Application of Analytic Hierarchy Process (AHP) and Simple Additive Weighting (SAW) Methods In Singer Selection Process

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***Abstract* – The position of a singer in a band is often important because it will interact directly with the audience. In an organization found a related problem about the selection of the best singers so there needs to be a decision support mechanism to be able to find a best singer. This problem can be solved by combining two decision support methods namely Analytic Hierarchy Process (AHP) for the weighting process of some criteria and Simple Additive Weighting (SAW) for value processing of participants. Based on the experimental results, the criteria used for the consistency weightedness priority level analysis found consistent results that were sufficient to determine the best performers based on all available alternatives. So that alternative ranking results can be used as a basic guideline to help decision making.**

Keywords – Multi criterion decision making (MCDM), Analytic Hierarchy Process (AHP), Simple Additive Weighting (SAW).

I. INTRODUCTION

The vowel is literally the voice in the spoken language where the vocal cords will open. In the composition of the band, the vocalist or so-called singer is a person (male or female) who sings the tone with the sound issued by the mouth [1]. The singer's position in the band also becomes important, as this is the vocalist who takes the role of interacting with the audience in live art performances.

Based on preliminary observations, there is a problem for a decision making in the process of selecting the best singer from an organization engaged in music that is, there is no clear assessment mechanism in the assessment process. Selection of personnel who previously only determined the aspects assessed in the selection process, but did not have a clear assessment mechanism. The assessment team only gave notes of comments from the participants' performances at the time of selection and deliberation to get the best choice. This has an impact on the time it takes to decide a decision. Because the problem is often the result of selection is not in accordance with the expected and more harmful again is doing re-selection.

Based on the problems described in the previous paragraph, there are several methods that can be used and combined in solving the problem, one of which is the decision making method that is Multi Criteria Decision Making (MCDM) using Analytic Hierarchy Process (AHP) and Simple Additive Weighting (SAW). AHP is used as a weighting counter for each criterion. While SAW is used as a ranking process. It is hoped that combining the two methods can help the assessment team make decisions in the selection of personnel according to the criteria.

II. RELATED THEORY

A. Multi Criteria Decision Making

Multi Criteria Decision Making was developed to facilitate the decision-making process [2]. The use of the MCDM method is proposed for decision making in singer selection, since decision support theory has become a useful tool and because many problems can be modeled as a MCDM problem [3].

MCDM is divided into two, namely Multi Atribute Decision Making and Multi Objective Decision Making. MCDM and MADM are commonly used to assess or select several alternatives in limited quantities [4].

Decision support play a role in providing support for considerations established by managers, not as a substitute for the function of managers in making decisions. With the decision of the support system manager can improve the efficiency of decision-making.

B. Analytic Hierarchy Process (AHP)

Research written by Ling Yu is said that the use of AHP method can provide optimal value, calculation formula and statistical data of each index, and even in the processing of qualitative index, also provide quantitative transformation method, sequentially to realize index evaluation of scientific, fairness and maneuver [5].

Analytical Hierarchy Process is a decision support model developed by Thomas L. Saaty of the University of Pittsburg [6]. AHP is the method for making the best decision when the decision maker has many criteria [7]. Stages in the Analytical Hierarchy Process method are as follows [8]:

1. Determine the problem then set the solution and compile the hierarchy of problems encountered;

2. Define the criteria weight by comparing in pairs each criterion. This comparing process uses the priority scheme described in Table 1 [9].

Table 1. Table of priority scheme

Intensity of Interest	Information	Description
1	Both elements are just as important	Two elements have the same effect on a goal
3	One element is slightly more important than the other	Experience and judgment support a little more than other elements
5	One element is more important than the other	Experience and judgment are very strong in favor of one element over the other
7	One element is clearly more important than any other element	One of the strongest elements is preserved and dominant in practice
9	One of the most important elements of the other elements	An evidence favor a task in relation to another with the highest degree of reliability
2,4,6,8	Values between two adjacent consideration values	This value is given when there are two compromises between two options
Inverse	If for activity "i" gets one number over activity "j", then "j" has its opposite value than "i"	

3. Perform normalization on a pairwise comparison matrix by summing the value of each matched pair matrix column then dividing each value from the column with the sum of the corresponding columns to obtain the normalization of the matrix.

$$\overline{a}_{jk} = \frac{a_{jk}}{\sum_{l=1}^{m} a_{lk}} \quad (1)$$

4. Calculates the weight of synthesis by summing each column in the same row from the comparison normalization result of the matrix.

$$\sum \textbf{column} = \textbf{k1} + \textbf{k2} + \textbf{k3} + \cdots + \textbf{kn} \quad (2)$$

5. Calculates the eigenvalues by multiplying each of the matched matrix columns in the same row, then being lifted by an existing criterion number.

$$\boldsymbol{\lambda_1 = (k1 \times k2 \times k3 \times \ldots \times kn)^{\frac{1}{n}}} \quad (3)$$

6. Calculates the priority weight of each criterion by means of the eigenvalues for each criterion divided by the total number of eigenvalues.
7. Calculates the importance of each criterion by dividing the weight of synthesis by priority weight.
8. Calculate the maximum eigen value (λmax) by dividing the total number of importance values by the number of criteria.
9. Measures the consistency of use to ensure that judgment for decision making is of high consistency.

$$\mathbf{CI} = \frac{(\lambda\, maks - n)}{n} \quad (4)$$

Where :

CI = *Consistency Index*
λmaks = Maximum eigenvalue
n = Number of elements

10. Checking for consistency in the hierarchy provided that if the consistency ratio (CI / IR) is less than or equal to 0.1 then the result of the calculation is declared true [10]. IR values can be seen in Table 2.

$$\mathbf{CR} = \frac{CI}{IR} \quad (5)$$

Where :

CR = *Consistency Ratio*
CI = *Consistency Index*
IR = *Index Random Consistency*

Table 2. Index Random Consistency

Matrix	1	2	3	4	5	6	7	8	9	10	11	12
IR	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48

C. Simple Additive Weighting (SAW)

The research written by Andri Pranolo and Siti Muslimah Widyastuti said that by using Simple Additive Weighting (SAW) method can help modeling intelligent agents for monitoring the health of urban forest [11].

Simple Additive Weighting is one of the methods of Multi-Attribute Decision Making (MADM) [11]. This method is also often known as the weighted summing method [12]. The total score for an alternative is obtained by summing up the results of the multiplication between the rating and the weight of each attribute [13]. The SAW method requires a process of normalizing the decision matrix (X) to a comparable with all existing alternative ratings.

The stages in using the SAW method are as follows:

1. The normalization of the matrix is adjusted to the type of attribute so that a normalized matrix will be obtained [14]. The calculation of matrix normalization is shown in Equation (6).

$$r_{ij} = \frac{x_{ij}}{\max_i x_{ij}} \quad (6)$$

Where :
r_{ij} = matrix is normalized [i][j];
X_{ij} = decision matrix [i][j];
For I = 1, 2, 3, …, m;
For j = 1, 2, 3, …, n;
max_i = The highest value of each matrix column.

2. Calculating the last alternative value, can be found using equation (7).

$$V_i = \sum_{j=1}^{n} w_i r_{ij} \quad (7)$$

Where :
V_i = the final value of the alternative;
w_i = weight value;
r_{ij} = normalized values;
n = number of criteria

3. Conduct descending rankings based on the preference value of each alternative, which will be the best result of the assessment.

D. Combined Method of AHP and SAW

Merging of two methods can be done if one method serves as a weighting criterion value and the other method acts as an alternative ranking. In this case, the Analytical Hierarchy Process (AHP) method is used for criteria weighting process and Simple Additive Weighting (SAW) method is used for alternative data ranking process.

III. PROPOSED METHOD

A. Knowledge Base Management

Aims to provide knowledge and intelligence for decision making. This knowledge base requires information from an expert to determine criteria related to the research and perform an assessment. In the process of weighting each criterion using the AHP method requires a knowledge base that is the criteria and pairwise comparison of each criterion.

In this research, there are some related criteria that can help the implementation of this research. In table 3.

Table 3. List of Criteria

Criteria	Code
Hamming Ionian	K1
Vowel Intonation	K2
Mastery of Songs	K3
Improvisation	K4
Appearance	K5
Tone Error	K6
Breathy Voice	K7
Emotional	K8
Honorarium	K9

B. Model Management

The model management describes the flowchart and the modeling of the process algorithm. The flow diagram of the AHP-SAW work process as shown in Figure 1.

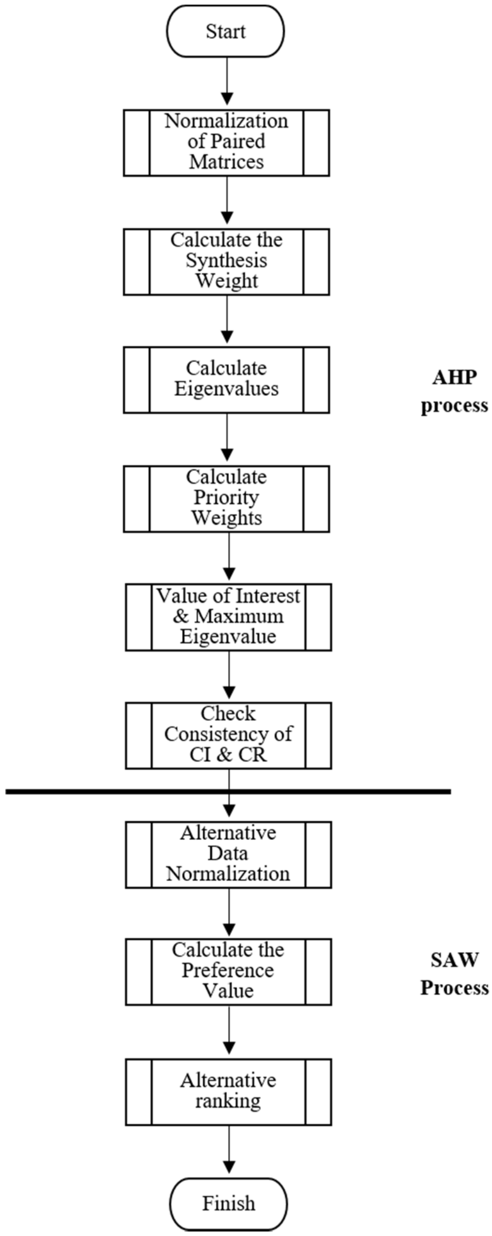

Fig. 1. AHP-SAW Calculation Process Flow Chart

IV. RESULT AND DISCUSSION

In this result and discussion will be explained the results of the application of a combination of both AHP and SAW methods in a case to help the decision process of the best singers.

A. AHP Weighted Calculation

The paired matrix normalization is to add each column of criteria to pairwise matrix matrices to then divide each of the matrix comparison matrix values by the number of each of the criteria columns. Based on the pairwise comparison matrices shown in Table 4.

Table 4. Matched Comparison Matrices

Criteria	Matched Comparison Matrices								
	K1	K2	K3	K4	K5	K6	K7	K8	K9
K1	**1**	2	2	3	3	0.33	0.33	2	2
K2	0.5	**1**	3	3	3	2	3	2	2
K3	0.5	0.33	**1**	2	2	1	1	2	3
K4	0.33	0.33	0.5	**1**	3	0.33	0.33	1	2
K5	0.33	0.33	0.5	0.33	**1**	0.33	0.33	2	2
K6	3	0.5	1	3	3	**1**	3	2	3
K7	3	0.33	1	3	3	0.33	**1**	2	2
K8	0.5	0.5	0.5	1	0.5	0.5	0.5	**1**	2
K9	0.5	0.5	0.33	0.5	0.5	0.33	0.5	0.5	**1**

An example of the process of calculating the normalization of pairwise matrix comparison based on equation (1) is as follows:

$$X_{1,1} = \frac{1}{1+0,5+0,5+0,33+0,33+3+3+0,5+0,5} = 0.103$$

$$X_{2,1} = \frac{0,5}{1+0,5+0,5+0,33+0,33+3+3+0,5+0,5} = 0.052$$

The above calculation example yields a value of the normalized result for the first column of the pairwise comparison matrix. The result values of the matched pairwise matrix of the first and second columns are shown in Table 5.

Table 5. List of Normalized Matrix Couples

Criteria	Normalization of Pairwise Comparison Matrices					
	K1	K2	K3	K4	K…	K9
K1	**0.103**	0.343	0.208	0.16	…	0.105
K2	**0.052**	0.171	0.305	0.178	…	0.105
K3	0.052	0.057	0.102	0.119	…	0.158
K4	0.034	0.057	0.051	0.059	…	0.105
K…	…	…	…	…	…	…
K9	0.052	0.086	0.034	0.030	…	0.053

The process of calculating the synthetic weight value is a continuation of the normalization process of pairwise comparison matrices. The synthesis weight is derived from the vertical addition of each row of the normalized pairwise matrix result according to equation (2).

- ✓ Value of synthesis / addition of criterion 1:
$$0.103 + 0.343 + 0.208 + 0.16 + 0.15 + 0.054 + 0.033 + 0.138 + 0.105 = \mathbf{1.295}$$
- ✓ Value of synthesis / addition of criterion 2:
$$0.052 + 0.171 + 0.305 + 0.178 + 0.158 + 0.324 + 0.333 + 0.138 + 0.105 = \mathbf{1.732}$$

The result of the complete synthetic weight value calculation is shown in Table 6.

Table 6. Value of Weight Synthesis

Criteria	Weight Synthesis
K1	1.295
K2	1.732
K3	0.993
K4	0.621
K…	…
K9	0.419

The process of calculating the eigenvalues begins by multiplying the matched matrix in pairs in a row. The result of matrix of pairwise ratio is then raised by 1/number of existing criteria according to equation (3) Example of eigen value calculation process is as follows:

- ✓ Eigenvalues criteria 1 :
$$\lambda_1 = (1 \times 2 \times 2 \times 3 \times 3 \times 0,333 \times 0,333 \times 2 \times 2)^{\frac{1}{9}} = 1.361$$
- ✓ Eigenvalues criteria 2 :
$$\lambda_2 = (0,5 \times 1 \times 3 \times 3 \times 3 \times 2 \times 3 \times 2 \times 2)^{\frac{1}{9}} = 1.901$$

The calculation result in this process is the eigen value of the criteria shown in Table 7. The result of calculating the total eigenvalues is summed. The total sum of the eigenvalues is used to calculate the priority weight value.

Table 7. Eigenvalues

Criteria	Eigenvalues
K1	1.361
K2	1.901
K3	1.260
K4	0.663
K…	…
K9	0.493

The eigenvalues are used to calculate the priority weight value. The calculation of the priority weight score is performed on each criterion by dividing the eigenvalues of each criterion by the total eigenvalues. The priority weighted values obtained from these calculations will then be used to calculate the preference at the SAW stage.

An example of a priority weighted value calculation based on the eigenvalues in Table 7 is as follows:

- ✓ Priority criteria weighted value 1 :
$$\mathrm{BP}_1 = \frac{1.361}{10.085} = 0.135$$
- ✓ Priority criteria weighted value 2 :
$$\mathrm{BP}_2 = \frac{1.901}{10.085} = 0.188$$

In Table 8 is the result of the priority weight value of each criterion used on the system.

Table 8. Priority Weight Value

Criteria	Priority Weight
K1	0.135
K2	0.188
K3	0.125
K4	0.066
K…	…
K9	0.049

Next calculate the importance value of each criterion to obtain maximum eigen value. The value of interest gained from this process is used to obtain the consistency value of CI and CR. The process of calculating the value of interest is as follows:

✓ Value of importance criterion 1:

$$\lambda_1 = 1.295/0.135 = 9.602$$

✓ Value of importance criterion 2:

$$\lambda_2 = 1.901/0.188 = 9.092$$

The results of the full maximum eigenvalue calculation are shown in Table 9.

Table 9. Value of Interest

Criteria	Value of Interest
K1	9.602
K2	9.093
K3	8.682
K4	9.627
K…	…
K9	8.482
Total	**81.142**
λ_{max}	**9.016**

The maximum eigen value obtained from the previous calculation step is used in the first process to check the consistency value of calculating the CI value. Then proceed the last calculation process to check the consistency value that is calculate CR value.

The first counting process that calculates the value of CI using equation (4) is as follows:

$$\begin{aligned} CI &= (\lambda \max - n)/(n-1) \\ &= (9.016 - 9)/(9-1) \\ &= 0{,}002 \end{aligned}$$

The last process on the application of the AHP method is to calculate the CR value by using equation (5). The IR value used in this process is obtained from the Index Random Consistency Table. By looking at the number of criteria that there are 9 criteria, the IR value used is 1.46. The process of calculating CR value is as follows:

$$\begin{aligned} CR &= CI/IR \\ &= 0{,}002/1.46 \\ &= 0.001 \end{aligned}$$

B. Calculation of Alternative Values

From the calculation process that has been done, obtained CR value of 0.001 or less than 0.1. From these results can be concluded that the pairwise comparison value used consistently and can be used in the process of choosing the best singer. Each data contained in the alternative data is normalized using Eq. (6).

✓ Normalization value Row-1 Column-1:

$$X_{1,1} = 7/9 = 0.78$$

✓ Normalization value Row-2 Column-1:

$$X_{2,1} = 5/9 = 0.56$$

The normalization process continues until all the values in the alternative data are normalized and produce the singer normalized matrix value as shown in Table 10.

Table 10. Alternative Data Normalization Value

Participants	Normalized Value					
	K1	**K2**	**K3**	**K4**	**K…**	**K9**
P1	0.78	1.00	1.00	1.00	…	0.67
P2	0.56	0.88	0.57	0.78	…	0.80
P3	0.67	0.75	1.00	1.00	…	0.57
P4	0.44	0.50	0.71	0.44	…	0.80
P…	…	…	…	…	…	…
P13	1.00	1.00	0.86	0.78	…	0.80

The process of calculating preferences uses Eq. (7). Calculation of singer preference value based on value of priority weight and normalized matrix value. Example calculation of singer preference "P1" is as follows:

✓ Preference value Row-1 Column-1 :

$$P_{1,1} = 0.78 \times 0.135 = 0.105$$

✓ Preference value Row-1 Column-2 :

$$P_{1,2} = 1 \times 0.189 = 0.188$$

After obtaining the value of AHP interest and the value of normalization for each criterion, the next step is to sum the results of the multiplication.

✓ Altenative value 1 :

$$\begin{aligned} P_1 = {} & 0.105 + 0.188 + 0.125 + 0.066 + 0.038 + 0.183 \\ & + 0.65 + 0.051 + 0.033 = 0.853 \end{aligned}$$

The process continues over and over until all participants get the preference value as shown in Table 11.

Table 11. Total Preference Value

Participants	Total Preferences
P1	0.853
P2	0.695
P3	0.700
P4	0.703
P…	…
P13	0.925

C. *Calculation of Accuracy*

Table 12. Comparison of Test Results

AHP & SAW		Expert team	
Participants	**Ranking**	**Participants**	**Ranking**
P13	1	P13	1
P1	2	P7	2
P7	3	P1	3
P12	4	P12	4
P…	…	P…	…
P6	13	P6	13

Based on the results of the test in Table 12, it can be calculated to find the level of accuracy. The accuracy level is obtained from the comparison of true test data and the amount of test data. Accuracy rate calculation results are as follows:

$$accuracy = \frac{11}{13} \times 100\% = 84.61\%$$

Limitations of the methods used to be accuracy factor can not reach 100%. In the calculation can not add assessments to participants who have been assessed if after assessment done addition of assessment factors by the expert team. Because the ranking results have an adjacent end value.

V. CONCLUSION

The results of this paper are suggested using the combined AHP and SAW methods to maximize the decision support process of the best singer selection. The criteria used to analyze the consistency level of priority weights have consistent results that are sufficient to determine the best singers based on all available alternatives. Based on the results of the measurement of the accuracy of the use of methods and the choice of expert teams obtained good results with a percentage of accuracy of 84.61%. When compared to previous research, the combination of AHP and SAW methods can improve the accuracy of alternative ranking results and can serve as a basic guideline for assisting decision making.

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