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Decision Support System for Employee Performance Assessment with SAW and TOPSIS Methods

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Employees are one important factor of a company. That's because many employees play a role in every activity of a company. Therefore, companies must carry out employee evaluation processes to be able to maintain and mature employee performance. In general, the employee assessment process requires a long time and the results obtained are not necessarily accurate. That is because there are many elements that must be assessed and also the calculation process is still done manually. These elements include work performance, honesty, cooperation, obedience, and loyalty. Based on the problem, a decision support system was created that could simplify and speed up the employee evaluation process. The method used is SAW and TOPSIS which can help to provide accurate results because both methods are suitable for processing data with many criteria or elements. To test the system that has been made, the authors conducted the activity of giving a questionnaire conducted or filled out by 15 users. Based on the results of testing and questionnaires that have been distributed and filled out by users, it was found that around 92% of respondents stated that they were very satisfied with the system as a whole. Then based on the data, this decision support system functions well and is beneficial for users because it helps and facilitates the company in the employee appraisal process and also helps employees know their potential.

Keywords: Employee Assessment, Decision Support System, SAW, TOPSIS

Introduction

The progress of the world of information technology is increasingly developing in all aspects of life that in its application can facilitate human work. Humans in everyday life often encounter problems in decision making. Problems that arise can be large or small scale that greatly affects the outcome of the decision. As is the case in making decisions when coaching workers or employees. Manpower is one of the important factors that must be considered by companies in order to achieve its objectives. That is because many workers or employees play a role in every activity of a company. So because of that the company must conduct an employee performance appraisal process to be able to maintain and mature employee performance.

Job performance assessment or performance appraisal is the process of employee performance evaluation or performance carried out by the organization to know feedback from all activities carried out by employees in an organization or company. (Veithzal el. all 2014 : 528). The purpose of the work performance appraisal is to determine the success or failure of an

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employee as well as to know the weaknesses and strengths that are owned by the employee in carrying out his duties. The results of the employee performance appraisal will be used as consideration in employee coaching, including promotion, education, training and awards.

Decision support system as a collection of model base procedures for processing data and decisions to assist managers in making decisions (Priranda & Sri 2013: 578). In a decision support system there are alternatives, criteria, and weights used to determine the best solution. Decision making with many elements of assessment or criteria requires a special way of handling, therefore a method is needed to help facilitate decision making.

There are several methods of decision support systems that can be used for decision making with many criteria, several DSS methods can be combined, one of which is the combination of Simple Additive Weighting (SAW) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). The Simple Additive Weighting method can be interpreted as a simple weighting method or a weighted sum in problem solving in a decision support system (Dicky & Sarjon 2017: 33). The TOPSIS method is a method where the concept of resolution is to choose the best alternative that has the shortest distance from a positive ideal solution, and also has the longest distance from a negative ideal solution (Dicky & Sarjon 2017: 41). Through these two methods an assessment process and ranking of employee performance will be carried out. In this ranking process, the first thing to do is the normalization process using the SAW method. After the normalization results using the SAW method are finished, then proceed with the ranking process using the TOPSIS method because TOPSIS can contain positive and negative ideal solutions so that it can produce alternatives that have the closest point of the positive ideal solution and the furthest point from the negative ideal solution.

Related Works

Job Performance Assessment

Job performance evaluation is the process of evaluating employee performance or performance carried out by the organization to find out feedback from all activities carried out by employees in an organization or company (Veithzal et.all 2014: 528). In performance appraisal, there are several things that can damage the valuation technique, as follows:

1. Unclear standards
2. Halo Effect
3. Centered Leaning
4. Bias issues

Performance

The definition of performance is as a result of work in quality and quantity achieved by an employee in carrying out their duties in accordance with the responsibilities given to him (Rangkuti 2016: 107)

Decision Support System

Definition decision support systems (DSS) quoted from Nofriansyah (2015: 1) according to Bonczek, et al., In the book Decision Support System and Intelligence Systems defines that decision support systems (DSS) as computer-based systems consisting of three interacting components. Among other things, namely the model system (a mechanism to provide communication between users and other decision support system components), knowledge systems (problem domain knowledge repositories that exist in decision support systems or can be as data or procedures), and problem processing systems (the relationship between two other components, consisting of one or more general problem manipulation capabilities needed for problem solving).

Methods

SAW (Simple Additive Weighting)

The Simple Additive Weighting (SAW) method is often also known as the weighted sum method. The basic concept of the SAW method is to find a weighted sum of the performance ratings for each alternative on all attributes. SAW method is also a method that is widely used in decision making that has many attributes. The SAW method requires the decision matrix normalization process (X) to a scale that can be compared with all available alternative ratings (Nofriansyah 2015: 11).

The formula used to normalize is as follows:

$$r_{ij} = \left\{ \begin{array}{ll} \frac{X_{ij}}{\text{Max } X_{ij}} & \text{Jika } j \text{ adalah atribut keuntungan (benefit)} \\ \frac{\text{Min } X_{ij}}{X_{ij}} & \text{Jika } j \text{ adalah atribut biaya (cost)} \end{array} \right\}$$

where is:

- R_{ij} : Normalized performance rating of alternative A_i on the C_j attribute
- $\text{Max } X_{ij}$: The biggest value of each criterion I
- $\text{Min } X_{ij}$: The smallest value of each criterion I
- X_{ij} : attribute value owned by each criterion
- Benefit : If the biggest value is the best
- Cost : If the smallest value is the best

The preference value for each alternative (V_i) is given the following formula:

$$V_i = \sum_{j=1}^n W_j r_{ij}$$

where is:

- V_i : Ranking for each alternative
- W_j : Value of ranking weight (of each alternative)
- R_{ij} : Normalized performance rating value

A greater value of V_i indicates that the alternative A_i is preferred.

The advantage of the SAW method compared to other decision system methods lies in its ability to carry out a more precise assessment because it is based on the value of the criteria and the level of importance required.

TOPSIS (The Technique for Order of Preference by Similarity to Ideal Solution)

Technique for Order Performance of Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision support system. TOPSIS has the principle that the chosen alternative must have

the shortest distance from the positive ideal solution and have the farthest distance from the negative ideal solution from a geometric point of view by using the Euclidean distance (distance between two points) to determine the relative proximity of an alternative (Nofriansyah 2015: 27) . The TOPSIS method has the following advantages:

1. The TOPSIS method is a simple method and rational concept that is easy to understand.
2. The TOPSIS method is able to measure relative performance in forming simple mathematical forms.

The TOPSIS method is based on the concept that the best chosen alternative not only has the shortest distance from the positive ideal solution but also has the farthest distance from the negative ideal solution. The following are the stages of the TOPSIS method:

1. Make a normalized decision matrix.
2. Make a normalized weighted decision matrix.
3. Determine a positive ideal solution matrix and a negative ideal solution matrix.
4. Determine the distance between the values of each alternative with a positive and negative ideal solution matrix.
5. Determine the preference value for each alternative.

TOPSIS requires a performance rating of each A_i alternative on each normalized C_i criteria, namely:

1. Determine the normalization of the decision matrix. The normalized value of r_{ij} is calculated by the formula:

$$r_{ij} = \frac{X_{ij}}{\sum_{i=1}^m X_{ij}^2}$$

where is:

$$i = 1, 2, \dots, m$$

$$j = 1, 2, \dots, n$$

2. Determine the normalized weight of the decision matrix. Y_{ij} normalized weight values are as follows:

$$y_{ij} = W_{ij} R_{ij}$$

where:

$$i = 1, 2, \dots, m$$

$$j = 1, 2, \dots, n$$

$$A^+ = (y_1^+, y_2^+, \dots, y_n^+)$$

where:

$$A^- = (y_1^-, y_2^-, \dots, y_n^-)$$

$$y_j^+ = \left\{ \begin{array}{l} \max y_{ij} : \text{jika } j \text{ adalah atribut keuntungan (benefit)} \\ \min y_{ij} : \text{jika } j \text{ adalah atribut biaya (cost)} \end{array} \right\}$$

$$y_j^- = \left\{ \begin{array}{l} \min y_{ij} : \text{jika } j \text{ adalah atribut keuntungan (benefit)} \\ \max y_{ij} : \text{jika } j \text{ adalah atribut biaya (cost)} \end{array} \right\}$$

value $j = 1, 2, \dots, n$

1. The distance between the alternative A_i with the positive ideal solution is formulated as: $D_i^+ =$

$$\sqrt{\sum_{j=1}^n (y_i^+ - y_{ij})^2}$$

where:

$i = 1, 2, \dots, m$

2. The distance between the alternative A_i with the negative ideal solution is formulated as:

$$D_i^- = \sqrt{\sum_{j=1}^n (y_{ij} - y_i^-)^2}$$

where:

$i = 1, 2, \dots, m$

3. The preference value for each alternative (V_i) is given as:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad i = 1, 2, \dots, m$$

A greater value of V_i indicates that alternative A_i is preferred.

Results

Stages of SAW and TOPSIS

The stages of combining the SAW and TOPSIS methods in the system are shown in the following flowchart:

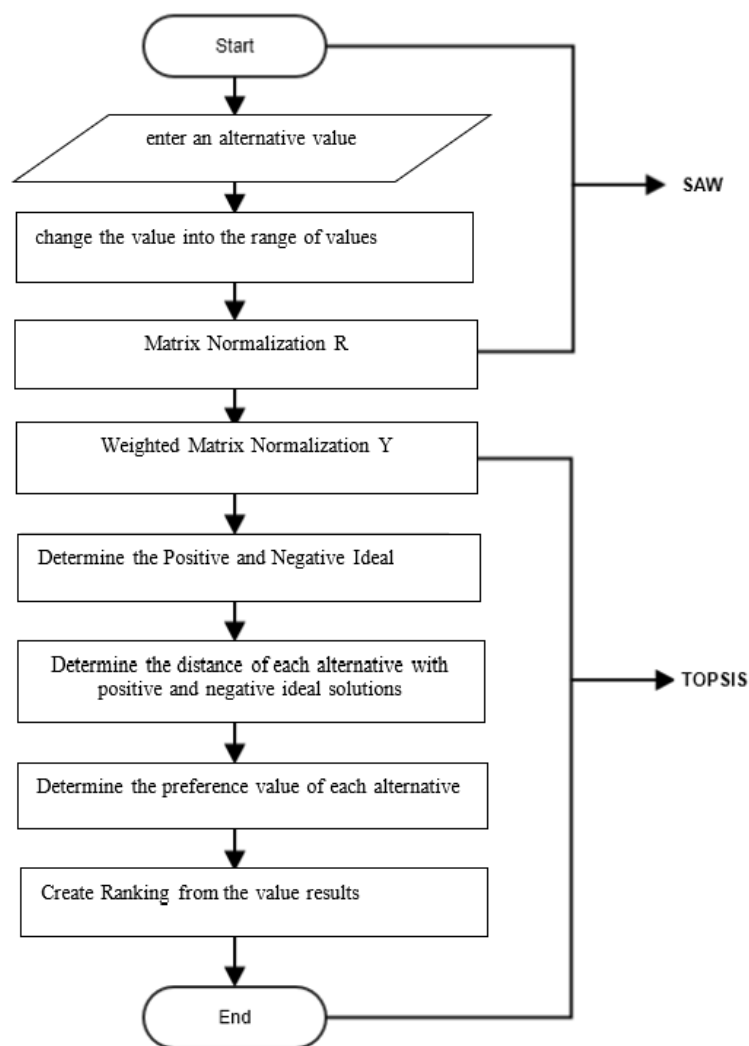


Figure 1 Flowchart Implementation of the SAW and TOPSIS Methods

Determination of Criteria and Alternatives

The criteria used for the assessment process are: C1 = Job performance, C2 = Honesty, C3 = Cooperation, C4 = Obedience, and C5 = Loyalty. Whereas there are 10 (ten) people or alternatives that will be assessed.

Matching ratings for each alternative on each criterion are assessed with 1 to 5, namely:

- 1: Very Poor
- 2: Poor
- 3: OK
- 4: Good
- 5: Very good

Assessment criteria that use a scale of 1-100 which are then converted to a predetermined rating rating (1-5). Here are the results of the conversion evaluation

Table 1 Rating Conversion

Criteria	Value Range	Conversion Value
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eCo-Buss

Job performance	> 75 - 100	5
	>= 65 - <=75	4
	>= 55 - < 65	3
	>= 45 - < 55	2
	< 45	1
Honesty	> 75 - 100	5
	>= 65 - <=75	4
	>= 55 - < 65	3
	>= 45 - < 55	2
	< 45	1
Cooperation	> 75 - 100	5
	>= 65 - <=75	4
	>= 55 - < 65	3
	>= 45 - < 55	2
	< 45	1
Obedience	> 75 - 100	5
	>= 65 - <=75	4
	>= 55 - < 65	3
	>= 45 - < 55	2
	< 45	1
Loyalty	> 75 - 100	5
	>= 65 - <=75	4
	>= 55 - < 65	3
	>= 45 - < 55	2
	< 45	1

Table 2 Match Ratings of Each Alternative on Each Criteria

Alternative	Criteria				
	C1	C2	C3	C4	C5
Gagan	4	3	4	4	3
Sebastian	3	2	4	3	2
Caesar	3	4	2	3	5
Topan	4	4	3	4	4
Dedi	4	2	4	3	3
Anton	3	3	4	2	4
Hanis	3	4	2	3	3
Benny	2	4	3	4	2
Iwan	4	3	3	4	4
Doddy	3	4	4	4	3

The company gives preference weights for each criterion as follows: C1 = 40%, C2 = 25%, C3 = 15%, C4 = 10%, and C5 = 10%, so as to obtain:

$$W = \{0.4; 0.25; 0.15; 0.1; 0.1\}$$

SAW Method

Step 1: Make a decision matrix X:

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \dots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix}$$

Result :

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

Step 2: Normalize the decision matrix R:

$$r_{ij} = \begin{cases} \frac{X_{ij}}{\max X_{ij}} & \text{Jika } j \text{ adalah atribut keuntungan (benefit)} \\ \frac{\min X_{ij}}{X_{ij}} & \text{Jika } j \text{ adalah atribut biaya (cost)} \end{cases}$$

$$r_{11} = \frac{4}{\max \{4,3,3,4,4,3,3,2,4,3\}} = \frac{4}{4} = 1.00$$

$$r_{12} = \frac{3}{\max \{3,2,4,4,2,3,4,4,3,4\}} = \frac{3}{4} = 0.75$$

$$r_{13} = \frac{4}{\max \{4,4,2,3,4,4,2,3,3,4\}} = \frac{4}{4} = 1.00$$

$$r_{14} = \frac{4}{\max \{4,3,3,4,3,2,3,4,4,4\}} = \frac{4}{4} = 1.00$$

$$r_{15} = \frac{3}{\max \{3,2,5,4,3,4,3,2,4,2\}} = \frac{3}{5} = 0.60$$

Continue to obtain a normalized matrix R:

$$R = \begin{bmatrix} 1.00 & 0.75 & 1.00 & 1.00 & 0.60 \\ 0.75 & 0.50 & 1.00 & 0.75 & 0.40 \\ 0.75 & 1.00 & 0.50 & 0.75 & 1.00 \\ 1.00 & 1.00 & 0.75 & 1.00 & 0.80 \\ 1.00 & 0.50 & 1.00 & 0.75 & 0.60 \\ 0.75 & 0.75 & 1.00 & 0.50 & 0.80 \\ 0.75 & 1.00 & 0.50 & 0.75 & 0.60 \\ 0.50 & 1.00 & 0.75 & 1.00 & 0.40 \\ 1.00 & 0.75 & 0.75 & 1.00 & 0.80 \\ 0.75 & 1.00 & 1.00 & 1.00 & 0.60 \end{bmatrix}$$

After the normalized matrix R is obtained then proceed by finding the value of a weighted matrix Y using the TOPSIS method.

TOPSIS Method

Step 1: Normalization of a Y-weighted matrix based on the value of each element in the normalized matrix R obtained from the SAW method:

$$y_{ij} = W_j R_{ij}$$

Result

$$y_{11} = 0.40 \times 1.00 = 0.4$$

$$y_{12} = 0.25 \times 0.75 = 0.1875$$

$$y_{13} = 0.15 \times 1.00 = 0.15$$

$$y_{14} = 0.10 \times 1.00 = 0.1$$

$$y_{15} = 0.10 \times 0.60 = 0.06$$

Continue to get a weighted Y matrix:

$$Y = \begin{bmatrix} 0.4 & 0.1875 & 0.15 & 0.1 & 0.06 \\ 0.3 & 0.125 & 0.15 & 0.075 & 0.04 \\ 0.3 & 0.25 & 0.075 & 0.075 & 0.1 \\ 0.4 & 0.25 & 0.1125 & 0.1 & 0.08 \\ 0.4 & 0.125 & 0.15 & 0.075 & 0.06 \\ 0.3 & 0.1875 & 0.15 & 0.05 & 0.08 \\ 0.3 & 0.25 & 0.075 & 0.075 & 0.06 \\ 0.2 & 0.25 & 0.1125 & 0.1 & 0.04 \\ 0.4 & 0.1875 & 0.1125 & 0.1 & 0.08 \\ 0.3 & 0.25 & 0.15 & 0.1 & 0.06 \end{bmatrix}$$

Step 2: Determine a positive ideal solution (A⁺):

$$A^+ = (y_1^+, y_2^+, \dots, y_n^+)$$

$$y_1^+ = \max\{0.4 ; 0.3 ; 0.3 ; 0.4 ; 0.4 ; 0.3 ; 0.3 ; 0.2 ; 0.4 ; 0.3\} = 0.4$$

$$y_2^+ = \max\{0.1875 ; 0.125 ; 0.25 ; 0.25 ; 0.125 ; 0.1875 ; 0.25 ; 0.25 ; 0.1875 ; 0.25\} = 0.25$$

$$y_3^+ = \max\{0.15 ; 0.15 ; 0.075 ; 0.1125 ; 0.15 ; 0.15 ; 0.075 ; 0.1125 ; 0.1125 ; 0.15\} = 0.15$$

$$y_4^+ = \max\{0.1 ; 0.075 ; 0.075 ; 0.1 ; 0.075 ; 0.05 ; 0.075 ; 0.1 ; 0.1 ; 0.1\} = 0.1$$

$$y_5^+ = \max\{0.06 ; 0.04 ; 0.1 ; 0.08 ; 0.06 ; 0.08 ; 0.06 ; 0.04 ; 0.08 ; 0.06\} = 0.1$$

Then A⁺:

$$A^+ = \{0.4 ; 0.25 ; 0.15 ; 0.1 ; 0.1\}$$

Step 3: Determine the negative ideal solution (A⁻):

$$A^- = (y_1^-, y_2^-, \dots, y_n^-)$$

$$y_1^- = \min\{0.4 ; 0.3 ; 0.3 ; 0.4 ; 0.4 ; 0.3 ; 0.3 ; 0.2 ; 0.4 ; 0.3\} = 0.2$$

$$y_2^- = \min\{0.1875 ; 0.125 ; 0.25 ; 0.25 ; 0.125 ; 0.1875 ; 0.25 ; 0.25 ; 0.1875 ; 0.25\} = 0.125$$

$$y_3^- = \min\{0.15 ; 0.15 ; 0.075 ; 0.1125 ; 0.15 ; 0.15 ; 0.075 ; 0.1125 ; 0.1125 ; 0.15\} = 0.075$$

$$y_4^- = \min\{0.1 ; 0.075 ; 0.075 ; 0.1 ; 0.075 ; 0.05 ; 0.075 ; 0.1 ; 0.1 ; 0.1\} = 0.05$$

$$y_5^- = \min\{0.06 ; 0.04 ; 0.1 ; 0.08 ; 0.06 ; 0.08 ; 0.06 ; 0.04 ; 0.08 ; 0.06\} = 0.04$$

Result A⁻:

$$A^- = \{0.2 ; 0.125 ; 0.075 ; 0.05 ; 0.04\}$$

Step 4: Determine the weighted distance of each alternative to the positive ideal solution:

$$D_i^+ = \sqrt{\sum_{j=1}^n (y_i^+ - y_{ij})^2}$$

$$D_1^+ = \sqrt{(0.4 - 0.4)^2 + (0.25 - 0.1875)^2 + (0.15 - 0.5)^2 + (0.1 - 0.1)^2 + (0.1 - 0.06)^2} = 0.07$$

$$D_2^+ = \sqrt{(0.4 - 0.3)^2 + (0.25 - 0.125)^2 + (0.15 - 0.15)^2 + (0.1 - 0.075)^2 + (0.1 - 0.04)^2} = 0.17$$

$$D_3^+ = \sqrt{(0.4 - 0.3)^2 + (0.25 - 0.25)^2 + (0.15 - 0.075)^2 + (0.1 - 0.075)^2 + (0.1 - 0.1)^2} = 0.13$$

$$D_4^+ = \sqrt{(0.4 - 0.4)^2 + (0.25 - 0.25)^2 + (0.15 - 0.1125)^2 + (0.1 - 0.1)^2 + (0.1 - 0.08)^2} = 0.04$$

$$D_5^+ = \sqrt{(0.4 - 0.4)^2 + (0.25 - 0.125)^2 + (0.15 - 0.15)^2 + (0.1 - 0.075)^2 + (0.1 - 0.06)^2} = 0.13$$

continue to all alternatif:

D_1^+ Gagan = 0.07, D_2^+ Sebastian = 0.17, D_3^+ Caesar = 0.13, D_4^+ Topan = 0.04, D_5^+ Dedi = 0.13, D_6^+ Anton = 0.13, D_7^+ Hanis = 0.13, D_8^+ Benny = 0.21, D_9^+ Iwan = 0.08, D_{10}^+ Doddy = 0.11

Step 5: Determine the weighted distance of each alternative to the negative ideal solution:

$$D_i^- = \sqrt{\sum_{j=1}^n (y_{ij} - y_i^-)^2}$$

$$D_1^- = \sqrt{(0.4 - 0.2)^2 + (0.1875 - 0.125)^2 + (0.15 - 0.075)^2 + (0.1 - 0.05)^2 + (0.06 - 0.04)^2} = 0.23$$

$$D_2^- = \sqrt{(0.3 - 0.2 - 0.2)^2 + (0.125 - 0.125)^2 + (0.15 - 0.075)^2 + (0.075 - 0.05)^2 + (0.04 - 0.04)^2} = 0.13$$

$$D_3^- = \sqrt{(0.3 - 0.2)^2 + (0.25 - 0.125)^2 + (0.075 - 0.075)^2 + (0.075 - 0.05)^2 + (0.1 - 0.04)^2} = 0.17$$

$$D_4^- = \sqrt{(0.4 - 0.2)^2 + (0.25 - 0.125)^2 + (0.1125 - 0.075)^2 + (0.1 - 0.05)^2 + (0.08 - 0.04)^2} = 0.25$$

$$D_5^- = \sqrt{(0.4 - 0.2)^2 + (0.125 - 0.125)^2 + (0.15 - 0.075)^2 + (0.075 - 0.05)^2 + (0.06 - 0.04)^2} = 0.22$$

continue to all alternatif:

D_1^- Gagan = 0.23, D_2^- Sebastian = 0.13, D_3^- Caesar = 0.17, D_4^- Topan = 0.25, D_5^- Dedi = 0.22, D_6^- Anton = 0.15, D_7^- Hanis = 0.16, D_8^- Benny = 0.14, D_9^- Iwan = 0.22, D_{10}^- Doddy = 0.18

Step 6: Determine the preference value for each alternative:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+}$$

$$V_1 = \frac{0.23}{0.23 + 0.07} = 0.767$$

$$V_2 = \frac{0.13}{0.33 + 0.17} = 0.433$$

$$V_3 = \frac{0.17}{0.17 + 0.13} = 0.567$$

And it continues in order to obtain preference values which are then sorted from the largest to the smallest so that employees are ranked as follows:

Tabel 3 *Ranking Karyawan*

Rank	Name	Preference Value	Alternative
1.	Topan	0.862	V ₄
2.	Gagan	0.767	V ₁
3.	Iwan	0.733	V ₉
4.	Dedi	0.629	V ₅
5.	Doddy	0.621	V ₁₀
6.	Caesar	0.567	V ₃
7.	Hanis	0.552	V ₇
8.	Anton	0.536	V ₆
9.	Sebastian	0.433	V ₂
10.	Benny	0.4	V ₈

Display System

Nama	Pekerjaan	Kelamin	Peringkat	Skor	Periode
Dedi	Teknisi	Pria	1	0.862	20184
Anton	Teknisi	Pria	4	0.629	20184
Hanis	Teknisi	Pria	8	0.536	20184
Iwan	Teknisi	Pria	10	0.4	20184
Doddy	Teknisi	Pria	3	0.733	20184
Sebastian	Administrasi	Pria	2	0.767	20184
Caesar	Administrasi	Pria	9	0.433	20184
Gagan	Staff	Pria	5	0.621	20184
Topan	Staff	Pria	6	0.567	20184
Benny	Staff	Pria	7	0.552	20184

Figure 2 Display ranking of employee performance

In Figure 2 can be seen the results of employee performance calculations using SAW + Topsis which are immediately given a rating and score within a certain assessment period

Nama	Pekerjaan	Peringkat	Skor	Periode
Gagan	Staff	5	0.621	20184
Gagan	Staff	9	0.467	20183
Gagan	Staff	2	0.767	20182
Gagan	Staff	3	0.733	20181
Gagan	Staff	5	0.611	20174
Gagan	Staff	10	0.382	20173
Gagan	Staff	8	0.536	20172
Gagan	Staff	10	0.4	20171

Figure 3 Display employee rankings for each period

In Figure 3 the system can also display the assessment history of one employee in all assessment periods, so that employees can use it to see their own performance from the previous period.

Conclusion

The performance appraisal decision support system using SAW and TOPSIS can display employee performance ratings making it easier for the company to process the ranking of employees more accurately based on predetermined criteria. In addition to the company, employees can see their performance every period so they can know their own potential. The company can also see the employee assessment history from the previous period to see the company's performance from year to year based on the performance of its employees.

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