Decision Support System for Employee Recruitment Using El Chinix Traduisant La Realite (Electre) and Weighted Product (WP)

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ABSTRACT

Management of human resources (HR) is important to achieve company goals. One of the activities in HR management is recruitment, selection, and training. Recruitment and selection are usually made not using a system so that the calculations are still done manually. But by processing data using the system can produce a decision in recommending prospective employees that can have a positive impact on the company. The company selection process is carried out through two stages: official selection and final selection in the form of psychological test assessment, interviews, ability tests, and communication. The use of the Elimination Et Choix Traduisant La Realite (ELECTRE) method in the official selection stage and the Weighted Product (WP) method in the final selection stage is a discovery made to get the best decision following the required criteria. By using this method, the final results will be obtained, namely the recommendation of several prospective employees who are fit to work in the company. The performance results of this system reach one hundred percent; the data from the system is in accordance with the expected calculation.

Keywords:
Decision Support System
Employee Recruitment
Elimination Et Choix Traduisant La Realite
Weighted Product.

1. INTRODUCTION

Generally, the leadership of each company expects its employees to have excellent performance in carrying out their work. Therefore, the level of quality of human resources needs to be developed so that the company's goals in managing human resources are efficient and effective. One of the activities in managing human resources in a company is recruitment, selection, and training [1], [2].

According to several sources, the selection is a series of activity steps used in deciding whether an applicant is accepted or not in the proposed company [3]–[6]. Other sources conclude that selection is an activity of determining whether a prospective employee is accepted or rejected based on certain specifications according to the company's needs [7]–[9].

Employees are people who work as workers in a company or institution to repay in the form of money to carry out workplace operations. Employees have duties by what has been determined by the supervisor or leader of the workplace. Generally, employees work by carrying out the tasks instructed by the company and can express their creativity according to the instructions at work [7].

The recruitment and selection process is always carried out by a company to improve quality HR and can advance and develop a company [10].

A banking company in Indonesia needs new employees who are expected to be able to meet the assessment criteria set by the company. The selection and recruitment process carried out by the company is carried out in two stages of the selection process for the first stage, namely the administrative selection process and for the second stage is the psychological test and interview stage. To fulfill both phases of the selection process, a system is needed to recommend and choose candidates who are suitable to work in the company.
This is very beneficial for the company because the time in selecting prospective employees who pass the selection and are eligible to work in the company is faster and more efficient and helps the HR in calculating the results of the selection, which is usually done manually.

The purpose of this research is to build a decision support system to help the company management in determining applicants who are suitable to work in the company. This work uses Elimination Et Choix Traduisant La Realite (ELECTRE) and Weighted Product (WP) as a method to be used in DSS. In previous work, both method show good accurate value and performance [11]–[18].

Based on observations, the assessment criteria used consisted of at least age, education, work experience, psychological testing, interviews, field, and language proficiency tests, in this case, using the TOEFL standard.

2. METHOD

In this study, data, and information obtained by conducting interviews with the management of a banking company and also direct observation. The data used in this system is taken from the data of prospective employees who register for the receipt that has been opened by the HR department. In the ELECTRE Method to determine prospective employees who passed the initial selection, potential employee data is needed to be taken from the registration stage conducted by prospective employees. The following are the criteria for prospective employees explained in table 1.

<table>
<thead>
<tr>
<th>Table 1. Criteria for Prospective Employees Early Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>C1</td>
</tr>
<tr>
<td>C2</td>
</tr>
<tr>
<td>C3</td>
</tr>
</tbody>
</table>

In the WP Method to determine the prospective employees who are accepted and pass in the final selection assessment criteria are determined and adjusted by the admin. The following are the criteria for evaluating the prospective employee’s final selection explained in table 2.

<table>
<thead>
<tr>
<th>Table 2. Criteria for Evaluating Prospective Employees for Final Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>Psychological</td>
</tr>
<tr>
<td>Skill and ability</td>
</tr>
<tr>
<td>TOEFL</td>
</tr>
<tr>
<td>Interview</td>
</tr>
</tbody>
</table>

In understanding application design using data that has been obtained and implementing the model desired by the user. Application modelling in the form of database design is accompanied by making use-case, activity diagrams, class diagrams, sequence diagrams, and flowcharts to facilitate subsequent processes.
Figure 1. Proposed Flowchart System

Figure 1 explains the proposed system flowchart there are two stages of the selection process, namely the initial selection and the final selection in which has the appraisal feature on each prospective employee so that the best potential employee is obtained from the top rank.

UML provides a standard for writing a blueprint system, which includes components in the system, database schema, business process concepts, and writing classes in a specific program language [19].
Based on figure 2, the admin has access to login, open vacancies for employees while managing vacancy criteria, manage applicant data, and calculate initial and final selection using both methods.

2.1 ELECTRE Implementation

The ELECTRE method is a multi-criteria decision-making analysis method originating in Europe in 1960. According to Janko and Bernoider, the ELECTRE method is one of the criteria for outranking multi-criteria by using alternative comparisons based on criteria appropriate to those needed, but in its use, there are many alternatives, but only a few criteria used [20]. The steps that are used by the ELECTRE method are as follows:

1. Normalization of the matrix
2. The normalized weighting of the matrix
3. Determine the concordance and discordance set
4. Calculate the concordance and discordance matrices
5. Determine the concordance and discordance dominant matrices
6. Determine the aggregate dominance matrix
7. Eliminate less favorable alternatives

The temporary data of prospective employees and the criteria that will become candidates at this stage are:

<table>
<thead>
<tr>
<th>Candidate</th>
<th>Criteria</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>C1 = Age</td>
<td>4</td>
</tr>
<tr>
<td>A2</td>
<td>C2 = Education</td>
<td>4</td>
</tr>
<tr>
<td>A3</td>
<td>C3 = Experience</td>
<td>2</td>
</tr>
</tbody>
</table>

To get a table of criteria values from each alternative as in table 4. Then, the weight update is done first from the previous weight $W = (0.4,0.4,0.2)$.

1) Normalization of the provision matrix can be changed to a comparable value

$$R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \text{ for } i=1,2,3,\ldots,m \text{ and } j=1,2,3,\ldots,n$$

$X = \begin{bmatrix} 4 & 4 & 6 \\ 2 & 2 & 5 \\ 3 & 3 & 4 \end{bmatrix}$

a. Normalization of alternative age criteria

$$|X_1| = \sqrt{4^2 + 2^2 + 3^2} = \sqrt{29} = 5.385$$

$$R_{11} = \frac{x_{11}}{X_1} = \frac{4}{5.385} = 0.7427$$

$$R_{21} = \frac{x_{21}}{X_1} = \frac{2}{5.385} = 0.3713$$

$$R_{31} = \frac{x_{31}}{X_1} = \frac{3}{5.385} = 0.5570$$

b. Normalization of alternative education criteria

$$|X_2| = \sqrt{2^2 + 3^2 + 4^2} = \sqrt{29} = 5.385$$

$$R_{12} = \frac{x_{12}}{X_2} = \frac{2}{5.385} = 0.3713$$

$$R_{22} = \frac{x_{22}}{X_2} = \frac{3}{5.385} = 0.5570$$

$$R_{32} = \frac{x_{32}}{X_2} = \frac{4}{5.385} = 0.7427$$

c. Normalization of alternative experience criteria
\[ |X_2| = \sqrt{5^2 + 4^2 + 6^2} = \sqrt{77} = 8.774 \]
\[ R_{12} = \frac{x_{12}}{\sqrt{77}} = 0.5698 \]
\[ R_{22} = \frac{x_{22}}{\sqrt{77}} = 0.4558 \]
\[ R_{32} = \frac{x_{32}}{\sqrt{77}} = 0.6837 \]

So we get the normalized R matrix as shown below:
\[
R = \begin{bmatrix}
0.3713 & 0.3713 & 0.5698 \\
0.5570 & 0.5570 & 0.4558 \\
0.7427 & 0.7427 & 0.6837
\end{bmatrix}
\]

2) Weighting in a normalized matrix. After normalizing, the column of matrix R will be multiplied with the weights (wj) that have been determined by the decision-maker. Knowing each other’s predetermined criteria \( W = (0.4, 0.4, 0.2) \).

a. Weighting the alternative matrix for age criteria
\[
V_{11} = R \times W = 0.3713 \times 0.4 = 1.2
\]
\[
V_{21} = R \times W = 0.5570 \times 0.4 = 1.8
\]
\[
V_{31} = R \times W = 0.7427 \times 0.4 = 1.2
\]

b. Weighting alternative matrices of educational criteria
\[
V_{12} = R \times W = 0.3713 \times 0.4 = 1.0692
\]
\[
V_{22} = R \times W = 0.5570 \times 0.4 = 1.0692
\]
\[
V_{32} = R \times W = 0.7427 \times 0.4 = 2.138
\]

c. The weighting of alternative matrices of experience criteria
\[
V_{13} = R \times W = 0.5698 \times 0.2 = 1.8352
\]
\[
V_{23} = R \times W = 0.4558 \times 0.2 = 0.9176
\]
\[
V_{33} = R \times W = 0.6837 \times 0.2 = 1.8352
\]

From the above calculation, get the matrix results below:
\[
V = \begin{bmatrix}
0.3713 & 0.3713 & 0.5698 \\
0.5570 & 0.5570 & 0.4558 \\
0.7427 & 0.7427 & 0.6837
\end{bmatrix}
\]

3) Calculate the concordance and discordance matrices
If the values specified for the concordance matrix of the elements are the weights that will be added together are included in the concordance set with the formula below:
\[
C_{kl} = \sum_{j \in C_{kl}} W_j \tag{1}
\]

Calculate the concordance of the first alternative:
\[
C_{12} = W_2 + W_3 + W_4 = 0 + 0 + 0 = 0
\]
\[
C_{13} = W_1 + W_3 + W_5 = 0.4 + 0.4 + 0 = 0.8
\]
\[
C_{14} = W_1 + W_4 + W_5 = 0.4 + 0.4 + 0.2 = 1
\]

Calculate the concordance of the second alternative:
\[
C_{21} = W_1 + W_2 + W_3 = 0.2 + 0 + 0 = 0.2
\]
\[
C_{23} = W_1 + W_8 + W_3 = 0 + 0 + 0 = 0
\]
\[
C_{24} = W_1 + W_8 + W_3 = 0.2 + 0 + 0 = 0.2
\]

Calculate the concordance of the third alternative:
\[
C_{31} = W_1 + W_2 + W_3 = 0 + 0 + 0 = 0
\]
\[
C_{32} = W_2 + W_3 + W_4 = 0 + 0 + 0 = 0
\]
\[
C_{34} = W_1 + W_2 + W_4 = 0 + 0 + 0 = 0
\]

Based on the above calculation, the concordance matrix is obtained below:
To determine the value of the elements in the discordance matrix is to divide the maximum of the different criteria included in the set of discordance parts by the maximum of the difference in the value of all existing criteria by the formula below:

\[
D_{kj} = \frac{\max(|v_{ki} - v_{kj}|)}{\max(|v_{kj} - v_{lj}|)} \forall j
\]

Calculate the discordance of the first alternative:

\[
D_{12} = \frac{\max(0.3713 - 0.5570)}{\max(0.5698 - 0.4558)} = 1
\]

\[
D_{13} = \frac{\max(0.3713 - 0.7427)}{\max(0.5698 - 0.6837)} = 1
\]

Calculate the discordance of the second alternative:

\[
D_{21} = \frac{\max(0.4558 - 0.5698)}{\max(0.5570 - 0.3713)} = 0.6136
\]

\[
D_{22} = \frac{\max(0.5570 - 0.7427)}{\max(0.4558 - 0.6837)} = 1
\]

Calculate the discordance of the third alternative:

\[
D_{31} = \frac{\max(0.6837 - 0.5698)}{\max(0.7427 - 0.3713)} = 0.3068
\]

\[
D_{32} = \frac{\max(0.4558 - 0.6837)}{\max(0.2279)} = 0.8147
\]

\[
D = \begin{bmatrix}
0.6136 & 1 & 1 \\
0.3068 & 0.8147 & - \\
\end{bmatrix}
\]

4) Determine the concordance and discordance dominant matrices

The F matrix as the dominant concordance matrix can be designed with the help of a threshold value, namely by comparing each element value of the concordance matrix with the threshold value.

\[
C = \begin{bmatrix}
-0.2 & 0 & 0 \\
0.8 & -0 & 0 \\
1 & 1 & - \\
\end{bmatrix}
\]

Threshold value with the following formula:

\[
\xi = \frac{C_{ij} \leq \xi}{0.8 + 0.2 + 0 + 0 + 1 + 1 + 1} = 3 \times (3 - 1) = 0.5
\]

So the concordance matrix is obtained as follows:

\[
F = \begin{bmatrix}
-0 & 0 & 0 \\
1 & -0 & 0 \\
1 & 1 & - \\
\end{bmatrix}
\]

Matrix G, as the dominant discordance matrix, can be built with the help of a threshold value d.
The threshold value obtained is the following matrix elements:

\[
G_{ij} = \begin{cases} 
1 & \text{if } G_{ij} \geq d \text{ dan } 0 \text{ jika } G_{ij} < d \\
0.6136 + 0.3068 & \\
0.8147 - 1 & \\
0.6136 + 0.3068 + 1 + 1 & \\
3(3 - 1) & \\
4.7352 & \\
6 & = 0.7892
\end{cases}
\]

So the discordance matrix obtained is as follows:

\[
G = \begin{bmatrix} 
-1 & 1 \\
0 & -1 \\
0 & 1
\end{bmatrix}
\]

5) Determine the dominant aggregate matrix

The E matrix as the dominant aggregate matrix is a matrix where each element is a multiplication of the elements of the matrix F with the elements of the matrix G corresponding to the following formula:

\[
E_{kl} = F_{kl} X G_{kl}
\]

\[
E = \begin{bmatrix} 
-0 & 0 \\
1 & -0 \\
1 & 1
\end{bmatrix} \times \begin{bmatrix} 
-1 & 1 \\
0 & -1 \\
0 & 1
\end{bmatrix}
\]

6) Eliminate less favorable alternatives

The results of calculations with the Electre method then obtained the highest rank, namely: A3, A2, A1. because if it indicates that the alternative E = 1 is the chosen alternative.

2.2 Weighted Product Implementation

Weighted Product is a method of Fuzzy Multi-Attribute Decision Making (FMADM), where it works to evaluate several alternative criteria where the criteria are not interdependent with each other. The Weighted Product method requires the normalization process by multiplying the results of the assessment of each attribute then divided by the standard values [12], [21]–[23].

The weighted Product calculation method is done with the following steps:

1. Repairing weights
2. Vector Calculations
3. The relative preference of each alternative

After meeting the qualification standards and administrative requirements, the next stage is selected based on the criteria needed by the company. The criteria used in the assessment as shown in table 5.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Initial Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological Test</td>
<td>C1 = 25</td>
</tr>
<tr>
<td>Ability and Skill</td>
<td>C2 = 35</td>
</tr>
<tr>
<td>TOEFL</td>
<td>C3 = 20</td>
</tr>
<tr>
<td>Interview</td>
<td>C4 = 20</td>
</tr>
</tbody>
</table>

After determining the criteria weights then the next stage determines alternative values according to the criteria that have been given, as shown in Table 6 below.

<table>
<thead>
<tr>
<th>Candidate</th>
<th>Criteria</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td></td>
<td>80</td>
<td>90</td>
<td>80</td>
<td>75</td>
</tr>
<tr>
<td>A2</td>
<td></td>
<td>88</td>
<td>85</td>
<td>76</td>
<td>87</td>
</tr>
<tr>
<td>A3</td>
<td></td>
<td>75</td>
<td>83</td>
<td>77</td>
<td>72</td>
</tr>
</tbody>
</table>

In calculating the WP method, first of all the weighting of the criteria is made. Criteria weights C1 = 25, C2 = 35, C3 = 20 and C4 = 20. Where the initial weight W = (25, 35, 20,20) will be corrected so that the total weight \(\sum w_j = 1\), by:

\[
W_j = \frac{W_j}{\sum W_j}
\]

\[
W_1 = \frac{25}{25 + 35 + 20 + 20} = \frac{25}{100} = 0.25
\]

\[
W_2 = \frac{35}{25 + 35 + 20 + 20} = \frac{35}{100} = 0.35
\]
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3. RESULTS AND DISCUSSION

The following is a recapitulation of the results of testing data between system calculations, and manual calculations can be seen in the following table 8:

Table 8. Testing Result

<table>
<thead>
<tr>
<th>No</th>
<th>Candidate</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A01</td>
<td>Correct</td>
</tr>
<tr>
<td>2</td>
<td>A02</td>
<td>Correct</td>
</tr>
<tr>
<td>3</td>
<td>A03</td>
<td>Correct</td>
</tr>
<tr>
<td>4</td>
<td>A04</td>
<td>Correct</td>
</tr>
<tr>
<td>5</td>
<td>A05</td>
<td>Correct</td>
</tr>
<tr>
<td>6</td>
<td>A06</td>
<td>Correct</td>
</tr>
<tr>
<td>7</td>
<td>A07</td>
<td>Correct</td>
</tr>
<tr>
<td>8</td>
<td>A08</td>
<td>Correct</td>
</tr>
<tr>
<td>9</td>
<td>A09</td>
<td>Correct</td>
</tr>
<tr>
<td>10</td>
<td>A10</td>
<td>Correct</td>
</tr>
<tr>
<td>11</td>
<td>A11</td>
<td>Correct</td>
</tr>
<tr>
<td>12</td>
<td>A12</td>
<td>Correct</td>
</tr>
<tr>
<td>13</td>
<td>A13</td>
<td>Correct</td>
</tr>
<tr>
<td>14</td>
<td>A14</td>
<td>Correct</td>
</tr>
<tr>
<td>15</td>
<td>A15</td>
<td>Correct</td>
</tr>
<tr>
<td>16</td>
<td>A16</td>
<td>Correct</td>
</tr>
<tr>
<td>17</td>
<td>A17</td>
<td>Correct</td>
</tr>
<tr>
<td>18</td>
<td>A18</td>
<td>Correct</td>
</tr>
<tr>
<td>19</td>
<td>A19</td>
<td>Correct</td>
</tr>
<tr>
<td>20</td>
<td>A20</td>
<td>Correct</td>
</tr>
</tbody>
</table>

\[
W_3 = \frac{20}{25 + 35 + 20 + 20} = \frac{20}{100} = 0.20
\]

\[
W_4 = \frac{20}{25 + 35 + 20 + 20} = \frac{20}{100} = 0.20
\]

Calculate the value of vector \( S \) by referring to the formula. Where \( W_J \) is a positive value rank for the type of benefit criteria and a negative value for the type of cost criterion. The solution is as follows:

\[
S = (80 \times 0.25) (90 \times 0.35) (80 \times 0.20) (75 \times 0.20) = 82,2977
\]

\[
S = (88 \times 0.25) (85 \times 0.35) (76 \times 0.20) (87 \times 0.20) = 84,233
\]

\[
S = (75 \times 0.25) (83 \times 0.35) (77 \times 0.20) (72 \times 0.20) = 77,4632
\]

Determine the value of vector \( V \) by referring to formula (2) where the highest \( V \) value will be the chosen alternative. The method of settlement is as follows:

\[
V_1 = \frac{82,2977}{243.9939} = 0.3372
\]

\[
V_2 = \frac{84,233}{77.4632} = 0.3452
\]

\[
V_3 = \frac{77,4632}{243.9939} = 0.3174
\]

The results after the calculation process using the WP method looks like in table 7.

Table 7. Calculation Results for the WP Method

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Vektor S</th>
<th>Vektor V</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>82.8977</td>
<td>0.3372</td>
</tr>
<tr>
<td>A2</td>
<td>84.233</td>
<td>0.3452</td>
</tr>
<tr>
<td>A3</td>
<td>77.4632</td>
<td>0.3174</td>
</tr>
</tbody>
</table>

Table 8 shows the results of testing the accuracy of the WP method, where the accuracy results reached 100, namely 20 experiments with accurate values. The largest to smallest order results or the ranking of prospective new employees from manual testing with a very precise system.
4. CONCLUSION

The new recruitment recommendation system built using the ELECTRE and WP methods has a 100% accuracy rate in testing the accuracy of the system with manual calculations so that it can be applied and can help in selecting new prospective employees at this banking company. Further work, this system can be adapted to the development of the company and can be made more detailed down to the type of work up to the job level.

5. REFERENCES (10 PT)