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COMPARATIVE STUDY OF MULTI CRITERIA DECISION MAKING METHODS IN A CASE STUDY OF THE BEST EMPLOYEE DECISION SUPPORT SYSTEMS

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Abstract: Selecting the best employees is an alternative for companies to maintain and improve the quality of employee work. Being best employee is a matter of pride for every employee, so this good thing will also have an impact on the company. Having employees with good quality will certainly improve the quality of the company itself. Making decisions for the best employees is a challenge for companies because its subjective nature makes the selection inaccurate, so an objective decision-making system is needed according to the criteria. The purpose of this study is to compare three multi-criteria decision-making methods (MCDM) namely AHP (Analysis Hierarchy Process), SAW (Simple Additive Weighting Model) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution). Based on comparative studies from several journals, the results of the accuracy levels obtained from different methods show that there are different results from several cases discussed in reference journals, this is due to differences in the number of criteria and alternatives used for analysis.

Keywords: Decision Support System, AHP, Topsis, SAW, MCDM

INTRODUCTION

Employees are human workers who are physically and spiritually healthy (mentally and mentally) who are always needed and are one of the main assets in matters of the world of work to achieve certain goals (A.W. Widjaja, 1986), the quality of a company cannot be separated from the good quality of its employees, To maintain the good quality of the company, the company must carry out an employee performance assessment, one of which is selecting the best employees. This is done by the company as a form of appreciation and maintaining the quality of employees, but this is often problematic because the process of placing human resources according to their qualifications is something that quite difficult and benchmarks for different companies. The use of a Decision Support System (DSS) is a system used to help top level management to make decisions on a problem, in the SPK there is a method for producing decisions based on predetermined criteria, one of which is known as MCDM (Multi Criteria Decision Making), namely a decision-making method to determine the best alternative from a few alternatives based on certain criteria. Criteria usually take the form of measures, rules or standards used in decision making. MCDM is used to assess or select a limited number of alternatives or can be said to select the best alternative from a number of alternatives (Tseng, 2011). MCDM continues to be developed to produce selection of alternatives that have many criteria. Several MCDM methods that have been widely used are AHP (Analysis Hierarchy Process), SAW (Simple Additive Weighting Model) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution).

This research aims to compare the AHP (Analysis Hierarchy Process), SAW (Simple Additive Weighting Model) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) methods using existing case studies to determine the accuracy of each method in selecting the best employees.

STUDY OF LITERATURE

Decision Support System

Initially, Decision Support Systems (DSS) were defined as a system that could assist a manager in making decisions in semi-structured situations [1]. DSS was developed as a tool for decision makers to expand their capabilities, but not to replace their judgment. DSS is intended for making decisions that require judgment or decisions that cannot be supported at all by algorithms [1]. SPK aims to assist management in analyzing situations that are less structured and have unclear criteria. DSS is not intended to automate decision making but provides an interactive tool that allows decision makers to carry out various analyzes using available models [2].

Selection of Multi-Criteria Decision-Making (MCDM) Methods

According to Mulliner, et al (2016) *Multi Criteria Decision Making* is a set of methods related to evaluating a series of alternatives in terms of many, various and often conflicting criteria, thereby providing a set of alternatives and a number of decision criteria. Objectives of MCDM is to provide options, ranking, description, classification, sorting and to order alternatives from most preferred to least preferred option. There are three stages followed by all *Multi Criteria Decision Making methods*, namely:

1. Determine relevant criteria and alternatives
2. Attach numerical measures to the relative importance of criteria and the impact on alternatives of those criteria
3. Processing numerical values to determine the ranking of each alternative

MCDM is a decision-making method that is quite popular and is used in various fields, one of which is in the business sector. MCDM continues to be developed to produce selection of alternatives that have many criteria. Several MCDM methods that have been widely used are AHP (Analysis Hierarchy Process), SAW (Simple Additive Weighting Model) and TOPSIS (*Technique for Order of Preference by Similarity to Ideal Solution*).

The MCDM methods that will be used as comparative study material in this research are the AHP, Topsis and SAW methods to determine the selection of the best employees using five criteria, namely *knowledge* , *skill* , *ability* , *physical* , and attitude with the weight of each criterion as follows:

Table 1. Weight Value for Each Criteria

Criteria	Weight
Knowledge	Currently
Skill	Tall
Ability	Tall
Physique	Tall
Attitude	Currently

Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a method for solving a problem with many complex criteria into a hierarchy [3]. The AHP method is carried out by providing a priority value for each criterion or variable, then carrying out pairwise comparisons of the criteria or variables. Research related to the AHP method has been carried out by Imron regarding determining the best salesperson [4].

Basic Principles of AHP [5]

In solving problems with AHP, there are several principles that must be understood, including:

1. Decomposition (Creating a Hierarchy), namely breaking down a complex system into several supporting elements and then arranging them in a hierarchy so that they are easier to understand after they are recombined or synthesized.
2. Comparative Judgment (Assessment of Criteria and Alternatives), namely providing an assessment of existing criteria and alternatives and then comparing them
3. Synthesis of priority (Determining Priorities), namely carrying out pairwise comparisons for each criterion and alternative (Pairwise Comparisons). The relative comparative values of all alternative criteria can be adjusted according to predetermined judgment to produce weights and priorities. Weights and priorities are calculated by manipulating matrices or through solving mathematical equations.

4. Logical Consistency, namely testing consistency in two things. The first is that similar objects can be grouped according to their type. Second, it concerns the level of relationship between objects which is based on certain criteria.

AHP Procedure [5]

The AHP procedure carried out in this research is:

1. Defining the problem and determining the desired solution, then compiling a hierarchy of the problems faced.
2. Determining Element Priority.
3. Synthesis, namely providing considerations for synthesized pairwise comparisons to obtain overall priorities.
4. Measuring Consistency. In making decisions, it is important to know how good the consistency is because you don't want decisions based on considerations with low consistency.
5. Calculate the Consistency Index (CI) with the formula:
   CI = (λ max-n) / n ..... (1)
   With n = number of elements
6. Calculate the Consistency Ratio (CR) with the formula:
   a. CR = CI/R …….. ..... (2)
   With CR = Consistency Ratio; CI = Consistency Index; IR = Random Consistency Index
7. Check the consistency of the hierarchy, if it is more than 10%, then the judgment data assessment must be corrected. However, if the consistency ratio (CI/RC) is less than or equal to 0.1, then the calculation results are declared correct.

SAW

The Simple Additive Weighting (SAW) method is a weighted addition method. The basic concept of the SAW method is searching for a valuable enumeration obtained from the performance ranking of each alternative in all criteria [6]. Steps in the SAW method [7]:

1. Making a decision matrix Z of size mxn, where m = alternative to be chosen and n = criteria
2. Determining the x value for each alternative (i) for each predetermined criterion (j), where i = 1,2,…. m and j = 1.2……. n on the decision matrix Z,

$$Z = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1j} \\ \vdots & \vdots & \ddots & \vdots \\ X_{i1} & X_{i2} & \cdots & X_{ij} \end{bmatrix}$$ .... (3)

3. Determining the preference weight value (W) by making decisions for each predetermined criterion W = [W_1 , W_2, W_3, …. W_j] … .... (4)
4. Normalize the decision matrix Z by calculating the normalized performance rating value (r_{ij}) of alternative A_1 on attribute C_j .

$$r_{ij} = \begin{cases} \frac{X_{ij}}{MAX_i(X_{ij})} & j \ \ if\ j\ is\ the\ profit\ attribute \\ \frac{MIN_i(X_{ij})}{X_{ij}} & if\ j\ is\ a\ cost\ attribute \end{cases}$$ … ..... (5)

   Under the condition :
   a. The profit attribute is if the attribute provides a lot of benefits for the decision maker, while the cost attribute is an attribute that provides a lot of expenditure if the value is greater for the decision maker.
   b. If it is a profit attribute, the value (Xij) of each attribute column is divided by the value (MAX xij) of each column, while for cost attributes, the value (MIN xij) of each attribute column is divided by the value (xij) of each column.
5. The results of the normalized performance rating (rij) form a normalized matrix (N)

$$N = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1j} \\ \vdots & \vdots & \ddots & \vdots \\ r_{i1} & r_{i2} & \cdots & r_{ij} \end{bmatrix}$$ .... (6)

6. Carry out the ranking process by multiplying the normalized matrix by the preference weight value (W).

7. Determine the preference value for each alternative (Vi) by adding the product of the normalized matrix (N) with the preference weight value (W).
   $V_i = \sum_{j=1}^{n} W_j r_{ij}$... .. .. (7)
   So a larger Vi value indicates that alternative A1 is the best alternative.

TOPSIS

TOPSIS (*Technique for Order of Preference by Similarity to Ideal Solution*) is a multi-criteria decision making method introduced by Hwang and Yoon . The principle used by TOPSIS is that the alternative chosen must have the shortest distance from the solution. positive ideal and farthest from the negative ideal solution from a geometric point of view using Euclidean distance to determine the proximity of alternative distances to the optimal solution. The positive ideal solution (A+) is defined as the sum of all the best achievable values for each attribute, while the negative ideal solution (A-) consists of all the worst achievable values for each attribute [8]. TOPSIS is a method based on the concept where the selected alternative does not only have the shortest distance from the best value and
the farthest from the worst value to determine a decision [8]. In general, the TOPSIS procedure follows the following steps: [9]

a. Determine the decision matrix normalized
b. Calculates the normalized decision matrix weighted
c. Calculate the positive ideal solution matrix and the ideal solution matrix nagative
d. Calculate the distance between the value of each alternative with the positive ideal solution matrix and the ideal solution matrix negative
e. Calculate the preference value for each alternative

TOPSIS requires a performance rating of each alternative A i on each normalized criterion C j , namely:

$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=2}^{m} x_{ij^2}}}$ with i=1,2...,m; and j=1,2 .....n. …….. .... (8)

The positive ideal solution A $^{+}$ and the negative ideal solution A $^{-}$ can be determined based on the normalized weight rating (y_{ij}) as:

$y_{ij} = w_i r_{ij}$ with i=1,2...,m; and j=1,2 ...n .... (9)

$A^{+} = (y_1^{+}, y_2^{+}, .., y_n^{+})$;..... ..... (10)

$A^{-} = (y_1^{-}, y_2^{-}, .., y_n^{-})$;.. .... (11)

With

$$y_j^{+} = \begin{cases} \max\limits_i y_{ij} \; ; \; if\ j\ is\ a\ profit\ attribute \\ \min\limits_i y_{ij} \quad ; \; if\ j\ is\ a\ cost\ attribute \end{cases}$$ …….. .... (12)

$$y_j^{-} = \begin{cases} \max\limits_i y_{ij} \; ; \; if\ j\ is\ a\ profit\ attribute \\ \min\limits_i y_{ij} \quad ; \; if\ j\ is\ a\ cost\ attribute \end{cases}$$ …….. .... (13)

Where: j = 1, 2, …, n.

Meanwhile, the gap between alternative A $_i$ and the positive ideal solution is formulated as:

$D_i^{+} = \sqrt{\sum_{j=1}^{n} (y_i^{+} - y_{ij})^2}$; i=1,2,…,m. …….. .... (14)

The distance between alternative A $_i$ and the negative ideal solution is formulated as:

$D_i^{-} = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^{-})^2}$; i=1,2,…,m. …….. .... (15)

The preference value for each alternative (V $_i$) is given as:

$V_i = \frac{D_i^{-}}{D_i^{-} + D_i^{-}}$;……. .... (16)

A larger value of V $_i$ indicates that alternative A $_i$ is preferred

RESULT AND DISCUSSION

In this research, from six journals (or mention them later in the literature) the same criteria were taken in selecting the best employees, namely knowledge, skills, abilities, physicality, attitude. The data used was 60 employee data from the company. The ranking results resulting from the three methods are compared with the results of recommendations from experts in this management matter to obtain the level of accuracy for each method. The comparison results of the AHP, SAW, and topsi methods are in Table 2 [10].

Table 2. Comparison of rankings between the AHP, SAW, and TOPSIS methods

Rating	AHP	SAW	TOPSIS
1	X19	X19	X19
2	X49	X49	X49
3	X59	X53	X53
4	X42	X42	X42
5	X47	X47	X47
6	X45*	X4	X4
7	X38*	X59	X59
8	X53*	X14	X14
9	X12	X38	X38
10	X24	X13*	X57
11	X4	X27	X27
12	X25	X25	X13
13	X57	X45	X45
14	X14	X48	X50
15	X28	X12	X48
16	X27	X24	X12
17	X5	X57	X24
18	X13*	X50*	X25
19	X44*	X3	X28
20	X15	X6	X6
21	X33	X33	X33
22	X48*	X1	X1
23	X50*	X34	X34
24	X35	X28*	X35
25	X26*	X16	X16
26	X32*	X23*	X26
27	X6*	X5	X5
28	X23*	X54	X54
29	X31*	X15	X15
30	X2*	X51	X51
31	X34*	X21	X21
32	X16*	X52*	X3
33	X1*	X32	X32
34	X54*	X31	X31
35	X21*	X35*	X23
36	X3*	X26*	X40
37	X17	X17	X17
38	X51*	X40*	X44
39	X41	X41	X41
40	X40*	X9*	X52*
41	X8*	X2	X2
42	X46	X46	X46
43	X9*	X8	X7*
44	X7	X7	X8*
45	X52*	X44*	X9
46	X56*	X20	X20
47	X58	X20	X20
48	X37*	X30	X30
49	X55	X55	X55
50	X20*	X10*	X10

Rating	AHP	SAW	TOPSIS
51	X11	X11	X11
52	X39	X39	X39
53	X36	X56	X56
54	X10*	X37	X37
55	X18	X18	X18
56	X30*	X36	X36
57	X22	X22	X22
58	X43	X43	X43
59	X29	X29	X29
60	X60	X60	X60

Based on the results in Table 2, the difference in ranking between the AHP, SAW, TOPSIS methods and the ranking produced by experts is calculated using the formula.

$Presantase = \frac{Jumlah\ Ketepatan}{Jumlah\ Data} \times 100\%$..... .... (8)

The level of accuracy of the AHP method is

$$Presantase = \frac{30}{60} \times 100\% = 50\%$$

The level of accuracy of the SAW method is

$$Presantase = \frac{49}{60} \times 100\% = 81.67\%$$

The level of accuracy of the TOPSIS method is

$$Presantase = \frac{57}{60} \times 100\% = 95\%$$

CONCLUSIONS AND RECOMMENDATIONS

Based on experiments conducted on 60 data for ranking the best employees using the AHP, SAW, TOPSIS methods, it was obtained with different levels of accuracy for each method. The TOPSIS method has the best level of accuracy so it can be the right alternative method choice if there are many criteria.

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