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Identification of Best Indian Entry–Level Segment SUV through TOPSIS Method

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Abstract*: Every car owner wants comfort, power, and efficiency with his/her car. As per the latest trend in the Indian automobile sector, buyers are more interested in SUV (Sport Utility Vehicle) or Micro SUV cars due to several reasons. It's observed that while driving a car, it is advantages if the driver sits at a higher height as compared with hatchback & sedan cars. This is one of the most common reasons for the increasing popularity of SUVs in India nowadays. Due to these reasons more and more companies are launching new cars in this segment to attract their buyers. On the one hand, customers are having many options to compare but on another hand, they are perplexed to determine which SUV is best for them as per their requirements, purpose & budget. In such a situation, buyers may look for the TOPSIS method which is a selection procedure technique. TOPSIS is based on the concept that the chosen alternative should have the shortest geometric distance from the positive ideal solution (PIS) and the longest geometric distance from the negative ideal solution (NIS). In this paper some SUV cars are considered with different attributes and the TOPSIS method is applied to determine the best car for the buyer.

***Keywords*: SUV, TOPSIS, Positive and Negative Ideal Solutions, Relative closeness, Ranking.**

I. INTRODUCTION

India is at the 4th rank in the list of countries by motor vehicle production all over the world [4]. However, due to increasing population and demand, more cars are in pipeline to be launched within a couple of years. Every car manufacturing company is planning to attract its customers to enable more and more features in their products. This situation is making a very tough competition among car manufacturers. From a buyer's point of view, it is also not so easy to select an appropriate vehicle for him/her. SUVs (Sport Utility Vehicles) are getting attention and popularity due to its several advantages. But as most of the major car manufacturers have either already launched or planning to launch new SUVs in a very short span of time; the new customers are in a condition of confusion as to which SUV they should select from a bunch of technologically enabled SUVs. This problem increases due to fake advertisements, fictitious promises at the dealer's end, prejudice reviews on social media, etc. So, obviously there is a need for such a mechanism that considers most of the parameters of car buying, analyzes it & competent enough to yield an outcome in the form of ranking of choices. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is the multi-criteria decision-making approach based on numerical methods. In this paper, we have applied the TOPSIS method to identify the best SUV car among the pool of four SUVs which approximately comes under the same segment & having different technical specifications. We have finalized four-parameter as Ex-Showroom Price (in INR), Fuel Economy (in KMPL), Engine Capacity (in cc) and Seating Capacity on which we have applied TOPSIS method.

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II. TOPSIS METHOD

TOPSIS method was initially presented by Yoon (1980) and Hwang & Yoon (1981). This is a method that is most suitable for Multiple Criteria Decision Making (MCDM) types of problems where we may have multiple choices & have to select the optimum solution be calculating the positive and negative ideal solutions [2] [3]. In practice, a positive ideal solution includes profits, gains, and productivity & minimizes the efforts, cost & time-related factors. On the other hand, for negative ideal solutions, price factors are maximized and profits are minimized. After performing the listed below operations, TOPSIS yields the ranking of all alternatives/options [1]. The ideal solution is marked as "1" and all other options are ranked as 2, 3, 4, & so on. Detailed procedure to apply the TOPSIS method is listed as steps below:

A. Establishment of Decision Matrix (DM)

In the primary step of TOPSIS method, we need to construct an evaluation matrix usually called as Decision Matrix mentioning all alternatives and criteria (parameters) on which we want comparisons.

$$\text{Decision Matrix (DM)} = \begin{bmatrix} X11 & X12 & \cdots & X1n \\ X21 & X22 & \cdots & X2n \\ \vdots & & \ddots & \vdots \\ Xm1 & Xm2 & \cdots & Xmn \end{bmatrix}.$$

In this decision matrix, all parameters are defined at row &alternatives/options are defined on columns.

B. Calculation of Normalized Decision Matrix

In this step, the decision matrix is normalized using the normalization method as –

$$R_{ij} = \frac{X_{ij}}{\sqrt{\sum_{k=1}^{m} X_{ij}^2}}$$

C. Determination of Weighted Decision Matrix

Selection criteria are assigned with appropriate weights as per their importance. For Weighted Decision Matrix (WDM) can be then constructed by multiplying each & every element of normalized decision matrix with the assigned weights as –

$$V_{ij} = W_j * R_{ij}$$

D. Identification of Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS)

The Positive Ideal Solution (A^+) and the Negative Ideal Solutions (A^-) can be calculated according to the Weighted Decision Matrix (WDM) as –

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

Where $V_i^+ = \{(\max (V_{ij}) \text{ if } j \in J); (\min V_{ij}) \text{ if } j \in J')\}$

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

Where $V_i^- = \{(\min (V_{ij}) \text{ if } j \in J); (\max V_{ij}) \text{ if } j \in J')\}$

Where, J is associated with the positive impact attributes and J' is associated with the negative impact attributes.

E. Calculation of the separation distance of each competitive alternative from the ideal and non- ideal solution

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

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

F. Measurement of relative closeness

Relative closeness for each alternative can be calculated as

$$C_i = S_i^+ / (S_i^+ + S_i^-),\ 0 \le C_i \le 1$$

G. Ranking of alternatives

Accordingto the value of Ci, the ranking of alternatives can be done. Thealternative having higher ranking is considered as optimum or best alternative.

III. IDENTIFICATION OF BEST INDIAN ENTRY–LEVEL SEGMENT SUV

For identification of best SUV, we have taken four alternatives as Maruti Suzuki S– Presso, Renault Kwid Climber, Mahindra KUV100 NXT and Renault Triber.

For uniformity and unbiased estimation, we have selected the top version of each SUV in Petrol variant. The cost of all four alternatives of SUVs are on the basis of Ex-Showroom prices of Mumbai. Additionally, it is also worthy to mention that all four SUVs selected are less than Rs. 7 Lakh (Ex-Showroom Price). The reason behind it is that we want to solve a dilemma for a middle – class family, who don't want to spend more money on vehicles but wanted to get as much as possible features.

In addition to this, the Fuel economy is measured in terms of Kilometer per liter. Engine capacity is measured in Cubic Centimeter (CC) [5] [6] [7] [8].

Table-I: SUVs alternatives and parameters

Alternatives	Parameters			
	Ex-Showroom Price (in INR)	Fuel Economy (in KMPL)	Engine Capacity (in CC)	Seating Capacity
Maruti Suzuki S-Presso	4,91,000	21.7	998	5
Renault Kwid Climber	5,02,190	24.4	999	5
Mahindra KUV100 NXT	6,97,030	25.32	1198	5
Renault Triber	6,53,250	20.5	999	7

To determine an unbiased decision, there are many factors associated directly or indirectly that affect the entire selection process. Some of the factors may be beneficial or some may be non-beneficial for the particular product.

In our case, we have categorized all four parameters into benefit & non–benefit. We have also assigned some weights to all parameters. These weights are on the basis of customer's and dealer's reviews. The following table shows data along with assigned weights.

Table-II: SUVs alternatives and parameters with assigned weights

Alternatives	Parameters			
	Ex-Showroom Price (in INR)	Fuel Economy (in KMPL)	Engine Capacity (in CC)	Seating Capacity
Maruti Suzuki S-Presso	4,91,000	21.7	998	5
Renault Kwid Climber	5,02,190	24.4	999	5
Mahindra KUV100 NXT	6,97,030	25.32	1198	5
Renault Triber	6,53,250	20.5	999	7
Weight	Non-Profit	Profit	Profit	Profit
	0.35	0.25	0.25	0.15

Decision matrix can be normalized as -

Table-III: Normalized matrix

Alternatives	Parameters			
	Ex-Showroom Price (in INR)	Fuel Economy (in KMPL)	Engine Capacity (in CC)	Seating Capacity
Maruti Suzuki S-Presso	0.414105	0.470451	0.474313	0.449013
Renault Kwid Climber	0.423542	0.528987	0.474789	0.449013
Mahindra KUV100 NXT	0.587868	0.548932	0.569366	0.449013
Renault Triber	0.550945	0.444435	0.474789	0.628619

Table-IV: Weighted Normalized matrix

Alternatives	Parameters			
	Ex-Showroom Price (in INR)	Fuel Economy (in KMPL)	Engine Capacity (in CC)	Seating Capacity
Maruti Suzuki S-Presso	0.144937	0.117613	0.118578	0.067352
Renault Kwid Climber	0.14824	0.132247	0.118697	0.067352
Mahindra KUV100 NXT	0.205754	0.137233	0.142342	0.067352
Renault Triber	0.192831	0.111109	0.118697	0.094293

Ideal best and Ideal worst values are calculated as -

V+ = {0.144937, 0.137233, 0.142342, 0.094293}
V– = {0.205754, 0.111109, 0.118578, 0.067352}

Calculation of Euclidean distance from the ideal best & ideal worst solution

Table-V: Identification of PIS and NIS

Alternatives	Parameters				Si+	Si–
	Ex-Showroom Price (in INR)	Fuel Economy (in KMPL)	Engine Capacity (in CC)	Seating Capacity		
Maruti Suzuki S-Presso	0.144937	0.117613	0.118578	0.067352	0.040932	0.061164
Renault Kwid Climber	0.14824	0.132247	0.118697	0.067352	0.036341	0.061276
Mahindra KUV100 NXT	0.205754	0.137233	0.142342	0.067352	0.066517	0.035315
Renault Triber	0.192831	0.111109	0.118697	0.094293	0.059459	0.02988

Calculating the performance score

Table-VI: Measurement of relative closeness

Alternatives	Parameters				Si+	Si–	Pi
	Ex-Showroom Price (in INR)	Fuel Economy (in KMPL)	Engine Capacity (in CC)	Seating Capacity			
Maruti Suzuki S-Presso	0.144937	0.117613	0.118578	0.067352	0.040932	0.061164	0.599082
Renault Kwid Climber	0.14824	0.132247	0.118697	0.067352	0.036341	0.061276	0.62772
Mahindra KUV100 NXT	0.205754	0.137233	0.142342	0.067352	0.066517	0.035315	0.346797
Renault Triber	0.192831	0.111109	0.118697	0.094293	0.059459	0.02988	0.334459

Ranking of alternatives

Table-VII: Ranking of available alternatives

Alternatives	Parameters				Si+	Si–	Pi	Rank
	Ex-Showroom Price (in INR)	Fuel Economy (in KMPL)	Engine Capacity (in CC)	Seating Capacity				
Maruti Suzuki S-Presso	0.144937	0.117613	0.118578	0.067352	0.040932	0.061164	0.599082	2
Renault Kwid Climber	0.14824	0.132247	0.118697	0.067352	0.036341	0.061276	0.62772	1
Mahindra KUV100 NXT	0.205754	0.137233	0.142342	0.067352	0.066517	0.035315	0.346797	3
Renault Triber	0.192831	0.111109	0.118697	0.094293	0.059459	0.02988	0.334459	4

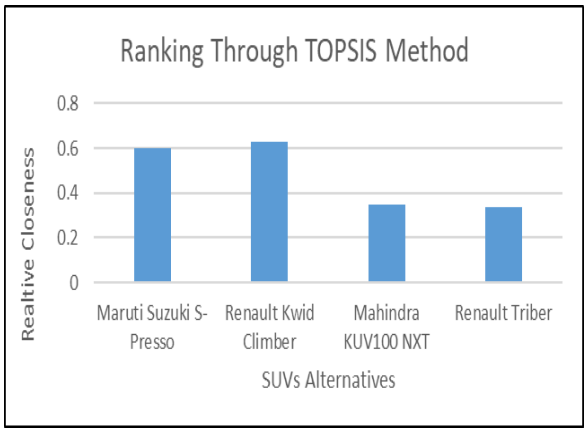

Fig. 1. Bar Chart for Ranking of SUVs through TOPSIS Method

IV. CONCLUSION

Through applying the TOPSIS method on various alternatives considering different parameters, it is obtained that Renault Kwid Climber is the best choice available in the market among presented alternatives on assigned weights. However, it is also notable that Maruti Suzuki S-Preaso is very close to the Renault Kwid Climber & having a difference of just 0.028638 Pi.

REFERENCES

1. C. L. Hwang, & K. Yoon, Multiple Attribute Decision Making: Methods & Applications, Berlin Heidelberg New York, Springer – Verlag, 1981.
2. Srikrishna S, Sreenivasulu Reddy. A, Vani S, "A New Car Selection in the Market using TOPSIS Technique", International Journal of Engineering Research and General Science Volume 2, Issue 4, June-July, 2014. pp 177-181
3. Alessio Ishizaka and Philippe Nemery, Multi-Criteria Decision Analysis: Methods and Software, 2013 John Wiley & Sons, Ltd.
4. 4.https://en.wikipedia.org/wiki/List_of_countries_by_motor_vehicle_production on (as on 07.11.2019)
5. https://www.marutisuzuki.com/channels/arena/suvs-muvs/s-presso (as on 8.11.2019)
6. https://www.renault.co.in/vehicles/personal-cars/kwid/prices.html (as on 9.11.2019)
7. https://www.mahindrakuv100.com/ (as on 8.11.2019)
8. https://www.renault.co.in/vehicles/personal-cars/triber.html (as on 10.11.2019)

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