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Performance Comparison of AHP and Saw Methods For Selection of Doc Broiler Chicken Suppliers

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Abstract— Choosing the most suitable day-old chick (DOC) broiler chicken supplier is currently one of the most important issues that must be addressed. This is because selecting the most suitable supplier can reduce the amount spent on purchases and the risk of sick chickens being delivered by the supplier. Another problem related to supplier selection that has been happening so far is the quality of products that are not following company standards or rejected products. The number of products provided does not match what was ordered by the company. The decision support system (DSS) can evaluate and select suppliers using multi-criteria characteristics related to the solutions offered based on parameters quality, price, delivery, supplier certificates, and death claims after the chickens have been delivered. The Analytical Hierarchy Process (AHP) and the Simple Additive Weighting (SAW) methods are used in this study as a comparison to produce the best-recommended accuracy value to get the best decision results based on ranking. The test results state that the AHP and SAW methods go well. The test was carried out using a dataset of the last ten months of history of purchasing docs broiler chicken from suppliers. The comparison of the results of the F1-score value between the AHP and SAW methods is 94% and 87%, respectively. The results state that the AHP method is superior as a system recommendation that can produce the best alternative supplier.
Keywords—DSS; AHP; SAW; Comparation Method; Performance Algorithm; Recommendation Alternatif

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I. INTRODUCTION

Technology in this era can be said to have developed very rapidly. In addition to the hardware and software subfields, there are also subfields within the area of computing that deal with methodologies, and all of these subfields are undergoing significant development at the moment. Decision support systems (DSS) are included in one of the developing computing methods. Decision support systems are a branch of decision support systems science that lies between intelligent systems and information systems [1]–[3]. This prompted the author to create a decision support system to assist companies in selecting broiler chicken suppliers. A decision support system can be described as supporting data analysis and modeling, guiding decisions, guiding future planning, and being used at unusual times [4]–[6] .

The dataset used in this study is from PT. Andalan Yasa Mitra is a company engaged in broiler chicken farming partnerships. In carrying out its production operations, the company obtains supplies of broiler chicken docs from suppliers. The growth point of chicken broiler reached its maximum when the 21 day old chicken was indicated by an optimal point and followed by slowing growth [7]. The problem that is quite important at this time is choosing the right broiler doc supplier because selecting the right supplier can reduce purchasing costs and reduce the possibility of sick chickens after being sent by the supplier. Another problem related to supplier selection that has been happening so far is the quality of products that are not following company standards or rejected products. The number of products provided does not match what was ordered by the company. While the interest of breeders is getting higher after knowing that broiler chickens can be sold before the age of seven weeks because at that age their body weight is almost the same as the body of an adult free-range chicken [8][9].

Meanwhile, the company feels that the process running so far in selecting suppliers is less effective, considering that the process is carried out almost daily. The selection and evaluation system for suppliers from currently used companies only emphasizes the aspect of cost criteria and other values that are only subjective. By only looking at the cost value, this evaluation system has no objective nature. It does not benefit the company, while the criteria that do not affect the assessment of suppliers can be used to assess the performance of suppliers.

Previous research for DSS for the selection of broiler doc suppliers using the AHP method with a tabulation test value of 20 respondents resulted in very high-reliability and moderate validity criteria. The dataset used was from CV. Berkah Jaya Abadi with criteria for chick quality, delivery, and company certification [10]. Another study using the AHP and WP methods obtained the four highest vector values from the choices, The dataset from PT. Sentral Unggas Perkasa criteria are based on CV, cage location, capital, and service [11]. Other research on decision-

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making for the selection of scholarship recipients at open universities uses the VIKOR method in determining the ranking for each alternative and the AHP method for weighting criteria, with each given weight producing the same ranking so that it can be used as a compromise solution in dealing with multi-criteria problems, The dataset used from Open University Educational Institution with the criteria of academic potential, achievement, economic ability, commitment, order of school quality, school representation and representation of regional origin [12]. The using of VIKOR method by other studied used for help breeders/enclosure technicians in determining the selection of the Best KUB Chicken Parent, while to determine the weighting using the Fuzzy Method [13]. Another study using the AHP, SMART, and TOPSIS methods for the selection of superior cattle breeds resulted in the same alternative recommendations even though they had different algorithms and working methods from the three methods with 80% priority determination accuracy, prospective cattle breeder dataset with cow health criteria, no defects physical appearance in cows, healthy reproductive organs, age, height, body size, and breast size of cows [14]. Another research that became the author's reference in making this system was using the AHP method to determine the strategy of development, The dataset used from duck breeders and cultivator groups with criteria for distance to the market, hatchery location, distance from settlements, availability of labor, availability of feed, hatchery technology, and ducks [15]. The last research that became author’s reference is to determine the best quality broiler chicks based on a decision support system using the MOORA method, The MOORA method in this decision support system plays a role in generating the value of broiler chicks in accordance with the required criteria [16]. Based on previous research that has not yet used two methods in determining the results of selecting the best supplier based on ranking. Therefore, this research will use the AHP and SAW methods to get the highest accuracy value in the use of these two methods for the selection of broiler doc suppliers according to the parameters used and slightly different from previous studies. That is, grade, price, delivery, certificate, and death claim.

The aim of this paper aims to compare the performance of the AHP and SAW methods in determining the best alternative supplier of broiler chicken docs. Comparison of methods using AHP and SAW based on parameters of price, grade, delivery, supplier certification, and death claims when day-old chick (DOC) is sent to the farmer's pen. The parameters used are based on literature studies on the results of previous studies and the results of interviews by expert judgment. The AHP and SAW methods were chosen based on literature studies on previous research, where this research focuses on assessing the best alternative. The AHP method is a method for describing complex multi-factor or multi-criteria problems into a hierarchy [17][18][19], while the SAW method has the advantage of finding the weight of the total performance score of each alternative on all attributes [20][21]. The urgency of researchers using

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these two methods is to find the best-recommended accuracy value to get the best decision results based on ranking the best alternative suppliers. The results of this study can provide convenience for the company's management to select the best supplier of doc broiler chicken following company standards.

II. RESEARCH METHOD

Generally, the system is a network related to the linkages between procedures and existing parts, united in an organization to carry out an activity to achieve the same goal [20]. While specifically, the system specification is a group of elements that interact or are interrelated between one component and another so that it affects the carrying out activities together that aim to achieve a specific goal [22].

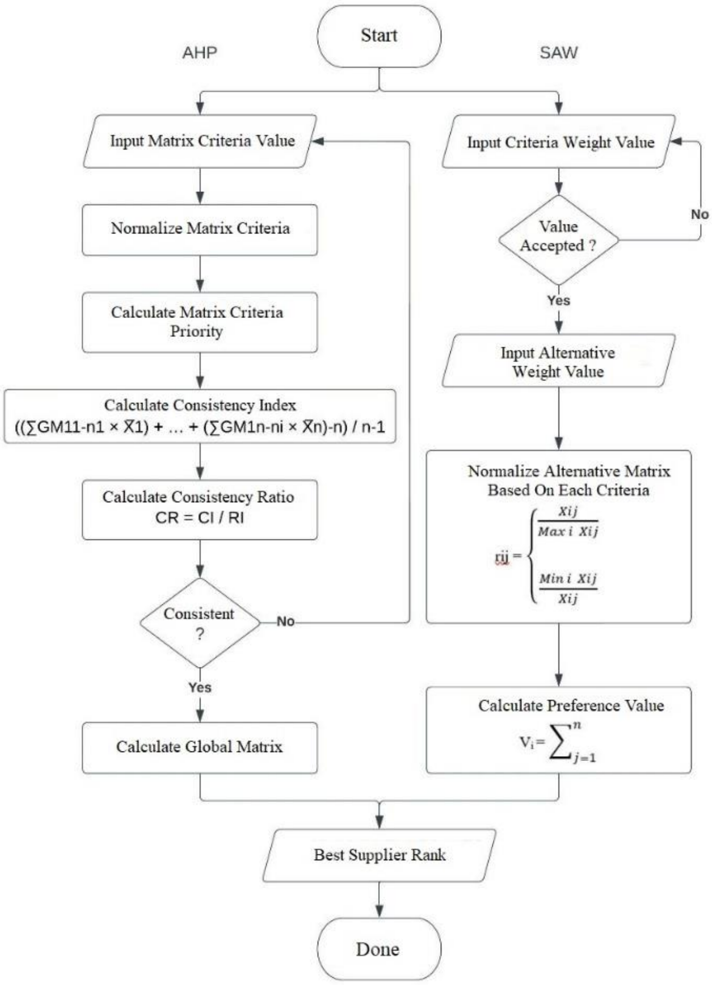

Figure 1. COMPARISON FLOWCHART OF THE PROPOSED AHP AND SAW METHOD

The data needed in this research is taken from the recap of the purchase history data that has been done by the company lately, and for calculating the weight of the criteria directly given by

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the user based on the recap of the purchase data to the supplier. The experimental procedure of the proposed method refers to in Figure 1.

The system analysis and design stage in this study is approached by the System Development Life Cycle (SDLC) software development paradigm [23][24]. PHP is the name of the programming language that was utilized in the creation of this system. The acronym PHP stands for hypertext pre-processor and refers to a type of interpreter language comparable to C and Perl and a type of computer language that enables rapid development of webpages [25]. In addition, this system's architecture uses the Unified Modeling Language (UML), a visual/graphical language that may be used to visualize, define, construct, and document object-oriented software development systems [26]. MySql was chosen to serve as the database for this particular system. MySQL is a database that operates as a server and does not place the database on the same machine as the application used to place a database on a specific device and provide remote computer access to that database [27].

The data used in this study are primary and secondary, that is, the history of purchasing broiler chicken docs from suppliers carried out by previous companies, which will later be used as alternatives. While the doc grade of broiler chickens (C1), broiler chicken doc price (C2), broiler chicken doc delivery time (C3), company certificate from the supplier (C4), and claim the death of broiler doc after being sent to the farmer's cage (C5) used as criteria.

1. *Analytical Hierarchy Process* (AHP)

The Analytical Hierarchy Process (AHP) method is a strategy that seeks to enhance the decision-making process by determining the optimal choice that can be taken from a number of alternatives that are available[17][18][19]. The AHP is a way of solving problems that involve multiple factors and/or criteria by describing them in the form of a hierarchy. Hierarchy is defined as the representation of complex issues in a multi-level structure. The first level is the goal, followed by the level of factors, criteria, sub-criteria, etc. The hierarchy represents complex issues in a multi-level structure, where the first level is the goal. A difficult issue can be simplified by segmenting it into groups, which can then be arranged in a hierarchical fashion to give the impression that the issue is more ordered and methodical. This is made possible through the use of a hierarchy[17][18][19]. In applying the AHP, problem-solving is guided by three primary principles: decomposition, comparative judgment, and logical consistency. The following steps are included in the AHP technique [17][18][19]:

- Problem decomposition.
- Rating weight.

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- The production of the matrix and a test of its consistency.
- Establishing priorities inside each of the hierarchies.
- A compilation of the synthesis of priorities.
- Decision-making.

2. *Simple Additive Weighting* (SAW)

In addition to its more common name, the weighted addition method is another name for the SAW method. Finding the total weighted performance score for each alternative based on its respective features is the fundamental idea behind the SAW approach [28][29] [19]. The SAW method necessitates the process of normalizing the decision matrix to a scale that allows for comparisons with all of the currently available alternatives [28][29][19]. The following are the SAW steps to use as a solution:

- Determine the alternative options and criteria.
- Provide the rating value.
- Establishing the relative importance of each preference weight.
- Make a table for ranking the matches.
- Create a decision matrix (X) using the appropriateness rating table for each choice that corresponds to each criterion. It is possible to write the value of X for each possible alternative (A_i) in terms of each criterion (C_j) that has been established as an equation (1), where I can range from 1 to m and j can range from 1 to n.

$$X = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1j} \\ \vdots & & & \vdots \\ X_{i1} & X_{i2} & \cdots & X_{ij} \end{bmatrix} \tag{1}$$

- Calculating the value of the normalized performance rating (R_{ij}) from the alternative A_i based on the C_j criterion can be stated as an equation (2). This will normalize the choice matrix.

$$R_{ij} = \begin{cases} \dfrac{X_{ij}}{Max\ i\ X_i} & \text{, In the event that } j \text{ is a benefit attribute} \\ \\ \dfrac{Min\ i\ X_i}{X_{ij}} & \text{, In the event that } j \text{ is a cost attribute} \end{cases} \tag{2}$$

Where R_{ij} is the value of the normalized performance rating, X_i is the value of the attribute associated with each i criterion, $Max_i\ X_{ij}$ is the largest value associated with each i criterion.

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$Min_i\ X_{ij}$ is the smallest value associated with each benefit criterion is the result if the largest value is the best, and the cost is the result if the smallest value is the best.

- The outcomes of the normalized performance rating value, denoted by the r_{ij} variable, compose a normalized matrix denoted by the R variable, the equation (3) for which is as follows:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1j} \\ \vdots & & & \vdots \\ r_{i1} & r_{i2} & \cdots & r_{ij} \end{bmatrix} \quad (3)$$

- The final result of the preference value (V_i) is obtained from the sum of the normalized matrix row elements (R) with the preference weights (W) corresponding to the matrix column elements (W). It can be written by equation (4):
- The final result of the preference value in the V_i variable is achieved by adding the preference weights in the W variable, corresponding to each of the matrix column elements to the normalized matrix row elements in the R variable. This results in the final preference value can be expressed mathematically as equation (4):

$$V_i = \sum_{j=1}^{n} \binom{n}{k} W_j\ R_{ij} \quad (4)$$

Where the higher V_i value suggests that alternative A_i is the one that should be chosen, where V_i is the ranking for each alternative, W_j is the weighted value of each criterion, and R_{ij} is the normalized performance rating value.

III. RESULT AND DISCUSSION

In addition, the AHP and SAW methods are distinguished from each other by comparing the accuracy of the calculation results produced by each approach with real data related to the business concerned. The results of the comparison of the AHP and SAW methods will each be tested on a dataset of the last ten months of history of purchasing docs broiler chicken from suppliers. Calculating the AHP and SAW values allows one to identify the best provider. When applying the AHP technique, the link between objectives, criteria, sub-criteria, and options is depicted as a hierarchical structure in Figure 2.

The consolidation of the hierarchical structure, the further steps consist of establishing the values and standards for the various options, validating the consistency of the ratio matrix comparison, and defining the relative importance of the various criteria. The following is a rundown of how the computations turned out while utilizing the AHP method:

Step 1: Determine the criteria and possible solutions to identified problems. The identifying problem in this study is determining the best supplier.

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Step 2: Construct a hierarchical structure with the intent of grouping criteria in conjunction with sub-criteria, as demonstrated in Figure 2.

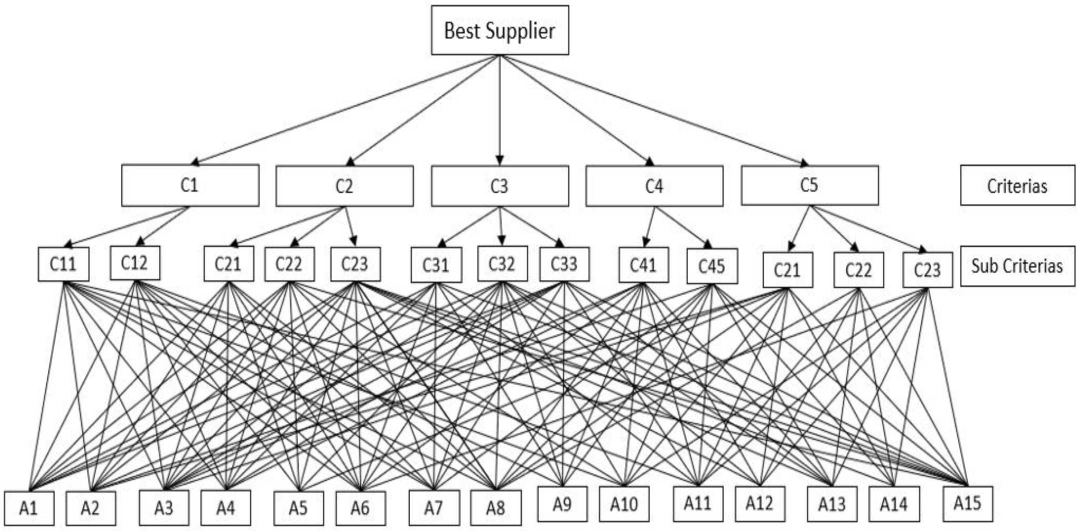

Figure 2. ORGANIZING IN A HIERARCHICAL STRUCTURE

Step 3: Make a paired matrix of each criterias and alternatives values on each criterias. The weight of each criterias is based on filling in the data carried out by company management (expert Judgement). The following is the result of the comparison between criteria in Figure 3:

Criteria Comparison Matrix

	C1	C2	C3	C4	C5
C1	1	1	3	3	1.5
C2	1	1	3	3	1.5
C3	0.3333	0.3333	1	1	0.5
C4	0.3333	0.3333	1	1	0.5
C5	0.6667	0.6667	2	2	1
Total	3.3333	3.3333	10	10	5

Figure 3. IMAGE OF PAIRED CRITERIA MATRIX

Step 4: Calculating normalized eigenvectors. The Calculate the normalized eigenvectors, it is necessary to multiply the rows and columns in the following matrix to calculate the normalized eigenvectors on the criteria in Figure 4. After knowing the matrix multiplication results, the results form a matrix by adding up each row with the results and then looking for the PVN value by dividing all the amounts in the matrix multiplication calculation and then dividing by the amount of data obtained based on the equation (5).

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$$PVN = \frac{Total\ Rows}{Amount\ of\ data} \qquad (5)$$

Criteria Priority Matrix

	C1	C2	C3	C4	C5	Priority	CM
C1	0.3	0.3	0.3	0.3	0.3	0.3	5
C2	0.3	0.3	0.3	0.3	0.3	0.3	5
C3	0.1	0.1	0.1	0.1	0.1	0.1	5
C4	0.1	0.1	0.1	0.1	0.1	0.1	5
C5	0.2	0.2	0.2	0.2	0.2	0.2	5

Consistency Index: 0
Ratio Index: 1.12
Consistency Ratio: 0 (Consistent)

Figure 4. Criteria Priority Matrix

Step 5: Perform the necessary calculations to determine the ratio's value. The Consistency Ratio is utilized to determine the level of consistency of the comparison criterion evaluation by carrying out the following procedures:

a. Determine the maximal eigenvalue (*λmaks*). This greatest eigenvalue can be found by multiplying the sum of each row in the pairwise comparison matrix by the vector that has been normalized.

   $\lambda maks = (0.3 \times 3.333) + (0.3 \times 3.333) + (0.1 \times 10) + (0.1 \times 10) + (0.2 \times 5) = 5$

b. The consistency index (*CI*) should be calculated, where *n* refers to the total number of criteria.

   $CI = (\lambda maks - n) / (n – 1) = (5 - 5) / (5 – 1)= 0$

c. Performing the calculation for the consistency ratio (*CR*). According to the table for the consistency index, the *IR* for the 5x5 matrix is 1.12. If *CR* is less than 0.1, the choice of weighting is considered to be consistent.

   $CR = CI / IR = 0 / 1.12 = 0$ (consistent)

Step 6: Determine Results. This stage is the last stage that calculates the ranking of the best students based on the normalized eigenvector of the values of all alternatives. The results are obtained from each row multiplied by the column on the PVN value to produce the final result value as in Figure 5. The calculations using the SAW method. In the first step, it is necessary to establish the criteria that will serve as a guide for making decisions. These criteria include the attribute initial grade criteria C1, the pricing attribute C2, the delivery criterion C3, the certificate criteria C4, and the claim death criteria C5. The next step is assessing the criterion's value for each possibility, which brings us to the second phase. Carry out the normalization of the matrix

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according to the attribute type. It is possible to compute it by using equation (2). Figure 6 displays the results of the calculations.

$$C1 = \frac{Xi1}{Max\ X1\ x\ Xi1}; C2 = \frac{Xi2}{Min\ X2\ x\ Xi2}; C3 = \frac{Xi3}{Max\ X2\ x\ Xi3}; C4 = \frac{Xi4}{Max\ X4\ x\ Xi4}; C5 = \frac{Xi5}{Max\ X5\ x\ Xi5}$$

Ranking

Rank	Code	Name	Total
1	A01	ITB	0.1084
2	A02	Star Breeder	0.1053
3	A05	Wonokoyo	0.1053
4	A07	Kencana Jaya	0.1053
5	A09	Putra Perkasa Farm	0.1053
6	A03	Tabassam	0.0998
7	A04	WMU	0.0998
8	A10	Firmala Mandiri	0.0998
9	A06	Kembar Makmur	0.0898
10	A08	Berdikari Putra Abadi	0.0812

Print

Figure 5. AHP METHOD RANKING RESULTS

Normalization Matrix

Name	C1	C2	C3	C4	C5
ITB	1	1	1	1	1
Star Breeder	1	1	0.75	1	1
Tabassam	1	1	0.75	1	0.75
WMU	1	1	0.75	1	0.75
Wonokoyo	1	1	0.75	1	1
Kembar Makmur	0.75	0.6667	1	1	1
Kencana Jaya	1	1	0.75	1	1
Berdikari Putra Abadi	0.75	0.6667	0.75	1	0.75
Putra Perkasa Farm	1	1	0.75	1	1
Firmala Mandiri	1	1	0.75	1	0.75

Figure 6. THE NORMALIZATION MATRIX

The calculation of the final result is the sum of the results of the normalization matrix using the weighted criterion based on equation (4). This is done to select the value with the highest absolute magnitude as the optimal response in Figure 7.

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Ranking

Rank	Name	Total
1	ITB	1
2	Star Breeder	0.975
3	Wonokoyo	0.975
4	Kencana Jaya	0.975
5	Putra Perkasa Farm	0.975
6	Tabassam	0.925
7	WMU	0.925
8	Firmala Mandiri	0.925
9	Kembar Makmur	0.825
10	Berdikari Putra Abadi	0.75

Figure 7. SAW METHOD CALCULATION RESULTS

Tests carried out to obtain the accuracy value are using the confusion matrix. In this test, using data from 9 different months, the data is said to be appropriate if the results of the recommendations from the system and the actual data in the field are the same. Table 2 explains the results obtained using the AHP Confusion Matrix. In light of the experiment's findings, the calculation of the AHP data testing looks like what is presented in Table 1.

Table 1. THE AHP DATA TESTING

Test Data	Prediction Data	Actual Data	Explanation
January	ITB	ITB	True Positive
February	WMU	WMU	True Positive
March	Star Breeder	ITB	False Negative
April	ITB	ITB	True Positive
May	Star Breeder	Star Breeder	True Positive
June	WMU	WMU	True Positive
July	WMU	WMU	True Positive
August	ITB	ITB	True Positive
September	ITB	ITB	True Positive

Table 2. THE AHP CONFUSION MATRIX

X		**Actual Value**	
		TRUE	FALSE
Prediction Value	POSITIVE	8	0
	NEGATIVE	0	1

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}$$
$$= \frac{8+0}{8+0+0+1} = \frac{8}{9} = 0.89$$
$$= 0.89 \text{ x } 100\% = 89\ \%$$

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Table 2 explains the results obtained using the SAW Confusion Matrix. In light of the experiment's findings, the SAW data testing calculation looks like what is presented in Table 3.

Table 3. The SAW Data Testing

Test Data	Prediction Data	Actual Data	Explanation
January	ITB	ITB	True Positive
February	Tabassam	WMU	False Negative
March	Star Breeder	ITB	False Negative
April	ITB	ITB	True Positive
May	Star Breeder	Star Breeder	True Positive
June	WMU	WMU	True Positive
July	WMU	WMU	True Positive
August	ITB	ITB	True Positive
September	ITB	ITB	True Positive

Table 4. The SAW Confusion Matrix

X		Actual Value	
		TRUE	FALSE
Prediction Value	POSITIVE	7	0
	NEGATIVE	0	2

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}$$
$$= \frac{7+0}{7+0+0+2} = \frac{7}{9} = 0.78$$
$$= 0.78 \times 100\% = 78\ \%$$

IV. CONCLUSION

The findings of this study indicate that the AHP method is superior to the SAW method as a DSS in selecting the best alternative supplier. The performance of the AHP and SAW methods for F1-score, accuracy, precision, and recall, are 94%, 89%, 100%, and 89%, respectively. While the SAW method is 87%, 78%, 100%, and 78%, respectively. The results of this study can be used by company management to find several alternative decisions through a comparison of methods with a superior F1 score. Further research can be developed using other factors or parameters as alternatives to produce the best decisions. In addition, alternative decisions can be developed that focus more on supplier data by providing options for sending documents online using the AI machine learning method.

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