

# A Paper on the Analysis of Vibration to the Passenger Seat

Nikhil Kishor Toke<sup>1</sup>, Pavan Vilas Kolate<sup>2</sup>, Pooja Valmik Mahajan<sup>3</sup>, Latika Bhalchandra Patil<sup>4</sup>

<sup>1,2</sup>Student, Department of Mechanical Engineering, SVIT Nashik, Maharashtra, India

<sup>3,4</sup>Student, Department of Mechanical Engineering, S.N.J.B's Chandwad, Maharashtra, India

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**Abstract** - This paper deals with the analysis of vibrations to the passenger seat through the irregularities on road surface. This analysis is carried out with the help of FFT analyzer for different classes of passenger car for variety of road conditions which have been validated by TOPSIS Tool. And also to identify the various parameter which directly affect the ride comfort of car and also study of these parameters. This study also involve the comparison of various reading taken with FFT analyzer with analytical method using the TOPSIS tool and gives the more better results and conclusions

**Key Words:** FFT analyzer, TOPSIS.

## 1. INTRODUCTION

Many people nowadays spend a significant proportion of their time travelling and there is an increasing demand for comfort in private and public transportation. A good ambience results in better performance by the driver, improving the safety of all the occupants. Also the fatigue of passengers following a journey will be significantly diminished if good ride conditions are provided. Three classes of factors are considered in the analysis of travelling comfort: organizational, local, and riding. To derive riding comfort, such factors as habitat, the vehicle, the vibration, and human must be considered when evaluating a car. However, realistically understanding riding comfort is difficult. It is also difficult to obtain evaluation results that can be fed back to the design stage. The present study targeted the driver who received the vibrations. The sense of the person who causes by this vibration is narrowly treated as riding comfort. Riding comfort is a subjective psychology response, although an objective evaluation approach is necessary as mentioned above. Because experts have done traditional evaluations, no objective evaluation indexes and universal development indicators have been done.

Ride comfort affect not only the comfort of the crew, work performance and physical health, but also directly or indirectly affect the vehicle's power, economy and handling performance. Ride Comfort is the general sensation of noise, vibration and motion inside a driving vehicle, experienced by both the driver as well as the passengers. Design of advanced suspension systems is one of the requirements, which provide comfortable ride by absorbing the road disturbances as well as maintain the vehicle stability. Hyperventilation, disorders of the back like back pain, osteoarthritis, slipping of disc etc. have commonly been associated with exposure to vibration.

Vehicles travel at various speeds and experience a large spectrum of vibrations. Due to road roughness and vehicle vibration, occupants are subjected to accelerations in different directions, which causes discomfort. Such vibrations are transmitted to the vehicle passengers as a result of their contact with the seat, steering wheel, and foot rest. Therefore, occupant comfort is directly associated with the ride performance of a road vehicle. Ride comfort evaluation is a major issue in the analysis of vehicle dynamics.<sup>1</sup> As a necessary part of simulation-based vehicle design, the theory of rigid multibody dynamics methods has been widely applied to assess ride comfort. However, due to the inevitable deformations of flexible parts of road vehicle, the application of rigid multibody dynamics has been found to be not sufficient to predict accurate results.<sup>2</sup> The suspension is one of the most important subsystems in terms of vehicle dynamics performance, especially for the ride and handling. Nevertheless, the deformations of the upper/lower control arms and other key parts of the suspension are generally neglected in the rigid multibody dynamics analysis. Therefore, the flexibility of the suspension structure is taken into consideration to make an accurate analysis of the ride comfort evaluation.

### 1.1 Literature Survey

[1] "Ride comfort evaluation for road vehicle based on rigid-flexible coupling" in this paper the Guangqiang Wu, Guodong Fan, and Jianbo Guo works on comparison between ride comfort analyses of two vehicles including rigid and rigid-flexible coupling multibody vehicle models is done. the two models of car ie. Rigid and Rigid flexible multi body coupling vehicle model and these models were built in the ADAMS/CAR software and the simulation were carried on the B type road ( For B level road, the average value of displacement power spectral density coefficient  $G_q(n0)$  is  $64 \times 10^{-6} m^3$ ) and the furture comfort testing is done Parameters :- frequency, amplitude, acceleration. Based on the comparison between ride comfort analyses of the two models, it can be concluded that the application of the rigid-flexible multibody dynamics can lead to a measurable improvement on the accuracy of the ride comfort evaluation.

[2] "Study on ride comfort of tractor with tandem suspension based on multi-body system dynamics" in this paper the Yong Yang , WeiqunRen , Liping Chen , Ming Jiang , Yuliang Yang works on The parametric model of tractor is done and the further computational simulation at specific speed and road surface is done. The vehicle is run out on the road surface at different speed i.e. 40 , 50 , 60 ,70 km/hr and the

measurement error due to elastic component can be as high as 15% and the comfort testing of the vehicle is obtained. PARAMETER :- Mass, length, edge. Most of the experiment data are provided in a form of subjective response and the corresponding acceleration range.

[3] "Simulation Testing Research on Ride Comfort of Vehicle with Global-coupling Torsion-elimination Suspension 1" in this paper the W. Tong, K. H. Guo works on the ride performance of vehicle with torsion elimination suspension is also same as original thus the torsion-elimination suspension will not bring any efforts to ride comfort of vehicle. in this system the vehicle torsion-elimination suspension is also the same as original vehicle were respects are accelerated to testing speed of 10,20,30,40,50 & 60km/hr and ran through a triangle a bump road and the comfort zone of the vehicle is obtain. The research revealed that this suspension could even vertical loads of each wheel, reduce the torsion of vehicle body and improve the wheel ground adhesion.

[4] "Multimodal approach to automobile driving comfort :the influence of visual setting on assessments of vibro-acoustic comfort in simulators" MaëlAmari, Etienne Parizet, Vincent Roussarie. In this paper they measure vertical vibrations by using accelerometer ,they perform exp. On 8 vehicles and 2 roads.

[5] The paper "Frequency-Domain Simulation And Analysis Of Vehicle Ride Comfort Based On Virtual Proving Ground", in this paper JieGao, Ke Chen states that, a multi-body dynamics simulation virtual vehicle model and a random road surface model are established based on VPG. LS-DYNA is used to solve simulation results. The main parameters of the actual vehicle and the simulation model studied in this paper 1. VEHICLE QUALITY , 2. ENGINE TYPE , 2. TYRE SIZE , 3.TRACK And The analysis of time-domain can accurately reflect the change of vehicle preferences with time and its results can be directly compared with real vehicle test data and the analysis of frequency domain can be directly obserb through a distribution amplitude.

[6] " Simulation And Analysis Of Full Car Model For Various Road Profile On A Analytically Validated Matlab/Simulink Model" proposed by A. Mitra and team In this work the methodology was developed to design a passive suspension for a passenger car for satisfying the two conflicting criteria viz. Ride comfort and Road holding. Mathematical modeling has been also performed using a seven degree-of-freedom model of the full car for passive system.

[7]"PyTOPS :A Python based tool for TOPSIS Vinay Yadava and team . The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method determines the best solution from a set of alternatives with certain attributes. The best alternative is chosen based on its Euclidean distance from the ideal solution. TOPSIS is widely used in various multi-attribute decision making problems such as supply chain logistics, marketing management, environmental management or chemical engineering. Despite the extensive

use of this method, there is no free and open-source software (FOSS) for TOPSIS with comprehensive post-analysis extensions. Therefore, this paper describes a Python-3 based tool PyTOPS for TOPSIS with the Berkeley Software Distribution (BSD)-3-Clause license.

[8] "A-TOPSIS –An approach Based on TOPSIS for Ranking Evolutionary Algorithms" Renato A. Krohlinga,b\*, André G. C. Pachecob. In this paper, we propose an alternative novel method based on the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to solve the problem of ranking and comparing algorithms. In evolutionary computation, algorithms are executed several times and then a statistic in terms of mean values and standard deviations are calculated. In order to compare algorithms performance it is very common to handle such issue by means of statistical tests. Ranking algorithms. In this case, the alternatives consist of the algorithms and the criteria are the benchmarks. The rating of the alternatives with respect to the criteria are expressed by means of a decision matrix in terms of mean values and standard deviations. A case study is used to illustrate the method for evolutionary algorithms. The simulation results show the feasibility of the A-TOPSIS to find out the ranking of algorithms under evaluation

## 1.2 Materials and Methods:

After selection of different categories of road vehicle, ISO 8608(1995) road profile classifications referred and accordingly variety of road profiles in the vicinity of research institute is selected. These roads are categorized as class A, B and C i.e. good, average and rough road respectively according to ISO 8608 (1995). The state-of-the-art ADASH 2-channel FFT analyzer with appropriate instrumentation is used -for the ride comfort analysis

- We selected the different categories of road profile.
- The FFT analyzer with appropriate instrumentation is used for the ride comfort analysis.
- The metal plate is placed and fixed on the passenger seat upon which an accelerometer is mounted.
- After this arrangement, the vehicle is made to travel at an average speed of 50-60 km/hr on selected class of road terrain.
- The displacement, velocity and acceleration response curves are obtained on FFT analyzer. The results from FFT analyzer are then exported to the TOPSIS Tool.
- The results obtained from on-road real time ride comfort testing are then plotted with respect to time

- According to the TOPSIS results, the comparison is made between all the selected vehicles for different road profiles.

### 1.3 TOPSIS

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.

**Methodology used in TOSIS:-** 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. 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).

$$\begin{matrix} & C_1 & C_2 & \dots & C_n \\ \begin{matrix} L_1 \\ L_2 \\ \vdots \\ L_m \end{matrix} & \begin{bmatrix} X_{11} & X_{12} & \dots & X_{1n} \\ X_{21} & X_{22} & \dots & X_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ X_{m1} & X_{m2} & \dots & X_{mn} \end{bmatrix} \end{matrix} \quad \text{---- (1)}$$

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  $C_1, C_2, \dots, C_n$  refer to the criteria: while  $L_1, L_2, \dots, L_m$  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 relative performance of the generated Design alternatives

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

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 via equations (4) and (5) below

$$PIS = A^+ = \{ V_{1+}, V_{2+}, \dots, V_{n+} \}, \text{ where: } V_j = \{ (\max_i (V_{ij}) \text{ if } j \in J); (\min_i V_{ij} \text{ if } j \notin J) \} \quad \text{----- (4)}$$

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

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-ideal solution

$$S^+ = \sqrt{\sum_{i=1}^n (V_j^+ - V_{ij})^2} \quad \text{----- (6)}$$

$$S^- = \sqrt{\sum_{i=1}^n (V_j^- - V_{ij})^2} \quad \text{----- (7)}$$

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.

$$\text{Performance } (C_i) = \frac{S_i^-}{S_i^+ + S_i^-} \quad \text{----- (8)}$$

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 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.

### 1.4 FFT ANALYZER

The resulting digital time record is then mathematically transformed into a frequency spectrum using an algorithm known as the Fast Fourier Transform, or FFT. The FFT is simply a clever set of operations which implements Fourier's theorem. The resulting spectrum shows the frequency components of the input signal.

The vibrations produced in a car are indicated by the device known as FFT (fast Fourier Transform) it indicates the vibrations in the form of graph and any waveform is actually just the sum of a series of simple sinusoids of different frequencies, amplitudes, and phases

### 2. EXPERIMENTATION DONE:-

#### Test 1

**Vehicle Type:** - Hatchback

**Vehicle Model:** - Vista

**Tyre Pressure:**-32

**Windows:**-All Closed

**Music System:**-Off

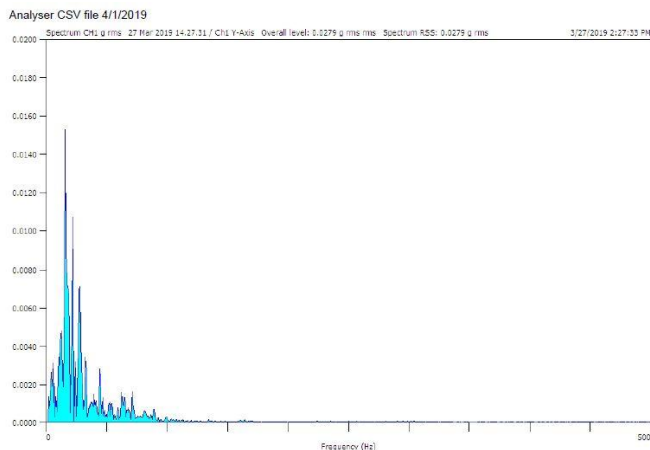
**-Air Conditioning:**-On

**Weight:**-1135+220 kg

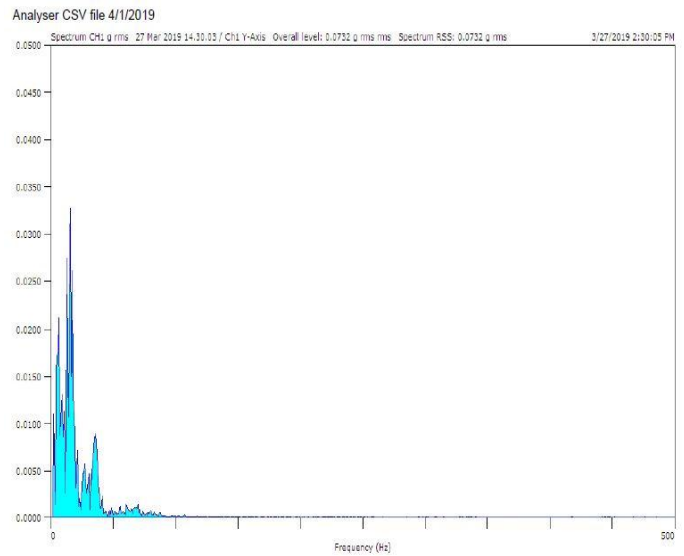
**Noise level:**-62 db

Table 3:- Readings of Vista

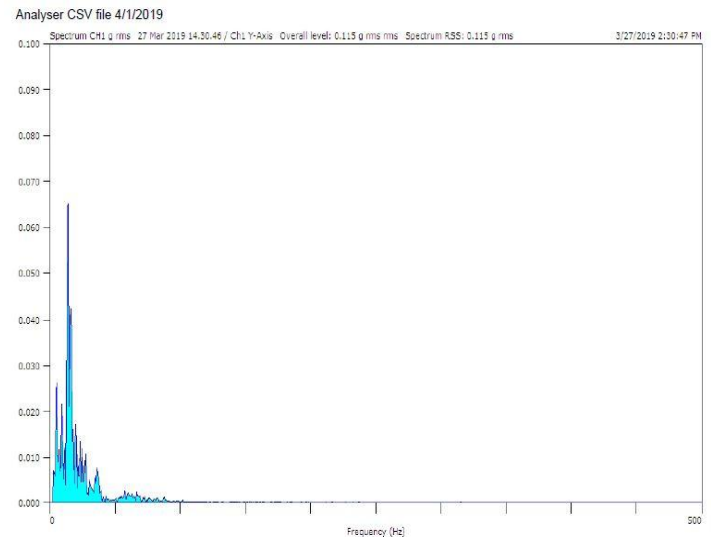
Vehicle Type	Road Type	Acceleration
Hatchback	Case1(Good)	0.105
Hatchback	Case2(Average)	0.209
Hatchback	Case3(Rough)	0.338



Graph 1:- Graph of Vista on Good road



Graph 2:- Graph of Vista on Average Road



Graph 3:-Graph of vista on Rough Road

### 2.1 Input Tables

#### Criteria Parametric Value for Hatchback and Sedan Car

While selecting a new car We consider a various Parameters for selection of vehicle like aesthetic look, lifespan, fuel economy, cost, Noise in passenger Cabin, Vibrations produced by the car. We considered the all the essential parameters while buying a new car. We collect the all necessary data from the features and specifications of the vehicle and vibrations are calculated experimentally by using FFT analyzer.

Table 11:- criteria parametric value of hatchback

Alternatives	Criteria's			
	Vista	Alto800	Datson go	Fiat punto
Style	Better	Good	Good	Better
Lifespan	10yrs	15yrs	8yrs	10yrs
Fuel economy	22(D)	22.05(D)	19 (P)	17 (D)
Cost	4Lac.	2.9 Lac.	3 Lac.	7.5Lac.
Noise	62 db	64 db	58 db	60 db
Vibration	Good	0.105	0.06479	0.0381
	Avg	0.209	0.1859	0.0773
	Rough	0.338	0.4138	0.1619

**Elements of Decision Matrix:-** This all parameters are divided into two groups, firstly we calculate the performance of the car by considering style, lifespan, fuel economy, cost. We give the values for this performance characteristics in above tables, after that we ranking them by considering a suitable range. A ranking is in between the 1 to 10. We consider Rank 1 is very poor and this is increased upto rank 10 and rank 10 is very best performance rank.

**Elemental Decision Matrix :-**

Table 13:-hatchback elemental decision matrix

	Vista	Alto800	Datson	Fiat punto
Style	7	6	6	7
Lifespan	7	9	6	7
Fuel economy	8	8	6	5
Cost	8	9	9	8

**Normal Decision Matrix:-**

This is the 2<sup>nd</sup> step of TOPSIS. In this step we calculate the Normal Decision Matrix by using the formula

$$NDM=R_{ij}=\frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}, \text{ where } X_{ij} \text{ is element of decision matrix}$$

It represents the relative performance of the generated Design alternatives

$$R_{11}=\frac{7}{\sqrt{7^2+8^2+8^2}}=0.6363$$

$$R_{21}=\frac{7}{\sqrt{7^2+8^2+8^2}}=0.5433$$

$$R_{31}=\frac{8}{\sqrt{7^2+7^2+8^2}}=0.7155$$

$$R_{41}=\frac{8}{\sqrt{7^2+7^2+8^2}}=0.5321$$

$$R_{12}=\frac{6}{\sqrt{9^2+8^2+9^2}}=0.5183$$

$$R_{22}=\frac{9}{\sqrt{6^2+8^2+9^2}}=0.7774$$

$$R_{32}=\frac{8}{\sqrt{6^2+9^2+9^2}}=0.7155$$

$$R_{42}=\frac{9}{\sqrt{6^2+9^2+8^2}}=0.6225$$

$$R_{13}=\frac{6}{\sqrt{6^2+6^2+9^2}}=0.5183$$

$$R_{23}=\frac{6}{\sqrt{6^2+6^2+9^2}}=0.4484$$

$$R_{33}=\frac{6}{\sqrt{6^2+6^2+9^2}}=0.4850$$

$$R_{43}=\frac{9}{\sqrt{6^2+6^2+6^2}}=0.6225$$

$$R_{14}=\frac{7}{\sqrt{7^2+5^2+8^2}}=0.6363$$

$$R_{24}=\frac{7}{\sqrt{7^2+5^2+8^2}}=0.5433$$

$$R_{34}=\frac{5}{\sqrt{7^2+7^2+8^2}}=0.3904$$

$$R_{44}=\frac{8}{\sqrt{7^2+7^2+5^2}}=0.5321$$

Table 14 :- Normal Decision Matrix

	Vista	Alto 800	Dats-on go	Fiat punto	Weig htage
Style	0.6363	0.5183	0.5183	0.6363	0.1
Lifespan	0.5433	0.7774	0.4484	0.5433	0.4
Fuel economy	0.7155	0.7155	0.4850	0.3904	0.3
Cost	0.5321	0.6225	0.6285	0.5321	0.2



**Determine the weighted decision matrix for Hatchback cars**

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.

Here we give the different importance to the different parameter, for style, lifespan, fuel economy, cost we give weightage as 0.1, 0.4, 0.3, 0.2 Respectively.

Elements of weighted decision matrix is calculate by the formula,

$$V_{ij} = W_j \times R_{ij}$$

$$V_{11} = 0.6363 \times 0.1 = 0.6363$$

$$V_{21} = 0.5433 \times 0.4 = 0.2173$$

$$V_{31} = 0.7155 \times 0.2 = 0.2146$$

$$V_{41} = 0.5321 \times 0.2 = 0.1064$$

$$V_{12} = 0.5183 \times 0.1 = 0.05183$$

$$V_{22} = 0.7774 \times 0.4 = 0.1793$$

$$V_{32} = 0.7155 \times 0.3 = 0.1455$$

$$V_{42} = 0.6225 \times 0.2 = 0.1245$$

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$$V_{23} = 0.4484 \times 0.4 = 0.1793$$

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$$V_{43} = 0.6225 \times 0.2 = 0.1245$$

$$V_{14} = 0.6363 \times 0.1 = 0.06363$$

$$V_{24} = 0.5433 \times 0.4 = 0.2173$$

$$V_{34} = 0.3904 \times 0.3 = 0.1171$$

$$V_{44} = 0.5321 \times 0.2 = 0.1064$$

**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

Table 15 :- Weighted value of Decision Matrix

	Style	Lifespan	Fuel economy	Cost
<b>Vista</b>	0.06363	0.2173	0.2146	0.1064
<b>Alto 800</b>	0.05183	0.3109	0.2146	0.1245
<b>Datson go</b>	0.05183	0.1793	0.1455	0.1245
<b>Fiat punto</b>	0.06363	0.2173	0.1171	0.1064
<b>Vj<sup>+</sup></b>	0.06363	0.3109	0.2146	0.1245
<b>Vj<sup>-</sup></b>	0.05183	0.1793	0.1171	0.1064

The separation distance of each competitive alternative from the ideal and non-ideal solution is calculated by the formula,

$$S^+ = \sqrt{\sum_{j=1}^n (V_j^+ - V_{ij})^2}$$

$$S_1^+ =$$

$$\sqrt{(0.06363 - 0.06363)^2 + (0.3109 - 0.2173)^2 + (0.2146 - 0.2146)^2 + (0.1245 - 0.1064)^2} = 0.09533$$

$$S_2^+ =$$

$$\sqrt{(0.06363 - 0.05183)^2 + (0.3109 - 0.3109)^2 + (0.2146 - 0.2146)^2 + (0.1245 - 0.1245)^2} = 0.0118$$

$$S_3^+ =$$

$$\sqrt{(0.06363 - 0.05183)^2 + (0.3109 - 0.1793)^2 + (0.2146 - 0.1455)^2 + (0.1245 - 0.1245)^2} = 0.1491$$

$$S_4^+ =$$

$$\sqrt{(0.06363 - 0.06363)^2 + (0.3109 - 0.2173)^2 + (0.2146 - 0.1171)^2 + (0.1245 - 0.1064)^2} = 0.1363$$

$$S^- = \sqrt{\sum_{i=1}^n (V_j^- - V_{ij})^2}$$

$$S_1^- = \sqrt{(0.05183 - 0.06363)^2 + (0.1793 - 0.2173)^2 + (0.1171 - 0.2146)^2 + (0.1064 - 0.1046)^2}$$

$$= 0.105$$

$$S_2^- = \sqrt{(0.05183 - 0.05183)^2 + (0.1793 - 0.3109)^2 + (0.1171 - 0.2146)^2 + (0.1064 - 0.1245)^2}$$

$$= 0.16477$$

$$S_3^- = \sqrt{(0.05183 - 0.05183)^2 + (0.06363 - 0.1793)^2 + (0.1171 - 0.1455)^2 + (0.1064 - 0.1245)^2} =$$

$$0.03367$$

$$S_4^- = \sqrt{(0.05183 - 0.06363)^2 + (0.1793 - 0.2173)^2 + (0.1171 - 0.1171)^2 + (0.1064 - 0.1064)^2}$$

$$= 0.03978$$

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

$$\text{Performance } (C_i) = \frac{S_i^-}{S_i^+ + S_i^-}$$

$$C_1 = \frac{0.10530}{0.09533 + 0.10530} = 0.5248$$

$$C_2 = \frac{0.16477}{0.0118 + 0.16477} = 0.9331$$

$$C_3 = \frac{0.03367}{0.1491 + 0.03367} = 0.1842$$

$$C_4 = \frac{0.03978}{0.1363 + 0.03978} = 0.2259$$

Table16 :- Performance Table for Hatchback Class

Vehicle	S <sup>+</sup>	S <sup>-</sup>	Performance	Rank
Vista	0.09533	0.10530	0.5248	2
Alto 800	0.0118	0.16477	0.9331	1
Datson Go	0.1491	0.03367	0.1842	4
Fiat Punto	0.1363	0.03978	0.2259	3

### Result 1

From performance table, we conclude that the alto 800 is best in above criterion parameters

### SIMILARLY CALCULATIONS FOR ALL TYPES OF VEHICLES.

### 3. CONCLUSIONS

TOPSIS proposed the procedure for four wheeler selection is to find the best car among available ones in market using of decision making method after checking the aggregation 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 ranking preferences in descending order, thus allowing relative performances to be compared.

From the results 1, it is observed that in Hatchback class Indica Vista, Alto 800, Datson Go and fiat punto obtained relative closeness to Ideal solution and the values are 0.520, 0.92, 0.18, and 0.22 respectively. It is observed Alto 800 is identified as the best car among the observed one in Hatchback class.

If we calculate results 2, we will observe that in Sedan class Honda Amaze, Mahindra verito, Skoda laura and Toyota Etios obtained relative closeness to Ideal solution and the values are 0.7293, 0.3640, 0.597 and 0.6302 respectively. It is observed Honda Amaze is identified as the best car among the observed one in sedan class.

If we calculate Result 3 and 4, we will observe that for all the classes of road profile Datson Go and Mahindra verito from the hatchback and sedan class respectively, provides the better ride comfort over other classes of road vehicle with verticle displacement as the performance parameter.

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### BIOGRAPHIES



Nikhil Kishor Toke.  
Mechanical Engineer.  
SVIT, Nashik



Pavan Vilas Kolate.  
Mechanical Engineer.  
SVIT, Nashik





**Pooja Valmik Mahajan.**  
Mechanical Engineer.  
SNJB Chandwad



**Latika Bhalchandra Patil.**  
Mechanical Engineer.  
SNJB Chandwad