A New Car Selection in the Market using TOPSIS Technique

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Abstract— Now days purchasing of automobiles i.e, especially cars in the market is very tough task to the customers due to day to day changes in various technical and operational parameter specifications like style, life span, fuel economy, suspension and cost etc. Therefore to overcome from this confusion state some selection procedure techniques are required. 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 cars are considered with different attributes and select the best car using TOPSIS technique.

Keywords— TOPSIS, MCDM, Car Selection, Normalized decision matrix, Positive and Negative Ideal solutions, Relative closeness, Ranking.

INTRODUCTION

The selection of automobile is crucial for the purchaser due to the confusion created by fake publicity of the dealers. Choosing just the right one becomes a critical decision making problem. The possible budget is then a constraint in the decision on which car to buy. Other important criteria's while selection include: fuel economy, comfort and convenience features, life span, suspension, style and cost. An appropriate decision-making method for selecting the best car is useful to both customers and manufacturers.

LITERATURE REVIEW

Hwang and Yoon (1981) proposed that the ranking of alternatives will be based on the shortest distance from the Positive Ideal Solution (PIS) and the farthest from the Negative Ideal Solution (NIS). Hsu-Shih Shiha, et al (2007) investigated on extension of a Multi-Attribute Decision Making (MADM) technique, to a group decision environment. MajidBehzadian, et al (2012) had given review on state-of the-art survey of "Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)" applications.

METHODOLOGY

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

Selection criteria

Buying a new car is a big decision-making problem and reflection of customer preference. Customer choice must be made among several cars for a given application, it is necessary to compare their performance characteristics in proper manner [1]. Some of the main criteria's of four wheelers are fuel economy, quality, life span, style, engine power, engine limits, and dimensions of the car and cost of the car. The importance of these criteria is commonly known and thus not elaborated.

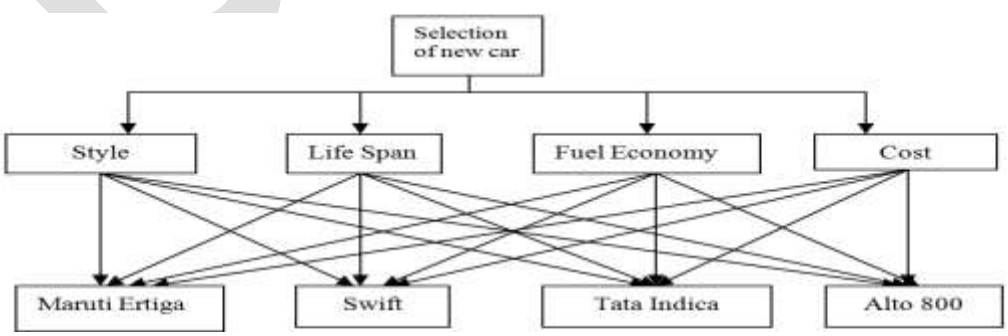

Fig.1. Selection criteria of TOPSIS

TOPSIS Method

TOPSISwas first presented by Yoon (1980) and Hwang and Yoon (1981), for solving Multiple Criteria Decision Making (MCDM) 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.

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 [3]. The ideal solution should have a rank of '1' (one), while the worst alternative should have a rank approaching '0' (zero). As ideal cars 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 cars under the same set of selection criteria allows accurate weighting of relative car suitability and hence optimal car 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 (DM).

$$DM = \begin{array}{c} \\ L_1 \\ L_2 \\ \vdots \\ L_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} \text{----------- (1)}$$

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 $C_{1,}$ $C2_{…,}$ C_n refer to the criteria: while L_1, $L_{2…,}$ $L_n$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 (NDM) which represents the relativeperformance of the generated design alternatives.

$$NDM = R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} X^2{}_{ij}}} \text{----------- (2)}$$

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. Theweighting decision matrix is simply constructed by multiply each element of each column of the normalized decision matrix by the random weights.

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

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 via equations (4) and (5) below

$$PIS = A^+ = \{ V_1^+, V_2^+ \ldots, V_n^+ \}, \text{ where: } V_j^+ = \{(\max_i (V_{ij}) \text{ if } j \in J); (\min_i V_{ij} \text{ if } j \in J') \} \text{ ------------ (4)}$$

$$NIS = A^- = \{ V_1^-, V_2^- \ldots, V_n^- \}, \text{ where: } V_j^- = \{(\min_i (V_{ij}) \text{ if } j \in J); (\max_i V_{ij} \text{ if } j \in J') \} \text{ ------------ (5)}$$

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- idealsolution.

$$S^{+} = \sqrt{\sum_{j=1}^{n} (V^{+}_{j} - V_{ij})^2} \quad i = 1,\ldots, m \qquad \text{--------- (6)}$$

$$S^{-} = \sqrt{\sum_{j=1}^{n} (V^{-}_{j} - V_{ij})^2} \quad i = 1,\ldots, m \qquad \text{--------- (7)}$$

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

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

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

$$C_i = S_i^- / (S_i^+ + S_i^-),\ 0 \le C_i \le 1 \qquad \text{--------- (8)}$$

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 orderand hence the better the performance of the alternative. Ranking of the preference in descending order thusallows relatively better performances to be compared.

INPUT TABLES

Table 1: Criterion Parametric values

Attributes		Alternatives			
		MarutiErtiga	Swift	Tata Indica	Alto800
Fuel Economy	City	18kmph	15.2kmph	20kmph	16kmph
	Highway	22.2kmph	18.6kmph	24kmph	21.7kmph
Style		Better	Extreme	Good	Good
Life Span in Average		10yrs	12yrs	10yrs	8yrs
Cost (Rs)		5.99 -8.77 lakhs	4.58 - 6.9 lakhs	4.20-5.3 lakhs	2.5 – 3.6 lakhs

Table 2:Elements of the Decision matrix

Alternatives	Criteria's			
	Style	Lifespan	Fuel economy	Cost
MarutiErtiga	6	7	8	6
Swift	8	7	8	7
Tata Indica	7	9	9	8
Alto800	9	6	8	9
Weights	0.1	0.4	0.3	0.2

RESULTS

- After taking the decision matrix from selection criteria, first we had to do normalise decision matrix. According to formula R_{ij} is written as (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 3: Normalised values of Decision matrix

Alternatives	Criteria's			
	Style	Lifespan	Fuel economy	Cost
MarutiErtiga	0.40	0.48	0.48	0.40
Swift	0.53	0.48	0.48	0.46
Tata Indica	0.46	0.61	0.54	0.53
Alto800	0.59	0.41	0.48	0.59

- Then it is multiplied with weight criteria. Therefore it is

$$V_{13}= 0.1\times0.46= 0.046$$
$$V_{23}= 0.4\times0.61= 0.244$$
$$V_{33}= 0.3\times0.54= 0.162$$
$$V_{43}= 0.2\times0.53= 0.106$$

Table 4: Weighted values of Decision matrix

Alternatives	Criteria's			
	Style	Lifespan	Fuel economy	Cost
MarutiErtiga	0.040	0.192	0.144	0.080
Swift	0.053	0.192	0.144	0.092
Tata Indica	0.046	0.244	0.162	0.106
Alto800	0.059	0.164	0.144	0.118

- The positive ideal (A^+) and the negative ideal (A^-) solutions are defined according to the weighted decision matrix via 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. Therefore (Eq.6 and 7)

$$S^+ = \{0.058; 0.057; 0.029; 0.090\}$$
$$S^- = \{0.047; 0.040; 0.083; 0.019\}$$

- For each competitive alternative the relative closeness of the potential location with respect to the ideal solution is computed (equation 8).

$$C_i= \{0.45; 0.41; 0.74; 0.17\}$$

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

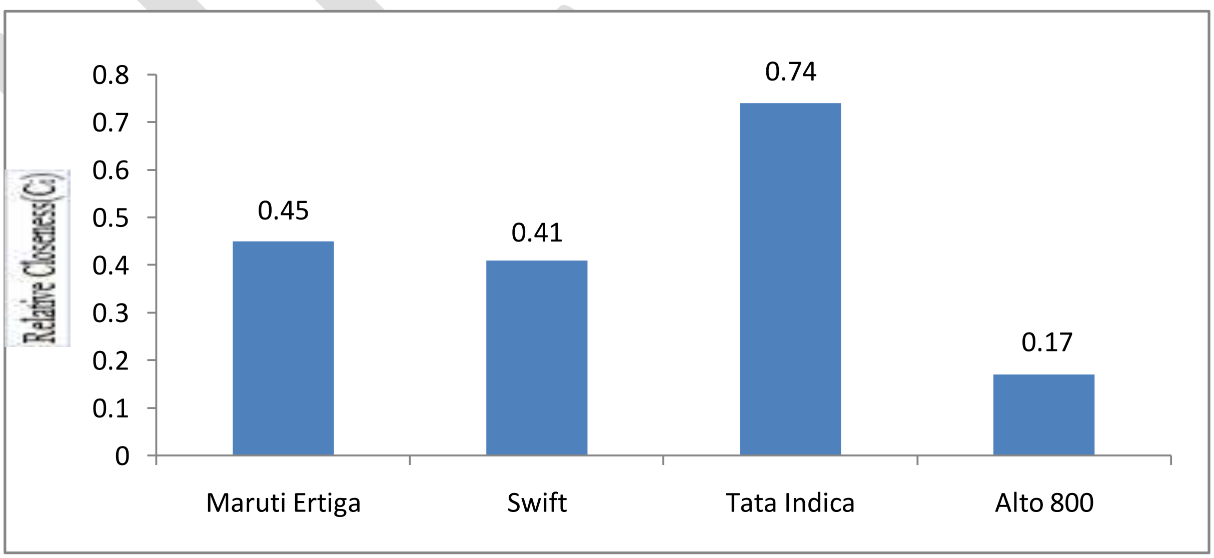

Fig. 2.Histogram of different cars

CONCLUSIONS

The proposed new procedure for four wheeler selection is to find the best car among available ones in market 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. TOPSIS is applied to achieve final ranking preferences in descending order; thus allowing relative performances to be compared.

- From the results it is observed that MARUTI ERTIGA, SWIFT, TATA INDICA and ALTO800 obtained the relative closeness to ideal solution and the values are 0.45, 0.41, 0.74 and 0.17 respectively.
- It is observed INDICA is identified as the best car among the considered ones which has the best relative closeness value
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REERENCES:

[1] Deng, H.,Yeh, C.H., Willis, R.J., "Inter - company comparison using modified TOPSIS with objective weights", Computers & Operations Research, 27, 2000, 963 – 973.

[2] C. L. Hwang, & K. Yoon, Multiple Attribute Decision Making: Methods & Applications, Berlin Heidelberg New York, Springer-Verlag, 1981.

[3] Hu Yonghong. The Improvement of the Application of TOPSIS Method to Comprehensive Evaluation [J]. Mathematics in Practice and Theory, 32 (4), 572 – 575, 2002.

[4] Li Chunhui, Li Aizhen. The Application of TOPSIS Method to Comprehensive Assessment of Environmental Quality, Journal of Geological Hazard and Environmental Preservation, 10(2),9 – 13, 1999.

[5] Vimal J., Chaturverdi V., DubeyA.K, Application of TOPSIS method for supplier selection in manufacturing industry, IJREAS, 2(5), 2012, 25 – 35.

[6] Y. J. Lai, T. Y. Liu, and. L. Hwang, TOPSIS for MODM, European Journal of Operational Research, 76, 1994, 486 – 500.

[7] MajidBehzadian , S. KhanmohammadiOtaghsara , MortezaYazdani , Joshua Ignatius, A Review on state-of the-art survey of TOPSIS applications,Expert Systems with Applications, 39, 2012, 13051–13069.

[8] Jiang J., Chen Y.W., Tang D.W., Chen Y.W,(2010), "Topsis with belief structure for group belief multiple criteria decision making", international journal of Automation and Computing, vol.7,no.3, pp 359-364.

[9] Huang, Y. S., & Li, W. H. (2010). A study on aggregation of TOPSIS ideal solutions for group decision-making. Group Decision and Negotiation. http://dx.doi.org/10.1007/s10726-010-9218-2.

[10] H.S. Byun, K.H. Lee, A decision support system for the selection of a rapid prototyping process using the modified TOPSIS method, International Journal of Advanced Manufacturing Technology 26 (11–12) (2005) 1338–1347.

[11] C. L. Hwang, Y. J. Lai, and T. Y. Liu, A new approach for multiple objective decision making, Computers and Operational Research 20, pp. 889-899, 1983.

[12] Fazlollahtabar, H., Mahdavi, I., TalebiAshoori, M., Kaviani, S., &Mahdavi-Amiri, N. (2011). A multi-objective decision-making process of supplier selection and order allocation for multi-period scheduling in an electronic market. International Journal of Advanced Manufacturing Technology, 52, 1039–1052