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Comparison of Analytical Hierarchy Process and Simple Additive Weightingon the Selection of Outstanding Employees

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ABSTRACT : *The selection of outstanding employees is part of the company's efforts in managing human resources. This step becomes one of the determinants of the company's progress because it aims to motivate employees increasing dedication and performance to the company. Each elected employee is awarded according to company's ability. The selection is based on several criteria. Sometimes a company can't determine a decision support method that suits the needs because each method has its own way. This research was conducted to study and compare multi-criteria decision making (MCDM) method in the selection of outstanding employees. Those methods are Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) with calculation using several criteria, such as selling, attendance, guest service, product description, and appearance. Comparison is based on the mean value, deviation value and consistency of each method. It is expected that this research can be used as a references for companies in choosing a method for decision analysis.*

KEYWORDS *-Selection of outstanding employees, MCDM, AHP, SAW, comparison.*

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I. INTRODUCTION

The selection of outstanding employees is part of the company's efforts in managing human resources. This step becomes one of the determinants of the company's progress because it aims to motivate employees increasing dedication and performance to the company. That's why employee performance needs to be evaluated gradually. Individual employees are considered as well, such as organizational accomplishments, citizenship behavior, strengths and weaknesses, potential for future improvement, etc. Overall, employee evaluations are used by a company to rate employees and decide how they perform in their positions for the purposes of adjusting their salaries [1].

The selection of outstanding employees is based on several criteria. The selection process is a problem that involves many criteria assessed so that its completion requires a multi-criteria decision making (MCDM) method.MCDM methods have been applied in various areas. The development of MCDM methods as a discipline is closely related to advances in computer technology [2]. There have been many methods available for solving MCDM problems as reviewed by Hwang and Yoon [3].

The use of these methods has been proven in various studies including research conducted by Sousa Junior et, all [4]that used the preference ranking organization method for enrichment evaluation (Promethee) and elimination and choice expressing reality (Electre) methods to select highway trucks for a mining operation.YeniMelia[5]and T.K. Biswas[6]made an investment selection using Simple Additive Weighting (SAW) based on several criteria.

Various methods that can be used in decision making often make decision makers unable to determine methods that are appropriate to the problem at hand. Sometimes a company can't determine a decision support method that suits the needs because each method has its own way.There are several successful studies that show a description of the method of decision making through several indicators. Richard [7]made a study of the comparison between Analytical Hierarchy Process (AHP)danElectree methods while Agus [8] made the comparison of the SAW and Weighted Product (WP) methods. In this research was conducted to study and

compare multi-criteria decision making (MCDM) method in the selection of outstanding employees. Those methods are AHP and SAWwith calculation using several criteria, such as selling, attendance, guest service, product description and appearance. Comparison is based on the mean value, deviation value and consistency of each method. It is expected that this research can be used as a references for companies in choosing a method for decision analysis.

II. MATERIAL AND METHOD

This research used two methods in decision support systems namely AHP dan SAW. The AHP developed by Thomas Saaty[9]. It is one of the best-known and most widely used models for Multiple Attribute Decision Making (MADM) because this technique can create a formulation of problems according to hierarchies. AHP is powerful for determining priorities among different criteria. AHP is very suitable and flexible for determining decision for decision makers that are qualitative or quantitative. The strength of AHP is found on usability, an effortlessly reasonable system, disentangles a troublesome issue by separating it into littler steps thatdoes not require authentic information sets [10]. AHP method has emerged as a useful decision making technique for solving and analyzing the complex problems. Indeed, the AHP converts a complex problem to several simple problems and solve them [11].

In its application it is divided into several stages [9]:

Step 1 is composing a hierarchy based on the problem.

Step 2 is comparing for different criteria using their weight in pairwise comparison matrix. Matrix size is based on the number of criteria.Pairwise comparison matrix is arranged in the following 9 scales [9]. The decision maker uses the fundamental 1-9 scale to assess the priority score.

Table 1: Scale of Preference between Two Parameters in AHP

Scale	Degree of Preferences	Explanation
1	Equally	Two activities contribute equally to the objective
3	Moderately	Experience and judgment slightly to moderately favor one activity over another
5	Strongly	Experience and judgment slightly to strongly or essentially favor one activity over another
7	Very Strong	An activity is strongly favored over another and its dominance has shown in practice
9	Extremely	The evidence of favoring one activity over another is of the highest degree possible of an affirmation
2,4,6,8		Used to represent compromises between the preferences in weights 1, 3, 5, 7 and 9

Step 3 is calculating normalized eigenvectors.

Step 4 is calculating consistency ratio with following formula:

$$\text{Pattern of Ratio Consistency: } CR = \frac{CI}{RI}$$

CR is parameter for check if the pairwise comparison has been done consequently or not. The value of RI is the random value of the index issued by Oakridge Laboratory such as table below [12].

Table 2:Random Index

Ordo	1,2	3	4	5	6	7	8	9	10	11	12	13	14	15
Random Index	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Calculating the consistency of the index used the following formula:

$$CI = \frac{(\lambda_{max} - n)}{(n-1)}$$

To know the consistency of the index is acceptable or not if CR < 0.1.

Step 5 is displaying the results oh AHP calculation.

The simple additive weighting (SAW) is a weighted summation method, however prior to the performance value summation of each alternative on all attributes. This method will first execute the

normalization process of decision matrix (X) to a scale that can be compared with all the ratings of existing alternatives [13]. SAW method has two attributes, there are:

$$r_{ij} \begin{cases} \dfrac{X_{ij}}{Max_i \quad X_{ij}} & \text{If } j \text{ is atributte benefit} \\ \dfrac{Min_i \quad X_{ij}}{X_{ij}} & \text{If } j \text{ is atributte cost} \end{cases}$$

Pattern of preferency: $V_i = \sum_{j=1}^{n} W_j \; r_{ij}$

The calculation of the SAW method is performed with the following steps:
Step 1 is determining the alternatives.
Step 2 is defining the criteria that will be used as reference in decision making.
Step 3 is providing an alternative match rating on each criterion.
Step 4 is determining the weight of preferences or importance of each criterion.
Step 5 is creating a match rating table of each alternative on each criterion.
Step 6 is creating a decision matrix formed from the match rating table of each alternative on each criterion.
Step 7 is performe normalized matrix by calculating the value of the performance of normalized performance which will form a normalized matrix.
The end result of preference value is derived from the sum of the matrix elements of the normalize matrix element with the corresponding preference weightof the matrix column [12].The advantage of this method is that it is proportional linier transformation of the raw data which mean that the relative order of magnitude of the standardized scores remains equal [13].

III. EXPERIMENT

Comparing process is started with the elaboration of the criteria used to select prospective outstanding employees in a company.The criteria are compiled and described into sub criteria as shown in Table 3 and Table 4.

Table 3: Data of Prospective Outstanding Employees

Prospective	Selling (Rp)	Attendance (Day)	Guest Service (Person)	Product Description	Appearance
A	130.000.000	1	160	Sufficient	90
B	50.000.000	2	125	Sufficient	80
C	80.000.000	2	110	Sufficient	75
D	125.000.000	-	70	Good	80
E	75.000.000	3	95	Less	70

Table 4: Sub Criteria

Criteria	Good	Sufficient	Less
Selling (Rp)	>=125.000.000	>= 75.000.000	<75.000.000
Attendance (Day)	<= 1	<= 3	> 3
Guest Service (Person)	>= 150	>= 120	< 120
Product Description	Good	Sufficient	Less
Appearance	>= 85	>= 65	< 65

Table 3 contains the criteria for prospective outstanding employees. The number of prospective employees who were sampled was 5 persons. Each employee is assessed based on the criteria in Table 3 then each of them has three sub criteria namely good, sufficient and less as presented in Table 4. These sub criteria determine the weight of each prospective employee in the following AHP and SAW calculations.

3.1 Analytical Hierarchy Process (AHP) Calculation

In this research, AHP aimed to make easier for companies to determine an outstanding employee through predetermined criteria. AHP calculations are divided into three main parts namely criteria priority calculation, sub criteria priority calculation, and results calculation. The following is the explanation of the calculation in question.

Criteria Priority Calculation

AHP calculation process starts with determining criteria priority by making pairwaisecomparison matrix. The matrix is composed of five existing criteria by comparing the importance of one criteria value with the other criteria value. Assessment results can be seen in Table 5 below.

Table 5:Pairwise Comparison Matrix

Criteria	Selling	Attendance	Guest Service	Product Description	Performance
Selling	1	1	2	1	2
Absence	1	1	1	1	1
Guest Service	0.5	1	1	1	1
Product Description	1	1	1	1	2
Appearance	0.5	1	1	0.5	1
Amount	4.00	5.00	6.00	4.50	7

Fill in Table 5,reffering to Table 1. Selling criteria are considered equally important as the attendance criteria andthe selling criteria also considered twice important as guest service. The level of importance is determined by company.

Next is creating a criteria value matrix as shown in Table 6. Value matrix is obtained by dividing the selling value by the number of values for each column of criteria.

Table6:Criteria Value Matrix

Criteria	Selling	Attendance	Guest Service	Product Description	Appearance	Amount	Priority
Selling	0.25	0.20	0.33	0.22	0.285	1.29	0.26
Attendance	0.25	0.20	0.166	0.22	0.142	0.98	0.20
Guest Service	0.125	0.20	0.166	0.22	0.142	0.86	0.17
Product Description	0.25	0.20	0.166	0.22	0.285	1.12	0.22
Appearance	0.125	0.20	0.166	0.11	0.142	0.75	0.15

The amount values in Table 6 are obtained from the sum of each criterion. The value 1.29 is the sum of 0.25+0.20+0.33+0.22+0.29.The priority values are obtained from the amount values divide by the number of criteria. For the first row, 0.26 is obtained from 1.29 divided by 5. The result of each division is the value for the priority column.

After creating the criteria value matrix, amount matrix of each row is formed. This matrix calculation is done by multiplying the value of each priority in Table 6 with the values in Table 5 and the all calculations can be seen in Table 7.

Table 7:Amount Matrix ofEach Row

Criteria	Selling	Attendance	Guest Service	Product Description	Appearance	Amount
Selling	0.26	0.20	0.34	0.22	0.29	1.3204
Attendance	0.26	0.20	0.17	0.22	0.15	1
Guest Service	0.13	0.17	0.17	0.22	0.15	0.8708
Product Description	0.26	0.22	0.17	0.22	0.30	1.1491
Appearance	0.13	0.15	0.17	0.11	0.15	0.7584

After generating the amount of each row as in Table 7, the following calculation of the consistency ratio (CR) is carried out. This aims to ensure that the value of CR <= 0.1. If CR value greater than 0.1 then the pairwise comparison matrix must be fixed. Calculation of CR can be seen in Table 8.

Table 8: Consistency Ratio

Criteria	Amount of Each Row	Priority	Results
Selling	1.3204	0.26	1.578
Absence	1	0.20	1.196
Guest Service	0.8708	0.17	1.042
Product Description	1.1491	0.22	1.374
Appearance	0.7584	0.15	0.907
Amount			6.097

Table 8 consists of the amount of each row thatobtained from amount colomn in Table 7. Priority obtained from Table 6. The results obtained from sum of amount of each row with priority. To find out whether CR can be accepted or not, the following calculation given:

Amount (from results) : 6.09
n(number of criteria) : 5
λmax(amount/n) : 1.219
CI((λmax-n)/n-1) : - 0.945
CR (CI/IR) : - 0.843

The result is CR < 0.1, means that consistency ratioabove can be accepted.

Sub Criteria Priority Calculation

The same steps are taken to obtained sub criteria priority calculation. The composed of sub criteria as shown in Table 4 then each sub criteriais processed like the following explanation.

Sub Criteria- Selling

The initial step of the calculation is to create pairwise comparison matrix for the selling sub criteria that shown in Table 9.

Table9:Pairwise Comparison Matrix for Selling Sub Criteria

Selling	Good	Sufficient	Less
Good	1	2	3
Sufficient	0.5	1	2
Less	0.3	0.5	1
Amount	1.83	3.5	6

The matrixin Table 9 is composed by comparing the importance of one sub criteria value with the other sub criteria value. Good selling is considered to be three times important as the less selling. The level of importance is determined by company.

The next process is to create a criteria value matrix for selling sub criteria as in Table 10.

Table 10:Criteria Value Matrix for SellingSub Criteria

Selling	Good	Sufficient	Less	Amount	Priority	Sub Criteria Priority
Good	0.55	0.57	0.5	1.61	0.54	1
Sufficient	0.27	0.28	0.33	0.89	0.3	0.55
Less	0.18	0.14	0.17	0.49	0.16	0.30

The calculation process of Table 10 same as the calculation process in Table 6.

The compilation of the amount matrix for each row is the next step. This matrix is arranged for selling sub criteria and the results are shown in the following table.

Table11:Amount Matrix of Each Row for Selling Sub Criteria

Selling	Good	Sufficient	Less	Amount
Good	0.54	0.59	0.49	1.62
Sufficient	0.27	0.30	0.33	0.89
Less	0.18	0.15	0.16	0.4

The value of 0.54 in the first row of Table 11 is obtained from multiplication of the priority values in the first row of Table 10 (0.54) with the value in the first row of Table 9 (1). While the value 1.62 in Table 11 is obtained from the sum of row of each sub criteria where 0.54 + 0.59 + 0.49 and so on.

The last step is to calculate CR for selling sub criteria and determine its feasibility. This CR calculation is the same as the calculation of CR on all criteria in Table 8 and its result is shown in Table 12 below.

Table 12:Consistency Ratio for Selling Sub Criteria

Selling	Amount of Each Row	Priority	Results
Good	1.62	0.54	2.16
Sufficient	0.89	0.30	1.19

Less	0.49	0.16	0.66
Amount			4.01

To find out whether CR can be accepted or not, the following calculation given:

Amount (from results) : 4.01
n(number of criteria) : 3
λmax(amount/n) : 1.34
CI ((λmax-n)/n-1) : - 0.83
CR (CI/IR) : - 0.43

The result is CR < 0.1, means that consistency ratiofor selling sub criteria can be accepted.

A series of calculations for selling sub criteria is also carried out on other sub criteria such as attendance, guest service, product description, and appearance. The level of importance is determined by company. While the calculation results of CR of each sub criteria is summarized in Table 13 below.

Table 13: Consistency Ratioof Each Sub Criteria

Sub Kriteria	CR Value
Attendance	-1.41
Guest Service	-1.43
Product Description	-1.41
Appearance	-1.43

The result of CR in Table 13 shows that the value of CR for each sub criteria is acceptable because of CR < 0.1.

Result Calculation

The final step in AHP is result calculation. To get the results of selection of outstanding employees, starting with setting the priority values of all criteria contained in Table 6 and the priority values of each sub criteria contained in Table 10. The results of compilation are expressed in the form of results matrix as shown in Table 14.

Table 14: Results Matrix

Selling	Attendance	Guest Service	Product Description	Appearance
0.26	0.20	0.17	0.22	0.15
Good	Good	Good	Good	Good
1.00	1.00	1.00	1.00	1.00
Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
0.55	0.41	0.55	0.41	0.55
Less	Less	Less	Less	Less
0.30	0.17	0.30	0.17	0.30

In order to get the calculation of outstanding employees, results matrix in Table 14 are processed together with data of prospective outstanding employees. In this research, five data samples were given below.

Table 15:Data of Prospective Outstanding Employees

Prospective	Selling (Rp)	Attendance (Day)	Guest (Person)	Service	Product Description	Appearance
A	130.000.000	1	160		Sufficient	90
B	50.000.000	2	125		Sufficient	80
C	80.000.000	2	110		Sufficient	75
D	125.000.000	-	70		Good	80
E	75.000.000	3	95		Less	70

In Table 15, selling value of A is grether then 125.000.000 or >=125.000.000 (refer to Table 4). This means that selling value of A has a priority value 0.26 and included into good sub criteria. The value of good sub criteria is 1 as shown in Table 14. Then do the multiplication between 0.26 and 1. The result is final AHP calculation. As well as attendance value of E which is <=3. This means that attendance value of E has a priority value 0.20 and included into sufficient sub criteria which is 0.41, then AHP calculation is obtained from multiplication of 0.20 and 0.41 and calculations are performed on all values that are in Table 14 and Table15. Final results of AHP calculation to select outstanding employees can be seen in following table.

Table 16: Final Results of AHP Process

Prospective	Selling	Attendance	Guest Service	Product Description	Appearance	Total
A	0.26	0.20	0.17	0.09	0.15	0.87
B	0.08	0.08	0.09	0.09	0.08	0.43
C	0.14	0.08	0.05	0.09	0.08	0.45
D	0.26	0.20	0.05	0.22	0.08	0.81
E	0.14	0.08	0.05	0.04	0.08	0.40

The total value in Table 16 is the sum of each row of prospective data. The prospective with highest total value recommend as an outstanding employee.

3.2 Simple Additive Weighting (SAW) Calculation

The next is calculation to select outstanding employee using SAW. SAW process has several steps as explaning below.

Criteria Determination

This stage carried out to determine criteria and attributes that used in SAW calculation. There are 5 criteria that used as reference in decision making. Benefit is an adventage attribute which higher is better and cost is cost attribute which lower is better. Because each criterion is the higest value is the best then all criteria are assumed as benefits based on Table 17.

Table17: The Employee Criteria

C1: Selling	Benefit
C2: Attendance	Benefit
C3: Guest Service	Benefit
C4: Product Description	Benefit
C5: Appearance	Benefit

The Matching Rating Determination

The matching rating in SAW is away to form a category for each criteria. In this research, categorieshave been determined namely good, sufficient and less with the respective suitability rating of 0.33 for less category, 0.66 for sufficient category and 1 for good category. Each category forms the interval of each prospective outstanding employee data as follows:

Table 18:The Matching Rating of Criteria

Criteria	Good(1)	Sufficient(0.66)	Less(0.33)
Selling (Rp)	>= 125.000.000	>= Rp 75.000.000	<75.000.000
Attendance (Day)	<= 1	<=3 Hari	> 3
Guest Service (Person)	>= 150	>=120 Orang	< 120
Product Description	Good	Sufficient	Less
Appearance	>=85	>=65	<65

The Weight of Criteria Determination

At this stage, weighting is carried out on each criterion where each criteria weight is obtained from the results of questionnaire, those are:

1. Selling = 100
2. Attendance = 85
3. Guest Service = 65
4. Product Description = 90
5. Appearance = 60

All criteria weights are added. Each criterion value is divided by the total value of all weights and multiplied by 100%. For a sample is (100/400)x100% = 25% and all calculation can be seen in Table 19.

Table 19:The Weight of Criteria

Weight of Criteria		
Selling	25%	0.25
Attendance	21%	0.21
Guest Service	16%	0.16

Product Description	23%	0.23
Appearance	15%	0.15
Total	**100%**	**1.00**

Decision Matrix

Decision matrix is based on 5 data of prospective outstanding employeesasAHP calculation (Table 3). All data are alternatives in the SAW calculation.Two processes are needed to produce a decision matrix, there are normalization matrix such as Table 20 and make the normalized matrix as in Table 21. Normalization matrix is adjusted to the benefits in Table 17 and matching rating of criteria in Table 18.

Table 20: Normalization Matrix

Alternatives	C1	C2	C3	C4	C5
A	1.00	1.00	1.00	0.66	1.00
B	0.33	0.66	0.66	0.66	0.66
C	0.66	0.66	0.33	0.66	0.66
D	1.00	1.00	0.33	1.00	0.66
E	0.66	0.66	0.33	0.33	0.66
Benefit	1.00	1.00	1.00	1.00	1.00

In Table 3, selling data ofalternativeA is greater than 125.000.000 or > 125.000.000. It means that selling data included into good categorywithrespective suitability rating is 1. Data attendance alternative E is <=3. This means that attendance value of E included into sufficient with respective suitability rating is 0.66 and so on. Benefit is obtained from the maximum value of each criterion so that if the division between the values of each alternative with the benefit value is obtained the normalized matrix as in Table 21 below.

Table21:Normalized Matrix

Alternatives	C1	C2	C3	C4	C5
A	1.00	1.00	1.00	0.66	1.00
B	0.33	0.66	0.66	0.66	0.66
C	0.66	0.66	0.33	0.66	0.66
D	1.00	1.00	0.33	1.00	0.66
E	0.66	0.66	0.33	0.33	0.66

Final Result

The final result of SAW calculation is the sum of normalized matrix multiplication with the weight of criteria as in Table 22. The alternative with the highest result is solution as the best alternative recommended.

Table 22:Final Result of SAW Calculation

Alternatives	C1	C2	C3	C4	C5	Amount
A	0.25	0.21	0.16	0.15	0.15	0.92
B	0.08	0.14	0.11	0.15	0.10	0.58
C	0.17	0.14	0.05	0.15	0.10	0.61
D	0.25	0.21	0.05	0.23	0.10	0.84
E	0.17	0.14	0.05	0.08	0.10	0.53

IV. RESULT AND DISCUSSION

From the calculation of two methods, recommendation of prospective outstanding employee is obtained from the highest value. The result of both methods showed that employee A has the highest value. After being ranked based on the highest value then the final calculation of them is performed in following table.

Table 23:Final Result of AHP and SAW Calculation

No	Prospective	AHP Result	Prospective	SAW Result
1	A	0.87	A	0.92
2	D	0.81	D	0.84
3	C	0.45	C	0.61
4	B	0.43	B	0.58
5	E	0.40	E	0.53

Based on all processes can be made a comparison of AHP and SAW methods. It can be seen from the mean value, deviation value and consistency. Table 24 shows the comparison in question.

Table 24:The Comparison of AHP and SAW

Comparison	AHP	SAW
Mean Value	0.59	0.70
Deviation Value	0.23	0.17
Consistency	Yes	No

From Table 24, SAW method has the highest of mean value and the lowest deviation. But when viewed from consistency, AHP provides consistency on every criterion and SAW does not. This is because SAW does not have comparative indexes as indicators [14]. For larger mean value with smaller deviation, SAW is more appropriate for selecting outstanding employees.

V. CONCLUSION

This research has produced a very clear comparison of two methods in MCDM. This research also shows the other side of previous research [3] that MCDM methods can be seen by its advantages through the mean value, deviation value and consistency.The method with the highest value and the lowest deviation is considered to represent the best MCDM methods. If calculation prioritizes consistency from each criterion then the method that has a consistency index is preferable. Therefore in this research, SAW method is more appropriate to use even though it does not have consistency indexes. The absence of consistency index made SAW calculation faster. The use of three criteria above as comparison does not rule out the possibility that can be combined with other existing criteria. This is expected to be a recommendation for a company in choosing the fast and precise MCDM methods.

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