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Multi Criteria Decision Making For Selecting the Best Laptop

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Abstract : Decision making is a sub-discipline of operation research. Multi criteria decision making is one of the important method which plays a vital role in day today life. The Technique for Order Preference by Similarity Ideal Solution (TOPSIS) is one of the best approaches for such multi criteria decision making problem. So, the aim of this paper is to extend the TOPSIS method for decision making problems. By extension of TOPSIS method, an algorithm is proposed to determine the most preferable choice of the Laptop with possible features. The procedure is illustrated through the example.

Keywords : MCDM, TOPSIS, Mining.

1. INTRODUCTION

Multi-criteria decision making has been one of the fastest growing areas during the last decades depending on the changings in the business sector. Decision maker(s) need a decision aid to decide between the alternative and mainly excel less preferable alternatives fast. With the help of computers the decision making methods have found great acceptance in all areas of the decision making processes. Since multi criteria decision making (MCDM) has found acceptance in areas of operation research and management science, the discipline has created several methodologies. Especially in the last years, where computer usage has increased significantly, the application of MCDM methods has considerably become easier for the users the decision makers as the application of most of the methods are corresponded with complex mathematics. In discrete alternative multi criteria decision problems, the primary concern for the decision aid is the following:

1. Choosing the most preferred alternative to the decision maker (DM),
2. Ranking alternatives in order of importance for selection problems, or
3. Screening alternatives for the final decision.

The general concepts of domination structures and non-dominated solutions play an important role in describing the decision problems and the decision maker's revealed preferences described above [10]. So far, various approaches have been developed as the decision aid (see, for example [9]). That is, for many such problems, the decision maker wants to solve a multiple criteria decision making (MCDM) problem. In MCDM problems, there does not necessarily exist the solution that optimizes all objectives functions, and then the concept which is called Pareto optimal solution (or effcient solution) is introduced. Usually, there exist a number of Pareto optimal solutions, which are considered as candidates of final decision making solution. It is an issue how decision makers decide one from the set of Pareto optimal solutions as the final solution (see, for more details [6]). A MCDM problem can be concisely expressed in matrix format as

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	C_1	C_2	...	C_n
A_1	x_{11}	x_{12}	...	x_{1n}
A_2	x_{21}	x_{22}	...	x_{2n}
A_m	x_{m1}	x_{m2}	...	x_{mn}

where $A_1, A_2, \ldots, A_m$ are possible alternatives among which decision makers have to choose, $C_1, C_2, \ldots, C_n$ are criteria with which alternative performance are measured, x_{ij} is the rating of alternative A_i with respect to criterion C_j, w_j is the weight of criterion C_j.

The main steps of multiple criteria decision making are the following:

(*a*) establishing system evaluation criteria that relate system capabilities to goals;

(*b*) developing alternative systems for attaining the goals (generating alternatives);

(*c*) evaluating alternatives in terms of criteria (the values of the criterion functions);

(*d*) applying a normative multi criteria analysis method;

(*e*) accepting one alternative as ‘‘optimal’’ (preferred);

(*f*) if the final solution is not accepted, gather new information and go into the next iteration of multi criteria optimization.

Steps (*a*) and (*e*) are performed at the upper level, where decision makers have the central role, and the other steps are mostly engineering tasks. For step (*d*), a decision maker should express his/her preferences in terms of the relative importance of criteria, and one approach is to introduce criteria weights. This weights in MCDM do not have a clear economic significance, but their use provides the opportunity to model the actual aspects of decision making (the preference structure). Technique for order performance by similarity to ideal solution (TOPSIS) [7], one of known classical MCDM method, was first developed by Hwang and Yoon [4] for solving a MCDM problem. TOPSIS, known as one of the most classical MCDM methods, is based on the idea, that the chosen alternative should have the shortest distance from the positive ideal solution and on the other side the farthest distance of the negative ideal solution. The TOPSIS-method will be applied to a case study, which is described in detail. In classical MCDM methods, the ratings and the weights of the criteria are known precisely [3,4]. A survey of the methods has been presented in Hwang and Yoon [4]. In the process of TOPSIS, the performance ratings and the weights of the criteria are given as exact values. Recently, Abosinna and Amer [1] extend TOPSIS approach to solve multi-objective nonlinear programming problems. Jahanshahloo et al. [5] extend the concept of TOPSIS to develop a methodology for solving multi-criteria decision-making problems with interval data.

2. ALGORITHM FOR THE PROPOSED METHOD

To select the best Laptop through the multi criteria decision making the following steps are followed.

Step 1: Construct a decision matrix consisting of m alternatives and n criteria in the form of $(x_{ij})_{m \times n}$.

Step 2: Construct a normalized decision matrix, $R = (r_{ij})_{m \times n}$,

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{n}(x_{ij})}}, \; i = 1 \text{ to } m, \; j = 1 \text{ to } n$$

Step 3: Form the weighted normalized decision matrix

$$V = (v_{ij})_{m \times n} = (w_j . r_{ij})_{m \times n}, \; i = 1 \text{ to } m, \; j = 1 \text{ to } n$$

and

$$w_j = \frac{w_j}{\sum_{j=1}^{n} W_j}$$

So that $\sum_{j=1}^{n} W_j = 1$ & W_j is the original weight given to the indicator.

Step 4: Determine the positive ideal solution s^+ and negative ideal solution s–

$$S^+ = \{\min_i v_{ij} \,/\, j \in j^-, \min_i v_{ij} \,/\, j \in j^+\}$$

Where j^+ is associated with benefit criteria and j- is associated with cost criteria.

Step 5: Calculate the L2 distance between the target alternative i and s^+

$$d_{i+} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{j+})^2}, \quad i = 1 \text{ to } m \text{ and}$$

the distance between the alternative i and s^-

$$d_{i-} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{j-})^2}, \quad i = 1 \text{ to } m \text{ and}$$

Step 6 : Calculate the relative closeness c_i^* , to the ideal solution where

$$C_i^* = \frac{d_{i-}}{d_{i+} + d_{i-}}, \quad i = 1 \text{ to } m \text{ where } 0 \le c_i^* \le 1$$

The larger the index value, the better the performance of the alternative.

Step 7: Rank the preference order according to the descending order of the value of c_i^*, set of alternatives can be preference ranked.

3. NUMERICAL EXAMPLE

Here we consider a problem for selection of a Laptop among the four alternatives, based on four criteria as specified in Table 1. Table 1. Contains the data which are collected from 30 individuals in that 15 are PG students, 10 are teaching faculties and 5 are computer lab technicians.

Table 1

Problem Specification

	Design or Style	*Tech support*	*Memory*	*Reviews*
Laptop 1	Good	Excellent	Excellent	28/30
Laptop 2	Better	Good	Better	23/30
Laptop3	Good	Better	Good	16/30
Laptop4	Excellent	Good	Good	24/30

Formation of Decision matrix of the problem of Laptop comparison is viewed in Table 2.Normalised Decision matrix is formed in Table 3followed by weighted normalized decision matrix.

Table 2

Decision Matrix

	Design or Style	*Tech support*	*Memory*	*Reviews*
Laptop 1	6	9	9	9
Laptop 2	8	6	8	7
Laptop 3	6	7	7	5
Laptop 4	9	6	7	8

Table 3

Normalised Matrix

	Design or Style	*Tech support*	*Memory*	*Reviews*
Laptop 1	0.40738	0.6333	0.5773	0.6081
Laptop 2	0.5431	0.4222	0.5131	0.4729
Laptop3	0.4073	0.4926	0.4490	0.3378
Laptop4	0.6109	0.4222	0.4490	0.5405

Table 4

Weighted Normalised Matrix

W_i	6	3	4	7
W_j	0.3	0.15	0.2	0.35
	Design or Style	Tech support	Memory	Reviews
Laptop 1	0.1222	0.0949	0.1155	0.2128
Laptop 2	0.1629	0.0633	0.1026	0.1655
Laptop 3	0.1222	0.0739	0.0898	0.1182
Laptop 4	0.1833	0.0633	0.0898	0.1892

Table 5

Final Preference Order

d_{i+}	0.1228	01479	0.0674	0.1759
d_{i-}	0.3006	0.26792	0.1257	0.3364
C_i^*	0.40851634	0.549405696	0.536197295	0.522889422
Preference order	4	1	2	3

The distance (d_{i+}) between alternative i and PIS, thedistance (d_{i-}) between alternative *i* and NIS along with the closeness coefficient and the final preference orderis given in Table 5. From the table, Laptop 2 hasthe highest closeness coefficient. Therefore, it is thebest Laptop.

4. CONCLUSION

In this paper, we have applied the multi-criteria decision making method TOPSIS for selecting the best Laptop. Different weightages are given for each feature of the Laptop. The rankings are prepared, based on our evaluation process. The ranking order generated by TOPSIS method shows that the Laptop 2 is the best alternative. TOPSIS is an efficient MCDM method, simpler and faster than most other methods. When the number of criteria or alternatives are more TOPSIS method can be considered as more feasible in comparison with other methods.

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