Research Article

Recruitment of Medical Staff in Health Department by Using TOPSIS Method

Rana Muhammad Zulqarnain[1], Xiao Long Xin[1*], Muhammad Saeed[2], Nadeem Ahmad[2], Fazal Dayan[2], Bilal Ahmad[3]

[1.]School of Mathematics, Northwest University, Xian 710127, China.

[2.] School of Science, Department of Mathematics, University of Management and Technology, Lahore, Pakistan.

[3.] Department of Mathematics and Statistics, The University of Lahore, Pakistan.

***Corresponding author's E-mail:** xlxin@nwu.edu.cn

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ABSTRACT

In this paper, we debate the order preference by similarity ideal solution (TOPSIS) method and develop a model for the TOPSIS method. The selection of medical staff is a very significant portion of our life to promote the quality of health in our society. We select the more appropriate medical staff for the health department by using the TOPSIS method in the following research.

Keywords: Multiple Criteria Decision Making (MCDM), TOPSIS, Positive Ideal Solution (PIS), Negative Ideal Solution (NIS)

INTRODUCTION

Decision Making is the best procedure to choose a superlative alternative from all feasible alternatives. Almost in all other issues, the overall number of criteria because decision making the general alternatives is pervasive. Such criteria normally contrast one another so there might be no way out satisfying all criteria simultaneously. To deal with such problems the decision-makers want to solve the MCDM problem. There are different methods to solve MCDM problems. One of them presented by Hwang and Yoon in a study[1] is known as a TOPSIS to solve the MCDM problem with many alternatives. The core concept of this technique is that the chosen alternative should have the smallest geometrical distance from the PIS and the largest geometrical distance from NIS [2].

Nowadays this technique used in different fields of life such as energy[3–7] medicine[2,8–10] engineering and manufacturing systems[11–16] safety and environmental fields[17–22] chemical engineering[5,23,24] and water resources studies [5,19,23,25]. Chen & Hwang extend the idea of the TOPSIS method and presented a new model for TOPSIS[26]. Moreover, to solve uncertain data Chen extended the TOPSIS for Group Decision Making in the fuzzy atmosphere [27] and used the newly proposed method for decision making. Zulqarnain et al. developed the graphical model of the TOPSIS method and used for the selection of medical clinic in [28]. The importance weights of multi-criteria and alternative rating w.r.t. these criteria were treated as linguistic variables, evaluated by a group of decision-makers. To facilitate the decision making in a fuzzy environment many researchers extended the TOPSIS technique reported in literature [3,4,6,8,11–15,17–19,25,29–35]. The author's developed the idea of generalized interval valued fuzzy soft matrices (IVFSM) in [36]. The usage of interval numbers is too a significant enhancement of [37–39] and trapezoidal fuzzy numbers are used for disease identification in[40]. The extension of TOPSIS under fuzzy data has been used to express the prospect of achievement for pancreatic transplantation [8]. A decision-making method on IVFSM introduced in [41] and the authors provided the application of IVFSM [42] and comparative study with a fuzzy soft matrix [43].

Mahmood Zadeh et al. developed a technique for the project selection by combining fuzzy AHP and TOPSIS methods and used the upgraded technique to calculate the weights of each criterion at first and then the TOPSIS algorithm was engaged for ranking the projects to be selected [44]. The authors faced some difficulties to determine the accurate value of the elements of the decision matrix, such as their values were considered as intervals, to overcome these difficulties they extended the TOPSIS method with interval data in [37]. Several approaches have been established for MCDM problems, in [45] the authors provided a proper guideline of how and which method could be used for MCDM problems according to the situation.

In [46], the authors extended the TOPSIS to Atanassov intuitionistic fuzzy set and proposed the algorithm of extended TOPSIS for multi-attribute group decision-making problem. The idea of multiple attribute intuitionistic fuzzy group decision-making algorithm was introduced in [46]. Many researchers worked on the TOPSIS method and used in medical diagnosis and for decision making in different fields of life reported in literature[47–50].

Firstly, in this paper, we study and discuss some basic concepts of the TOPSIS method. Secondly, the graphical model is proposed in this research. Nowadays the selection of good teachers in any institute is very necessary to improve the quality of education. In the following work, we choose the more appropriate teachers for the education department by using the TOPSIS method.

TOPSIS Method

Hwang and Yoon [1] developed a technique to resolve MCDM known as the TOPSIS method. To support the shortest Euclidean distance, they proposed the PIS and NIS and each criterion needs to be maximized or minimized. They claimed that the TOPSIS method helps rank alternatives closeness which based on optimum ideal solution and obtained the maximum level from available alternatives. The best alternative has rank one and the worst alternative approaches rank zero. For every alternative, there is an intermediate ranking between the best answer extremes. An identical set of choice criteria permits correct weighting of relative disease and therefore the optimum disease is alarming which needs attention. Here are presented the steps for the TOPSIS technique. TOPSIS views an MCDM problem with m-alternatives as a geometric system with m points in the n-dimensional space [51]. The core concept of this technique is that the chosen alternative should have the smallest geometrical distance from the PIS and the largest geometrical distance from the NIS [52]. To apply TOPSIS [53], a common assumption is that criteria should be either monotonically increasing or decreasing so that PIS and NIS can be easily identified.

Classical Topsis Algorithm

Step 1: Establishment of DM

Construct the decision matrix as follows

$$DM = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_p \end{array} \begin{array}{c} \begin{array}{cccc} R_1 & R_2 & \cdots & R_q \end{array} \\ \begin{bmatrix} c_{11} & c_{12} & \cdots & c_{1q} \\ c_{21} & c_{22} & \cdots & c_{2q} \\ \vdots & \vdots & \ddots & \vdots \\ c_{p1} & c_{p2} & \cdots & c_{pq} \end{bmatrix} \end{array}$$

Where l is the alternative index ($l = 1, 2, ..., q$); n is the number of potential sites and m is the criteria index ($m = 1, 2, ..., p$).

The elements $R_1, R_2, ..., R_q$ of the DM define the criteria while $A_1, A_2, \ldots, A_p$ defining the alternatives.

Step 2: Calculation of the Normalized Decision Matrix (NDM)

To represent the relative performance of the alternatives the NDM constructed as follows.

$$NDM = L_{lm} = \frac{c_{lm}}{\sqrt{\sum_{l=1}^{q} c_{lm}^2}}$$

Step 3: Determination of the Weighted Normalized Decision Matrix (WNDM)

By multiplying every element of each column of NDM got a weighted decision matrix.

$$V = V_{lm} = W_m \times L_{lm}$$

Step 4: Identification of the PIS and NIS

The PIS (I^+) and the NIS (I^-) are defined for the weighted decision matrix as follows

$$\text{NIS} = I^- = \{V_1^-, V_2^-, \ldots, V_q^-\}, \text{ where:}$$

$$V_m^- = \{(\text{mini}(V_{lm}) \text{ if } m \in J); (\text{maxi } V_{lm} \text{ if } m \in J')\}$$

Where J' is associated with the non-beneficial attributes and

J is associated with beneficial attributes.

Step 5: Separation Distance from PIS and NIS of each alternative

$$S_l^+ = \sqrt{\sum_{m=1}^{p} (V_m^+ - V_{lm})^2} \; ; l = 1, 2, \ldots, q$$

$$S_l^- = \sqrt{\sum_{m=1}^{p} (V_m^- - V_{lm})^2} \; ; l = 1, 2, \ldots, q$$

Where, l = Alternative index,

m = Criteria index.

Step 6: Relative Closeness to the Ideal Solution.

The relative closeness of the ideal solution is computed as

$$C_l = \frac{S_l^-}{(S_l^+ + S_l^-)}, \; 0 \le C_l \le 1$$

Step 7: Ranking of Preference Order

Ranking is done based on the values of C_l the higher value of the relative closeness has a high rank and hence the better performance of the alternative. Rank the preference in descending order to compare the better performances of alternative.

Application of Topsis Method

The selection of medical staff in the health department is very necessary to improve health quality nowadays in any society. Ministry of health department wants to hire three outstanding doctors out of seven given as follows D = $\{D_1, D_2, D_3, D_4, D_5, D_6, D_7\}$. The secretary of health department announces a panel for the selection of doctors according to the following parameters H = {Personality (h_1), determination (h_2), academic record (h_3), management skills in the emergency room (h_4), surgery command (h_5), behavior with patient (h_6) and (h_7) experience}.

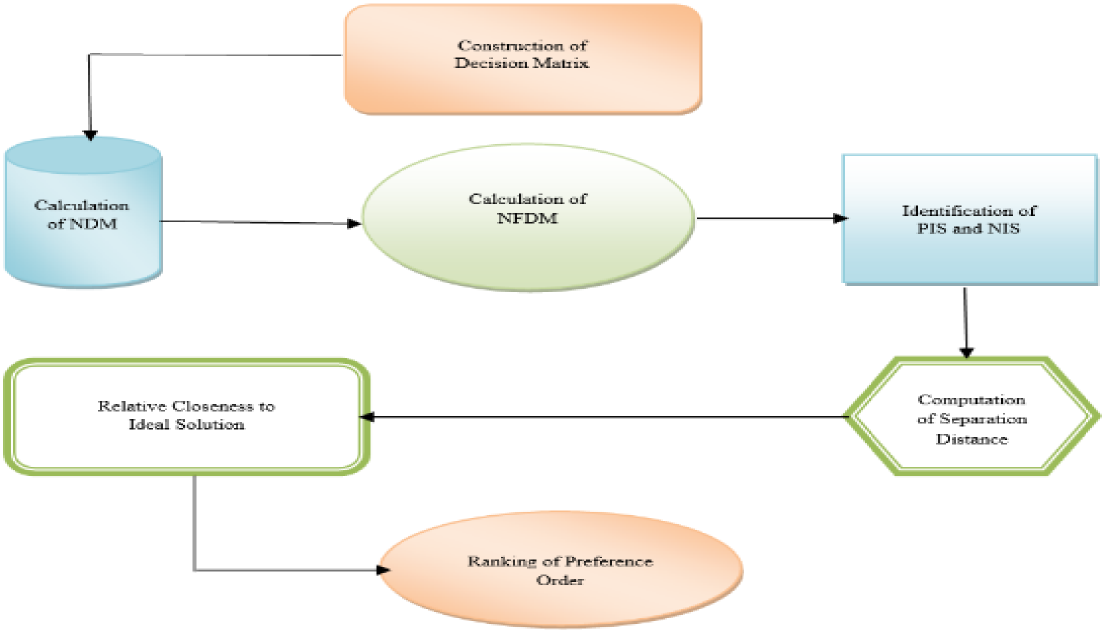

Figure 1: Graphical Model for TOPSIS

Solution by Topsis

TOPSIS method will be illustrated with the help of a selection of faculty members in the education department. The set of alternatives is D = {D_1, D_2, D_3, D_4, D_5, D_6, D_7} and the set of evaluation criteria is H = {Personality (h_1), determination (h_2), academic record (h_3), management skills in the emergency room (h_4), surgery command (h_5), behavior with patient (h_6) and (h_7) experience}.

Step 1: Construction of a Decision Matrix

Table 1: Decision Matrix D = $[x_{ij}]_{m\times n}$

	h_1	h_2	h_3	h_4	h_5	h_6	h_7
D_1	1	0.7	0.9	0.8	0.5	0.9	0.6
D_2	0.7	0.9	0.8	0.9	0.6	0.7	0.8
D_3	0.5	1	0.7	1	0.7	0.8	0.9
D_4	0.9	0.3	0.8	0.5	1	0,9	0.9
D_5	0.8	0.9	0.8	1	0.7	0.4	0.5
D_6	0.3	0.7	0.9	0.5	0.9	0.7	1
D_7	0.8	0.8	0.7	0.8	1	0.9	0.8

Step 2: Normalization

By using $\sqrt{\sum_{i=1}^{m} x_{ij}^2}$, we get

Table 2: Calculating $\sqrt{\sum_{i=1}^{m} x_{ij}^2}$

	h_1	h_2	h_3	h_4	h_5	h_6	h_7
D_1	1	0.49	0.81	0.64	0.25	0.81	0.36
D_2	0.49	0.81	0.64	0.81	0.36	0.49	0.64
D_3	0.25	1	0.49	1	0.49	0.64	0.81
D_4	0.81	0.09	0.64	0.25	1	0,81	0.81
D_5	0.64	0.81	0.64	1	0.49	0.16	0.25
D_6	0.09	0.49	0.81	0.25	0.81	0.49	1
D_7	0.64	0.64	0.49	0.64	1	0.81	0.64
$\sum_{i=1}^{m} x_{ij}^2$	3.92	4.33	4.52	4.59	4.4	4.65	4.51
$\sqrt{\sum_{i=1}^{m} x_{ij}^2}$	1.97989	2.08087	2.12603	2.14243	2.09762	2.15638	2.12368

By dividing each entry of the above matrix by $\sqrt{\sum_{i=1}^{m} x_{ij}^2}$ we get normalized decision matrix

Table 3: Normalized Decision Matrix

	h_1	h_2	h_3	h_4	h_5	h_6	h_7
D_1	0.50508	0.33639	0.42332	0.37341	0.16799	0.41737	0.28253
D_2	0.35356	0.44325	0.37629	0.42008	0.28604	0.32462	0.37670
D_3	0.25254	0.48057	0.32925	0.46676	0.33371	0.37099	0.42379
D_4	0.45457	0.14417	0.37629	0.23338	0.47673	0.41737	0.42379
D_5	0.40406	0.43251	0.37629	0.46676	0.33371	0.18549	0.23544
D_6	0.15152	0.33639	0.42332	0.23338	0.42906	0.32462	0.44707
D_7	0.40406	0.38445	0.32925	0.37341	0.47673	0.41737	0.37670

Step 3: Computation of Weight Matrix

The weights assigned by the panel to the criteria are given by the matrix

$$W = [h_1 = 0.2, h_2 = 0.1, h_3 = 0.25, \quad h_4 = 0.28, h_5 = 0.3, h_6 = 0.22, h_7 = 0.3]^{Transpose}$$

Step 4: Weighted Normalized Decision Matrix (WNDM)

Multiplying each column of NDM in Table 3 by weights w_j, of weight vector computed in step 3 to get WNDM.

Table 4: Weighted Normalized Decision Matrix

	h_1	h_2	h_3	h_4	h_5	h_6	h_7
D_1	0.10102	0.03364	0.10583	0.10445	0.05039	0.09182	0.08476
D_2	0.07071	0.04433	0.09407	0.11762	0.08581	0.07142	0.11301
D_3	0.05050	0.04806	0.08231	0.13069	0.10011	0.08162	0.12714
D_4	0.09091	0.01441	0.09407	0.06534	0.14302	0.09182	0.12714
D_5	0.08081	0.04325	0.09407	0.13069	0.10011	0.04081	0.07063
D_6	0.03030	0.03364	0.10583	0.06534	0.12872	0.07142	0.13412
D_7	0.08081	0.03845	0.08231	0.10445	0.14302	0.09182	0.11301

Step 5: The calculation of PIS

To find the PIS D^*

Table 5: Calculation of PIS

	h_1	h_2	h_3	h_4	h_5	h_6	h_7
D_1	0.10102=v_1^*	0.03364	0.10583=v_3^*	0.10445	0.05039	0.09182=v_6^*	0.08476
D_2	0.07071	0.04433	0.09407	0.11762	0.08581	0.07142	0.11301
D_3	0.05050	0.04806=v_2^*	0.08231	0.13069=v_4^*	0.10011	0.08162	0.12714
D_4	0.09091	0.01441	0.09407	0.06534	0.14302=v_5^*	0.09182=v_6^*	0.12714
D_5	0.08081	0.04325	0.09407	0.13069=v_4^*	0.10011	0.04081	0.07063
D_6	0.03030	0.03364	0.10583=v_3^*	0.06534	0.12872	0.07142	0.13412=v_7^*
D_7	0.08081	0.03845	0.08231	0.10445	0.14302=v_5^*	0.09182=v_6^*	0.11301

Therefore D^* = {0.10102, 0.04806, 0.10583, 0.13069, 0.14302, 0.09182, 0.13412}

To find the PIS D'

Table 6: Calculation of NIS

	h_1	h_2	h_3	h_4	h_5	h_6	h_7
D_1	0.10102	0.03364	0.10583	0.10445	0.05039=v_5'	0.09182	0.08476
D_2	0.07071	0.04433	0.09407	0.11762	0.08581	0.07142	0.11301
D_3	0.05050	0.04806	0.08231=v_3'	0.13069	0.10011	0.08162	0.12714
D_4	0.09091	0.01441=v_2'	0.09407	0.06534=v_4'	0.14302	0.09182	0.12714
D_5	0.08081	0.04325	0.09407	0.13069	0.10011	0.04081=v_6'	0.07063=v_7'
D_6	0.03030=v_1'	0.03364	0.10583	0.06534=v_4'	0.12872	0.07142	0.13412
D_7	0.08081	0.03845	0.08231=v_3'	0.10445	0.14302	0.09182	0.11301

Therefore D' = {0.03030, 0.01441, 0.08231, 0.06534, 0.05039, 0.04081, 0.07063}

Step 6: Determine the separation measures for each alternative

Separation measure from PIS D^*

Table 7: Calculation of D_i^*

	h_1	h_2	h_3	h_4	h_5	h_6	h_7	$\sum_{j=1}^{n}((v_j^* - v_{ij}))^2$	$D_i^* = \sqrt{\sum_{j=1}^{n}(v_j^* - v_{ij})2}$
D_1	0	0.00021	0	0.00069	0.00858	0	0.00244	0.00334	0.05779
D_2	0.00092	0.00001	0.00014	0.00017	0.00327	0.00042	0.00045	0.00538	0.07335
D_3	0.00255	0	0.00055	0	0.00184	0.00010	0.00005	0.00509	0.07134
D_4	0.00010	0.00113	0.00014	0.00427	0	0	0.00005	0.00569	0.07543
D_5	0.00041	0.00002	0.00014	0	0.00184	0.00260	0.00403	0.00904	0.09508
D_6	0.00500	0.00021	0	0.00427	0.00020	0.00042	0	0.0101	0.10049
D_7	0.00041	0.00009	0.00055	0.00069	0	0	0.00045	0.00219	0.04679

Separation measure from NIS D'

Table 8: Calculation of D_i'

	h_1	h_2	h_3	h_4	h_5	h_6	h_7	$\sum_{j=1}^{n}((v_j' - v_{ij}))^2$	$D_i' = \sqrt{\sum_{j=1}^{n}(v_j^* - v_{ij})2}$
D_1	0.00500	0.00037	0.00055	0.00153	0	0.00260	0.00019	0.01024	0.10119
D_2	0.00163	0.00089	0.00014	0.00273	0.00125	0.00094	0.00179	0.00937	0.09679
D_3	0.00041	0.00113	0	0.00427	0.00247	0.00167	0.00319	0.01314	0.11463
D_4	0.00367	0	0.00014	0	0.00858	0.00260	0.00319	0.01818	0.13483
D_5	0.00255	0.00083	0.00014	0.00427	0.00247	0	0	0.01026	0.10129
D_6	0	0.00037	0.00055	0	0.00614	0.00094	0.00403	0.01203	0.10968
D_7	0.00255	0.00058	0	0.00153	0.00858	0.00260	0.00179	0.01763	0.13278

Step 7: Computation of RCC to the ideal solution C_i^*

RCC to the ideal solution C_i^* is computed as follows

$$C_1^* = \frac{D_1'}{D_1' + D_1^*} = \frac{0.10119}{0.10119 + 0.05779} = \frac{0.10119}{0.15898} = 0.63649\ (3^{rd})$$

$$C_2^* = \frac{D_2'}{D_2' + D_2^*} = \frac{0.09679}{0.09679 + 0.07335} = \frac{0.09679}{0.17014} = 0.56888$$

$$C_3^* = \frac{D_3'}{D_3' + D_3^*} = \frac{0.11463}{0.11463 + 0.07134} = \frac{0.11463}{0.18597} = 0.61639$$

$$C_4^* = \frac{D_4'}{D_4' + D_4^*} = \frac{0.13483}{0.13483 + 0.07543} = \frac{0.13483}{0.21026} = 0.64125\ (2^{nd})$$

$$C_5^* = \frac{D_5'}{D_5' + D_5^*} = \frac{0.10129}{0.10129 + 0.09508} = \frac{0.10129}{0.19637} = 0.51581$$

$$C_6^* = \frac{D_6'}{D_6' + D_6^*} = \frac{0.10968}{0.10968 + 0.10049} = \frac{0.10968}{0.21017} = 0.52186$$

$$C_7^* = \frac{D_7'}{D_7' + D_7^*} = \frac{0.13278}{0.13278 + 0.04679} = \frac{0.13278}{0.17957} = 0.73943\ (1^{st})$$

So $C_7^* > C_4^* > C_1^* > C_3^* > C_2^* > C_6^* > C_5^*$. Hence D_7, D_4, D_1 are more appropriate doctors for health department according to the given parameters.

CONCLUSION

The selection of the medical staff in the health department is very necessary to improve the health quality in any society. In this paper, we discuss the TOPSIS method and constructed a graphical model for the TOPSIS method. Finally, we choose the more appropriate doctors for the health department by using the TOPSIS method.

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