International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Issue-7, July 2019 E-ISSN: 2347-2693

A TOPSIS Approach for Ranking Warmth Service Providers

P.K. Parida

Department of Mathematics, C.V. Raman (Autonomous) College of Engineering, Bhubaneswar, India

Corresponding Author: prashanta_math@yahoo.co.in, Tel.: +91-88957-25340

DOI: https://doi.org/10.26438/ijcse/v7i7.235240 | Available online at: www.ijcseonline.org

Accepted: 12/Jul/2019, Published: 31/Jul/2019

***Abstract*—** In the competitive situation, different methods of Multi-criteria decision support have been used to help decision maker select better alternatives for various decision problems. To an economic consideration, there are several criteria needed to be taken into account the temperatures in different cities in the World. According to that base we recorded the temperature in the different months in a city in the year 2018. In this paper, we presented the warmth temperature in the city and crisp temperature of the city by account of the decision making processes. To solve complex real-world decision making problems, multi-attribute decision making (MADM) methods have been developed. The TOPSIS is among the most widely used methods at present which provides valuable outputs in different application areas. With the above hypotheses, calculations involving Eigen vector, square rooting and summations are used for obtaining a relative closeness value of the criteria tested. TOPSIS ranks these values of relative closeness of the whole system by assigning the highest value of the relative closeness to the best attributes in the system. A numerical example given to illustrate the solution process of the suggested approach.

***Keywords*—** Crisp, DM, MADM, MCDM, TOPSIS, Warmth.

I. INTRODUCTION

The main focus of the multi-criteria decision making (MCDM) field is to introduce procedures, methods as well as tools for solving problems and consequently to support decision-makers (DM) to make better decisions. In MCDM problems, the overall performance of the alternatives is evaluated with respect to several and conflicting criteria, and the objectives are combined based on the DM's preferences [1]. To an economic consideration, there are several criteria needed to be taken into account the temperatures in different cities in the World. According to that base we recorded the temperature in the month of April and May in Bhubaneswar city in the year 2018. In this paper we presented the warmth temperature in the city and crisp temperature of the city by account of the decision making processes. To solve complex real-world decision making problems, multi-attribute decision making (MADM) methods have been developed. The TOPSIS is among the most widely used methods at present which provides valuable outputs in different application areas. With the above hypotheses, calculations involving eigenvector, square rooting and summations are used for obtaining a relative closeness value of the criteria tested. TOPSIS ranks these values of relative closeness of the whole system by assigning the highest value of the relative closeness to the best attributes in the system. For environmental aspects and level of comfort we consider these multiple criteria such as maximum and minimum temperature evaluations in multi-criteria decision making problems.

The Technique TOPSIS was utilized to the selection of technology alternatives in conceptual and preliminary aircraft design [2]. However, TOPSIS has the limitations that it assumes that each criterion's utility is monotonic and is rather sensitive to the weighting factors. A multi-criteria interactive decision-making advisor for the selection of the most appropriate decision making method was developed [3]. TOPSIS is used to assess the performance of alternatives through the similarity with the IS given by Hwang and Yoon [1]. According to the technique of Hwang and Yoon [1], the most suitable alternative is one which is nearest to the PIS and at maximum apart from the NIS [4,5,6] . The PIS makes the benefit criteria maximum while minimizing the cost criteria. The NIS on the other hand enhances the cost criteria to a maximum level while minimizing the benefit criteria.

Here compare attributes to identify the significance of each of them in the selection of options. Finally, after identifying the weights of attributes in decision making, the selection is made by considering how much benefit an option offers over another option.

Decision criteria and weighting factors are main input data in the DM process. It is observed that there are always uncertainties existing in the decision criteria due to incomplete information. The weighting factors are often highly subjective, considering the fact that they are elicited based on the decision making experience or intuition [7,8]. Therefore, uncertainty assessment for the decision criteria and the weighting factors should be prudently performed. Also find the distances of PIS and NIS from the respective alternatives by applying the TOPSIS methodology [9]. Moreover, here define a closeness coefficient to determine the ranking order of the alternative.

A DM's preference ordering between two alternatives changes when an alternative is added or removed and this clearly contradicts the Principle of Independence from irrelevant alternatives. The TOPSIS method has been widely used in the literature. However, the classical version of the method, as proposed by Hwang and Yoon [4], was chosen as the focus of this paper based on the literature review conducted by de Farias Aires and Ferreira [10] and also because, to our knowledge, only four papers were published on RRP in the TOPSIS method: (i) García-Cascales and Lamata [11] proposed modifications to the normalization procedure and the introduction of fictitious alternatives; (ii) Senouci, Mushtaq, Hoceini, and Mellouk [12] analyzed the effect of four normalization procedures on RRP; (iii) Mufazzal and Muzakkir [13] proposed the incorporation of two new measures called the Weighted Proximity Index and the Overall Proximity Value to minimize the RRP; and (iv) Cables, Lamata, and Verdegay [14] propose a new concept for an ideal solution called the Reference Ideal Method. These papers have presented interesting ideas and solutions, they have presented some limitations, such as: (i) they consider only the addition and removal of alternatives in order to evaluate cases of temperature. Therefore, they do not include an analysis on the important property of transitivity and other possible RR situations, as detailed in 2.2; (ii) they typically use case studies. This approach hinders the generalization of results; (iii) they have limited applications. For example, García-Cascales and Lamata [15] consider that all criteria must have the same range of values; (iv) some of the proposals do not solve the problem, for example, those by Senouci et al. [12] and Mufazzal and Muzakkir [13]; and (v) they include modifications to the method that may make them difficult for DMs to use, see, for example, Cables et al. [14].

In the following section II, we discuss briefly on fundamental terminologies involving TOPSIS methodology, and an algorithm associated with it. Section III contain the some parameter of the evaluation of Euclidean and weighted distance values of eight alternatives, the average linguistic performance of the temperature, warmth and crisp data of the city by account of the decision making processes, the linguistic weights for seven criteria, Section IV contains the application and result discussion and Section V contains conclusion of research work with future scope.

II. METHODOLOGY

The TOPSIS method is one of the most widely used multi-criteria decision analysis methods, see for example Behzadian et al. [16] and Ferreira, Borenstein, Righi [10]. This TOPSIS method was first developed by Hwang and Yoon in [4] and extended by Yoon (1987). In this method, the best alternative is the one nearest to the positive ideal solution (PIS) and farthest from the negative ideal solution (NIS). PIS is a hypothetical alternative that maximizes the benefit criteria and simultaneously minimizes the cost criteria. The alternative which has the least Euclidean distance from PIS while being farthest from NIS is the best one of all (Mufazzal & Muzakkir, [13]). With the above hypotheses, calculations involving eigenvector, square rooting and summations are used for obtaining a relative closeness value of the criteria tested. TOPSIS ranks these values of relative closeness of the whole system by assigning the highest value of the relative closeness to the best attributes in the system. By various linguistic rating applied to represent the performances under certain alternative criteria [17,18,19,20,21,22,23]. For calculation of TOPSIS values, we have to go through the following Algorithm.

III. ALGORITHM

Step-1 Let the Decision Matrix D,

$$D = A_\alpha \overset{C_\beta}{\left(x_{\alpha\beta}\right)}_{m\times n}$$

where A_α , $\alpha = 1,\cdots,m$ are alternatives and C_β , $\beta = 1,\cdots,n$ are criteria, $x_{\alpha\beta}$ are original scores indicates the rating of the alternative A_α with respect to criteria C_β . The weight vector $w = (w_1, w_2, \cdots, w_n)$ is composed of the individual weights w_β $(\beta = 1,2,\cdots,n)$ for each criteria C_β . Generally, the criteria are classified into two types: benefit and cost. The benefit criterion is higher value while a cost criterion is valid for opposite value.

Step-2 Define the normalized decision matrix $N_{\alpha\beta}$, where $N_{\alpha\beta} = x_{\alpha\beta} \Big/ \sqrt{\Sigma x_{\alpha\beta}^2}$ for $\alpha = 1,\cdots,m;\ \beta = 1,\cdots,n$, where $x_{\alpha\beta}$ and $N_{\alpha\beta}$ are original and normalized score of decision matrix, respectively.

Step-3 Define the weighted normalized decision matrix: $V_{\alpha\beta} = w_\beta N_{\alpha\beta}$, where w_β is the weight for β^{th} criteria and $\Sigma w_\beta = 1$.

Step-4 Define the positive ideal solution and negative ideal solution.

$$A^+ = \left(v_1^+, v_2^+, \cdots, v_n^+\right) \text{ and } A^- = \left(v_1^-, v_2^-, \cdots, v_n^-\right),$$

where $v_\beta^+ = \{\max_\alpha V_{\alpha\beta} \big| \beta \in J_1; \min_\alpha V_{\alpha\beta} \big| \beta \in J_2\}$

and $v_\beta^- = \{\min_\alpha V_{\alpha\beta} \big| \beta \in J_1; \max_\alpha V_{\alpha\beta} \big| \beta \in J_2\}$

where J_1 and J_2 represents the benefit criteria and cost criteria respectively.

Step-5 Calculate the Euclidean distances from the positive ideal A^+ and negative ideal A^- solutions for each alternative A_α respectively:

$$d_\alpha^+ = \sqrt{\Sigma_\beta\left(\Delta_{\alpha\beta}^+\right)^2} \quad \text{and} \quad d_\alpha^- = \sqrt{\Sigma_\beta\left(\Delta_{\alpha\beta}^-\right)^2}$$

where $\Delta_{\alpha\beta}^+ = \left(v_\beta^+ - V_{\alpha\beta}\right)$ and $\Delta_{\alpha\beta}^- = \left(v_\beta^- - V_{\alpha\beta}\right)$ with $\alpha = 1, \cdots, m$

Step-6 Determine the relative closeness Ω_α for each alternative A_α with respect to positive ideal solution A^+ as given by

$$\Omega_\alpha = d_\alpha^- / \left(d_\alpha^- + d_\alpha^+\right),$$

where $\alpha = 1, \cdots, m$.

IV. EVALUATION FRAMWORK

In the MCDM problem, a number of alternatives can determine and compared to using the different criteria. The aim of MCDM problem is to provide support to the decision-maker in the process of making the choice between alternatives. The ranking order of a set of alternatives according to their closeness coefficients and best alternative is found from the set of alternatives.

In Table-1 we define Negative Weighted Distance (NWD) for each alternative, Positive Weighted Distance (PWD) for each alternative, Negative Euclidean Distance (NED) for each alternative and Positive Euclidean Distance (PED) for each alternative.

Table 1. The Euclidean and Weighted Distance Values of Eight Alternatives

Alt.	NWD	PWD	NED	PED
AW1	v_1^-	v_1^+	d_1^-	d_1^+
AW2	v_2^-	v_2^+	d_2^-	d_2^+
⋮	⋮	⋮	⋮	⋮
AW8	v_8^-	v_8^+	d_8^+	d_8^-

V. APPLICATION

In this section, we work out a numerical example to illustrate the TOPSIS method for decision making problem with crisp data. Assume that eight weeks recorded temperature $AW1, AW2, \cdots\cdots, AW8$ are evaluated by crisp environment for operation performance against seven days criteria like, Sun, Mon, Tues, Wed, Thurs, Fri, Sat.. Suppose that we have seven criteria $CD1, CD2, \cdots\cdots, CD7$ are identified and eight alternatives $AW1, AW2, \cdots\cdots, AW8$ are identified as the evaluation criteria for these alternatives. TOPSIS method is proposed for evaluating the temperature of the summer session in the Odisha capital city Bhubaneswar, considering the different criteria and weights of the criteria. The proposed method is applied to solve this problem. Here two different problems are solved. One is to construct the maximum temperature of the city in summer session in the month of April and May. Other one is to construct the minimum temperature of the city in summer session in the month of April and May. Also both the temperature combining and solving by TOPSIS method and get the ranking order of the temperature performance of the city in summer session in 2018.

Table 2. The Decision Matrix and Weights of Eight Alternatives

Alt.\Cri.	CD1	CD2	CD3	CD4	CD5	CD6	CD7
AW1	36	32	35	35	33	35	36
AW2	34	36	34	36	36	37	38
AW3	40	41	41	38	38	37	39
AW4	39	39	38	40	38	37	37
AW5	37	37	32	35	36	35	37
AW6	36	35	37	37	38	38	38
AW 7	36	33	34	35	35	36	35
AW8	36	35	36	30	34	35	36
weight	0.21	0.15	0.32	0.1	0.05	0.12	0.11

Table 3. The Normalized Decision Matrix

Alt.\Cri.	CD1	CD2	CD3	CD4	CD5	CD6	CD7
AW1	0.3459	0.3133	0.344	0.3451	0.3237	0.3412	0.3438
AW2	0.3267	0.3525	0.3342	0.355	0.3531	0.3607	0.3629
AW3	0.3844	0.4015	0.403	0.3747	0.3727	0.3607	0.3725
AW4	0.3748	0.3819	0.3735	0.3944	0.3727	0.3607	0.3534
AW5	0.3555	0.3623	0.3145	0.3451	0.3531	0.3412	0.3534
AW6	0.3459	0.3427	0.3637	0.3649	0.3727	0.3705	0.3629
AW 7	0.3459	0.3231	0.3342	0.3451	0.3433	0.351	0.3343
AW8	0.3459	0.3427	0.3538	0.2958	0.3335	0.3412	0.3438

Table 4. The Weighted Normalized Decision Matrix

Alt.\Cri.	CD1	CD2	CD3	CD4	CD5	CD6	CD7
AW1	0.0726	0.047	0.1101	0.0345	0.0162	0.0409	0.0378
AW2	0.0686	0.0529	0.1069	0.0355	0.0177	0.0433	0.0399
AW3	0.0807	0.0602	0.129	0.0375	0.0186	0.0433	0.041
AW4	0.0787	0.0573	0.1195	0.0394	0.0186	0.0433	0.0389
AW5	0.0747	0.0543	0.1006	0.0345	0.0177	0.0409	0.0389
AW6	0.0726	0.0514	0.1164	0.0365	0.0186	0.0445	0.0399
AW 7	0.0726	0.0485	0.1069	0.0345	0.0172	0.0421	0.0368
AW8	0.0726	0.0514	0.1132	0.0296	0.0167	0.0409	0.0378

Table 5. For Ideal solution

Alt.\Cri.	CD1	CD2	CD3	CD4	CD5	CD6	CD7
AW1	0.0081	0.0132	0.0189	0.0049	0.0025	0.0035	0.0032
AW2	0.0121	0.0073	0.022	0.0039	0.001	0.0012	0.0011
AW3	0	0	0	0.002	0	0.0012	0
AW4	0.002	0.0029	0.0094	0	0	0.0012	0.0021
AW5	0.0061	0.0059	0.0283	0.0049	0.001	0.0035	0.0021
AW6	0.0081	0.0088	0.0126	0.003	0	0	0.0011
AW 7	0.0081	0.0118	0.022	0.0049	0.0015	0.0023	0.0042
AW8	0.0081	0.0088	0.0157	0.0099	0.002	0.0035	0.0032

Table 6. For Worst Solution

Alt.\Cri.	CD1	CD2	CD3	CD4	CD5	CD6	CD7
AW1	0.004	0	0.0094	0.0049	0	0	0.0011
AW2	0	0.0059	0.0063	0.0059	0.0015	0.0023	0.0032
AW3	0.0121	0.0132	0.0283	0.0079	0.0025	0.0023	0.0042
AW4	0.0101	0.0103	0.0189	0.0099	0.0025	0.0023	0.0021
AW5	0.0061	0.0073	0	0.0049	0.0015	0	0.0021
AW6	0.004	0.0044	0.0157	0.0069	0.0025	0.0035	0.0032
AW 7	0.004	0.0015	0.0063	0.0049	0.001	0.0012	0
AW8	0.004	0.0044	0.0126	0	0.0005	0	0.0011

Table 7. Closeness Coefficients

IS\Alt.	AW1	AW2	AW3	AW4	AW5	AW6	AW7	AW8
d_δ^+	0.0255	0.0265	0.0023	0.0104	0.0302	0.0176	0.0272	0.0227
d_δ^-	0.0114	0.0113	0.0348	0.026	0.011	0.0189	0.0092	0.014

Table 8. Ranking Order

Alt.	AW1	AW2	AW3	AW4	AW5	AW6	AW7	AW8
Ω_δ^+	0.3099	0.2978	0.9383	0.715	0.2671	0.5179	0.2531	0.3815
Rank	5	6	1	2	7	3	8	4

Table 9. The Decision Matrix and Weights of Seven Alternatives

Alt.\Cri.	CD1	CD2	CD3	CD4	CD5	CD6	CD7
AW1	21	21	23	21	19	25	23
AW2	22	24	22	24	25	22	26
AW3	24	26	27	25	26	28	27
AW4	28	26	23	25	27	27	25
AW5	22	23	21	25	23	25	27
AW6	28	28	28	28	25	27	26
AW7	21	22	22	23	21	27	25
AW8	23	22	28	23	25	28	28

Table 10. The Normalized Decision Matrix

Alt.\Cri.	CD1	CD2	CD3	CD4	CD5	CD6	CD7
AW1	0.3123	0.308	0.3332	0.3052	0.2798	0.3374	0.3138
AW2	0.3271	0.352	0.3187	0.3488	0.3682	0.2969	0.3547
AW3	0.3569	0.3813	0.3912	0.3634	0.3829	0.3779	0.3683
AW4	0.4163	0.3813	0.3332	0.3634	0.3976	0.3644	0.3411
AW5	0.3271	0.3373	0.3043	0.3634	0.3387	0.3374	0.3683
AW6	0.4163	0.4106	0.4057	0.407	0.3682	0.3644	0.3547
AW7	0.3123	0.3226	0.3187	0.3343	0.3093	0.3644	0.3411
AW8	0.342	0.3226	0.4057	0.3343	0.3682	0.3779	0.382

Table 11. The Weighted Normalized Decision Matrix

Alt.\Cri.	CD1	CD2	CD3	CD4	CD5	CD6	CD7
AW1	0.0312	0.0246	0.04	0.0214	0.042	0.027	0.0628
AW2	0.0327	0.0282	0.0382	0.0244	0.0552	0.0238	0.0709
AW3	0.0357	0.0305	0.0469	0.0254	0.0574	0.0302	0.0737
AW4	0.0416	0.0305	0.04	0.0254	0.0596	0.0292	0.0682
AW5	0.0327	0.027	0.0365	0.0254	0.0508	0.027	0.0737
AW6	0.0416	0.0328	0.0487	0.0285	0.0552	0.0292	0.0709
AW7	0.0312	0.0258	0.0382	0.0234	0.0464	0.0292	0.0682
AW8	0.0342	0.0258	0.0487	0.0234	0.0552	0.0302	0.0764

Table 12. For Ideal solution

Alt.\Cri.	CD1	CD2	CD3	CD4	CD5	CD6	CD7
AW1	0.0104	0.0082	0.0087	0.0071	0.0177	0.0032	0.0136
AW2	0.0089	0.0047	0.0104	0.0041	0.0044	0.0065	0.0055
AW3	0.0059	0.0023	0.0017	0.0031	0.0022	0	0.0027
AW4	0	0.0023	0.0087	0.0031	0	0.0011	0.0082
AW5	0.0089	0.0059	0.0122	0.0031	0.0088	0.0032	0.0027
AW6	0	0	0	0	0.0044	0.0011	0.0055
AW7	0.0104	0.007	0.0104	0.0051	0.0133	0.0011	0.0082
AW8	0.0074	0.007	0	0.0051	0.0044	0	0

Table 13. For Worst Solution

Alt.\Cri.	CD1	CD2	CD3	CD4	CD5	CD6	CD7
AW1	0	0	0.0035	0	0	0.0032	0
AW2	0.0015	0.0035	0.0017	0.0031	0.0133	0	0.0082
AW3	0.0045	0.0059	0.0104	0.0041	0.0155	0.0065	0.0109
AW4	0.0104	0.0059	0.0035	0.0041	0.0177	0.0054	0.0055
AW5	0.0015	0.0023	0	0.0041	0.0088	0.0032	0.0109
AW6	0.0104	0.0082	0.0122	0.0071	0.0133	0.0054	0.0082
AW7	0	0.0012	0.0017	0.002	0.0044	0.0054	0.0055
AW8	0.003	0.0012	0.0122	0.002	0.0133	0.0065	0.0136

Table 14. Closeness Coefficients

Alt.\Cri.	AW1	AW2	AW3	AW4	AW5	AW6	AW7	AW8
d_δ^+	0.0285	0.0178	0.0081	0.0126	0.0192	0.0071	0.0232	0.0123
d_δ^-	0.0048	0.0164	0.0241	0.0233	0.0152	0.0254	0.0093	0.0238

Table 15. Ranking Order

Alt.	AW1	AW2	AW3	AW4	AW5	AW6	AW7	AW8
Ω_δ^-	0.143	0.4793	0.7484	0.6491	0.4428	0.7816	0.2871	0.66
Rank	8	5	2	4	6	1	7	3

Table 16. General ranking order of maximum and minimum temperature of the city in month of April and May 2018

Alt.	AW1	AW2	AW3	AW4	AW5	AW6	AW7	AW8
Ω_δ	0.3158	0.6168	0.4437	0.4759	0.6237	0.6015	0.5315	0.6337
Rank	8	3	7	6	2	4	5	1

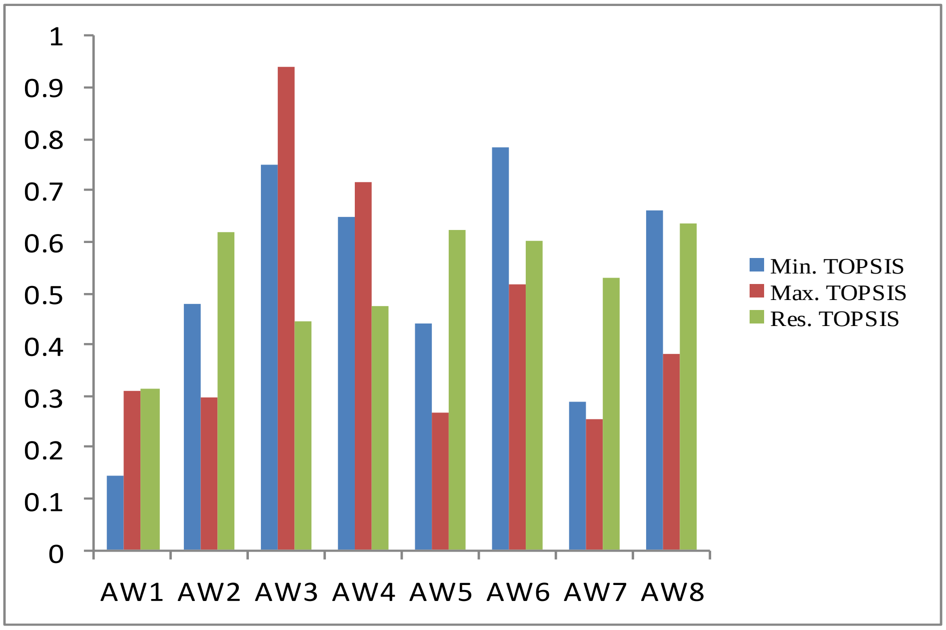

Figure 1. Ranking the Alternative with respect to Relative Closeness by applying the TOPSIS Decision Making

These data and also the vector of corresponding weight, of each criteria, the normalized decision matrix, weighted normalized decision matrix, for ideal solution, for worst solution are given in Table 2, Table 3, Table 4, Table 5, Table 6 and Table 9, Table 10, Table 11, Table 12, Table 13 respectively. The closeness coefficients, which are defined to determine the ranking order of all alternatives by calculating the distance to both the PIS and NIS, are given in Table 9 and Table 14 respectively. According to the closeness coefficient, ranking the order preference, order of these alternatives is also given in Table 10 and Table 15.

Table 16 shows the results obtained for the above example by using the proposed approach and Fig.1 shows the best temperature represented by using different criteria, and finite number of alternatives. So the ranking order of 8 weeks temperature is selected as follows:

$AW3 > AW7 > AW5 > AW4 > AW8 > AW2 > AW6 > AW1$

The best selection in the given alternatives, the selected week temperature is $AW3$.

VI. CONCLUSION AND FUTURE SCOPE

The solution of most of MADM problems include both quantitative and qualitative criteria which are often assessed using erroneous data and human awareness. Here we provide a thorough and precise review of the existing MADM methods. The input data and the algorithm of TOPSIS approach are discussed in steps. Here, consider the distance of PIS and NIS. In this paper, we propose a new methodology to provide a simple approach to find best alternative weeks based on temperature and help decision makers to select the best one of the among week.

There is enormous scope of research on TOPSIS in various directions. Several opportunities can be created involving the distance from the positive and negative solutions and the relative closeness to the ideal solution. Although several techniques have been earlier integrated with the TOPSIS, many other new techniques involving TOPSIS have not yet been explored.

ACKNOWLEDGMENT

We acknowledge the content of this article has been prepared as a part of research work carried out in C. V. Raman College of Engineering, Bhubaneswar.

REFERENCES

[1] M. R. Kirby. *A Methodology for Technology Identification, Evaluation, and Selection in Conceptual and Preliminary Aircraft Design.* PhD thesis, Aerospace Systems Design Laboratory, School of Aerospace Engineering, Georgia Institute of Technology, 2001.
[2] Y. Li. *An Intelligent Knowledge-based Multiple Criteria Decision Making Advisor for Systems Design.* PhD thesis, Aerospace Systems Design Laboratory, School of Aerospace Engineering, Georgia Institute of Technology, 2007.
[3] C.L. Hwang, K. Yoon, "*Multiple attribute decision making: Methods and Applications*", Springer-Verlag , 1981.
[4] C.T. Chen, "*Extensions of the TOPSIS for group decision-making under fuzzy environment*", Fuzzy Sets and Systems, Vol. 114, pp.01-09, 2010.
[5] D.L. Olson, "*Comparison of Weights in TOPSIS Models*", Mathematical and Computer Modelling, Vol. 40, pp.721-727, 2004.
[6] I. Ertugrul, N. Karakasoglu, "*Performance evaluation of Turkish cement firms with fuzzy analytic hierarchy process and TOPSIS methods*", Expert Systems with Applications, Vol. 36, pp.702-715, 2009.
[7] M. Ehrgott, J. Figueira, S. Greco, "Trends in Multiple Criteria Decision Analysis", Springer, 2010.
[8] V. Belton, T. J. Stewart, *Multiple Criteria Decision Analysis - An Integrated Approach*, Kluwer Academic Publishers, 2002.
[9] J.-W. Wang, C.-H. Cheng, H.K. Cheng, "*Fuzzy hierarchical TOPSIS for supplier selection*", *Applied Soft Computing*, Vol. 9, Issue 1, pp.377-386, 2009.
[10] L. Ferreira, D. Borenstein, M. B. Righi, A. T. de Almeida Filho, "*A fuzzy hybrid integrated framework for portfolio optimization in private banking*", Expert Systems with Applications, Vol. 92, pp. 350–362, 2018.
[11] M. S. García-Cascales, M. T. Lamata, "On rank reversal and TOPSIS method", Mathematical and Computer Modelling, Vol. 56(5–6), pp. 123–132, 2012.
[12] M. A. Senouci, M. S. Mushtaq, S. Hoceini, A. Mellouk, "TOPSIS-based dynamic approach for mobile network interface selection", Computer Networks, Vol. 107, pp. 304–314, 2016.
[13] S. Mufazzal, S. Muzakkir, "*A new multi-criterion decision-making (MCDM) method based on proximity indexed value for minimizing rank reversals*", Computers & Industrial Engineering, Vol. 119, pp. 427–438, 2018.
[14] E. Roszkowska, D. Kacprzak, "*The fuzzy saw and fuzzy TOPSIS procedures based on ordered fuzzy numbers*", Information Sciences, Vol. 369, pp. 564–584, 2016.
[15] E. Cables, M. Lamata, J. Verdegay, "Rim-reference ideal method in multicriteria decision-making", Information Sciences, pp. 1–10, 2016.
[16] M. Behzadian, S. Khanmohammadi Otaghsara, M. Yazdani, J. Ignatius, "*A state-of the-art survey of TOPSIS applications*", Expert Systems with Applications, Vol. 39(17), pp. 13051–13069, 2012.
[17] F. Herrera, E. Herrera-Viedma, J.L. Verdegay, "*A model of consensus in group decision making under linguistic assessments*", Fuzzy Sets and Systems, Vol. 78, pp. 73-87, 1996.
[18] J. Wang, S.Y. Liu, J. Zhang, "*An extension of TOPSIS for MCDM based on vague set theory*", Journal of System Science and System Engineering, Vol. 14, pp. 73-84, 2005.
[19] M. Delgado, J.L. Verdegay, M.A. Vila, "*Linguistic decision-making models*", International journal of Intelligent System, Vol. 7, Issue 5, pp. 479-492, 1992.
[20] P.K. Parida, S.K. Sahoo, B. Behera, "*Multi-criteria decision making models using fuzzy TOPSIS technique*", Journal of Altra-Scientist of Physical Sciences, Vol. 28, Issue 5, pp. 286-293, 2016.
[21] P.K. Parida, D. Mishra, B. Behera, "*Some generalised results on TOPSIS method involving Multi-attributes decision making problem*", International Journal of Computer Sciences and Engineering, Vol. 6, Issue 6, pp. 147-152, 2018.
[22] R.A. Krohling, G.C.P. Andre, "*A-TOPSIS-An approach based on TOPSIS for ranking evolutionary algorithms*", Procedia Computer Science, Vol. 55, pp. 308-317, 2015.
[23] T.C. Chu, Y.C. Lin, "*Improved extensions of the TOPSIS for group decision making under fuzzy environment*", Journal of Information and Optimization Sciences, Vol. 23, pp. 273-286, 2013.

Authors Profile

Mr. P K Parida pursed Bachelor of Science from Utkal University, India in 1998 and Master of Science from F.M. University in year 2000. Also, he was completed Master of Philosophy from Sambalpur University in year 2004 and Ph.D. from Sambalpur University in the 2010, India. He is currently working as Assistant Professor in Department of Mathematics, C V Raman (Auto.) College of Engineering, Bhubaneswar, India. He has published more than 17 research papers in reputed national & international journals including Thomson Reuters (SCI & Web of Science). His main research work focuses on Fuzzy Optimization, Soft Computing, Cosmology and Managment based education. He has 13 years of teaching experience and 9 years of Research Experience.