Comparison of the simple additive weighting saw method and multi-objective optimization by ratio analysis MOORA

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Abstract. The manual assessment process is very likely to be at risk of errors and sometimes there is nepotism fraud and takes a long time due to the large number of employees. Currently, the East Jakarta Administration City Water Resources Water Resources Department does not yet have a special method and application that is used for evaluation and performance appraisal. Therefore, the purpose of this research is to build a decision support system using the simple additive weighting (SAW) method and multi-objective optimization by ratio analysis (MOORA). With the hope that it will make it easier to carry out the process of evaluating and appraising employee performance and can be carried out objectively with predetermined criteria.

1. Introduction

In the era of the Industrial Revolution 4.0, currently the development of technology is quite rapid, especially in the fields of smart systems, decision support systems and data mining. This makes us required to continue to learn and adapt in each of its developments [1]. Nowadays, humans can start developing a system that can help determine alternatives in solving a problem, namely the Decision Support System DSS. In the evaluation and appraisal of employee performance at the East Jakarta City Water Resources Office, there are four indicators in the assessment process. The indicators are as follows: Job Achievement, Employee Honesty, Attitudes and Responsibility. The four indicators are calculated and accumulated as a whole whether the employee passed or not and whether the work contract can be extended or not. In this case, only employees who are non-Civil Servants (Honorary) who will be assessed are those who are bound by an annual contract.

The solution used in this study is to use two methods, namely Simple Additive Weighting SAW and Multi-Objective Optimization by Ratio Analysis MOORA. The SAW method was chosen because of this method determine the weight value for each attribute, then proceed with a selection process to choose the best alternative from a number of existing alternatives [2]. The Multi Objective Optimization method on Basis of Ratio Analysis (MOORA) was chosen because it can determine the weight value for each attribute and is followed by a ranking process to determine the best alternative. [3]. The author did not find similar studies before, but did find several similar studies [4] [5] [6] [7]. The four studies have the same variable, namely human resources.

2. Methodology
In this research, the system development method used is SDLC (System Development Life Cycle) or commonly known as the waterfall method. The framework that is carried out can be seen in the following description:

a. Identification Problem
   The problem identified in this study is the unavailability of calculation methods that are specific to the evaluation and appraisal of employee performance.

b. Analysis Problem
   The approach taken in this study is an approach to the sciences of employee performance appraisal. With this approach the writer can find out and understand how the phenomena in the employee appraisal process. So it can be concluded that there is no specific calculation method that can be used to quickly and accurately assess employee performance.

c. Determination Goal
   After analyzing the existing problems, the purpose of this study can be determined, namely implementing simple additive weighting SAW and Multi-Objective Optimization by Ratio Analysis MOORA to make it easier to assess employee performance quickly and accurately.

d. Study Literature
   In accordance with the objectives to achieve the results to be achieved from the research, a literature review is carried out related to the literature. The literature studies is taken from various sources such as books, and journal.

e. Data Collection
   Data were collected from various existing sources. Data collection in this study was carried out by two methods, namely interviews. Interviews are conducted by employee staff to employees who are evaluated and assessed for their performance. The results of the interview were analyzed and then compiled in the form of a paper. Meanwhile, for the questionnaire containing seven multiple choice questions and six essay questions. The results of the questionnaire were scored by the committee staff.

f. Analysis System
   In this proposed system analysis, all stages from employee performance appraisal starting from entering employee main data to performance appraisal can be carried out using the MOORA and SAW methods with set objectives criteria.

g. Testing and Implementation
   For implementation in performance appraisal and evaluation, whether this method has been running quite effectively or whether there are still errors.

h. Conclusion and Suggestion
   The final stage of the research is drawing conclusion based on the results obtained from the previous stages.

2.1 Decision Support System DSS
   Decision Support Systems are systems that are intended to support managerial decision making in certain situations. And is intended as a tool for decision makers to expand their capabilities, but not to replace their judgment [8].

2.2 Method Simple Additive Weighting SAW
   The basic concept of the SAW method is to find the weighted sum of the performance ratings for each alternative on all attributes. The calculation method is quite efficient. but the calculation using the Simple Additive Weighting method only the largest value procedure will be selected as the best alternative. The calculation will be in accordance with this method if the selected alternatives meet the predetermined criteria. [9].
2.3 Method Multi-Objective Optimization By Ratio Analysis MOORA

The steps in solving problems with the MOORA method are as follows, step one determine the purpose for identifying the relevant evaluation criteria. Step two All attributes that have been identified are then formatted into a matrix decision. And the data is described as where is the alternative to \( x_{m,n} \), \( m \) is also induced as an alternative and \( n \) as an attribute which is then developed again and becomes an alternative comparison which is then compared as the attribute denominator of the attribute itself [10].

\[
x = \begin{bmatrix}
    x_{11} & x_{12} & \ldots & x_{1n} \\
    x_{21} & x_{22} & \ldots & x_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    x_{m1} & x_{m2} & \ldots & x_{mn}
\end{bmatrix}
\]

Step three normalization in the MOORA method, normalization aims to unify the matrix elements so that the elements in the matrix have uniform values. Normalization on MOORA can be calculated by the equation:

\[
x^{*}_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{n} x^{2}_{ij}}}
\]

Step four reducing the maximax and minimax values in indicating each attribute is more important so it can be multiplied by the appropriate weight (significance coefficient) And when the attributes are considered, the following calculations are used:

\[
y_i = \sum_{j=1}^{m} w_j x^{*}_{ij} - \sum_{j=g+1}^{n} w_j x^{*}_{ij}
\]

Step five the value can be positive or negative depending on the maximum and minimum of the decision matrix, the results of which are the results of the ranking. And the results of the best alternative value have the lowest and the lowest alternative value has the lowest. Before calculating using the Simple Additive Weighting SAW and Multi-Objective Optimization on The Basis of Ratio Analysis MOORA, The writer wants to do a needs analysis. The needs analysis includes Determining Criteria (Ci) and Preference Weights (W) and Determining Alternative Data (Ai).

| Table 1. Assessment Criteria Employee | Table 2. Alternative Employee Assessments |
|-------------------------|-------------------------------|
| Code | Criteria | Weight | Importance | Score | Type |
| A1 | Name | 10% | Importance | Budi Kumidi | |
| A2 | Name | 10% | Importance | Rio Rinaldy | |
| A3 | Name | 10% | Importance | M. N. Kasbudi | |
| A4 | Name | 10% | Importance | Andrian Srafar | |
| A5 | Name | 10% | Importance | Teguh Imam Santoso | |
3. Result and Discussion

3.1 Method SAW Calculation

The first step that must be taken in processing data using the SAW method is to create an Employee Assessment Matrix. The next step in calculating using the SAW method is to perform normalization calculations to obtain the benefit and cost criteria. Then the following results are obtained.

**Table 3. Alternatives and Criteria Match**

| Alternatives | C1 | C2 | C3 | C4 | C5 |
|--------------|----|----|----|----|----|
| A1           | 2  | 5  | 3  | 4  | 6  |
| A2           | 3  | 5  | 4  | 3  | 6  |
| A3           | 1  | 4  | 6  | 1  | 2  |
| A4           | 4  | 5  | 3  | 1  | 1  |
| A5           | 1  | 3  | 2  | 1  | 1  |

After completing the calculations, then arrange them in table form as follows. The next step in the calculating the SAW method is to calculate the ranking calculation. The calculation results in the form of a matrix are the multiplied by the weight of the employee assessment criteria after which the results are sorted and arranged in tabular form. The following is the ranking results which is attached in table form.

**Table 4. Normalization Calculation Results**

| Alternatives | C1 | C2 | C3 | C4 | C5 |
|--------------|----|----|----|----|----|
| A1           | 0.34 | 1 | 1 | 1 | 1 |
| A2           | 0.87 | 1 | 1 | 1 | 1 |
| A3           | 1 | 0.94 | 0.87 | 1 | 1.2 |
| A4           | 0.84 | 1 | 0.87 | 1 | 1 |
| A5           | 1 | 0.84 | 1 | 1 | 1 |

| Criteria   | A1 | A2 | A3 | A4 | A5 |
|------------|----|----|----|----|----|
| A1         | 5 | 5 | 5 | 5 | 5 |
| A2         | 5 | 5 | 5 | 5 | 5 |
| A3         | 5 | 5 | 5 | 5 | 5 |
| A4         | 5 | 5 | 5 | 5 | 5 |
| A5         | 5 | 5 | 5 | 5 | 5 |

The final result of the calculation using the simple additive weighting method of SAW shows that the first rank is filled by Budi Kurniadi with a score of 110.2 followed by the second rank in the name of Teguh Imam Santoso with a score of 102.7 and the third is in the name of M Napis Kurtubi with a score of 95.2 and the fourth is on behalf of Andrian Syafar with a score of 91.25 and the last is Rio Rinaldy with a score of 85.3

3.2 Method MOORA Calculation

The first step in calculating the MOORA method is creating an Employee Assessment Matrix. After obtaining the results of alternative criteria and the matrix has been created as well, now is the time to calculate the results of normalization.

**Table 5. Ranking Results**

| Alternatives | C1 | C2 | C3 | C4 | C5 | Total | Rank |
|--------------|----|----|----|----|----|-------|------|
| A1           | 0.84 | 1 | 1 | 1 | 1 | 102.7 | 1 |
| A2           | 0.84 | 1 | 1 | 1 | 1 | 85.3  | 3 |
| A3           | 1 | 0.94 | 0.87 | 1 | 1.2 | 95.2  | 3 |
| A4           | 0.84 | 1 | 0.87 | 1 | 1 | 91.25 | 4 |
| A5           | 1 | 0.84 | 1 | 1 | 1 | 102.7 | 2 |

**Table 6. Employee Assessment Matrix**

| Alternatives | C1 | C2 | C3 | C4 | C5 |
|--------------|----|----|----|----|----|
| A1           | 1 | 4 | 5 | 5 | 5 |
| A2           | 5 | 5 | 5 | 5 | 5 |
| A3           | 5 | 5 | 5 | 5 | 5 |
| A4           | 5 | 5 | 5 | 5 | 5 |
| A5           | 5 | 5 | 5 | 5 | 5 |
After the calculation is complete then arrange it in table form as attached as follows. After obtaining the calculation of the alternative normalization results and criteria in tabular form. The next stage is the calculation of a weighted normalization matrix by means of the weight of the assessment criteria multiplied by the results of the weight table for each criteria. And the made in the form of a matrix:

Table 7. Results Normalization

| Alternative | Criteria | C1 | C2 | C3 | C4 | C5 |
|-------------|----------|----|----|----|----|----|
| A1          |          | 0.458 | 0.332 | 0.4472 | 0.4472 | 0.4287 |
| A2          |          | 0.3463 | 0.4496 | 0.4472 | 0.4472 | 0.4287 |
| A3          |          | 0.3597 | 0.4496 | 0.4472 | 0.4472 | 0.4287 |
| A4          |          | 0.4356 | 0.3549 | 0.4472 | 0.4472 | 0.4287 |
| A5          |          | 0.5397 | 0.4496 | 0.4472 | 0.4472 | 0.4287 |

\[ W_{j1} = 0.30 * 0.4256 = 0.1276 \]

Perform the same calculation until the five weight after that is arranged in a matrix form as follows. After making the matrix column, add it from column one to column four. Then the results are entered into the maximum table and the drink is is attached as follows. After making the table, the final results are just sorting it. The following is the ranking results attached in tabular form.

Table 8. Criteria Results Maximum and Minimum

| Alternative | Minimum | Maximum |
|-------------|---------|---------|
| A1          | 0.430   | 0.4472  |
| A2          | 0.3912  | 0.4472  |
| A3          | 0.3630  | 0.4472  |
| A4          | 0.3904  | 0.4472  |
| A5          | 0.432   | 0.4472  |

Table 9. Ranking Results

| Alternative | Ranking |
|-------------|---------|
| A1          | 1       |
| A2          | 2       |
| A3          | 3       |
| A4          | 4       |
| A5          | 2       |

3.3 The Results of a Comparison SAW and MOORA Methods

Table 10. Comparison Table

| Alternative | SAW | MOORA |
|-------------|-----|-------|
| A1          | 110.2 | 0.4223 |
| A2          | 102.7 | 0.4212 |
| A3          | 95.2  | 0.3946 |
| A4          | 91.25 | 0.3690 |
| A5          | 85.3  | 0.3701 |

The final result of the calculation shows the same result, but the calculation process is different. The results are sorted from largest to smallest. It is proven that these two methods have the right calculation accuracy.

4. Conclusion

The conclusions obtained by implementing a good decision support system in any case are quite helpful and easy to add to the existence of several methods with specific alternative criteria, just adjust to the problem to be made a decision. Both the SAW and MOORA methods are good enough and provide solutions to problems in appraising and evaluating employee performance. Because it is more
specific and detailed and the results obtained are very accurate. So that the company can really get qualified and competent human resources in their fields.

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