Analysis of the Best Employee Selection Decision Support System Using Analytical Hierarchy Process (AHP)

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Abstract. The award is given by the company to the best employees always to provide the best performance for companies that carry out duties and obligations in the company. How to give rewards to employees not only for how long they have been working at the company but about the results achieved. The gift can be in the form of salary or inventory from the company. So employees have great loyalty to the company. Decision making to determine the company can do the best employee by assessing the performance that has been done by employees at a specific time. Performance evaluation of Hon Chuan Company is influenced by several criteria, namely discipline, innovation, and responsibility. The support system for the best employee selection method uses the Analytical Hierarchy Process (AHP) method. The decision-making system is carried out to assess choices based on predetermined criteria. AHP method is applied to choose the best prospective employees. The calculation of the AHP method gives the results of the order of importance of criteria, namely discipline level (0.5584), responsibility (0.3196), and innovation (0.1220) and the best employee selection results obtained by Hendra (0.189), Vienna (0.189), Yin (0.145), Paul (0.109), Kandi (0.108), Kusworo (0.101), Bayu (0.088), and Ade Muhidin (0.072).

Keyword: Decision Making, Analytical Hierarchy Process (AHP), Best Employees, Criteria, Calculation of Assessments.

1. Introduction
Human Resources (HR) is the most critical part of a company. The company will grow very well by the quality of human resources working in the company. Employees determine how to be directly appointed by the leadership, but the company must make an agreement that has been done by employees at a certain time, and there will be an award for performance. Assessment is intended to
encourage employees to provide the best performance for the company in carrying out its duties and obligations. Employee performance evaluation in each company is based on established criteria. Hon Chuan Company Indonesia has many interrelated departments to support the company's progress. Some of these sections are the Production Department, the Finance Department, the Sales Department, the General Affairs Department, and so on. The current research takes one of the departments, namely the sales department, because the marketing department is the spearhead of the company's advance. Therefore the company needs to assess the best performance of the employees of the Hon Chuan Indonesia Company, which in turn results can be considered by employee standards. Hon Chuan Indonesia Company has criteria in evaluating employee performance [1] [2]. The assessment is done by giving points to the requirements set for each employee in the company. The complexity of the criteria set is more specific for company employees, but this makes assessment difficult. Improving the quality of employee performance so that they have a good reputation and can be increasingly motivated to carry out the most critical points in their work, given awards for these employees, for example, to get additional incentive money, inventory from the company, etc. Also, evaluations for employees are needed so that in the future, Hon Chuan Indonesia Company can improve the quality of its employees.

Decision Support Systems (DSS) can be used to assist in making decisions to choose the best employees. This Decision Support System uses the Analytical Hierarchy Process (AHP) Method. By using the AHP Method, the problem is decomposed based on more specific criteria using a hierarchical system, then processed in such a way as to find an optimal alternative solution. Also, the Analytical Hierarchy Process method has the advantage of deciding by comparing in pairs each criterion owned by a problem so that the weight value is obtained from the interests of each of the existing rules. This system is expected to be a solution in determining the best employee choices and can simplify the work of company owners in choosing the best employees.

2. Literature Review

2.1. DSS for Determining Employees Using the AHP Method

Decision Support Systems (DSS) are often used when dealing with artificial environments [3] [4]. The importance of an organization lies in comparing several features, calculated using parameters and subjective and objective calculation methods [5] [6] [7]. DSS is based on several data processing techniques, but usually, all of them are based on Multi-Criteria Engineering Analysis, where the possibility of data normalization, elaboration, comparison, and finally, ranking and selection of alternatives [8][9]. A reliable method, often used on DSS, is the Analytical Hierarchy Process (AHP), which allows for the calculation of parameter weights. This method was first proposed by mathematician Saaty in the 80s [10],[11]. AHP-based models are used to help investors assess and choose [12].

2.2. The procedure of the Analytical Hierarchy Process (AHP) Method

The procedure or steps in AHP [13],[14] are as follows:

a. Identify the problem and determine the desired solution, then arrange the hierarchy of problems faced. Hierarchy preparation is setting goals that are the target of the entire system at the top level.

b. Determine priority elements.
   1) The first step in determining the priority of an element is to make a paired comparison, e.g., comparing elements in pairs according to the criteria given.
   2) Pairwise comparison matrices are filled with numbers to represent the relative importance of an element to other elements.

c. Synthesis

d. Considerations for synthesized paired comparisons get overall priority. The things done in this step are:
1) Summarize the values for each column in the matrix.
2) Divide each column value by matching the total column to get the normalization matrix.
3) Summarize the value of each row and divide it by the number of elements to get the average value.

e. Measuring Consistency
In making decisions, it is important to know how true consistency is because we do not want decisions based on low consistency considerations. Things that are done in this case, the steps are:
1) Fold multiply each value in the first column with the relative priority of the first element, the value in the second column with relative priority from the second element, and so on.
2) The number of each row.
3) Then, the number of rows is divided by relative priority elements.
4) Add the number of elements available, and the result is called λ max.

f. Calculate the Consistency Index (CI) with the formula: CI = (λ max n) / n or CI = t-n / n-1
Where n = number of element.

g. Calculate Consistency Ratio (CR) with the formula:
CR = CI / RC
Where:
CR = Consistency Ratio
CI = Consistency Index
IR = Random Consistency Index

h. Check the consistency of the hierarchy. If the value is more than 10%, the assessment of assessment data must be improved. However, if the consistency ratio (CI / IR) is less or equal to 0.1, then the calculation results can be stated correctly.

2.3. Best Employee Selection in Industry 4.0
With the help of each and each of them, each is related to their respective authority and their Z standards for prospective job applicants [15]. Selection is the process of identifying the suitability between position and someone, both in internal and external scope with the concept of a higher percentage of relevance, the better the performance of this human resource [16].

The selection process is not only oriented to the point of view or the interests of the company but also to think about the desires of employees to be placed in an ideal position. Selection is the basis and design for the performance of human resources [15].

3. Research Methodology

3.1. Data Collection
Data collection is the most important stage in conducting research because data collection is used to obtain information in order to achieve research objectives. In collecting data, some information is obtained regarding employee ratings at Hon Chuan Company from direct interviews with the leaders of the company and employees. Searching for literature from books, and journals related to the assessment was also conducted in order to get maximum results in this study. Data collection used includes:

a. Observation
In observing data collection is observing and assessing employees based on the required criteria.

b. Interview
In interviews, the author conducted interviews with company leaders to obtain employee data, assessment data and other data needed.
3.2. Library Research Method
The study of the literature used by the author to get more information about DSS, the AHP method, the selection of the best employees, and so on is by searching, reading, and collecting data.

3.3. Data analysis
a. Determination of Criteria
The next step after collecting the data that has been obtained is to analyze the data obtained. From the results of this data analysis, some information is obtained, such as an assessment of the previous criteria. The previous criterion has seven criteria, namely productivity, work knowledge, work quality [17][18], work attitude, relationship, presence and reliability, and resilience. But at present, these criteria are made more specific, namely into three criteria, including discipline, responsibility and innovation.

b. Data processing
After the criteria are identified to be used in the selection of the best employees, then it is to determine the criteria and sub-criteria weights using the AHP method and processing data with the Expert Choice Application. The following is figure 1. is the AHP structure diagram in Figure 1, and Table 1. Pairing Comparison Matrix:

|   | A₁  | A₂  | A₃  | ... | Aᵢ  |
|---|-----|-----|-----|-----|-----|
| A₁ | a₁₁ | a₁₂ | a₁₃ | ... | a₁ᵢ |
| A₂ | a₂₁ | a₂₂ | a₂₃ | ... | a₂ᵢ |
| ... | ... | ... | ... | ... | ... |
| Aᵢ | aᵢ₁ | aᵢ₂ | aᵢ₃ | ... | aᵢᵢ |

A value is determined by the rule:
a. If \( a_{ij} = a \), then \( a_{ij} = 1 / a, a \neq 0 \)
b. If \( A1 \) has the same relative importance as \( a1 \), then \( a_{ij} = a_{ji} = 1 \)
c. Special thing, \( a_{ii} = 1 \), for all \( i \).

4. Results and Discussion
4.1. Calculating Value Using AHP
Results from respondents who received:
a. Discipline is twice as important as responsibility.
b. Responsible is three times more important than innovation.
c. Discipline is four times more important than innovation.
The pairwise comparison have five values.
The values used are as follows:
1) : same
2): medium
3): strong
4): very strong
5): extreme

From the above assessment, pairwise comparison tables can be made as in Table 2:
Table 2. Pairwise Comparison Criteria

|               | Responsible | Discipline | Innovation |
|---------------|-------------|------------|------------|
| Responsible   | 1/1         | 1/2        | 3/1        |
| Discipline    | 2/1         | 1/1        | 4/1        |
| Innovation    | 1/3         | 1/4        | 1/1        |

Figure 1. AHP Structure Diagram

Here’s how to find an eigenvector solution:
a. A short computational method that can be used to obtain rank is to use this paired matrix as a basis for paired matrix quadratic calculations at any time.
b. The number of each row is calculated and normalized.
c. The calculation is stopped if the difference between these numbers in two consecutive calculations is smaller than a number.

Stage 1: Square the paired matrix in table 3:

Table 3. Paired matrix

|               | Responsible | Discipline | Innovation |
|---------------|-------------|------------|------------|
| Responsible   | 1           | 0,5        | 3          |
| Discipline    | 2           | 1          | 4          |
| Innovation    | 0,33        | 0,25       | 1          |

The process of squaring Paired Matrices is shown in table 4:
Table 4. The process of squaring paired matrices

|     | 1   | 0.5 | 3   |
|-----|-----|-----|-----|
| 1   | 2   | 1   | 4   |
| 0.33| 0.25| 1   |

\[
\begin{bmatrix}
1 & 0.5 & 3 \\
2 & 1 & 4 \\
0.33 & 0.25 & 1
\end{bmatrix}
\times
\begin{bmatrix}
1 & 0.5 & 3 \\
2 & 1 & 4 \\
0.33 & 0.25 & 1
\end{bmatrix}
= \begin{bmatrix}
3 & 1.75 & 8 \\
5.33 & 3 & 14 \\
1.16 & 0.67 & 3
\end{bmatrix}
\]

Stage 2: Calculate the first eigenvector shown in table 5:
a. Add the lines.
b. Add the total of the rows.
c. The total value of each row is normalized

Table 5. Calculate the first eigenvector

|     | 3   | 1.75 | 8    |
|-----|-----|------|------|
| 5.33| 3   | 14   |      |
| 1.16| 0.67| 3    |      |

\[
\begin{bmatrix}
3 & 1.75 & 8 \\
5.33 & 3 & 14 \\
1.16 & 0.67 & 3
\end{bmatrix}
= \begin{bmatrix}
12.75 \\
22.23 \\
4.83
\end{bmatrix}
= \begin{bmatrix}
0.3194 \\
0.5595 \\
0.121
\end{bmatrix}
\]

The first normalization number is obtained by dividing the results of the first number divided by the total. So the first Eigenvector is:

This position will continue to be repeated by squaring, summing, and normalizing so that you get the second Eigenvector. And the second Eigenvector is:

|     | 0.3194 |
|-----|--------|
| 0.5595 |
| 0.121  |

This position will continue to be repeated by squaring, summing, and normalizing so that you get the second Eigenvector, and the second Eigenvector is:

|     | 0.3196 |
|-----|--------|
| 0.5584 |
| 0.1220 |

The first criterion is ranking number 2 (two) most important, the second criterion is ranking number 1 (one) most important, and the third criterion is ranking number 3 (three) most important like Figure 4.
Figure 4. Criteria Value

For alternative choices, a comparison is also made of the criteria for each. Results of respondents criteria for a discipline like Table 6:

|          | Bayu | Hendar | Yedin | Ade Muhidin | Kusworo | Kandi | Wina | Padli |
|----------|------|--------|-------|-------------|---------|-------|------|-------|
| Bayu     | 1/1  | 1/3    | 1/2   | 1/1         | 1/2     | 1/2   | 1/3  | 1/1   |
| Hendar   | 3/1  | 1/1    | 1/1   | 2/1         | 2/1     | 3/1   | 1/1  | 3/1   |
| Yedin    | 2/1  | 1/1    | 1/1   | 3/1         | 1/1     | 2/1   | 1/1  | 2/1   |
| Ade Muhidin | 1/1 | 1/2    | 1/3   | 1/1         | 1/2     | 1/2   | 1/3  | 1/1   |
| Kusworo  | 2/1  | 1/2    | 1/1   | 2/1         | 1/1     | 2/1   | 1/2  | 1/3   |
| Kandi    | 2/1  | 1/3    | 1/2   | 2/1         | 1/2     | 1/2   | 1/2  | 2/1   |
| Wina     | 3/1  | 1/1    | 1/1   | 3/1         | 2/1     | 2/1   | 1/1  | 3/1   |
| Padli    | 1/1  | 1/3    | 1/2   | 1/1         | 3/1     | 1/2   | 1/3  | 1/1   |
The results of the quadratic comparison pairs are alternative disciplinary criteria in Table 7:

|                | Bayu  | Hendar | Yedin | Ade Muhidin | Kusworo | Kandi | Wina | Padli |
|----------------|-------|--------|-------|-------------|---------|-------|------|-------|
| Bayu           | 1     | 0.33   | 0.5   | 1           | 0.5     | 0.5   | 0.33 | 1     |
| Hendar         | 3     | 1      | 1     | 2           | 2       | 3     | 1    | 3     |
| Yedin          | 2     | 1      | 1     | 3           | 1       | 2     | 1    | 2     |
| Ade Muhidin    | 1     | 0.5    | 0.33  | 1           | 0.5     | 0.5   | 0.33 | 1     |
| Kusworo        | 2     | 0.5    | 1     | 2           | 1       | 2     | 0.5  | 0.33  |
| Kandi          | 2     | 0.33   | 0.5   | 2           | 0.5     | 1     | 0.5  | 2     |
| Wina           | 3     | 1      | 1     | 3           | 2       | 2     | 1    | 3     |
| Padli          | 1     | 0.33   | 0.5   | 1           | 3       | 0.5   | 0.33 | 1     |
| **Total**      | 15    | 3      | 4     | 15          | 9       | 10    | 3    | 13    |

After getting the weight criteria, then we can check whether the weights are consistent or not. The first is to calculate the Principal Eigen Value (\(\lambda_{\text{max}}\)). Calculation of the main eigenvalue matrix (\(\lambda_{\text{max}}\)) by adding up the multiplication between numbers and priority vectors. The average matrix for each row of disciplinary criteria is shown in table 8 and table 9:

|                | SUM   | PV    | A     | CI    | CR    |
|----------------|-------|-------|-------|-------|-------|
| Bayu           | 3     | 0,15983 | 0,47949 | 1,0744 | 0,762 |
| Hendar         | 16    | 1,80107 | 28,8171 | 2,97387 | 2,1903 |
| Yedin          | 13    | 1,58034 | 20,5444 | 1,79206 | 1,27096 |
| Ade Muhidin    | 3     | 0,15821 | 0,47463 | 1,0751  | 0,7624 |
| Kusworo        | 8     | 0,83031 | 6,64248 | 0,1939  | 0,1375 |
| Kandi          | 7     | 0,39595 | 2,77165 | 0,7469  | 0,5297 |
| Wina           | 16    | 1,76774 | 28,2838 | 2,89769 | 2,0551 |
| Padli          | 6     | 0,49278 | 2,95668 | 0,7205  | 0,511  |

|                | SUM   | PV    | A     | CI    | CR    |
|----------------|-------|-------|-------|-------|-------|
| Bayu           | 7,66  | 0,65060 | 4,9836 | -0,4309 | -0,3056 |
| Hendar         | 22    | 1,88044 | 41,3697 | 4,7671  | 3,38092 |
| Yedin          | 12,33 | 0,94166 | 11,6107 | 0,51581 | 0,36582 |
| Ade Muhidin    | 5,16  | 0,47023 | 2,42639 | -0,7962 | -0,5647 |
| Kusworo        | 6,16  | 0,57640 | 3,55062 | -0,6356 | -0,4508 |
| Kandi          | 6,16  | 0,53292 | 3,28279 | -0,6739 | -0,4779 |
| Wina           | 9,16  | 0,76075 | 6,96847 | -0,1474 | -0,1045 |
| Padli          | 16,83 | 1,31201 | 22,0811 | 2,01159 | 1,42666 |
Average matrix for each line of criteria responsibility in Table 10:

| Bayu   | 9,5   | 0,93718 | 8,90321 | 0,12903 | 0,09151 |
|--------|-------|---------|---------|---------|---------|
| Hendar | 10,5  | 1,04829 | 11,007  | 0,42958 | 0,30467 |
| Yedin  | 9     | 0,87051 | 7,83459 | -0,0236 | -0,0168 |
| Ade Muhidin | 6 | 0,59220 | 3,5532  | -0,6353 | -0,4505 |
| Kusworo| 5,5   | 0,52553 | 2,89042 | -0,7299 | -0,5177 |
| Kandi  | 9     | 0,95385 | 8,58465 | 0,08352 | 0,05924 |
| Wina   | 14    | 1,42051 | 19,8871 | 1,69816 | 1,20437 |
| Padli  | 7,5   | 0,77692 | 5,8269  | -0,3104 | -0,2202 |

After the results of the consistency of the above criteria are obtained, the hierarchy of criteria is similar to Figure 5.

The priority vector above shows the weight values of each alternative criterion, so the best employees are accepted by Hendar, then Vienna, Yedin, Kusworo, Padli, Kandi, Bayu, and the last is Ade Muhidin.
The best employee

Responsible (0.3196)  Discipline (0.5584)  Innovation (0.1220)

Bayu (0.93718)  Bayu (0.15983)  Bayu (0.65060)

Hendar (1.04829)  Hendar (1.80107)  Hendar (1.88044)

Yedin (0.87051)  Yedin (1.58034)  Yedin (0.94166)

Ade Muhidin (0.59220)  Ade Muhidin (0.15821)  Ade Muhidin (0.47023)

Kusworo (0.52553)  Kusworo (0.83031)  Kusworo (0.57640)

Kandi (0.95385)  Kandi (0.39595)  Kandi (0.53292)

Wina (1.42051)  Wina (1.76774)  Wina (0.76075)

Padli (0.77692)  Padli (0.49278)  Padli (1.31201)

Figure 5. Value Of Each Criterion

4.2. Data Processing Using the Expert Choice Application

a. Hierarchy Drafting
   The stages of this preparation are carried out as a stage to form a hierarchy structure for the selection of the best canary in the marketing department, the picture of hierarchy formation can be shown in Figure 6:

b. Criteria Synthesis in Figure 7.
   Following are the results of the synthesis calculation regarding the purpose of selecting the best employees in the marketing department, here is a picture of the synthesis output shown in Figure 7:

The results of the analysis use the Expert Choice Application, which is the best employee at Hon Chuan Indonesia in the sales department is an employee named Hendar. And with the results of the Expert Choice Application ratio, as shown in Figure 7 and Figure 8:
5. Conclusion
The Analytical Hierarchy Process (AHP) method can be used to evaluate the performance results of employees. AHP method can also be a very effective and efficient method based on all aspects of complex issues by simplifying and accelerating decision support processes. The calculation of the AHP method gives the results of the order of importance of criteria, namely the level of discipline (0.5584), responsibility (0.3196), and innovation (0.1220) and the best employee election results obtained by Hendar (0.189), Vienna (0.189), Yedin (0.145), Padli (0.109), Kandi (0.108), Kusworo (0.101), Bayu (0.088), and Ade Muhidin (0.072).

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