International Journal of Experimental Research and Review (IJERR)

ISSN: 2455-4855 (Online) ***Original Article***

Received: 12th October, 2019; **Accepted:** 13th November, 2019; **Published:** 30th December, 2019

DOI: https://doi.org/10.52756/ijerr.2019.v20.002

Selection of Optimal Four Wheeler Applying AHP & TOPSIS Technique

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Abstract

Now a day's purchasing one car among the verities of model of car available in the market are very difficult task to the customers. Day by day various technical and operational parameter specifications like price, yearly maintenance cost, millage, breaking efficiency, comfort etc. are changed. Therefore, to overcome this confusion some selection procedure techniques are required. TOPSIS and AHP is the one of them selection procedure technique are adopted for this problem. These two techniques provide a base for decision-making processes, where there are limited numbers of alternatives but each has large number of criteria. It is very difficult to understand for all the demands of customer and to make a product which will fulfill the all demands completely. For the complicated decision making problem including qualitative and quantitative factors, different decision making techniques such as AHP and TOPSIS can also be used with MCDA for better results. In this research work the customer's priorities are explored, while purchasing a four wheeler automobile segment using Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). In this study, different criteria to be considered during purchasing of four wheeler using structured questionnaire which based on SAATY scale. From the calculations, it is proved that FORD (ASPIRE) is ranked as best and appropriate alternative which has extremely good breaking efficiency compared to Volkswagen (Vento), Toyota (Etios), Hyundai (Verna), Nissan (Sunny), Honda (Amaze) and Tata (Nexon).

Keywords: AHP, breaking efficiency, MCDA, TOPSIS.

Introduction

The increasing complexity of the rapidly evolving business, engineering, science and technology environments entails making right decisions when considering a diversity of factors (Karim et al., 2016; Reddy et al., 2014; Aggarwal et al., 2013). Now a day the manufacturing industry is growing rapidly and more variety of products are available in the market. For this reason the customer can't choose their desire quality product with short time period. The MCDA (Multi Criteria Decision Analysis) is the only solution for finding the best alternatives among the different product criteria. MCDA is a criteria base decision making analytical process which can be classified as one of the important discipline of operation research (Deswal et al., 2015; Apaka et al., 2013). In a common personal context, a person wants to buy a car, which is characterized in terms of price, size, style, safety, comfort, etc. Mainly, cost is the foremost criteria considered while choosing a supplier, others such as product quality of the material, delivery time and service quality of the supplier also play a vital role (Alexandre et al., 2011).

Objective of the present research work

In this research work selection of best (optimal) four wheeler is done by applying AHP & TOPSIS techniques. The aim of this research work is to develop a hybrid multi-criteria model for selecting the most efficient car (four-wheeler) in the market. The proposed research methodology combines the TOPSIS and AHP methods, usually used in the decision-making process.

Overview of MCDA

Multiple-criteria decision-making (MCDM) or multiple-criteria decision analysis (MCDA) is a sub-discipline of operations research that explicitly evaluates multiple conflicting criteria in decision making such that both in daily life and in settings such as business, government and medicine (Sriyogi, 2015; Lee et al., 2011, Yousefi et al., 2010). Conflicting criteria are typical in evaluating options: cost or price is usually one of the main criteria, and some measure of quality is typically another criterion, easily in conflict with the cost (Agrawal et al., 2015; Yoshi et al., 2009). In purchasing a car, cost, comfort, safety, and fuel economy may be some of the main criteria. It is very difficult to select a cheapest car which is more comfortable and the safe.

Structure complex problems well and considering multiple criteria explicitly lead to more informed and better decisions (Valamarthi, 2015; Dagdeviren et al., 2008). There have been important advances in this field since the start of the modern multiple-criteria decision-making discipline in the early 1960s.

Different types of MCDA method

There are so many methods available for solving MCDA problems. These are listed in given below:

1. Analytic hierarchy process (AHP)
2. Analytic network process (ANP)
3. Evidential reasoning approach (ER)
4. Goal programming (GP)
5. Grey relational analysis (GRA)
6. Multi-attribute utility theory (MAUT)

7. Technique for the Order of Prioritisation by Similarity to Ideal Solution (TOPSIS)

But in this research work AHP and TOPSIS methods are used for selecting a new four wheeler in market with minimum budget.

Overview of AHP Method

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making approach and was introduced by Saaty (1977 and 1994). The AHP has attracted the interest of many researchers mainly due to the nice mathematical properties of the method and the fact that the required input data are rather easy to obtain. The AHP is a decision support tool which can be used to solve complex decision problems. It uses a multi-level hierarchical structure of objectives, criteria, sub criteria and alternatives.

Some of the industrial engineering applications of the AHP include its use in integrated manufacturing (Putrus, 1990), in the evaluation of technology investment decisions (Boucher and Mc Stravic, 1991), in flexible manufacturing systems (Wabalickis, 1988), layout design (Cambron and Evans, 1991), and also in other engineering problems (Ossadnik et al., 1991, Triantaphyllou et al., 1995). Figure-2 shows the block diagram of AHP method.

Saaty's Semantic Scale of AHP

The second step in the AHP process is to derive the relative priorities (weights) for the criteria. It is called relative because they obtained criteria priorities are measured with respect to each other as we will see in the following discussion. We first are required to derive by pair wise comparisons the relative priority of each criterion with respect to each of the others using a numerical scale for comparison developed by Saaty's (2012) as shown in table 1.

Consistency Ratio (CR) of AHP

For this purpose, AHP calculates a consistency ratio (CR) comparing the consistency index (CI) of the matrix in question (the one with our judgments) versus the consistency index of a random-like matrix (RI). Saaty's (2012) provides the calculated RI value for matrices of different sizes as shown in table 2. Where n is the number of compared elements.

Overview of TOPSIS Method

The Technique for the Order of Prioritisation by Similarity to Ideal Solution (TOPSIS) method was initiated for solving a multiple attribute decision making problem with no articulation of preference information (Hwang and Yoon, 1981). TOPSIS technique is based on the concept that the ideal alternative has the best level for all attributes considered, whereas the negative ideal is the one with all the best attribute values (Christopher et al., 2014, Lapersonne et al., 1995). A TOPSIS solution is defined as the alternative which is simultaneously farthest from the negative-ideal and closest to the ideal alternative (Nilashi et al., 2014, Chang et al., 2007, Vaidya et al., 2006). Figure-3 shows that block diagram of TOPSIS method.

Developing a Model

The first step in an AHP analysis is to build a hierarchy for the decision. This is also called decision modelling and it simply consists of building a hierarchy to analyse the decision (Saravanan et al., 2014).

In figure-4 shows that first level of the hierarchy for buying a new car. The second level in the hierarchy is constituted by the criteria which are used for purchasing. In this research work the selecting five criteria are price, yearly maintenance cost, Mileage, breaking efficiency and comfort for importing a new car. The third level consists of selecting seven alternatives areVolkswagen (Vento), Toyota (Etios), Hyundai (Verna), Nissan (Sunny), Honda (Amaze), Ford (Aspire), Tata (Nexon).

Calculation of AHP Method

The first step in an AHP analysis is to build a hierarchy for the decision. This is also called decision modeling and it simply consists of building a hierarchy to analyse the decision.

Step 1: Cells in comparison matrices have been taken from the numeric scale as shown in table-1. For reflecting the relative preference also called intensity judgment or simply judgment in each of the compared pairs. It is considered that price is very strongly more important than the Mileage factor; the price-Mileage comparison cell (i.e., the intersection of the row 'price' and column 'Mileage'). Mathematically this means that the ratio of the importance of price versus the importance of Mileage is seven (price/Mileage = 4). Because of this, the opposite comparison, the importance of Mileage relative to the importance of price, will yield the reciprocal of this value (Mileage/price = 1/4) as shown in the Mileage-price cell in the comparison matrix in table 3.

Step 2: In this research work the overall priorities or weights of the criteria are devolved. There are two methods available for this purpose, one is the exact and another is the approximate (Vincent et al., 1999). At this point, any of the matrix columns constitutes the desired set of priorities. This calculation can be done very easily using AHP-based software packages. The approximate method requires the normalization of the comparison matrix; i.e., add the values in each column shown in table-4.

Step 3: However, keep in mind that this method provides a valid approximation to the overall weights only when the comparison matrix has a very low inconsistency. Then divide each cell by the total of the column is shown in table-5.

Step 4: From this normalized matrix simply calculating the average value of each row (e.g., for the Price row: (0.045+0.024+0.045+0.015+0.073) / 5 = 0.040) is shown in table-6.

Step 5: Although there is no standardized way of presenting the results. It is shown the comparison matrix with the original judgments from table 3 along with the calculated priorities obtained from table- 5, which is a useful way to see the judgments and priorities at the same time. Calculations of priorities are shown in table 6. According to the results in table 7, it is clear that in this research work the breaking efficiency is the most important criteria which value is 0.475. From the table 4.6 breaking efficiency is 47.5% of the overall importance of the criteria, followed by comfort with 27.8%, Mileage is 12.7%, yearly maintenance cost is 8.0% and price is 4.0% respectively.

Step 6: Not all the criteria will have the same importance. Therefore, this step in the AHP process is to derive the relative priorities (weights) for the criteria. It is called relative, because they obtained criteria priorities are measured with respect to each other as it is explained following discussion (Badri et al., 2001). At first pair wise comparisons the relative priority of each criterion with respect to each of the others are required to derive using a numerical scale for comparison developed by Saaty (2012) as shown in table-8.

Step 7: Multiply each value in the first column of the comparison matrix in Table 8 by the first criterion priority (i.e., 1.000 *0.040 = 0.040; 4.000 * 0.040 = 0.160; 6.000 * 0.040 = 0.240; 4.000 * 0.040 = 0.160: 7.000 * 0.040 = 0.280) as shown in the table-9, multiply each value in the second column of the second criterion priority and continue this process for the entire column.

Step 8: Add the values in each row to obtain a set of values called weighted sum as shown in table 10.

Step 9: In this table-11, to find out ƛmax the following formula has been used.

ƛmax = Weighted sum / Priority

From the table 4.10 the value of ƛmax= 5.361

Now the calculation of consistency index (CI) as follows:

C: I: = (ƛmax - n) / (n - 1)

Where n is the number of compared elements (in our example n = 5)

Therefore,

C: I: = (ƛmax - n) / (n - 1)
= (5.361 - 5) / (5 - 1)
= 0.090

Now calculate the consistency ratio, defined as:

CR = CI/RI
= 0.090/1.12
= 0.080

Result and Discussion of AHP Method

In this research work AHP method is used to get the average value of ƛmax and put this value for plotting graph between ƛmax and criteria as shown in figure-5. The bar chart shows that breaking efficiency is more preferable than price, Mileage, comfort and yearly maintenance cost, so breaking efficiency is the most important criteria in this research work.

From the figure-6, it is clearly shown that the final result. From the result the ford (aspire) is ranked as best and appropriate alternative which has extremely good breaking efficiency than Volkswagen (Vento), Toyota (Etios), Hyundai (Verna), Nissan (Sunny), Honda (Amaze) and Tata (Nexon).

Calculation of TOPSIS Method

TOPSIS is one of the most widely used techniques of multi-criteria decision making. This technique is based on the principle that the selected alternative should have the least distance to the positive ideal and the most distance to the negative ideal. So in this research work TOPSIS method is used to compare AHP method, and verify the result of AHP method. Table-12 shows that selected different alternatives and there various criteria in this research work.

Step 1: The first step of the TOPSIS method involves the construction of a Decision Matrix (DM). Tzeng et al., (1998) classified weighting approaches into subjective or objective. The weights in the subjective methods are determined based on preference information of criteria, subjective opinions and decision-makers knowledge. However, the objective approaches select the weights of criteria based on a mathematical calculation. In this research work, the ratio estimation procedure, which is a subjective method, is adopted to decide the relative importance of weights of attributes and criteria based on the opinion of experts. In this method, an arbitrary highest weight is assigned to the most important criterion (Dalila et al., 2013). Correspondingly, smaller weights are assigned to the remaining 5 criteria with lower order until a score is assigned to the least important criterion. The ratio is calculated by dividing each weight to the lowest weight shown in table-13.

Step 2: The normalized values indicate the Normalized Decision Matrix (NDM), which represents the relative performance of the generated design alternatives. Generally, there are benefit attributes and cost attributes in an MCDM problem (Punj et al, 2002). To transform various attribute dimensions into non-dimensional units and facilitate inter-attribute comparisons, several known standardized equations are introduced to normalize each attribute value xij in decision matrix X = (xij) $_{m\times n}$. The following equation is the most frequently used method of calculating the normalized value Rij shown in table 14.

$$R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

Rij

Step 3: Not all of the selection criteria may be of equal importance and hence weighting are introduced from AHP (Analytical Hierarchy Process) technique to quantify the relative importance of the different selection criteria (Byun et al., 2001). The weighting decision matrix is simply constructed by multiply each element of each column of the normalized decision matrix by the random weights shown in table-15.

$$\mathbf{V_{ij} = W_{ij} \times Rij}$$

Step 4: The positive ideal solution minimizes the cost criteria and maximizes the benefit criteria i.e., on the contrary; the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria shown in table 16. The equations are as follows:

Where positive ideal (V_J^+) = $\{(\max V_{ij/j} \times €_J), (\min V_{ij/j} \times €_J)\}$

And, negative ideal (V_J^-) = $\{(\min V_{ij/j} \times €_J), (\max V_{ij/j} \times €_J)\}$

Where, J= Associated with the cost criteria

Step 5: In this table 17 the separation of each alternative from the positive ideal solution and the negative ideal solution is calculated and then two different equations S_i^+ and S_i^- are created. The equations are as follows:

$S_i^+ = [\sum_{j=1}^{n}(V_{ij} - V_j^+)^2]^{\frac{1}{2}}$ and

$S_i^- = [\sum_{j=1}^{n}(V_{ij} - V_j^-)^2]^{\frac{1}{2}}$

Where i = 1, 2, 3,…, m

Step 6: For each competitive alternative, the relative closeness of the potential location with respect to the ideal solution is computed which is shown in table-18.

Where, $\mathbf{P_i = S_i^- / (S_i^+ + S_i^-)}$ $\quad \mathbf{[0 \le P_i \le 1]}$

Results and Discussion of TOPSIS Method

In this research work TOPSIS method is used to get the relative closeness value and put this value is plotting the graph between breaking efficiency vs. alternatives shown in figure-7. From this graph it is shown that ford (aspire) is ranked as best and appropriate alternative which has extremely good breaking efficiency than Volkswagen (Vento), Toyota (Etios), Hyundai (Verna), Nissan (Sunny), Honda (Amaze), Tata (Nexon).

Compare Between AHP and TOPSIS Method

In this research work applying AHP &TOPSIS technique for selecting a new four wheeler in the market with minimum budget has been discussed.

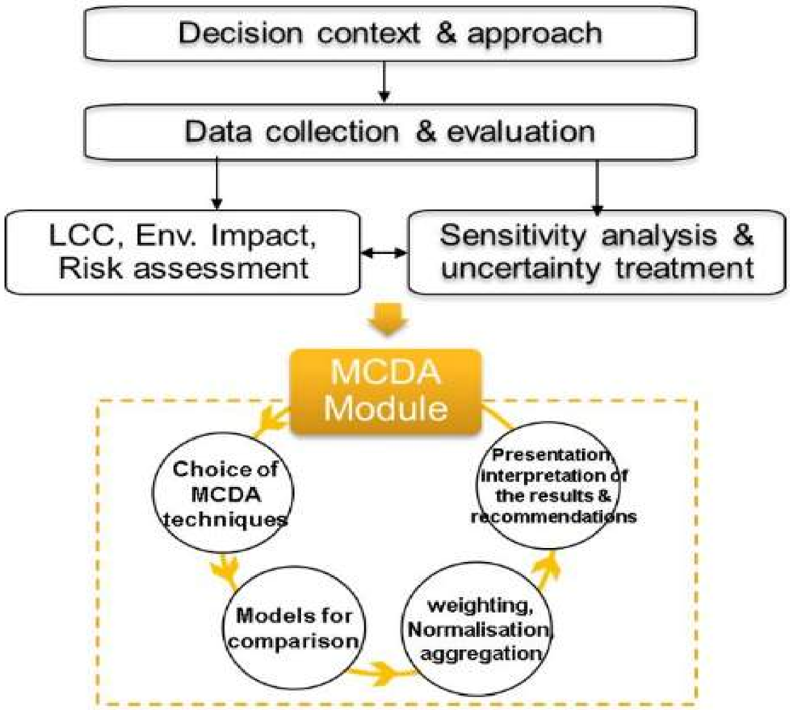

Fig.1. Generic framework for MCDA workflow.

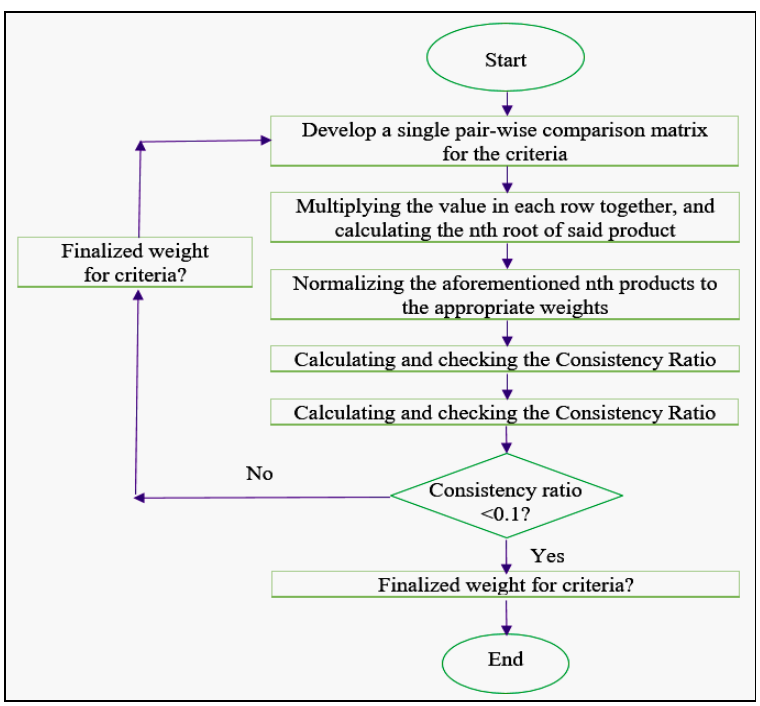

Fig.2. AHP block diagram.

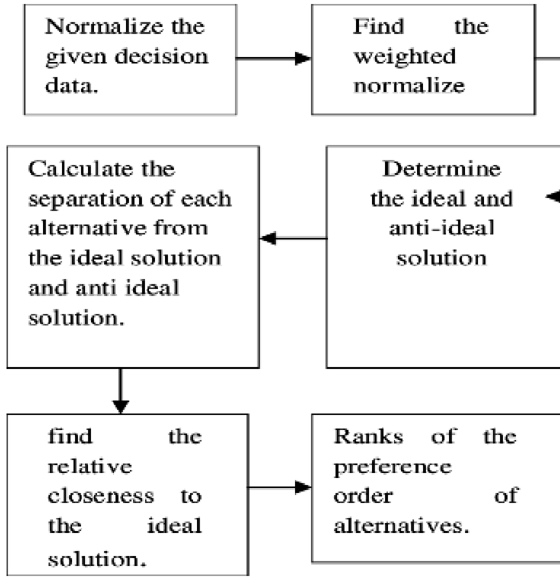

Fig.3. TOPSIS block diagram.

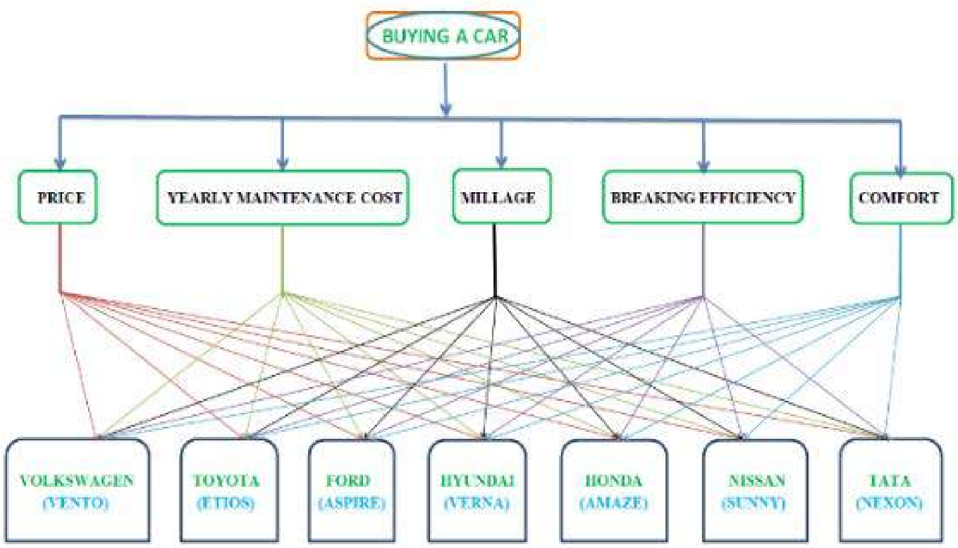

Fig.4. Decision hierarchy for buying a car.

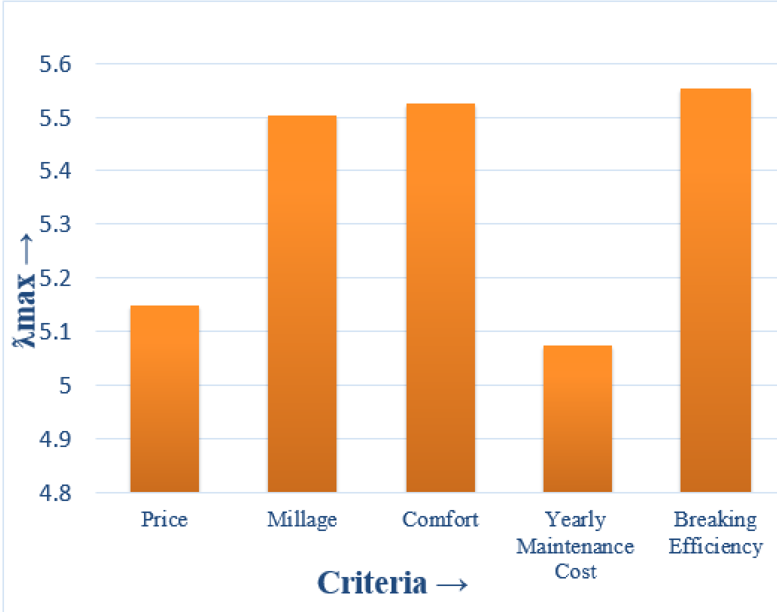

Fig. 5. Criteria vs. λmax bar chart for AHP method.

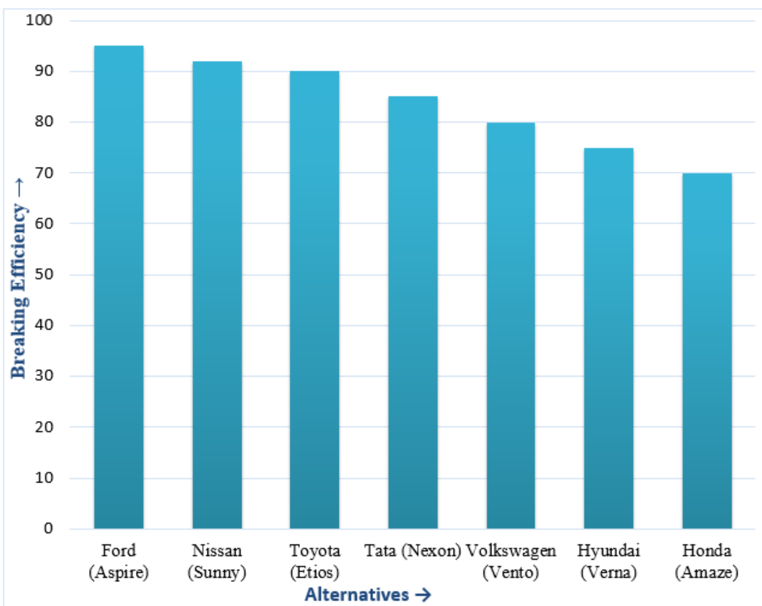

Fig. 6. Breaking efficiency vs. alternatives bar chart for AHP method.

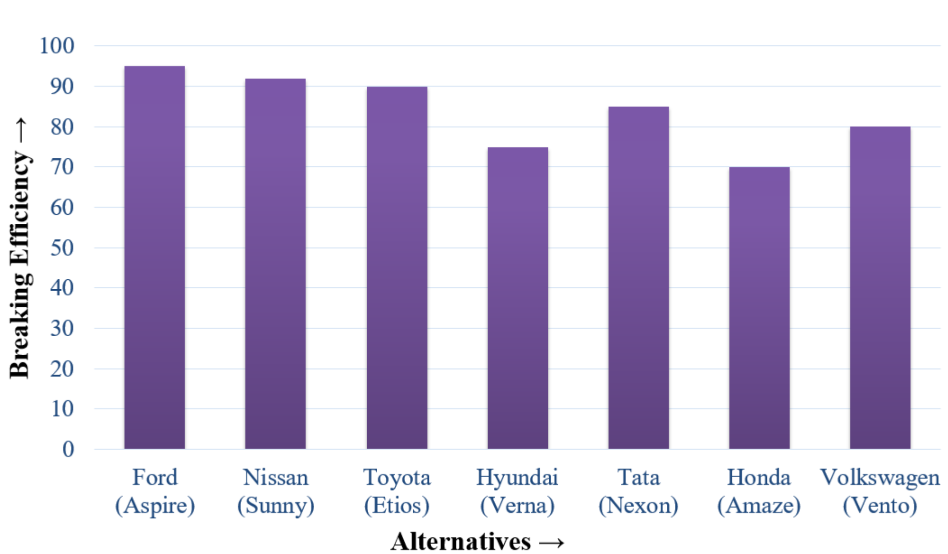

Fig.7. Breaking efficiency vs. alternatives bar chart for TOPSIS method.

Table 1. Saaty's pair wise comparison scale.

Degree of importance	AHP scale of importance for comparison pair (aij)	Explanation	Reciprocal (Decimal)
1	Equal importance	Two activities contribute equally to the objective.	1
2	Weak or slight		1/2
3	Moderate importance	Experience and judgement slightly favour one activity over another.	1/3
4	Moderate plus		1/4
5	Strong importance	Experience and judgement strongly favour one activity over another.	1/5
6	Strong plus		1/6
7	Very strong or demonstrated importance	An activity is favoured very strongly over another: its dominance demonstrated in practice	1/7
8	Very, very strong		1/8
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation.	1/9

Table 2. Consistency ratio table.

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Table 3. Pair wise comparison matrix with intensity judgments.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)
Price (Lakhs)	1	1/4	1/6	1/4	1/7
Millage (Km/l)	4	1	1/3	3	1/6
Comfort (%)	6	3	1	5	1/2
Yearly Maintenance Cost (Rs.)	4	1/3	1/5	1	1/7
Breaking Efficiency (%)	7	6	2	7	1

Table 4. Column addition.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)
Price (Lakhs)	1.000	0.250	0.167	0.250	0.143
Millage (Km/l)	4.000	1.000	0.333	3.000	0.167
Comfort (%)	6.000	3.000	1.000	5.000	0.500
Yearly Maintenance Cost (Rs.)	4.000	0.333	0.200	1.000	0.143
Breaking Efficiency (%)	7.000	6.000	2.000	7.000	1.000
SUM	22.000	10.583	3.700	16.250	1.953

Table 5. Normalized matrix.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)
Price (Lakhs)	0.045	0.024	0.045	0.015	0.073
Millage (Km/l)	0.181	0.095	0.090	0.185	0.086
Comfort (%)	0.273	0.283	0.270	0.308	0.256
Yearly Maintenance Cost (Rs.)	0.181	0.031	0.054	0.062	0.073
Breaking Efficiency (%)	0.318	0.567	0.541	0.431	0.512

Table 6. Calculation of priorities: row averages.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)	Priority
Price (Lakhs)	0.045	0.024	0.045	0.015	0.073	0.040
Millage (Km/l)	0.181	0.095	0.090	0.185	0.086	0.127
Comfort (%)	0.273	0.283	0.270	0.308	0.256	0.278
Yearly Maintenance Cost (Rs.)	0.181	0.031	0.054	0.062	0.073	0.080
Breaking Efficiency (%)	0.318	0.567	0.541	0.431	0.512	0.475

Table 7. Presentation of results: original judgments and priorities.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)	Priority
Price (Lakhs)	1.000	0.250	0.167	0.250	0.143	0.040
Millage (Km/l)	4.000	1.000	0.333	3.000	0.167	0.127
Comfort (%)	6.000	3.000	1.000	5.000	0.500	0.278
Yearly Maintenance Cost (Rs.)	4.000	0.333	0.200	1.000	0.143	0.080
Breaking Efficiency (%)	7.000	6.000	2.000	7.000	1.000	0.475

Table 8. Priorities as factors.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)
Criteria Weights ->	0.040	0.127	0.278	0.080	0.474
Price (Lakhs)	1.000	0.250	0.167	0.250	0.143
Millage (Km/l)	4.000	1.000	0.333	3.000	0.167
Comfort (%)	6.000	3.000	1.000	5.000	0.500
Yearly Maintenance Cost (Rs.)	4.000	0.333	0.200	1.000	0.143
Breaking Efficiency (%)	7.000	6.000	2.000	7.000	1.000

Table 9: Calculation of weighted columns.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)
Price (Lakhs)	0.040	0.032	0.046	0.020	0.068
Millage (Km/l)	0.160	0.127	0.093	0.240	0.079
Comfort (%)	0.240	0.381	0.278	0.400	0.237
Yearly Maintenance Cost (Rs.)	0.160	0.042	0.056	0.080	0.068
Breaking Efficiency (%)	0.280	0.762	0.556	0.560	0.474

Table 10: Calculation of weighted sum.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)	Weighted sum
Price (Lakhs)	0.040	0.032	0.046	0.020	0.068	0.206
Millage (Km/l)	0.160	0.127	0.093	0.240	0.079	0.699
Comfort (%)	0.240	0.381	0.278	0.400	0.237	1.536
Yearly Maintenance Cost (Rs.)	0.160	0.042	0.056	0.080	0.068	0.406
Breaking Efficiency (%)	0.280	0.762	0.556	0.560	0.474	2.632

Table 11: Calculation of ƛmax

	Weighted sum	Priority	(Weighted sum / Priority)
Price (Lakhs)	0.206	0.040	5.150
Millage (Km/l)	0.699	0.127	5.504
Comfort (%)	1.536	0.278	5.525
Yearly Maintenance Cost (Rs.)	0.406	0.080	5.075
Breaking Efficiency (%)	2.632	0.474	5.553
		Total	26.807
		Divide Total by 5	5.361

Table 12. Different alternatives and there various criteria.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)
Volkswagen (Vento)	8.7	16.29	80	8200	92
Toyota (Etios)	8.4	16.78	90	4850	95
Hyundai (Verna)	8.1	17.4	75	4050	85
Nissan (Sunny)	7.2	16.95	92	4800	75
Honda (Amaze)	7.5	19.5	70	6500	80
Ford (Aspire)	7.8	20	95	4600	90
Tata (Nexon)	8	17.88	85	5300	70

Table 13. Establish the decision matrix.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)
Volkswagen (Vento)	8.7	16.29	80	8200	92
Toyota (Etios)	8.4	16.78	90	4850	95
Hyundai (Verna)	8.1	17.4	75	4050	85
Nissan (Sunny)	7.2	16.95	92	4800	75
Honda (Amaze)	7.5	19.5	70	6500	80
Ford (Aspire)	7.8	20	95	4600	90
Tata (Nexon)	8	17.88	85	5300	70
$\sqrt{\sum_{j=1}^{n} Xij^2}$	**21.09**	**47.30**	**223.22**	**14889.76**	**223.02**

Table 14. Construct normalized decision matrix.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)
Volkswagen (Vento)	0.413	0.413	0.358	0.551	0.413
Toyota (Etios)	0.398	0.398	0.403	0.326	0.426
Hyundai (Verna)	0.384	0.384	0.336	0.272	0.381
Nissan (Sunny)	0.341	0.341	0.412	0.322	0.336
Honda (Amaze)	0.356	0.356	0.314	0.437	0.359
Ford (Aspire)	0.370	0.370	0.426	0.309	0.404
Tata (Nexon)	0.397	0.397	0.381	0.356	0.314

Table 15. Calculate the weighted normalized decision matrix.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)
Volkswagen (Vento)	0.0826	0.0688	0.0716	0.1102	0.0826
Toyota (Etios)	0.0796	0.0708	0.0816	0.0652	0.0852
Hyundai (Verna)	0.0768	0.0736	0.0672	0.0544	0.0762
Nissan (Sunny)	0.0642	0.0716	0.0824	0.0644	0.0672
Honda (Amaze)	0.0712	0.0824	0.0628	0.0874	0.0718
Ford (Aspire)	0.0740	0.0846	0.0852	0.0618	0.0808
Tata (Nexon)	0.0794	0.0756	0.0762	0.0712	0.0628

Table 16. Determine the positive ideal and negative ideal solution.

	Price (Lakhs)	Millage (Km/l)	Comfort (%)	Yearly Maintenance Cost (Rs.)	Breaking Efficiency (%)
Volkswagen (Vento)	0.0826	0.0688	0.0716	0.1102	0.0826
Toyota (Etios)	0.0796	0.0708	0.0816	0.0652	0.0852
Hyundai (Verna)	0.0768	0.0736	0.0672	0.0544	0.0762
Nissan (Sunny)	0.0642	0.0716	0.0824	0.0644	0.0672
Honda (Amaze)	0.0712	0.0824	0.0628	0.0874	0.0718
Ford (Aspire)	0.0740	0.0846	0.0852	0.0618	0.0808
Tata (Nexon)	0.0794	0.0756	0.0762	0.0712	0.0628
V_J^+	**0.0642**	**0.0846**	**0.0852**	**0.0544**	**0.0852**
V_J^-	**0.0826**	**0.0688**	**0.0628**	**0.1102**	**0.0628**

Table 17.Calculate the separation measures for each alternative.

	S_i^+	S_i^-	$S_i^+ + S_i^-$
Volkswagen (Vento)	0.0624	0.0217	0.0841
Toyota (Etios)	0.0236	0.0538	0.0774
Hyundai (Verna)	0.0262	0.0581	0.0843
Nissan (Sunny)	0.0224	0.0534	0.0758
Honda (Amaze)	0.0427	0.0303	0.0730
Ford (Aspire)	0.0131	0.0591	0.0722
Tata (Nexon)	0.0343	0.0419	0.0762

Table 18: Calculate the relative closeness to the ideal solution.

	P_i
Volkswagen (Vento)	0.2580
Toyota (Etios)	0.6951
Hyundai (Verna)	0.6892
Nissan (Sunny)	0.7045
Honda (Amaze)	0.4151
Ford (Aspire)	0.8186
Tata (Nexon)	0.5499

Table 19. Comparison between AHP and TOPSIS Method.

	AHP METHOD (Breaking Efficiency)	TOPSIS METHOD (Breaking Efficiency)
1.	FORD (ASPIRE)	FORD (ASPIRE)
2.	NISSAN (SUNNY)	NISSAN (SUNNY)
3.	TOYOTA (ETIOS)	TOYOTA (ETIOS)
4.	TATA (NEXON)	HYUNDAI (VERNA)
5.	VOLKSWAGEN (VENTO)	TATA (NEXON)
6.	HYUNDAI (VERNA)	HONDA (AMAZE)
7.	HONDA (AMAZE)	VOLKSWAGEN (VENTO)

Table-19 shows the comparison between AHP and TOPSIS method. From this table it is shown that the result that ford (aspire) is ranked as best and appropriate alternative which has extremely good breaking efficiency than Volkswagen (Vento), Toyota (Etios), Hyundai (Verna), Nissan (Sunny), Honda (Amaze), Tata (Nexon).

Conclusion

This research work provides a multi-criteria decision analysis and solving a selection problem of different model of car based on AHP and TOPSIS method. Within the limitation of resources, the following conclusions can be drawn:

I. The TOPSIS method is simple to use and understandable, the computation processes are straightforward and the concept permits the pursuit of best alternatives criterion depicted in a simple mathematical calculation.

II. AHP can measure the degree to which a manager's judgments are consistent. The selection of car is based on different criteria such as price, yearly maintenance cost, Mileage, breaking efficiency and comfort.

III. Several alternatives are evaluated but and only seven alternatives have been chosen i.e., Volkswagen (Vento), Toyota (Etios), Hyundai (Verna), Nissan (Sunny), Honda (Amaze), Ford (Aspire), Tata (Nexon).

IV. The alternative is ranked with respect to their main criteria using AHP pair wise comparison approach and also the same alternative is obtained using TOPSIS method.

V. From the calculations, it is proved that FORD (ASPIRE) is ranked as best.

VI. The AHP and TOPSIS method is very much efficient technique for alternatives selection under multiple criteria.

It is evident that the existing research work on The MCDA (Multi Criteria Decision Analysis) is the only solution for finding the best alternatives among the different product criteria (Wei et al., 2005). MCDA is a criteria base decision making analytical process which can be classified as one of the important discipline of operation research (Nagai et al., 2005, Ngai et al., 2003). It is also expected that the present work on selecting best car using AHP and TOPSIS method will provide more technical information and database for any types of selection problem.

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