alternative meets the desired criteria[25][26][27]. For the calculation of the evaluation value as a whole, it can be defined by several equations, formulated as follows[28][12]:

1. Creating a Decision Matrix

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

   Where m is the number of alternative candidates, n is the number of evaluation criteria and Xij is the alternative performance with respect to j's performance.

2. Normalizing
   For the benefit criterion, equation 2 is used, while the cost criterion is used equation 3

$$r_{ij}^{*} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \quad (2)$$

$$r_{ij}^{*} = 1 + \left(\frac{\min(x_{ij}) - (x_{ij})}{\max(x_{ij}) - \min(x_{ij})}\right) \quad (3)$$

3. Calculating the Marginal Utility (UIJ) value

$$U_{ij} = \frac{\exp\left(r_{ij}^{*}\right) - 1}{1.71} \quad (4)$$

4. Calculating the End Utility (UI) value

$$U_i = \sum_j^n = 1 \;\; U_{ij}.W_j \quad (5)$$

2.4 Method OCRA

Method *Operational Competitiveness Rating Analysis* (OCRA) is a strategy to evaluate relative performance using a nonparametric model. This method has been used in various competitive analyses to comprehensively evaluate marketing competition between organizations. One of the significant benefits of the OCRA method is its simplicity in comparing different decision units. Initially, this method was developed as a non-parametric efficiency measurement tool aimed at overcoming productivity analysis problems. In this approach, decisions are made by sorting the values from lowest to highest. This method is designed to achieve optimal decisions and provide convenience in recommending prospective heads of study programs.[29][30]. Overall, the OCRA Method can assist companies in managing and utilizing resources. The working process of the OCRA method is as follows [31][32][33]:

1. To form the X decision matrix, the decision alternative is placed in the matrix rows, while the criteria are placed in the columns on the matrix. In the matrix, Xij indicates the alternative performance i in criterion j.

$$X = \left[X_{ij}\right]_{mxn} = \begin{bmatrix} X_{11} & \cdots & X_{12} & \cdots & X_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ X_{21} & \cdots & X_{22} & \cdots & X_{2n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ X_{31} & \cdots & X_{32} & \cdots & X_{3n} \end{bmatrix} \text{i=1,....,m;} \quad \text{j=1 ,2,....,n} \quad (6)$$

   Where the formula m is the Number of Alternatives, n is the Number of Criteria, is the Performance Value of the alternative i to the criterion jX_{ij}

2. Preference ranking involves calculating the value of performance only for the criteria that must be minimized (cost).

$$\overline{I_i} = \sum_{j=1}^{g} W_j \frac{max(X_{ij}) - X_{ij}}{min(X_{ij})} \text{ (i=1,2,....,m; j=1,2,....,g)} \quad (7)$$

3. In this stage, a linear preference ranking calculation is carried out for each alternative related to the criteria that need to be minimized (cost).

$$\overline{\overline{I_i}} = \overline{I_i} - \min(\overline{I_i}) \quad (8)$$

4. In the preference ranking, only the performance value of the alternative on the criteria to be maximized (benefit) is calculated.

$$\overline{O_i} = \sum_{j=g+1}^{n} W_j \frac{X_{ij} - \min(X_{ij})}{\min(X_{ij})} \text{ (i = 1, 2, ..., m; j = g + 1, g + 2, ..., n)} \quad (9)$$

5. In this step, a linear preference ranking is calculated for each alternative related to the criteria that will be the top priority (bebefit).

$$\overline{\overline{O_i}} = \overline{O_i} - \min\left(\overline{O_i}\right) \quad (10)$$

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6. In this step, the total number of preference values for each alternative is calculated.
$$P_i = \left(\bar{\bar{I_l}} + \bar{\bar{O_l}}\right) - \min\left(\bar{\bar{I}} + \bar{\bar{O}}\right) \quad i = 1, 2, ..., m \tag{11}$$

2.5 CoCoSo Method

Method *combine compromise solution* is one of the multi-criteria decision-making techniques that aims to find the best solution or compromise from the various available alternatives. This method is useful in situations where there is a conflict between criteria and there is no alternative that ideally meets all criteria. By seeking a compromise solution, this method helps in better and effective decision-making[34]–[37]. Stages in the *combine compromise solution* This can be done based on the following steps:

1. Forming a decision matrix
2. Normalize the criteria:

$$\text{Benefit} \quad : r_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \tag{12}$$

$$\text{Cost} \quad : r_{ij} = \frac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}} \tag{13}$$

   The formula in equation one (12) is used for the attribute (criterion) of the benefit type while for the criterion of the type of cost (non-benefit) can use the second equation formula (13).
3. Calculating the positive ideal solution (Si) and the negative ideal solution (Pi)

$$S_i = \sum_{j=1}^{n} (W_j r_{ij}) \tag{14}$$

$$P_i = \sum_{j=1}^{n} (r_{ij})^{w_j} \tag{15}$$

   The second stage is to calculate the value of the Positive Ideal Solution (Si) using the third equation formula (14) and the value of the Negative Ideal Solution (Pi) using the fourth equation formula (15). These two values serve as ideal solutions used to compare different alternatives in the decision-making process
4. Calculating Relative Weights with Aggregation Techniques
   In the third stage, the relative weight calculation for each alternative is carried out using an aggregation technique. This process consists of three steps of calculating the assessment score that results in relative weight. Here is the equation for calculating the relative weight.

$$K_{ia} = \frac{P_i + S_i}{\sum_{i=1}^{m} (P_i + S_i)} \tag{16}$$

$$K_{ib} = \frac{S_i}{\min S_i} + \frac{P_i}{\min P_i} \tag{17}$$

$$K_{ic} = \frac{\lambda(S_i) + (1-\lambda)(P_i)}{(\lambda \max S_i + (1-\lambda) \max P_i)} \tag{18}$$

5. Calculate the total Ki value

$$K_i = (k_{ia} k_{ib} k_{ic})^{\frac{1}{3}} + \frac{1}{3}(k_{ia} + k_{ib} + k_{ic}) \tag{19}$$

   The Combined Compromise Solution (CoCoSo) method ends by calculating the total value of ki for each alternative, using equation 19.

3. RESULTS AND DISCUSSION

In this study, a selection will be made on the acquisition of eligible employee wards and in accordance with the provisions that have been made, these provisions are usually in the form of criteria used in the determination. The criteria used are 5 criteria as an employee assessment to obtain awards such as Performance (C1) in the benefit type, Initiative and Creativity (C2) in the benefit type, Teamwork (C3) in the benefit type, Absence (C4) in the cost type and Self-Development (C5) in the benefit type. Each criterion is given a different level of importance weight, namely criteria C1 and C2 have the same importance weight of 0.25, criterion C3 is given an importance weight of 0.2 and importance weight of 0.15 is set for criteria C4 and C5. The employees who will be assessed are 10 people who are called alternatives. In determining employees who are entitled to receive awards using the MCDM method, there are 3 MCDM methods that will be compared in determining employees who obtain awards, including the MAUT method, the OCRA method and the CoCoSo method. The three methods are compared by analyzing the final results of each method. The initial stage is to determine the data sample which can be seen in the following Table 1.

Based on the sample data in Table 1 above, it is necessary to improve the weights of linguistic criteria including criteria C1, C2, C3 and C5 so that the criteria need to be adjusted so that the linguistic data is converted into numerical form. The following table of weight improvements can be seen in Table 2.

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Table 1. Sampel Data

Alternative	Criterion				
	C1	C2	C3	C4	C5
A1	Excellent	Pretty good	Excellent	2	Pretty good
A2	Good	Pretty good	Good	3	Not good
A3	Not good	Pretty good	Excellent	2	Good
A4	Not good	Excellent	Pretty good	3	Excellent
A5	Good	Pretty good	Not good	4	Excellent
A6	Good	Good	Excellent	2	Excellent
A7	Excellent	Not good	Excellent	3	Excellent
A8	Excellent	Not good	Not good	4	Pretty good
A9	Good	Good	Excellent	4	Pretty good
A10	Pretty good	Excellent	Excellent	3	Good

Table 2. Improvement of data sample weights in criteria C1, C2, C3, and C5

Information	Weight Value
Excellent	5
Good	4
Pretty Good	3
Not Good	2
Bad	1

From Table 2 above, it can be seen that each of the 4 criteria has been determined by its weight value and adjustments have been made to the linguistic data sample in Table 1 so that a match rating table has been made that has been adjusted. The following is table 3 which contains the adjusted match rating data.

Table 3. Match rating data

Alternative	C1	C2	C3	C4	C5
A1	5	3	5	2	3
A2	4	3	4	3	2
A3	2	3	5	2	4
A4	2	5	3	3	5
A5	4	3	2	4	5
A6	4	4	5	2	5
A7	5	2	5	3	5
A8	5	2	2	4	3
A9	4	4	5	4	3
A10	3	5	5	3	4

The match rating data in Table 3 above has all the numerical values so that it can be used for the process of implementing the MCDM method, namely the MAUT, OCRA and CoCoSo methods. Follow the decision matrix made from the data sample in table 3 above.

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

3.1 Implementation of the MAUT method

1. Normalizing
   Normalization for benefit criteria using equation 2
   Kriteria Benefit: C1

   $r^*_{11} = \frac{5-2}{5-2} = 1$

   $r^*_{21} = \frac{4-2}{5-2} = 0,667$

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$r^*_{31} = \frac{2-2}{5-2} = 0$

$r^*_{41} = \frac{2-2}{5-2} = 0$

$r^*_{51} = \frac{4-2}{5-2} = 0,667$

In other criteria that are of the benefit type, namely criteria C2, C3 and C5, carry out the normalization calculation process like criterion C1 above from the normalization search r^*_{11} to $r^*_{10.1}$. The following is the calculation of the normalization value for the cost type criterion, namely the C4 criterion using equation 3.

$r^*_{14} = 1 + (\frac{2-2}{4-2}) = 1$

$r^*_{24} = 1 + (\frac{2-3}{4-2}) = 0,5$

$r^*_{34} = 1 + (\frac{2-2}{4-2}) = 1$

$r^*_{44} = 1 + (\frac{2-3}{4-2}) = 0,5$

$r^*_{54} = 1 + (\frac{2-4}{4-2}) = 0$

The normalization search for $r^*_{6.4}$ to $r^*_{10.4}$ can be done according to the normalization calculation for r^*_{14} to r^*_{54} above. The following is the R^*ij matrix for all the criteria that have been normalized.

$$
R^*ij = \begin{vmatrix}
1,000 & 0,333 & 1,000 & 1,000 & 0,333 \\
0,667 & 0,333 & 0,667 & 0,500 & 0,000 \\
0,000 & 0,333 & 1,000 & 1,000 & 0,667 \\
0,000 & 1,000 & 0,333 & 0,500 & 1,000 \\
0,667 & 0,333 & 0,000 & 0,000 & 1,000 \\
0,667 & 0,667 & 1,000 & 1,000 & 1,000 \\
1,000 & 0,000 & 1,000 & 0,500 & 1,000 \\
1,000 & 0,000 & 0,000 & 0,000 & 0,333 \\
0,667 & 0,667 & 1,000 & 0,000 & 0,333 \\
0,333 & 1,000 & 1,000 & 0,500 & 0,667
\end{vmatrix}
$$

2. Calculate the Marginal Utility (Uij) value according to equation 4.

$U_{11} = \frac{e^{(1,000)^2}-1}{1.71} = 1,005$

$U_{21} = \frac{e^{(0,667)^2}-1}{1.71} = 0,327$

$U_{31} = \frac{e^{(0)^2}-1}{1.71} = 0$

$U_{41} = \frac{e^{(0)^2}-1}{1.71} = 0$

$U_{51} = \frac{e^{(0,667)^2}-1}{1.71} = 0,327$

Finding the marginal utility value U61 to U10.5 do the process of calculating the marginal value of the utility such as U11 or up to U51 above, along with the Uij matrix after the calculation is made.

$$
Uij = \begin{vmatrix}
1,005 & 0,069 & 1,005 & 1,005 & 0,069 \\
0,327 & 0,069 & 0,327 & 0,166 & 0,000 \\
0,000 & 0,069 & 1,005 & 1,005 & 0,327 \\
0,000 & 1,005 & 0,069 & 0,166 & 1,005 \\
0,327 & 0,069 & 0,000 & 0,000 & 1,005 \\
0,327 & 0,327 & 1,005 & 1,005 & 1,005 \\
1,005 & 0,000 & 1,005 & 0,166 & 1,005 \\
1,005 & 0,000 & 0,000 & 0,000 & 0,069 \\
0,327 & 0,327 & 1,005 & 0,000 & 0,069 \\
0,069 & 1,005 & 1,005 & 0,166 & 0,327
\end{vmatrix}
$$

3. Calculating the End Utility (UI) value

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Calculate the final utility value (Ui) according to equation 5, where this final process will be multiplied by the value of Uij with the weight value of each criterion that has been determined, namely Wi (weight of criterion importance) = [0.25; 0.2; 0.15; 0.15].

$$U_1 = (1{,}005 * 0{,}25) + (0{,}069 * 0{,}25) + (1{,}005 * 0{,}2) + (1{,}005 * 0{,}15) + (0{,}069 * 0{,}15) = 0{,}630$$

$$U_2 = (0{,}327 * 0{,}25) + (0{,}069 * 0{,}25) + (0{,}327 * 0{,}2) + (0{,}166 * 0{,}15) + (0{,}000 * 0{,}15) = 0{,}189$$

Perform the calculation of the final utility value search for U3 to U10 as the utility value search U1 to U2 above, after the final utility value search is carried out, the final utility results in table 4 and the ranking results of each alternative are obtained.

Table 4. Final Result (Ranking) of the MAUT method

Alternative	Final Result (UI)	Rank
A1	0,630	2
A2	0,189	10
A3	0,418	6
A4	0,441	5
A5	0,250	9
A6	0,666	1
A7	0,628	3
A8	0,262	8
A9	0,375	7
A10	0,543	4

3.2 Implementation of OCRA Method

1. Calculate the preference rating on the cost criterion, which is the C4 criterion

$$\bar{I}_1 = \sum\left(0{,}15\ \frac{4-2}{2}\right) = 0{,}15$$

$$\bar{I}_2 = \sum\left(0{,}15\ \frac{4-3}{2}\right) = 0{,}075$$

$$\bar{I}_3 = \sum\left(0{,}15\ \frac{4-2}{2}\right) = 0{,}15$$

$$\bar{I}_4 = \sum\left(0{,}15\ \frac{4-3}{2}\right) = 0{,}075$$

$$\bar{I}_5 = \sum\left(0{,}15\ \frac{4-4}{2}\right) = 0$$

Perform the process of calculating the preference rating $\bar{I}_6$ up to as above $\bar{I}_{10}$from the search for the preference rank $\bar{I}_1$ until, after searching for all $\bar{I}_5$the preference ratings in the C4 criterion, the minimum value comparison is carried out between the value $\bar{I}_1$ and the value $\bar{I}_{10}$that will be used as a deduction in the calculation of the linear preference rating on the cost criterion, the minimum value is 0.

2. Calculate the linear preference rating on the cost criterion i.e. C4

$$\bar{\bar{I}}_1 = 0{,}15 - 0 = 0{,}15$$

$$\bar{\bar{I}}_2 = 0{,}075 - 0 = 0{,}075$$

$$\bar{\bar{I}}_3 = 0{,}15 - 0 = 0{,}15$$

$$\bar{\bar{I}}_4 = 0{,}075 - 0 = 0{,}075$$

$$\bar{\bar{I}}_5 = 0 - 0 = 0$$

Perform the process of calculating the linear preference rank $\bar{\bar{I}}_6$ up to as above $\bar{\bar{I}}_{10}$ from the search for the preference rank $\bar{\bar{I}}_1$ to.$\bar{\bar{I}}_5$

3. Calculate the preference rating on the benefit criteria, namely C1, C2, C3 and C5.

$$\bar{O}_1 = \sum\left(0{,}25\ \frac{5-2}{2}\right) + \left(0{,}25\ \frac{3-2}{2}\right) + \left(0{,}2\ \frac{5-2}{2}\right) + \left(0{,}15\ \frac{3-2}{2}\right) = 0{,}875$$

$$\bar{O}_2 = \sum\left(0{,}25\ \frac{4-2}{2}\right) + \left(0{,}25\ \frac{3-2}{2}\right) + \left(0{,}2\ \frac{4-2}{2}\right) + \left(0{,}15\ \frac{2-2}{2}\right) = 0{,}575$$

$$\bar{O}_3 = \sum\left(0{,}25\ \frac{2-2}{2}\right) + \left(0{,}25\ \frac{3-2}{2}\right) + \left(0{,}2\ \frac{5-2}{2}\right) + \left(0{,}15\ \frac{5-2}{2}\right) = 0{,}575$$

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$$\bar{O}_4 = \sum\left(0{,}25\ \frac{2-2}{2}\right) + \left(0{,}25\ \frac{5-2}{2}\right) + \left(0{,}2\ \frac{3-2}{2}\right) + \left(0{,}15\ \frac{5-2}{2}\right) = 0{,}7$$

$$\bar{O}_5 = \sum\left(0{,}25\ \frac{4-2}{2}\right) + \left(0{,}25\ \frac{3-2}{2}\right) + \left(0{,}2\ \frac{2-2}{2}\right) + \left(0{,}15\ \frac{5-2}{2}\right) = 0{,}6$$

Carry out the process of calculating the preference rating $\bar{O}_6$ up to as above $\bar{O}_{10}$ from the search for the preference rank $\bar{O}_1$ until, after searching all $\bar{O}_5$the preference ratings in the criteria C1, C2, C3 and C5, then a comparison of the minimum value between the to $\bar{O}_1\bar{O}_{10}$ will be used as a deduction in the calculation of the linear preference rating on the benefit criteria, the minimum value is 0.45.

4. Calculating Linear Benefit Preference Ranking

$$\bar{\bar{O}}_1 = 0{,}875 - 0{,}45 = 0{,}425$$

$$\bar{\bar{O}}_2 = 0{,}575 - 0{,}45 = 0{,}125$$

$$\bar{\bar{O}}_3 = 0{,}575 - 0{,}45 = 0{,}125$$

$$\bar{\bar{O}}_4 = 0{,}7 - 0{,}45 = 0{,}25$$

$$\bar{\bar{O}}_5 = 0{,}6 - 0{,}45 = 0{,}15$$

Perform the process of calculating the linear preference rank $\bar{\bar{O}}_6$ up to as above $\bar{\bar{O}}_{10}$ from the search for the preference rank $\bar{\bar{O}}_1$ to. $\bar{\bar{O}}_5$

5. Calculate the total preference value of each alternative

After the sum of the values is carried out $\bar{\bar{I}}_l\ dan\ \bar{\bar{O}}_l$, find the minimum value of the sum result to be used as a subtraction value from the sum result, more details can be seen below.$\bar{\bar{I}}_l\ dan\ \bar{\bar{O}}_l$

$$P_1 = (0{,}15 + 0{,}425) - 0 = 0{,}575$$

$$P_2 = (0{,}075 + 0{,}125) - 0 = 0{,}2$$

$$P_3 = (0{,}15 + 0{,}125) - 0 = 0{,}275$$

$$P_4 = (0{,}075 + 0{,}25) - 0 = 0{,}325$$

$$P_5 = (0 + 0{,}15) - 0 = 0{,}15$$

Calculate the total preference value for P6 to P10 based on the calculation of the total preference that has been done previously, which is in accordance with the calculation of P1 to P5 above. After calculating all the alternatives (P1 to P10), here is Table 5 which contains the final results of the application of the OCRA method and its functioning.

Table 5. Final Results (Ranking) of the OCRA method

Pi	Final Score	Rank
A1	0,575	2
A2	0,2	8
A3	0,275	7
A4	0,325	6
A5	0,15	9
A6	0,725	1
A7	0,525	4
A8	0	10
A9	0,425	5
A10	0,575	2

3.3 Implementation of the CoCoSo Method

1. Normalize the criteria:

Normalization for benefit criteria using equation 12
Kriteria Benefit: C1

$$r_{11} = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

$$r_{21} = \frac{4-2}{5-2} = \frac{2}{3} = 0{,}667$$

$$r_{31} = \frac{2-2}{5-2} = \frac{0}{3} = 0$$

$$r_{41} = \frac{2-2}{5-2} = \frac{0}{3} = 0$$

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$r_{51} = \frac{4-2}{5-2} = \frac{2}{3} = 0{,}667$

In other criteria that are of the benefit type, namely criteria C2, C3 and C5, carry out the normalization calculation process like criterion C1 above from the normalization search r^*_{11} to $r^*_{10.1}$. The following is the calculation of the normalization value for the cost criterion, namely the C4 criterion using equation 13.

$r_{14} = \frac{4-2}{4-2} = \frac{2}{2} = 1$

$r_{24} = \frac{4-3}{4-2} = \frac{1}{2} = 0{,}5$

$r_{34} = \frac{4-2}{4-2} = \frac{2}{2} = 1$

$r_{44} = \frac{4-3}{4-2} = \frac{1}{2} = 0{,}5$

$r_{54} = \frac{4-4}{4-2} = \frac{0}{2} = 0$

The normalization search for $r^*_{6.4}$ to $r^*_{10.4}$ can be done according to the normalization calculation for r^*_{14} to r^*_{54} above. The following is the R^*ij matrix for all the criteria that have been normalized.

$$R^*ij = \begin{vmatrix} 1{,}000 & 0{,}333 & 1{,}000 & 1{,}000 & 0{,}333 \\ 0{,}667 & 0{,}333 & 0{,}667 & 0{,}500 & 0{,}000 \\ 0{,}000 & 0{,}333 & 1{,}000 & 1{,}000 & 0{,}667 \\ 0{,}000 & 1{,}000 & 0{,}333 & 0{,}500 & 1{,}000 \\ 0{,}667 & 0{,}333 & 0{,}000 & 0{,}000 & 1{,}000 \\ 0{,}667 & 0{,}667 & 1{,}000 & 1{,}000 & 1{,}000 \\ 1{,}000 & 0{,}000 & 1{,}000 & 0{,}500 & 1{,}000 \\ 1{,}000 & 0{,}000 & 0{,}000 & 0{,}000 & 0{,}333 \\ 0{,}667 & 0{,}667 & 1{,}000 & 0{,}000 & 0{,}333 \\ 0{,}333 & 1{,}000 & 1{,}000 & 0{,}500 & 0{,}667 \end{vmatrix}$$

2. Calculating the positive ideal solution (Si) and the negative ideal solution (Pi)

Positive Ideal Solution (Si)

$S_1 = (0{,}25 * 1{,}000) + (0{,}25 * 0{,}333) + (0{,}2 * 1{,}000) + (0{,}15 * 1{,}000) + (0{,}15 * 0{,}333) = 0{,}733$

$S_2 = (0{,}25 * 0{,}667) + (0{,}25 * 0{,}333) + (0{,}2 * 0{,}667) + (0{,}15 * 0{,}500) + (0{,}15 * 0{,}000) = 0{,}458$

Perform calculations to find positive ideal solutions for S3 to S10 in accordance with the calculations for S1 to S2 that have been done above. Searching for negative ideal solutions (Pi) .

$P_1 = (1{,}000^{0{,}25}) + (0{,}333^{0{,}25}) + (1{,}000^{0{,}20}) + (1{,}000^{0{,}15}) + (0{,}333^{0{,}15}) = 4{,}608$

$P_2 = (0{,}667^{0{,}25}) + (0{,}333^{0{,}25}) + (0{,}667^{0{,}20}) + (0{,}500^{0{,}15}) + (0{,}000^{0{,}15}) = 3{,}487$

Perform the calculation to find a negative ideal solution to P3 to P10 in accordance with the calculation of P1 to P2 that has been done above. After the search for a positive ideal solution and a negative ideal solution to all alternatives, the following values of Si and Pi can be seen in table 6 below.

Table 6. Values positive and negative ideal solutions (Si and Pi)

Alternative	Yes	Pi
S1	0,733	4,608
S2	0,458	3,487
S3	0,533	3,701
S4	0,542	3,704
S5	0,400	2,663
S6	0,833	4,807
S7	0,675	3,901
S8	0,300	1,848
S9	0,583	3,655
S10	0,708	4,602

3. Calculating Relative Weights with Aggregation Techniques

$K_{1a} = \frac{0{,}733+4{,}608}{42{,}744} = \frac{5{,}341}{42{,}744} = 0{,}125$

$K_{2a} = \frac{0{,}458+3{,}487}{42{,}744} = \frac{3{,}945}{42{,}744} = 0{,}092$

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Perform a search for relative weights on K3a to K10a, after the calculation of the relative weight search for Kia (all alternatives) and ranking has been carried out, then look for the relative weight of Kib as follows.

$$K_{ib} = \frac{S_i}{\min S_i} + \frac{P_i}{\min P_i}$$

$$K_{1b} = \frac{0{,}733}{0{,}300} + \frac{4{,}608}{1{,}848} = 4{,}938$$

$$K_{2b} = \frac{0{,}6831}{0{,}300} + \frac{4{,}6000}{1{,}848} = 3{,}415$$

Perform a relative weight search on K3b to K10b, after the calculation of the relative weight search for Kib (all alternatives) and ranking has been carried out, then look for the relative weight of Kic with the value of lamda (λ) can be determined between 0 to 1, in this study the value of $\lambda = 0{,}5$

$$K_{1c} = \frac{0{,}5(0{,}733)+(1-0{,}5)(4{,}608)}{(0{,}5*0{,}833+(1-0{,}5)*4{,}807)} = 0{,}947$$

$$K_{2c} = \frac{0{,}5(0{,}6831)+(1-0{,}5)(4{,}6000)}{(0{,}5*0{,}833+(1-0{,}5)*4{,}807)} = 0{,}699$$

Perform a relative weight search on K3c to K10c, after the calculation of the relative weight search for Kic (all alternatives) then the following table 7 is the Calculation Results of the Relative Weight of Kic, Kib, and Kic.

Table 7. Results of Calculation of Alternative Relative Weights of Kia, Kib, and Kic

Alternative	There		Kib		Kic	
	There	Rank	Kib	Rank	Kic	Rank
K1a	0,125	2	4,938	2	0,947	2
K2a	0,092	8	3,415	8	0,699	8
K3a	0,099	7	3,780	7	0,751	7
K4a	0,099	5	3,810	6	0,753	5
K5a	0,072	9	2,775	9	0,543	9
K6a	0,132	1	5,379	1	1,000	1
K7a	0,107	4	4,361	4	0,811	4
K8a	0,050	10	2,000	10	0,381	10
K9a	0,099	6	3,922	5	0,751	6
K10a	0,124	3	4,851	3	0,941	3

4. Calculate the total Ki value

$$K_i = (k_{ia}k_{ib}k_{ic})^{\frac{1}{3}} + \frac{1}{3}(k_{ia} + k_{ib} + k_{ic})$$

$$K_1 = (k_{1a}k_{1b}k_{1c})^{\frac{1}{3}} + \frac{1}{3}(k_{1a} + k_{1b} + k_{1c}) = (0{,}125 * 4{,}938 * 0{,}947)^{\frac{1}{3}} + \frac{1}{3}(0{,}125 + 4{,}938 + 0{,}947) = 2{,}839$$

$$K_2 = (k_{2a}k_{2b}k_{2c})^{\frac{1}{3}} + \frac{1}{3}(k_{2a} + k_{2b} + k_{2c}) = (0{,}092 * 3{,}415 * 0{,}699)^{\frac{1}{3}} + \frac{1}{3}(0{,}092 + 3{,}415 + 0{,}699) = 2{,}006$$

Perform a Ki value search from K3 to K10 according to the Ki value search process from K1 to K2 above. After a search for all Ki, the final results can be seen in the following Table 8.

Table 8. Results of Ki Calculation

Alternative	To	Rank
K1	2,839	2
K2	2,006	8
K3	2,198	7
K4	2,212	6
K5	1,606	9
K6	3,062	1
K7	2,483	4
K8	1,147	10
K9	2,255	5
K10	2,800	3

3.4 Comparison

The comparison of the three MCDM methods is carried out by analyzing the final results in the form of ranking between one method and another, before the comparative analysis is carried out, the following is the final result in the

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form of ranking of the application of the three MCDM methods that have been carried out previously can be seen in the following Table 9.

Table 9. Results of the ranking of the MCDM method

Alternative	Ranking		
	MAUT Method	OCRA Method	CoCoSo Method
A1	2	2	3
A2	8	8	8
A3	7	7	7
A4	6	6	6
A5	9	9	9
A6	1	1	1
A7	4	4	4
A8	10	10	10
A9	5	5	5
A10	3	2	2

Based on Table 9, it can be seen that the best alternative is A6, where the results of the three methods look the same, so that it is easier to analyze the difference in the results of the three methods can be seen in Figure 2 below.

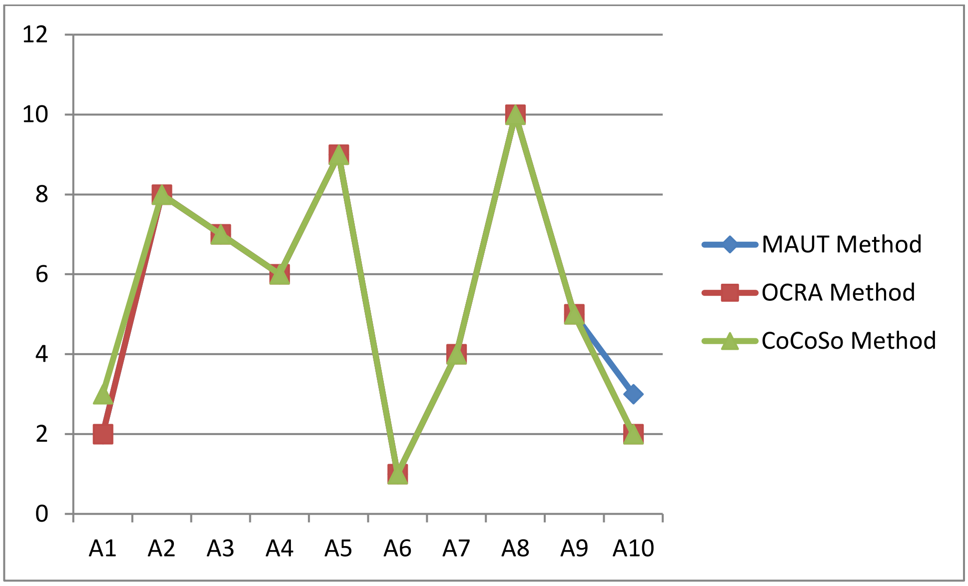

Figure 2. MCDM Result Visualization

Based on Figure 2, it can be seen that the results of the MAUT and CoCoSo methods have a poor balance, where the ranking results have one difference with the OCRA method which is considered quite consistent. So it can be said that the best method in determining the acquisition of employee awards is the OCRA method.

3.5 Discussion

The objective of this study was to compare the performance of three Multi-Criteria Decision Making (MCDM) methods, namely MAUT, OCRA, and CoCoSo, in ranking employees for employee award selection. As discussed in the introduction, employee performance evaluation is inherently a multi-criteria decision-making problem because organizations must simultaneously consider several performance indicators, including performance, initiative and creativity, teamwork, attendance, and self-development. These criteria involve both quantitative and qualitative aspects, making conventional assessment methods vulnerable to subjectivity. Therefore, the application of MCDM provides a systematic and objective approach for transforming multiple evaluation criteria into measurable preference values.

The comparative results presented in Table 9 indicate that all three methods produce highly consistent ranking results. Employee A6 is ranked first by MAUT, OCRA, and CoCoSo, while A8 consistently occupies the lowest rank. Likewise, seven of the ten alternatives receive identical rankings across all three methods. This high level of agreement demonstrates that the evaluation criteria and their assigned weights are sufficiently robust to produce stable decision outcomes regardless of the mathematical aggregation mechanism employed. In practical terms, this finding suggests that organizations can obtain reliable employee award recommendations using any of the three MCDM methods when the decision matrix exhibits clear differences among alternatives.

Although the overall rankings are highly consistent, slight differences are observed for alternatives A1 and A10. MAUT ranks A1 second and A10 third, whereas OCRA assigns both alternatives the same ranking because they obtain

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identical preference values. Conversely, CoCoSo ranks A10 second and A1 third. These differences arise from the distinct computational principles of each method. MAUT employs utility theory to transform normalized criterion values into utility scores, making the ranking more sensitive to variations in criterion performance. OCRA evaluates benefit and cost criteria separately using linear preference functions, which may generate identical scores when competing alternatives exhibit similar performance levels. Meanwhile, CoCoSo integrates weighted sum and weighted product models through a compromise solution strategy, allowing it to better distinguish alternatives with closely comparable evaluation results. Consequently, CoCoSo demonstrates greater discriminative capability without affecting the consistency of the final decision.

The findings of this study are consistent with the work of Aldinugroho and Aldisa [18], who demonstrated that MAUT effectively supports personnel selection by transforming multiple evaluation criteria into utility values that objectively identify the most suitable candidate. Their study successfully selected the best warehouse head candidate using MAUT and ROC weighting. Similarly, the present study confirms that MAUT effectively evaluates employee performance by producing stable rankings and successfully identifying the highest-performing employee. This consistency indicates that the utility-based framework of MAUT is suitable for various human resource decision-making problems beyond recruitment.

The performance of OCRA in this study also supports the findings reported by Pandiangan et al. [19]. Their research showed that OCRA provides objective recommendations for minimarket location selection through systematic evaluation of benefit and cost criteria. Although the application domain differs, both studies demonstrate that OCRA maintains reliable ranking performance while employing relatively straightforward computational procedures. The ability of OCRA to consistently identify the same best alternative as MAUT and CoCoSo indicates that the method is sufficiently robust for supporting employee performance evaluation and organizational decision-making.

Likewise, the results obtained from CoCoSo are in agreement with the study conducted by Pasaribu et al. [20], who reported that CoCoSo effectively generated rankings for internship candidate selection through the integration of multiple aggregation strategies. In the present study, CoCoSo also successfully identifies A6 as the best employee while providing slightly greater discrimination among alternatives with similar performance scores. This finding confirms that the compromise solution mechanism implemented in CoCoSo enhances ranking sensitivity, particularly when competing alternatives exhibit only small differences across evaluation criteria.

The overall findings also complement the research conducted by Munandar [21], who argued that employee assessment should not rely solely on performance achievement but should incorporate multiple dimensions, including attendance, communication, cooperation, discipline, and initiative. While Munandar employed the ELECTRE method to evaluate employee performance, the current study extends this concept by comparing three different MCDM methods using five comprehensive evaluation criteria. The consistency of the ranking results across MAUT, OCRA, and CoCoSo demonstrates that multi-criteria evaluation provides a more balanced and objective assessment than conventional single-criterion approaches, thereby supporting fairer employee award allocation.

Compared with previous studies, this research offers an important contribution because it does not merely implement a single MCDM method but evaluates the consistency of three different methods under the same decision environment. Previous studies focused individually on MAUT for recruitment [18], OCRA for location selection [19], CoCoSo for internship selection [20], and ELECTRE for employee bonus allocation [21]. In contrast, this study performs a direct comparative analysis of MAUT, OCRA, and CoCoSo using identical employee data, criteria, and criterion weights. This comparison enables decision-makers to better understand the strengths and characteristics of each method while verifying whether different mathematical approaches produce consistent decision outcomes.

Overall, the comparative analysis confirms that MAUT, OCRA, and CoCoSo are all appropriate methods for employee award ranking. The three methods consistently identify the same best-performing employee, indicating that the proposed evaluation framework is robust and reliable. However, each method exhibits different computational characteristics. MAUT provides flexible utility-based preference modeling, OCRA offers computational simplicity and ease of implementation, while CoCoSo demonstrates superior discrimination when alternatives have similar performance scores. Therefore, the choice of an MCDM method should consider not only ranking accuracy but also the complexity of implementation, interpretability, and the specific characteristics of the organizational decision-making process. These findings strengthen previous studies [18]–[21] while providing new evidence that comparative analysis of multiple MCDM methods can improve the reliability and transparency of employee award decision support systems.

4. CONCLUSION

Rawarding employees is an important form of appreciation, but the process of determining recipients is often difficult because it involves subjective assessments of various aspects of performance. The Multi-Criteria Decision Making (MCDM) method offers a more objective and systematic solution in overcoming this problem. MCDM allows decision-makers to consider many factors (criteria) simultaneously in determining employee ratings. Some popular MCDM methods are MAUT, OCRA, and CoCoSo. This study aims to compare the three methods to find the most effective method in determining employee award recipients. Based on the results of calculations and analysis using three different methods, the A6 alternative consistently occupies the top position. After an in-depth comparison of the ranking results obtained from each method, it can be concluded that the OCRA method provides the most consistent and reliable results. Therefore, the OCRA method is considered the most appropriate method to be used in determining the best alternative in this study.

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