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Decision Support System for Employee Performance Assessment Using Analytical Hierarchy Process and Simple Additive Weighting Methods

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Abstract

Evaluation of employee performance is carried out by company leaders at company work meetings to determine the best employees. In the process of assessing the best employees, the relevant company still does not use a digital system and does not have a clear weighting system for the criteria used. This results in inaccurate assessment results. Based on the problems found during field observations, research was carried out with the aim of developing a computerized decision support system for employee performance assessment and a system that applies weighting to each criterion. The Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods are the methods used in developing this decision support system. The AHP method is used to determine the weight of each criterion, while the SAW method is used to determine the ranking of the best employees. The research results are in the form of a website-based decision support system complete with criteria and weights for each criterion as well as the final results of the performance assessment of the 5 data samples used. This system has been tested using the User Acceptance Test method and obtained a score of 78.31%.

Keywords: Decision Support System, Performance Assesment, Accuracy, AHP, SAW

1. INTRODUCTION

The development of a company to become more advanced is influenced by many aspects, for example human resources, financial factors, regulations within the company, political turmoil and so on. One of the important components and indicators of a company's progress is the level of productivity of the company's employees. Therefore, it is important to pay attention to the quality of employees in order to increase the productivity of a company. The way to find out the quality of your employees is to carry out regular performance assessments.

Employee performance assessment is an assessment process carried out by companies to produce high quality and dedicated employees [1]. In the process, a common problem that occurs in a company is that the performance assessment

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process is not carried out objectively, which of course will result in an inaccurate assessment. Apart from the subjective nature of assessing employee performance without considering the achievements achieved by the employee concerned [2], this problem is also driven by the absence of a company policy regarding weighting of assessment criteria and an assessment system that is still carried out manually by filling in an assessment form to each employee. This problem is common in companies that implement employee performance appraisal systems. The issue of subjectivity which affects the accuracy of assessment results is the impetus for researchers to develop a decision support system (DSS) for determining the best employees.

DSS is an interactive computer information system and can provide alternative solutions for decision makers [3]. Decision support systems have been widely used to help support decision making in solving various problems, both in the fields of education, health and other public fields [4]. The advantages of DSS are that it expands the decision maker's ability to process data/information for decision making, saves the time needed to solve problems, produces solutions more quickly and the results are more reliable, is able to provide various alternatives in decision making, strengthens the decision maker's confidence in the decision made. taken, and provide a competitive advantage for the organization as a whole by saving time, effort and costs [5]. DSS is intended to be a tool for decision makers to expand their capabilities, but not to replace their judgment [6].

There are several similar studies that have been carried out, including: The first one is research with the topic of Selection of Candidates for Regency Level Science Olympiad Participants Using the Simple Additive Weighting (SAW) Method. The weakness of this research is that the system developed is desktop-based which does not allow it to be accessed anywhere and anytime and special memory space is required to install the application [7]. The second is research with the aim of determining the best employees using SAW. The results of the research are a web-based decision support system for determining the best employees for PDAM Tirta Silaupiasa Kisaran [8]. The third is research that carries out a comparison between two methods, namely the Simple Additive Weighting (SAW) method and the Analytical Hierarchy Process (AHP) in the selection of computer laboratory employees. The research results show that the Analytical Hierarchical Process (AHP) method is very effective in producing recommendations. AHP is considered appropriate to represent natural thinking which tends to group system elements into different levels, each level containing similar elements so that it is better used for selecting laboratory staff which involves many criteria with different hierarchical levels [9].

This research will raise the case of employee performance assessment based on predetermined criteria using two methods, namely Analytical Hierarchy Process

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(AHP) and Simple Additive Weighting (SAW). With this method, management can create prototypes and effective assessment mechanisms based on qualitative data and quantitative data from the proposed criteria. The final objective of this research is to develop a web-based employee performance assessment decision support system that can help provide convenience for leaders in the employee performance assessment process and with the hope of minimizing the occurrence of subjectivity in the assessment process and increasing the accuracy of assessment results.

2. METHODS

The methods used at the research stage include data collection, data indexing, and system development [10]. More details of the research steps can be seen in Figure 1.

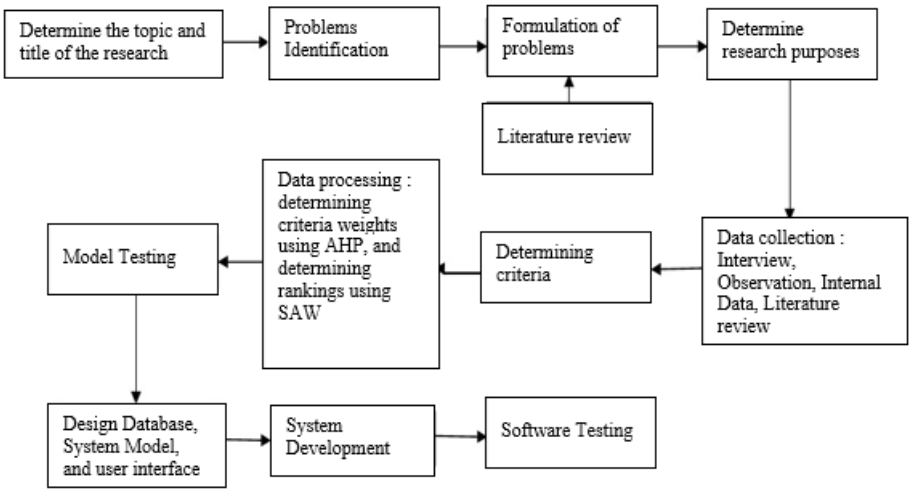

Figure 1. Research Steps

The research begins by formulating the research topic and title first, where in this case the research topic is about decision support systems. In the second stage, problem identification is carried out, which is then continued by formulating the problem in the second stage. At this problem identification stage, problems were found using traditional systems and subjectivity in assessment. Departing from the problems found, the next stage or fourth stage is to formulate the research objective, which is to solve the problem. In the fifth stage of data collection, the observation process, internal data collection and also literature study were carried out. The sixth stage is determining the criteria. The AHP and SAW methods are used in the seventh stage, namely in processing and analyzing alternative data and criteria. The eighth stage is to test the model first before continuing on to the ninth stage, namely designing the database, system model and user interface. After

carrying out the ninth stage of design, the tenth stage is building a web-based system. After the system has been successfully developed the final stage is to test the system

2.1. Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) method is a multi-criteria decision making model that can help the human thinking framework where the factors of logic, experience, knowledge, emotions and feelings are optimized into a systematic process [11]. The basic principles of the AHP method are creating a hierarchy, determining criteria and alternatives, determining priorities and logical consistency [12]. The stages in the AHP method are as follows [13]:

1) Define the problem and determine the desired solution.
2) Create a hierarchical structure that starts with the general goal, followed by criteria and alternative options.

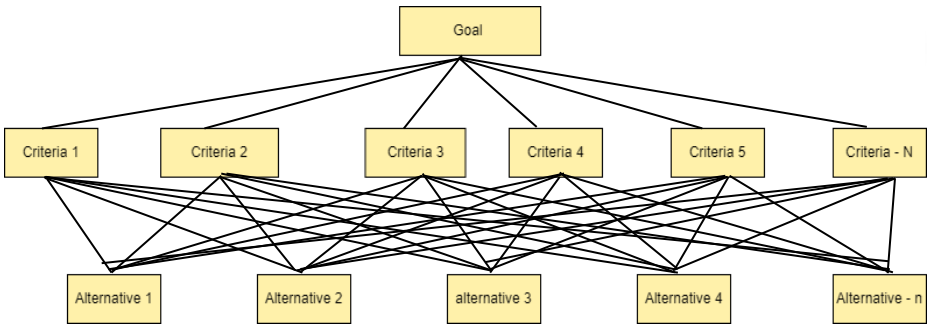

Figure 2. AHP Methods hierarchical structure

3) Create a pairwise comparison matrix. Pairwise comparisons were performed using the method described by Saaty [14] on a fundamental scale.
4) Normalize data
5) Calculate the eigenvector values and test their consistency.
6) Repeat steps 3, 4 and 5 for all hierarchical levels.
7) Calculate the eigenvector of each pairwise comparison matrix.
8) Test the consistency of the hierarchy. If it does not meet CR<0.100 then the assessment must be repeated.

2.2. Simple Additive Weighting

The steps in the SAW method are as follows [15]:

1) Determine the criteria that will be used in decision making (Ci).
2) Determine the suitability rating of each alternative on the criteria.

3) Create a decision matrix based on criteria (Ci).
4) Create a normalization matrix using an equation that is adjusted to the type of attribute (profit or cost attribute).

$$Rij = \begin{cases} \dfrac{Xij}{MaxiXij} & \text{If J is a profit attribute (Benefit)} \\ \dfrac{MiniXij}{Xij} & \text{If J is the cost attribute (Cost)} \end{cases} \quad (1)$$

5) Find the ranking of each alternative.

3. RESULTS AND DISCUSSION

3.2. Data Collection

The case study used in this research is PT. All Data International. The initial step taken to identify research objects is to conduct interviews to obtain information regarding the criteria that are the basis for assessment at PT. All Data International and a list of alternatives used in determining the best employees.

Table 1. List of Criteria

Code	Criteria Provisions	Information
C1	Responsibility	Benefit
C2	Communication Skill	Benefit
C3	Presence	Benefit
C4	Attitude	Benefit
C5	Knowledge	Benefit
C6	Working Age	Benefit

Table 1 shows a list of criteria resulting from the interview process. The criteria used in this research are responsibility, communication skills, attendance, attitude, knowledge and working age. The overall type of criteria used is Benefit criteria, meaning that the value obtained by employee alternatives for each criterion is determined or prioritized from the highest value.

Table 2. List of Alternative

No	Alternatif
1	Ade
2	Widodo
3	Yudi
4	Putri
5	Ega

The selection of alternative samples was carried out by researchers using the random sampling method, simple random sampling is a simple sampling technique that is carried out randomly. The alternative sample used is 5 employees as in table 2.

3.3. Data Processing

3.3.1. Analytical Hierarchy Process

Based on the AHP Methods hierarchical structure in Figure 2, the objectives, criteria and Comparison of Importance Between Criteria in this research can be described as follows:

1) Goals: The goal or objective of this research is the assessment of employees at PT. All Data International based on existing criteria.
2) Criteria: PT. All Data International uses several criteria, including: responsibility, communication skills, presence, attitude, knowledge, and working age.
3) Comparison of Importance Between Criteria: Based on the level of importance above from the questionnaire that has been submitted to decision makers, a comparison matrix table per criterion is obtained which is presented in Table 3.

Table 3. Importance Comparison Matrix Per Criteria

Criteria	Responsibilty	Communi-cation Skills	Presence	Attitude	Knowledge	Working Age
Responsibilty	1	1/3	1/2	1/2	1/3	1/5
Communication Skills	3	1	1/2	1/3	1/2	1/3
Presence	2	2	1	1/3	1/3	1/2
Attitude	2	3	3	1	1/2	1/3
Knowledge	3	2	3	2	1	1/2
Working Age	5	3	2	3	2	1

The steps in determining the weight of each criterion using the AHP (Analytical Hierarchy Process) model are as follows:

Step 1: Describe the matrix above into decimal form:

Table 4. Comparison Matrix to Decimal Form

Criteria	Responsibilty	Communi-cation Skills	Presence	Attitude	Knowledge	Working Age
Responsibilty	1.00000	0.33333	0.50000	0.50000	0.33333	0.20000
Communi-cation Skills	3.00000	1.00000	0.50000	0.33333	0.50000	0.33333
Presence	2.00000	2.00000	1.00000	0.33333	0.33333	0.50000
Attitude	2.00000	3.00000	3.00000	1.00000	0.50000	0.33333

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Criteria	Responsibilty	Communi-cation Skills	Presence	Attitude	Knowledge	Working Age
Knowledge	3.00000	2.00000	3.00000	2.00000	1.00000	0.50000
Working Age	5.00000	3.00000	2.00000	3.00000	2.00000	1.00000
	16.00000	11.33333	10.00000	7.16667	4.66667	2.86667

Step 2: Multiplying a matrix by itself:

Table 5. Comparison of Matrix Multiplication Results

Criteria	Responsi-bilty	Communi-cation Skills	Presence	Attitude	Knowledge	Working Age
Responsibilty	0.06250	0.02941	0.05000	0.06977	0.07143	0.06977
Communi-cation Skills	0.18750	0.08824	0.05000	0.04651	0.10714	0.11628
Presence	0.12500	0.17647	0.10000	0.04651	0.07143	0.17442
Attitude	0.12500	0.26471	0.30000	0.13953	0.10714	0.11628
Knowledge	0.18750	0.17647	0.30000	0.27907	0.21429	0.17442
Working Age	0.31250	0.26471	0.20000	0.41860	0.42857	0.34884

Step 3: Add up each row of the results of matrix multiplication

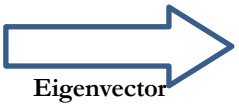
Table 6. Row sum result

Results
0.35288
0.59567
0.69383
1.05266
1.33174
1.97322

Step 4: Normalizing by dividing each number of rows in the matrix by the total rows will produce an eigenvector.

Table 7. Result

Result
0.35288
0.59567
0.69383
1.05266
1.33174
1.97322



Eigenvector
0.05881
0.09928
0.11564
0.17544
0.22196
0.32887

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Step 5: Determine the weight of each criteria taken from the eigenvector.

Table 8. Weight of Criteria

Criteria	Weight
Value of Responsibilty	0.05881
Value of Communication Skills	0.09928
Value of Presence	0.11564
Value of Attitude	0.17544
Value of Knowledge	0.22196
Value of Working Age	0.32887

Step 6: Multiplying the decimal number value and each matrix by the eigenvector criterion

Table 9. Decimal Form Comparison Matrix

Criteria	Responsibilty	Communi-cation Skills	Presence	Attitude	Knowledge	Working Age	Total
Responsibilty	0.05881	0.03309	0.05782	0.08772	0.07399	0.06577	0.37721
Communi-cation Skills	0.17644	0.09928	0.05782	0.05848	0.11098	0.10962	0.61262
Presence	0.11763	0.19856	0.11564	0.05848	0.07399	0.16443	0.72872
Attitude	0.11763	0.29783	0.34691	0.17544	0.11098	0.10962	1.15842
Knowledge	0.17644	0.19856	0.34691	0.35089	0.22196	0.16443	1.45919
Working Age	0.29406	0.29783	0.23128	0.52633	0.44391	0.32887	2.12229

Step 7: Calculating the Consistency Vector by determining the average value of the Weighted Sum Vector

$$\pi = \frac{0.37721 + 0.61262 + 0.72872 + 1.15842 + 1.45919 + 2.12229}{6} = 6.45844$$

Step 7: Calculate the Consistency Index value using the formula:

$$CI = \frac{(\pi - n)}{}$$

$$CI = \frac{(6.458444 - 6)}{6 - 1}$$

$$CI = \mathbf{0.091689}$$

Step 8: To calculate the Consistency Ratio, the RI value is needed, namely the Random Index obtained from the Oarkridge table CR = CI/CR. For n = 6, the RI value is 1.24.

$$CR = \frac{0.091689}{1.240}$$

$$CR = 0.07395$$

The comparative assessment is said to be consistent if the CR is no more than 0.1 so that the comparative assessment of the criteria for the best employees at PT. All Data International is consistent and does not require assessment revisions.

3.2.2 Simple Additive Weighting

The Simple Additive Weighting (SAW) method is used to calculate the final alternative value, namely determining the best employee. The output that will be produced is a sequence of alternatives from the highest value to the alternative with the lowest value. The steps taken are as follows.

1. Criteria Weight
   criteria and weighting of criteria needed for decision making on selecting the Best PT Employees. All International Data can be seen in the table 8.
2. Normalization Matrix

Table 10. Alternative Value Per Criteria

Alternative	Criteria					
	Value of Responsibilty	Value of Communi-cation Skills	Value of Presence	Value of Attitude	Value of Knowledge	Value of Working Age
Ade	6	5	300	7	7	4
Widodo	8	7	300	7	7	5
Yudi	7	6	295	8	7	2
Putri	6	8	298	6	7	2
Ega	7	7	290	5	8	3

First, normalization is carried out into a matrix to calculate the value of each criterion, calculating based on profit criteria or cost criteria using Equation 1.

3. Alternative Value Results
   Then the normalization matrix that has been obtained per the previous criteria is calculated to obtain the best alternative.

Table 11. Normalization Matrix Values

Alternative	Criteria					
	Value of Responsibilty	Value of Communi-cation Skills	Value of Presence	Value of Attitude	Value of Knowledge	Value of Working Age
Ade	0.75	0.625	1	0.875	0.875	0.8
Widodo	1	0.875	1	0.875	0.875	1
Yudi	0.875	0.75	0.983	1	0.875	0.4
Putri	0.75	1	0.993	0.75	0.875	0.4
Ega	0.875	0.875	0.966	0.625	1	0.6
Bobot	**0.05881**	**0.09928**	**0.11564**	**0.17544**	**0.22196**	**0.32887**

After the R value is obtained, the next step is to process the preference value for each employee.

Ade = (0.05881x0.75) + (0.09928x0.625) +(0.11564x1) + (0.17545x0.875) (0.22196x0.875) +(0.32887x0.8) = 0.83262725

Widodo = (0.05881x1) + (0.09928x0.875) +(0.11564x1) + (0.17545x0.875) (0.22196x0.875) +(0.32887x1) = 0.93792375

Yudi =(0.05881x0.875) + (0.09928x0.75) + (0.11564x0.98333333333333) (0.17545x1) + (0.22196x0.875) + (0.32887x0.4) = 0.74084441666667

Putri =(0.05881x0.75) + (0.09928x1) + (0.11564x0.99333333333333) (0.17545x0.75) + (0.22196x0.875) + (0.32887x0.4) = 0.71560706666667

Ega =(0.05881x0.875) + (0.09928x0.875) (0.11564x0.96666666666667) + (0.17545x0.625) + (0.22196x1) + (0.32887x0.6) = 0.77905233333333

From the above calculations, the following ranking results are obtained:

Table 12. Ranking

Rank	Alternative	Score
Rank 1	Widodo	0.937924
Rank 2	Ade	0.832627
Rank 3	Ega	0.779052
Rank 4	Yudi	0.740844
Rank 5	Putri	0.715607

So it can be concluded that the greatest value is obtained by Widodo as the best alternative with a value of **0.937924**.

3.3. System Design

System modeling is carried out using use cases in the unified modeling language. The use case diagram in Figure 4 explains that the decision support system being developed has several main features that can be accessed by users, namely: Entry Criteria, Entry sub criteria, enrty alternatives, evaluation, data calculation, user data, and profile.

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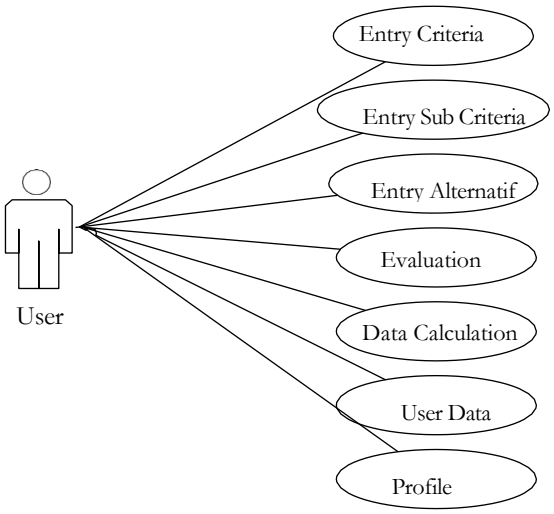

Figure 3. Use Case Diagram

3.4. System Interface Display

This section provides a comprehensive overview of the system interface for the decision support system, detailing each component's functionality and user interaction. The login page, illustrated in Figure 5, serves as the initial access point for the system. Users are prompted to enter their username and password. Upon submission, the system verifies the credentials to ensure they are valid. Successful authentication redirects the user to the home page, safeguarding the system from unauthorized access and ensuring user data privacy.

Figure 6 showcases the main home page of the system. This central hub features the primary menu, which allows users to navigate seamlessly through the system's various functionalities. The design prioritizes user experience by providing an intuitive layout that facilitates easy access to essential features and tools. The criteria page, depicted in Figure 7, lists the criteria employed in the best employee assessment system. This page enables users to review and manage these criteria, ensuring that the evaluation process remains accurate and unbiased. Users can add, remove, or modify criteria as needed, adapting the assessment framework to meet organizational requirements. The alternative page, shown in Figure 8, presents the different alternatives considered in the best employee assessment system. This page allows users to view and manage various options available for evaluation, providing flexibility in assessing multiple candidates or scenarios. Users can compare alternatives to ensure a comprehensive evaluation process.

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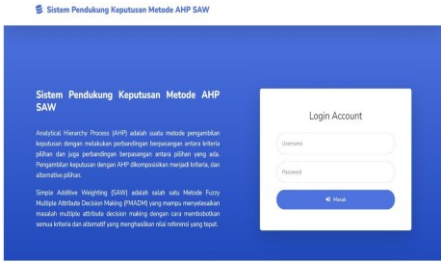

Figure 4. Login page

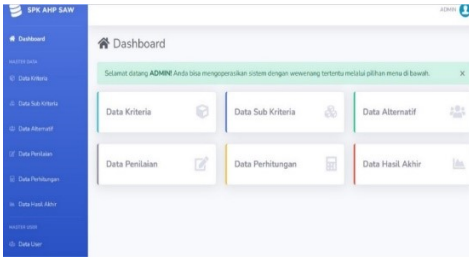

Figure 5. Home page

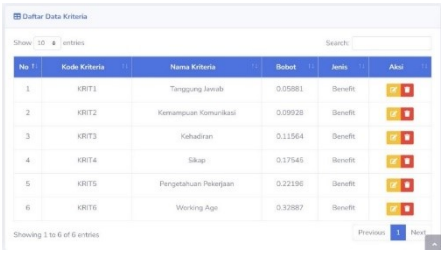

Figure 6. Criteria page

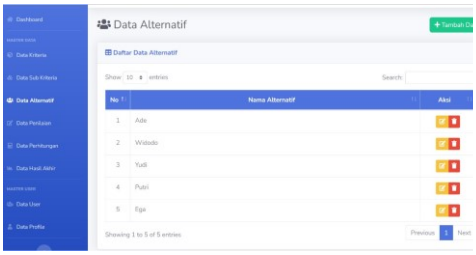

Figure 7. Alternative page

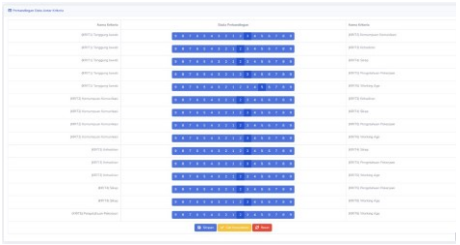

Figure 8. Analysis Page

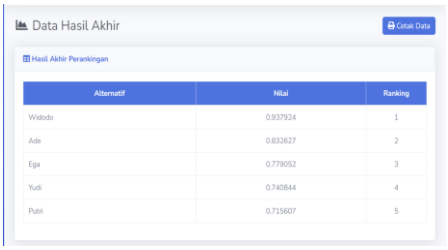

Figure 9. Ranking page

Figure 9 illustrates the analysis page, where the system processes data using the Simple Additive Weighting (SAW) method. This analysis page integrates both criteria and alternatives to generate meaningful insights, helping users make informed decisions based on a systematic evaluation of all factors. The SAW method ensures a balanced and objective analysis by weighing each criterion according to its importance. Finally, the ranking page, presented in Figure 10, displays the results of the SAW calculations. The output ranks the alternatives from first to fifth place, offering a clear and structured overview of the best options based on the assessment criteria. This ranking helps users quickly identify top performers or optimal choices, streamlining decision-making processes within the organization.

The results of this research were created to meet the needs of company management in the process of determining the best employees. By using criteria according to the company's needs. These criteria consist of 6 (six) criteria, which

are stated in table 1 Criteria for determining the best employees. This decision support system for determining the best employees is based on the needs of PT. All Data International. Starting with the need to find the best employees during the process of working at the company. With the criteria applied in the company, it becomes a reference for finding the best employees using these benchmarks, becoming an objective assessment for employees. Held the determination of the best employees for the company. This research produces an alternative in the form of a decision support system for determining the best employee which can provide several alternative employee choice results. Based on table 12 and figure 10, a ranking result can be drawn from determining the best employees. The results of ranking the best employees are as follows.

The first rank is employee Widodo with a value of 0.937924, for the second rank is employee Ade with a value of 0.832627, for the third rank is employee Ega with a value of 0.779052, for the fourth rank is Yudi with a value of 0.740844, and for the fifth rank is employee Putri with a value of amounting to 0.715607. From the ranking results, Widodo employees are recommended to be the best employees of PT. All Data International. After the results of the ranking of location alternatives are obtained, a conclusion can be drawn that the alternative that has the greatest value is the alternative that is able to meet the specified criteria well, so that the value obtained is the overall value. In this research, it is felt that there are still many shortcomings, due to several obstacles faced by the author when carrying out data collection, research and testing. So it is necessary to carry out further research to complete the many shortcomings in this research, things that need to be done in developing further research that can be carried out based on this research:

1. Adding criteria that are not yet in this research, so that they can be even more specific.
2. Combining criteria requirements that can be synergized to produce a better decision model.

4. CONCLUSION

Based on the results of the research that has been carried out and presented in the discussion description, it can be concluded that the use of the AHP method and SAW method in developing a decision support system can produce ideal weighting so that it can minimize the occurrence of subjectivity in the employee assessment process which of course will be directly proportional to increasing the accuracy of the results. performance assessment. To find out whether the system being developed has answered user needs or not, researchers have carried out a testing process to determine user perceptions of the system using the User Acceptance Test (UAT) method. The UAT test includes 4 (four) characteristics, namely Functionality, Reability, Usability, and Efficiency. The test results show a figure of

78.31%, which means that based on user perceptions the decision support system developed is in the good category.

In order to support further research, the following suggestions are given by the author, namely that this research still requires further development so that it can be used as a real decision support system. Special standard procedures need to be created if the assessment mechanism in this research is to be implemented. Because there will be changes to the assessment flow itself. This assessment testing method can still be complemented by other, more objective tests. Accuracy in inputting scores needs to be improved so that the selected employees are indeed employees who have the right to be the best employees.

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