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Technical Approach of TOPSIS in Decision Making

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Abstract - Stages of decision making done by the manager is a crucial stage. Given the resulting decisions affect the sustainability of the organization, then many managers use systems that can support the resulting decisions. This system is known as the decision support system, which applies to solving a problem, using methods such as ELECTRE, Promethee, SAW, TOPSIS. Using decision support systems makes it easy for decision makers to add new data, change data and make decisions more efficiently. In this article, the method used is Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

Keywords - TOPSIS, Decision Support, Decision Maker

I. INTRODUCTION

The development of today's computer technology tools is widely developed. It starts with the development of computers to mobile-based technology devices. Now the application of computers in providing appropriate information and used to support decisions to be made by a leader increasingly in demand. Decision support systems as a CBIS are the right tools, dedicated to managers in support of its decision. The application of decision support system methods in generating a decision using several criteria and alternatives. Each criterion is given the weight that corresponds to the interests of the problems encountered. The application of methods to decision-making is common in some cases, choosing the best lecturers by applying ELECTRE[1], computing tuition fees using Fuzzy Tsukamoto[2], student selection using the Composite Performance Indexc[3] and much more SPK applications to assist managers or managers in decision making.

Some methods of MADM are also capable of solving problems on decision making such as COPRAS, WSM, SAW, WP, EXPROM II[4][5], but in the following study, the author uses Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. TOPSIS is one of the decisions making methods that can choose the best alternative from some alternatives. The basic concept of the Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) method is that the best-selected alternative not only has the shortest distance from the ideal solution (the best solution) but also has the longest distance from the ideal negative solution (worst solution)[6][7]. From the results of the process using TOPSIS method, can provide effective information for managers in support of the decision made that is close to the best possible and far from the worst. Utilization of decision support systems in management is expected to make more efficient decisions generated by decision makers so that the final result (alternative) is selected the right and better decision.

II. METHODS AND MATERIAL

2.1 Decision Support System

The Decision Support System Concepts were first introduced in the 1970s by Michael S. Scott Morton under the term Management Decision Model (Sprague, 1982). The Decision Support System Concept is characterized by a computer-based interactive system that helps decision makers utilize data and models to solve unstructured problems. Decision Support System is designed to help all decision-making stages from identifying problems, selecting relevant data, determining the approach used in the decision-making process, to evaluating interactive selection.

According to Raymond McLeod, Jr (1998) defines decision support system is an information system intended to assist management in solving problems it faces (McLeod, 1998). According to Litlle (1970), Decision Support System is a computer-based information system that produces various decision alternatives to help management handle a variety of structured or unstructured problems using data and models. It can be concluded that Decision Support System is a specific information system helps managers produce alternative decisions in solving problems it faces.

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

The TOPSIS method was first introduced by Hwang and Yoon in 1981, with the main idea coming from the compromise concept of the alternative solution chosen to have the closest distance to a positive ideal solution (optimal solution) and having the furthest distance from the ideal solution (non-optimal solution)[8]. TOPSIS is based on the concept that the best-chosen alternative not only has the shortest distance from the ideal positive solution but also has the longest distance from the ideal solution. This concept is widely used on some MADM models to solve practical decision problems. This is because the concept is simple and easy to understand, computing is efficient, and can measure the relative performance of decision alternatives in the simple mathematical form[9][10]. The TOPSIS method is based on the concept that the best-chosen alternative not only has the shortest distance from the ideal solution but also has the longest distance from the ideal solution.

Application of TOPSIS method on decision support system[7], as follows:

Step 1: **Preparing Decision Matrix**

The decision matrix column contains column criteria (n) and on the line as an alternative (m).

$$x_{ij} = \begin{bmatrix} x_{11} & x_{12} & x_{13} & \cdots & x_{1n} \\ x_{21} & x_{21} & x_{22} & \cdots & x_{2n} \\ . & . & . & \cdots & . \\ x_{m1} & x_{m2} & x_{m3} & \cdots & x_{mn} \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Step 2: **Normalized Matrix**

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^{\ 2}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

i=1,2,..., m ;   j=1,2, ..., n ;

Step 3: **Calculate the weighted normalized decision matrix**

$y_{ij} = w_i r_{ij}$ i=1,2,...,m and j=1,2,...,n ……………….(3)

Step 4: **Calculate the positive and negative ideal solution**

The ideal A^+ positive solution and the ideal A^- negative solution can be determined based on the normalized weighted rank (Yij), as follows:

$A^+ = (y_1^+, y_2^+, \dots, y_n^+)$ ………………………………...(4)

A- $= (y_1^-, y_2^-, \dots, y_n^-)$ ……………………………….(5)

$$y_j^+ \begin{cases} max_i\, y_{ij} \\ \\ min_i y_{ij} \end{cases}$$

if j, benefit attribute

if j, cost attribute

$$y_j^- \begin{cases} min_i\, y_{ij} \\ \\ max_i y_{ij} \end{cases}$$ if j, benefit attribute

if j, cost attribute

Step 5: **Calculating distance with ideal solution**

Distance is an alternative Ai with a positive ideal solution is assumed as follows:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_j^+)}$$ i=1,2, …, m ……………………(6)

Distance is the alternative Ai with the ideal solution is assumed as follows:

$$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_j^-)}$$ i=1,2, …, m ……………………(7)

Step 6: **Calculating the preference value**

The preference value for each alternative (Vi) is given as:

$$V_i = \frac{D_i^-}{D_i^- - D_i^+}$$ i=1,2,...,m ……………………..(8)

At the end of the calculation, the greater value of Vi indicates that alternative Ai is preferred.

III. RESULTS AND DISCUSSION

In the initial application of decision support systems, it requires several things to be prepared, namely alternative lists, criteria, and weights. Here are the criteria and weights used in the TOPSIS calculation process. Criteria and weight is a requirement that must be determined by decision makers in the decision-making process.

TABLE I Criteria and Weighted

Criteria	Weighted	Type
C1 – Criteria 1	0.30	Benefit
C2 – Criteria 2	0.25	Benefit
C3 – Criteria 3	0.25	Cost
C4 – Criteria 4	0.20	Benefit

After determining the criteria and weights in table 1, the decision maker determines the list of alternatives to be selected. The alternative is an alternative that will be selected 1 or some of the best alternatives of the existing alternative.

TABLE II The Alternative

Alternative	C1	C2	C3	C4
A_1	60	90	80	50
A_2	70	80	80	75
A_3	90	85	70	85
A_4	80	85	85	85
A_5	75	85	80	85
A_6	70	80	75	80
A_7	60	80	85	70
A_8	50	80	80	55
A_9	55	70	75	65
A_{10}	80	85	85	60

The first step of implementing TOPSIS in decision support systems prepares the decision matrix (equation 1).

$$x = \begin{bmatrix} 60 & 90 & 80 & 50 \\ 70 & 80 & 80 & 75 \\ 90 & 85 & 70 & 85 \\ 80 & 85 & 85 & 85 \\ 75 & 85 & 80 & 85 \\ 70 & 80 & 75 & 80 \\ 60 & 80 & 85 & 70 \\ 50 & 80 & 80 & 55 \\ 55 & 70 & 75 & 65 \\ 80 & 85 & 85 & 60 \end{bmatrix}$$

After the matrix x (decision matrix) is formed, then use equation 2 to find a normalized matrix.

$$r_{1,1} = \frac{60}{\sqrt{60^2+70^2+90^2+80^2+75^2+70^2+60^2+50^2+55^2+80^2}} = 0.2709$$

$$r_{1,2} = \frac{90}{\sqrt{90^2+80^2+85^2+85^2+85^2+80^2+80^2+80^2+70^2+85^2}} = 0.3464$$

$$r_{1,3} = \frac{80}{\sqrt{80^2+80^2+70^2+85^2+80^2+75^2+85^2+80^2+75^2+85^2}} = 0.3177$$

$$r_{1,4} = \frac{50}{\sqrt{50^2+75^2+85^2+85^2+85^2+80^2+70^2+55^2+65^2+60^2}} = 0.2194$$

The above calculation is done up to the matrix $X_{10,4}$, so that the r matrix as follows:

$$r = \begin{bmatrix} 0.2709 & 0.3464 & 0.3177 & 0.2194 \\ 0.3161 & 0.3079 & 0.3177 & 0.3291 \\ 0.4064 & 0.3272 & 0.2780 & 0.3729 \\ 0.3612 & 0.3272 & 0.3375 & 0.3729 \\ 0.3386 & 0.3272 & 0.3177 & 0.3729 \\ 0.3161 & 0.3079 & 0.2978 & 0.3510 \\ 0.2709 & 0.3079 & 0.3375 & 0.3071 \\ 0.2258 & 0.3079 & 0.3177 & 0.2413 \\ 0.2483 & 0.2694 & 0.2978 & 0.2852 \\ 0.3612 & 0.3272 & 0.3375 & 0.2632 \end{bmatrix}$$

Next, use equation 3 to compute a weighted normalized matrix.

$y_{1,1} = w_1 \, r_{1,1} = 0.30 \times 0.2709 = 0.0813$
$y_{1,2} = w_2 \, r_{1,2} = 0.25 \times 0.3464 = 0.0866$
$y_{1,3} = w_3 \, r_{1,3} = 0.25 \times 0.3177 = 0.0794$
$y_{1,4} = w_4 \, r_{1,4} = 0.20 \times 0.2194 = 0.0439$

The above step is done up to the calculation of $y_{10,4}$, so it will produce the y matrix, as follows.

$$y = \begin{bmatrix} 0.0813 & 0.0866 & 0.0794 & 0.0439 \\ 0.0948 & 0.0770 & 0.0794 & 0.0658 \\ 0.1219 & 0.0818 & 0.0695 & 0.0746 \\ 0.1084 & 0.0818 & 0.0844 & 0.0746 \\ 0.1016 & 0.0818 & 0.0794 & 0.0746 \\ 0.0948 & 0.0770 & 0.0745 & 0.0702 \\ 0.0813 & 0.0770 & 0.0844 & 0.0614 \\ 0.0677 & 0.0770 & 0.0794 & 0.0483 \\ 0.0745 & 0.0674 & 0.0745 & 0.0570 \\ 0.1084 & 0.0818 & 0.0844 & 0.0526 \end{bmatrix}$$

Then look for a positive ideal solution and a negative ideal solution based on 4th and 5th simultaneously

y_1^+ = max{0.0813;0.0948;0.1219;0.1084;0.1016;0.0948;0.0813;
0.0677;0.0745;0.1084}=0.1219
y_2^+ = max{0.0866;0.0770;0.0818;0.0818;0.0818;0.0770;0.0770;
0.0770;0.0674;0.0818}=0.0866
y_3^+ = min{0.0794;0.0794;0.0695;0.0844;0.0794;0.0745;0.0844;
0.0794;0.0745;0.0844}=0.0695
y_4^+ = max{0.0439;0.0658;0.0746;0.0746;0.0746;0.0702;0.0614;
0.0483;0.0570;0.0526}=0.0746
A^+ = {0.1219;0.0866;0.0695;0.0746}

y_1^- = min{0.0813;0.0948;0.1219;0.1084;0.1016;0.0948;0.0813;
0.0677;0.0745;0.1084}=0.0677
y_2^- = min{0.0866;0.0770;0.0818;0.0818;0.0818;0.0770;0.0770;
0.0770;0.0674;0.0818}=0.0674
y_3^- = max{0.0794;0.0794;0.0695;0.0844;0.0794;0.0745;0.0844;
0.0794;0.0745;0.0844}=0.0844
y_4^- = min{0.0439;0.0658;0.0746;0.0746;0.0746;0.0702;0.0614;
0.0483;0.0570;0.0526}=0.0439
A^- = {0.0677;0.0674;0.0844;0.0439}

Next look for distance with an ideal solution, either positive (equation 6), or negative (equation 7).

$$D_1^+ = \sqrt{(0.0813-0.1219)^2 + (0.0866-0.0866)^2 + (0.0794-0.0695)^2 + (0.0439-0.0746)^2}$$
$$= 0.0519$$

$$D_1^- = \sqrt{(0.0813-0.0677)^2 + (0.0866-0.0674)^2 + (0.0794-0.0844)^2 + (0.0439-0.0439)^2}$$
$$= 0.0241$$

The calculation is made up to D10 +, as well as D10- and the results are as in the following table:

TABLE III The distances of weighted normalized matrix with ideal solution

Alternative	D^+	D^-
A_1	0.0519	0.0241
A_2	0.0317	0.0365
A_3	0.0048	0.0656
A_4	0.0207	0.0529
A_5	0.0231	0.0482
A_6	0.0295	0.0402
A_7	0.0462	0.0242
A_8	0.0618	0.0117
A_9	0.0543	0.0178
A_{10}	0.0302	0.0440

The last step then calculates the preference value using equation 8.

TABLE IV The Preferences Value

Alternative	The Calculation	Preferences Value
A_1	0.0241 / (0.0241 - 0.0519)	0.317
A_2	0.0365 / (0.0365 - 0.0317)	0.536
A_3	0.0656 / (0.0656 - 0.0048)	0.932
A_4	0.0529 / (0.0529 - 0.0207)	0.719
A_5	0.0482 / (0.0482 - 0.0231)	0.676
A_6	0.0402 / (0.0402 - 0.0295)	0.577
A_7	0.0242 / (0.0242 - 0.0462)	0.343
A_8	0.0117 / (0.0117 - 0.0618)	0.159
A_9	0.0178 / (0.0178 - 0.0543)	0.247
A_{10}	0.0440 / (0.0440 - 0.0302)	0.593

TABLE V The rangking

Alternative	Preferences Value (V)	Rank
A_3	0.932	1
A_4	0.719	2
A_5	0.676	3
A_{10}	0.593	4
A_6	0.577	5
A_2	0.536	6
A_7	0.343	7
A_1	0.317	8
A_9	0.247	9
A_8	0.159	10

From the calculation process yields that A3 is at the top with a value of 0.932.

IV. CONCLUSION

In the step decision processing step using the TOPSIS method, compare each value of the alternative with the ideal solution positive and negative. This describes that to find the best solution not only to look at the best value but also to have the greatest distance from the worst possible.

REFERENCES

I. Mesran, G. Ginting, Suginam, and R. Rahim, “Implementation of Elimination and Choice Expressing Reality (ELECTRE) Method in Selecting the Best Lecturer (Case Study STMIK BUDI DARMA),” Int. J. Eng. Res. Technol. (IJERT, vol. 6, no. 2, pp. 141–144, 2017.

II. M. Iswan, W. Fitriani, N. Mayasari, and A. P. U. Siahaan, “Tuition Reduction Determination Using Fuzzy Tsukamoto,” Int. J. Eng. Sci. Invent., vol. 5, no. 9, pp. 68–72, 2016.

III. R. Rahim, Mesran, A. Putera, U. Siahaan, and S. Aryza, “Composite performance index for student admission,” Int. J. Res. Sci. Eng., vol. 3, no. 3, pp. 68–74, 2017.

IV. A. V. Manikrao and C. Shankar, “Facility Location Selection using PROMETHEE II Method,” Int. Conf. Ind. Eng. Oper. Manag. Dhaka, pp. 59–64, 2010.

V. M. Madić, J. Antucheviciene, M. Radovanović, and D. Petković, “Determination of laser cutting process conditions using the preference selection index method,” Opt. Laser Technol., vol. 89, no. October 2016, pp. 214–220, 2017.

VI. K. SHAHROUDI and S. M. S. TONEKABONI, “APPLICATION OF TOPSIS METHOD TO SUPPLIER SELECTION IN IRAN AUTO SUPPLY CHAIN,” J. Glob. Strateg. Manag., vol. 6, no. 2, pp. 123–131, 2012.

VII. J. Papathanasiou, N. P. B, T. Bournaris, and B. Manos, “A Decision Support System for Multiple Criteria Alternative Ranking Using TOPSIS and VIKOR : A Case Study on Social Sustainability in Agriculture,” ICDSST, vol. 2, pp. 3–15, 2016.

VIII. C.-L. Yoon, K.P., & Hwang, “Multiple Attribute Decision Making: An Introduction,” Sage Univ. Pap. Ser. Quantative Appl. Soc. Sci., pp. 47–53, 1995.

IX. S. Kusumadewi, S. Hartati, A. Harjoko, and R. Wardoyo, Fuzzy Multi-Attribute Decision Making (Fuzzy MADM). Yogyakarta: Graha Ilmu, 2006.

X. Jasri, D. Siregar, and R. Rahim, “Decision Support System Best Employee Assessments with Technique for Order of Preference by Similarity to Ideal Solution,” Int. J. Recent TRENDS Eng. Res., vol. 3, no. 3, pp. 6–17, 2017.