Selection of City using MCDM Technique

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Abstract: ***Selection of city, the process of determining the best city which is able to provide the decision maker with the educational facility, medical facility, beauties and things are available at right cost. In other words, selection of city is a multi-criteria decision making problem which includes both qualitative and quantitative factors. In order to choose the best criteria, it is essential to make a relation between these tangible and intangible factors, some of which may conflict. The aim of this study is to develop a methodology to evaluate best criteria in multiple choice by using MCDM Technique which is based on Technique for Order Preference by Similarity to Ideal Solution method (TOPSIS). In this paper, I have taken into consideration some important criteria which affect the process of city selection, that is, educational facility, medical facility, beauties and things are available at right cost. The entire methodology is illustrated with the help of a numerical example. In this paper some cities are considered with different attributes and select the best city using TOPSIS technique.***

Keywords: Multi-criteria decision making, selection of city, Technique for Order Preference by Similarity to Ideal Solution method (TOPSIS), Normalized decision matrix, Positive and Negative Ideal solutions.

1. Introduction

In order to maintain a competitive position in the global market, decision makers have to follow strategies to achieve best educational facility, best medical facility, beauties of the city and things are available at reduced costs. Therefore, decision makers play a key role in achieving competitiveness, and as a result of this, selecting the right criteria is a critical component of these new strategies. Several conflicting quantitative and qualitative factors or criteria like educational facility, medical facility, beauties and things are available at right cost, affect decision makers selection problem. Therefore, it is a multi-criteria decision making problem that includes both quantitative and qualitative factors, some of which conflict to each other. Increases and varieties of customer demands, advances of recent technologies in medical and educational systems, competition in global environment, decreases in governmental regulations, and increases in environmental consciousness. Besides, selection of criteria is a complicated process by the facts that numerous criteria must be considered in the decision making process. Research results indicate that criteria selection process is one of the most significant method. On the other hand, selection of criteria i.e. decision making problem involves among multiple criteria that involve both quantitative and qualitative factors, which may also be conflicting. In this paper, we have identified some effective criteria which affect the process of criteria selection. We have calculated the weights for each criterion and inputted those weights to the TOPSIS method to rank cities.

TOPSIS is one the selection procedure technique is adopted for this problem. This technique provides a base for decision-making processes where there are limited numbers of choices but each has large number of attributes. In this paper some cities are considered with educational facility, medical facility, beauties and things are available at right cost and select the best option using TOPSIS technique.

2. Methodology

The objective of this work is to develop TOPSIS method for selection of city. In order to comply with collecting quantitative and qualitative data for TOPSIS best selection model that could be applied by a seven steps approach was performed to ensure successful implementation.

Selection criteria

Choosing a city is a big decision-making problem and reflection of decision makers preference. Decision makers choice must be made among several criteria like educational facility, medical facility, beauties and things are available at right cost for a given problem, it is necessary to compare in proper manner [3]. Some of the main criteria of four cities are educational facility, medical facility, beauties and things are available at right cost. The importance of these criteria is commonly known and thus not elaborated.

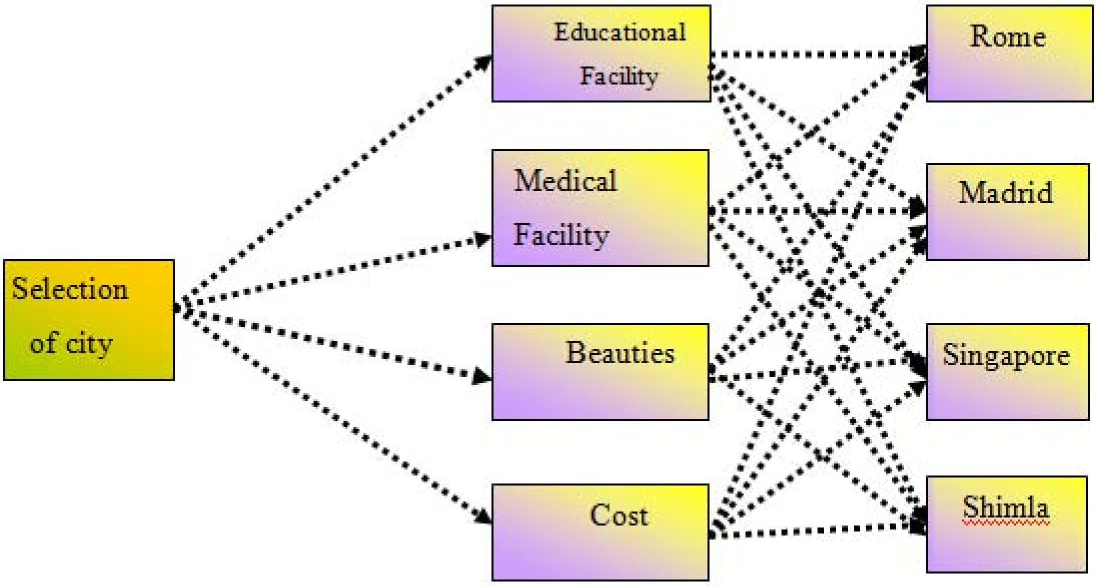

Figure 1: Selection criteria of TOPSIS

TOPSIS Method

TOPSIS was first presented, for solving Multiple Criteria Decision Making (MCDM) [1] problems based on the concept that the chosen alternative should have the shortest Euclidian distance from the Positive Ideal Solution (PIS) and the farthest from the Negative Ideal Solution (NIS). For instance, PIS maximizes the benefit and minimizes the cost, whereas the NIS maximizes the cost and minimizes the benefit. It assumes that each criterion require to be maximized or minimized.

TOPSIS is a simple and useful technique for ranking a number of possible alternatives according to closeness to the ideal solution[2]. The TOPSIS procedure is based on an intuitive and simple idea, which is that the optimal ideal solution, having the maximum benefit, is obtained by selecting the best alternative which is far from the most unsuitable alternative, having minimal benefits [6]. The ideal solution should have a rank of 1 (one), while the worst alternative should have a rank approaching 0 (zero). As ideal criteria are not probable and each alternative would have some intermediate ranking between the ideal solution extremes. Regardless of absolute accuracy of rankings, comparison of number of different criteria under the same set of selection criteria allows accurate weighting of relative distances suitability and hence best criteria selection. Mathematically the application of the TOPSIS method involves the following steps.

Step 1: Establish the decision matrix:
The first step of the TOPSIS method involves the construction of a Decision Matrix (D).

$$D = \begin{pmatrix} & C_1 & C_2 \cdots\cdots & C_j \cdots\cdots C_n \\ A_1 & x_{11} & x_{12} \cdots\cdots & x_{1j} \cdots\cdots x_{1n} \\ A_2 & x_{21} & x_{22} \cdots\cdots & x_{2j} \cdots\cdots x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ A_i & x_{i1} & x_{i2} \cdots\cdots & x_{ij} \cdots\cdots x_{in} \\ \cdots & \cdots & \cdots & \cdots \\ A_m & x_{m1} & x_{m2} \cdots\cdots & x_{mj} \cdots\cdots x_{mn} \end{pmatrix} \quad \text{.....(1)}$$

Where i is the criterion index (i = 1 . . . m); m is the number of potential sites and j is the alternative index (j= 1 . . . n). The elements C_1, C_2…, C_n refer to the criteria: while A_1, A_2…, A_n refer to the alternative locations. The elements of the matrix are related to the values of criteria i with respect to alternative j.

Step 2: Calculate a normalised decision matrix:
The normalized values denote the Normalized Decision Matrix (ND) which represents the relative performance of the generated design alternatives.

$$ND = R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad \text{.............. (2)}$$

Step 3: Determine the weighted decision matrix:
Not all of the selection criteria may be of equal importance and hence weighting were introduced from AHP (Analytical Hierarchy Process) technique to quantify the relative importance of the different selection criteria. The weighting decision matrix is simply constructed by multiply each element of each column of the normalized decision matrix by the random weights.

$$V = V_{ij} = W_j \times R_{ij} \quad \text{............... (3)}$$

Step 4: Identify the Positive and Negative Ideal Solution:

The positive ideal (A^+) and the negative ideal (A^-) solutions are defined according to the weighted decision matrix by equations (4) and (5) below

$$PIS = A^+ = \{ V_1^+, V_2^+ \ldots\ldots\ldots V_n^+ \}, \quad \ldots\ldots.(4)$$

where: $V_j^+ = \{(\max_i (V_{ij}) \text{ if } j \in J);(\min V_{ij} \text{ if } j \in J') \}$

$$NIS = A^- = \{ V_1^-, V_2^- \ldots\ldots\ldots V_n^- \}, \quad \ldots\ldots.(5)$$

where: $V_j^- = \{(\min_i (V_{ij}) \text{ if } j \in J);(\max V_{ij} \text{ if } j \in J') \}$

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

Step 5: Calculate the separation distance of each competitive alternative from the ideal and non- ideal solution:

$$S^+ = \sqrt{\sum_{j=1}^{n} (V_j^+ - V_{ij})^2} \; i = 1, \ldots. m \ldots\ldots\ldots\ldots(6)$$

$$S^- = \sqrt{\sum_{j=1}^{n} (V_j^- - V_{ij})^2} \; i = 1, \ldots. m \ldots\ldots\ldots\ldots(7)$$

Where, i = criterion index, j = alternative index.

Step 6: Measure the relative closeness of each location to the ideal solution:

For each competitive alternative the relative closeness of the potential location with respect to the ideal solution is computed.

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}, \qquad 0 < C_i < 1 \qquad .(8)$$

Step 7: Rank the preference order:

According to the value of C_i the higher the value of the relative closeness, the higher the ranking order and hence the better the performance of the alternative. Ranking of the preference in descending order thus allows relatively better performances to be compared.

Input Tables

Table 1: Elements of the Decision matrix

Alternatives	Criteria			
	Educational Facility	Medical Facility	Beauties	Cost
Rome	6	7	8	6
Madrid	8	7	8	7
Singapore	7	9	9	8
Shimla	9	6	8	9
Weights	0.1	0.4	0.3	0.2

3. Results

After taking the decision matrix from selection criteria, first we had to do normalise decision matrix by equation (2).

$R_{13} = 7/ (8^2 + 6^2 + 9^2)^{1/2} = 0.46$

$R_{23} = 9/ (7^2 + 7^2 + 6^2)^{1/2} = 0.61$

$R_{33} = 9/ (8^2 + 8^2 + 8^2)^{1/2} = 0.54$

$R_{43} = 8/ (6^2 + 7^2 + 9^2)^{1/2} = 0.53$

Table 2: Normalised values of Decision matrix

Alternatives	Criteria			
	Educational Facility	Medical Facility	Beauties	Cost
Rome	0.40	0.48	0.48	0.40
Madrid	0.53	0.48	0.48	0.46
Singapore	0.46	0.61	0.54	0.53
Shimla	0.59	0.41	0.48	0.59

Then it is multiplied with weight criteria.

Then

$V_{13} = 0.1 \times 0.46 = 0.046$

$V_{23} = 0.4 \times 0.61 = 0.244$

$V_{33} = 0.3 \times 0.54 = 0.162$

$V_{43} = 0.2 \times 0.53 = 0.106$

Table 3: Weighted values of Decision matrix

Alternatives	Criteria			
	Educational Facility	Medical Facility	Beauties	Cost
Rome	0.40	0.192	0.144	0.080
Madrid	0.53	0.192	0.144	0.092
Singapore	0.46	0.244	0.162	0.106
Shimla	0.59	0.164	0.144	0.118

The positive ideal (A^+) and the negative ideal (A^-) solutions are defined according to the weighted decision matrix by equations, where J is associated with the beneficial attributes and J' is associated with the non-beneficial attributes. Then we calculate the separation distance of each competitive alternative from the ideal and non-ideal solution.

Table 4: Positive ideal solution and Negative ideal solution

	Educational Facility	Medical Facility	Beauties	Cost
A+	0.59	0.244	0.162	0.080
A-	0.40	0.164	0.144	0.118

Therefore,

$S^+ = \{0.058; 0.057; 0.029; 0.090\}$ by (6)

$S^- = \{0.047; 0.040; 0.083; 0.019\}$ by (7)

For each competitive alternative the relative closeness of the potential location with respect to the ideal solution is computed,

$C_i = \{0.45; 0.41; 0.74; 0.17\}$ by (8)

Therefore the maximum value is the best one. If the value is lesser than the value of 1, then it is acceptable condition.

4. Conclusions

We have proposed a group TOPSIS model for decision making. After checking the aggregations under various circumstances, we can see that the model is rather simple to use and meaningful for aggregation, and it will not cause more computational burden than the original TOPSIS [7] [8]. In addition, example has demonstrated the model is efficient and robust. It is quite good for real-world applications.

The proposed new procedure for selection of city is to find the best city among available ones using of decision making method. After checking the aggregations on various process parameters under different circumstances, it is observed that the proposed model is rather simple to use and meaningful for aggregation of the process parameters [4][5]. TOPSIS is applied to achieve final ranking preferences in descending order; thus allowing relative performances to be compared [9].

- From the results it is observed that best educational facility, best medical facility, beauties of the city and things are available at reduced costs obtained the relative closeness to ideal solution and the values are 0.45, 0.41, 0.74 and 0.17 respectively.

- It is observed Singapore is identified as the best city among the considered ones which has the best relative closeness value.

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