Research Paper Mathematics

Selection of Best Smartphone Using Multi-Criteria Decision Making Method

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ABSTRACT

- Multi-Criteria Decision Making (MCDM) is a sub-discipline of Operations Research which deals with decision problems under the presence of a number of criteria. A typical MCDM problem involves the evaluation of a set of alternatives in terms of a set of decision criteria. Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is one of the popular multi-criteria decision-making method. It is based on the concept that the best alternative should have the shortest distance from the ideal solution and the farthest distance from the negative ideal solution. In this paper we have described TOPSIS method to determine the preference order of the set of smart phones based on their various features.

KEYWORDS : MCDM, TOPSIS.

INTRODUCTION

Multi-criteria decision making problem is used to evaluate a set of alternatives by decision making which involves several considerations like the risks, the costs ,benefits of making the right decision and the penalties of wrong decision in real life situations. MCDM method plays a vital role in analyzing such problems.

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a popular method used for MCDM. In TOPSIS method we use Euclidean distance approach to evaluate the relative closeness of alternatives to the ideal solution which gives the order of preference based on relative distances. TOPSIS method has been implemented for various selection processes, such as selection of grippers in flexible manufacturing [1],[2], selection of robotic processes [3],[4],[5] and manufacturing processes [6] and financial investment[7]. TOPSIS Method was proposed by Hwang and Yoon [8] in 1981 and was further improved by K. Yoon and C.L. Hwang [9] and Y.J. Lai, T. Y. Liu and C. L. Hwang [10].

Here, we apply TOPSIS to select the best smart phone based on five criteria from five smart phones.

TOPSIS METHOD

The following are the steps involved in TOPSIS Method.

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

Step 2: Construct the normalized decision matrix,

$$R = (r_{ij})_{m\times n} \quad (1)$$

$$\text{where } r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{n}(x_{ij})^2}}, \quad (2)$$

i = 1 to m, j= 1 to n.

Step 3: Form the weighted normalized decision matrix,

$$V = (v_{ij})_{m\times n} = (w_j r_{ij})_{m\times n}, \quad (3)$$

i = 1 to m, j= 1 to n,

$$\text{where } w_j = \frac{w_j}{\sum_{j=1}^{n} w_j} \quad (4)$$

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

Step 4: Determine the Positive Ideal Solution(PIS) , S^+ and the Negative Ideal Solution (NIS), S^-.

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

$$= \{ v_{j+} / j = 1 \text{ to } n \} \quad (5)$$

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

$$= \{ v_{j-} / j = 1 \text{ to } n \} \quad (6)$$

where, $j^+$is associated with benefit criteria and j^- is associated with cost criteria.

Step 5 : Calculate the L_2 distance between the target alternative i and S^+,

$$d_{i+} = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_{j+})^2} \quad , \qquad (7)$$

$i = 1\ to\ m\ \ and$

the distance between the alternative i and S^-

$$d_{i-} = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_{j-})^2} \quad , \ i = 1\ to\ m \qquad (8)$$

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

$$C_I^* = {d_{i-}}/{d_{i+} + d_{i-}} \quad , \qquad (9)$$

$i = 1\ to\ m$ where $0 \leq C_i^* \leq 1$.

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

NUMERICAL EXAMPLE

Here we consider a problem for selection of a smart phone (Sph) among five alternatives, based on five criteria as specified in Table 1. The selected criteria are Purchase Price (PP),Battery Life (BL), Internal Storage (IS), Camera (CM) and Display Resolution (DR).

TABLE 1. PROBLEM SPECIFICATIONS

	Sph1	Sph2	Sph3	Sph4	Sph5
Purchase Price	15599	19000	14500	21000	17500
Battery Life (hrs)	17	18	20	19	24
Internal Storage (GB)	16	32	16	64	16
Camera (MP)	13	21	13	21	16
Display Resolution (Pixel)	720 x 1280	1080 x 1920	720 x 1280	1080 x 1920	1080 x 1920

Formation of Decision matrix of the problem of smart phone comparison is viewed in Table 2. Normalised Decision matrix is formed in Table 3 followed by Weighted normalized decision matrix. In Table 4, underlined values indicate positive ideal solution and the bold values indicate negative ideal solution. The lowest values for purchase price, and highest value for other criteria are considered as positive ideal solution and reverse for the negative ideal solution.

TABLE 2. DECISION MATRIX

	Purchase Price (PP)	Battery Life (hrs)	Internal Storage (GB)	Camera (MP)	Display Res. (Pixel)
Sph1	15599	17	16	13	921600
Sph2	19000	18	32	21	2073600
Sph3	14500	20	16	13	921600
Sph4	21000	19	64	21	2073600
Sph5	17500	24	16	16	2073600

TABLE 3. NORMALISED MATRIX

	PP	BL	IS	CM	DR
Sph1	0.3947	0.3849	0.2085	0.3383	0.2412
Sph2	0.4807	0.4076	0.4170	0.5466	0.5427
Sph3	0.3669	0.4529	0.2085	0.3383	0.2412
Sph4	0.5313	0.4302	0.8340	0.5466	0.5427

Sph5	0.4428	0.5434	0.2085	0.4164	0.5427

TABLE 4. WEIGHTED NORMALISED MATRIX

Wj	5	3	6	4	7
Wj	0.2	0.12	0.24	0.16	0.28
	PP	BL	IS	CM	DR
Sph1	0.0789	0.0462	0.0500	0.0541	0.0675
Sph2	0.0961	0.0489	0.1000	0.0874	0.1519
Sph3	0.0733	0.0543	0.0500	0.0541	0.0675
Sph4	0.1062	0.0516	0.2001	0.0874	0.1519
Sph5	0.0885	0.0652	0.0500	0.0666	0.1519

The distance (di+) between alternative i and PIS, the distance (di-) between alternative i and NIS along with the closeness coefficient and the final preference order is given in Table 5. From the table, Smartphone-4 has the highest closeness coefficient. Therefore, it is the best smart phone.

TABLE 5. FINAL PREFERENCE ORDER

	Distance between alternative and pis	Distance between alternative and nis	Closeness coeff.	Pre. order
Sph1	0.1765	0.0273	0.1340	5
Sph2	0.1039	0.1041	0.5005	2
Sph3	0.1757	0.0338	0.1616	4
Sph4	0.0355	0.1755	0.8314	1
Sph5	0.1523	0.0892	0.3693	3

CONCLUSION

We have applied the multi-criteria decision-making method TOPSIS for selecting the best smart phone. Different weightages are given for each feature of the smart phone. The phone rankings are prepared, based on our evaluation process. The ranking order generated by TOPSIS method shows that smart phone 4 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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