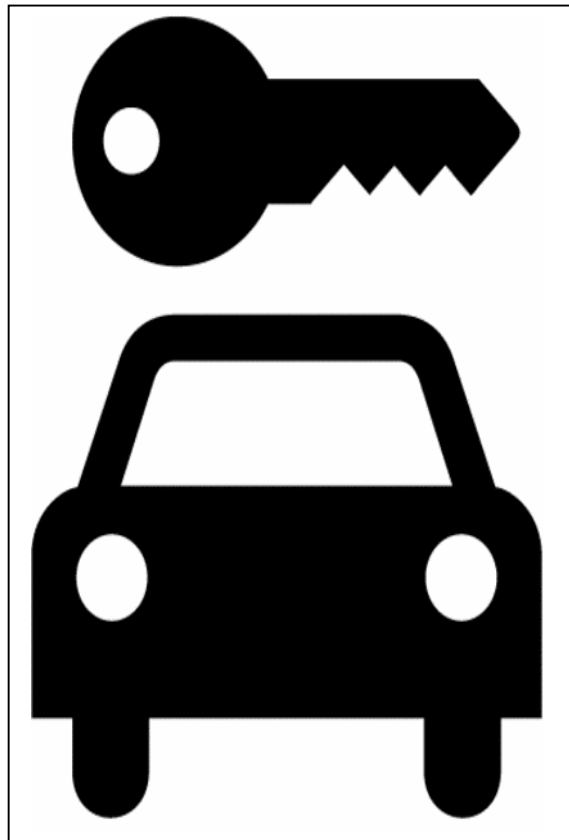# **C**ar

Selection

Problem

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CAR

A car gives us the freedom that we desire. Having your own car means you can reduce the amount of time you spend on public transport. Although public transport is a useful tool for work commuters and students, many of us out there are not too keen on the idea. A car also gives you the opportunity to go on spontaneous road trips that public transport simply cannot accommodate you with.

People also love their cars because they are an expression of their personality. When choosing a new car you can decide on what features are going to suit you, and if they don't already, YOU can change them. From custom paint jobs and designed cover art, to body kits and roof racks, your car can express the type of person you are and what your car means to you.

The best thing about owning a car is that it is totally yours. Nobody can tell you how to run it or what to do with it and it's entirely up to you where you take it. People love cars because of these exact reasons and this is essentially why it is such a big business across the world.

ABOUT CAR SELECTION PROBLEM

Buying car is not a small decision because we have to spend huge amount of money to buy a car. So Buyer must be aware about the car before purchase. Their decision to buy a particular car is their own.

My motive is to aware the buyer and to teach them how to make a decision. I have found that most of the people make a mistake well choose their car. So I have done a research on car selection problem to find how to choose best car from available option. So that people will not make mistake well choosing their dream car and will not regard in future.

Mistakes made by people while choosing their cars:

1. Sticking to buying a dream car
2. Focusing on the deal instead of the car
3. Having only dealer financing in mind
4. False suggestion from others.

VOTES FOR BRAND NAME

FROM SURVEY REPORT

% PERCENTAGE
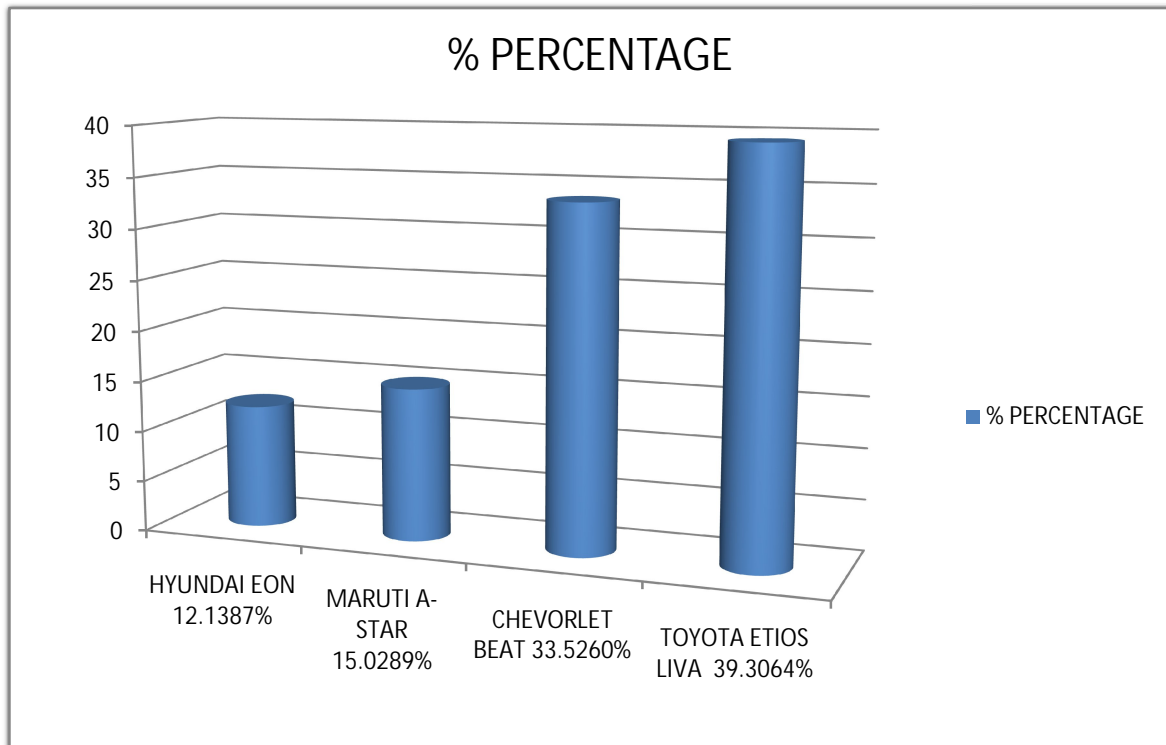
Vote as per brand name

This is to show how people blindly go for their dream car, just because of a brand name. This kind decision may leads to lose of yours initial as well future investment.

TOOL USED TO SOLVE THE CAR SELECTION PROBLEM

ANALYTIC HIERARCHY PROCESS

The Analytic Hierarchy Process (AHP), is a procedure designed to quantify managerial judgments of the relative importance of each of several conflicting criteria used in the decision making process. The concept of AHP was developed, amongst other theories, by **Thomas Saaty**, an American mathematician working at the University of Pittsburgh.

I choose this tool because it gives us the freedom to made comparison when number of alternative and criteria is more than two.

And it simplifies the decision make by people and in return gives more satisfaction to that decision.

During the application of AHP in car selection problem, I have done both qualitative and quantitative

Analysis to gets the best car from available alternative compare with criteria.

Qualitative information Collected from car wale

HYUNDAI

MODEL	Eon (sportz) petrol	
COST	3,75,883(Ex-showroom price)	
MILEAGE	21.1 kmpl	
SERVICING FACILITIES	241 dealerships in 168 cities across India	
COMFORT AND CONVIENCE	Cup-holders	√
	Folder rear seat	√
	Tachometer	-
	Leather seats	-
	AM/FM radio	√
	CD player	√
	Air conditioner	√
	Power door locks	√
	Power steering	√
	Power steering	√
	Power seats	-
	Steering adjustment	√
	Central locking	√
	Defogger (rear)	-

	Remote boot/ fuel-lid	√
	Power window	√
	Alloy wheels	-
	Tubeless tyres	√
	Sun – roof	-
	Front fog lights	√
	Rear wash wiper	-
	Anti-lock braking system	-
	Driver air-bags	√
	Passenger air-bags	-
	Immobilizer	√
	Traction control	-
	Child safety locks	√

CHEVORLET

MODEL	Chevrolet beat (Ls petrol)	
COST	3,91,859 (Ex-showroom price)	
MILEAGE	18.61 kmpl	
SERVICING FACILITIES	180 dealerships in 141 cities across India	
COMFORT AND CONVIENCE	Cup-holders	√
	Folder rear seat	√
	Tachometer	√
	Leather seats	-
	AM/FM radio	-
	CD player	-
	Air conditioner	√
	Power door locks	-
	Power steering	√
	Power steering	√
	Power seats	-
	Steering adjustment	-
	Central locking	√
	Defogger (rear)	-
	Remote boot/ fuel-lid	√
	Power window	√
	Alloy wheels	-
	Tubeless tyres	√
	Sun – roof	-
	Front fog lights	-
	Rear wash wiper	-
	Anti-lock braking system	-
	Driver air-bags	-

	Passenger air-bags	-
	Immobilizer	-
	Traction control	-
	Child safety locks	-

MARUTI

MODEL	A-star (VXi) petrol	
COST	3,96,169	
MILEAGE	19.5 kmpl	
SERVICING FACILITIES	457 dealerships in 253 cities across India	
COMFORT AND CONVIENCE	Cup-holders	√
	Folder rear seat	-
	Tachometer	-
	Leather seats	-
	AM/FM radio	√
	CD player	√
	Air conditioner	√
	Power door locks	-
	Power steering	√
	Power steering	√
	Power seats	-
	Steering adjustment	√
	Central locking	√
	Defogger (rear)	-
	Remote boot/ fuel-lid	√
	Power window	-
	Alloy wheels	-
	Tubeless tyres	-
	Sun – roof	-
	Front fog lights	-
	Rear wash wiper	-

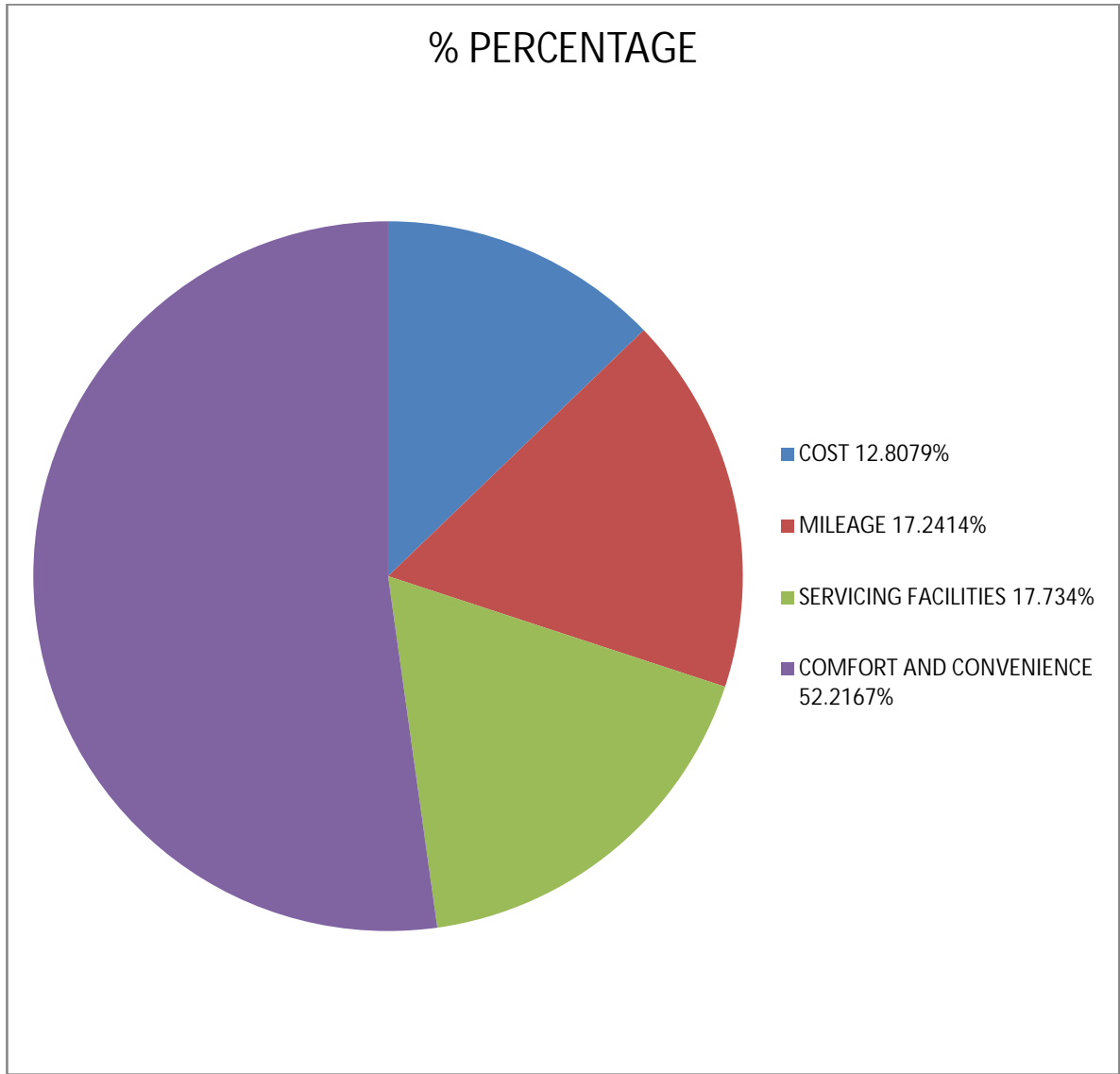|		
	Anti-lock braking system	-
	Driver air-bags	-
	Passenger air-bags	-
	Immobilizer	√
	Traction control	-
	Child safety locks	√

TOYOTA

MODEL	Etios liva (J) petrol
COST	4,21,686 (Ex-show room price)
MILEAGE	15 kmpl
SERVICING FACILITIES	147 dealerships in 92 cities across India

COMFORT AND CONVIENCE		
	Cup-holders	√
	Folder rear seat	-
	Tachometer	-
	Leather seats	
	AM/FM radio	-
	CD player	-
	Air conditioner	-
	Power door locks	√
	Power steering	-
	Power steering	-
	Power seats	-
	Steering adjustment	-
	Central locking	-
	Defogger (rear)	-
	Remote boot/ fuel-lid	-
	Power window	-
	Alloy wheels	-
	Tubeless tyres	√
	Sun – roof	-
	Front fog lights	-
	Rear wash wiper	

	Anti-lock braking system	√
	Driver air-bags	-
	Passenger air-bags	-
	Immobilizer	-
	Traction control	-
	Child safety locks	-
		-
		-
		√
		-
		-

Quantitative information from survey voting

% PERCENTAGE

- COST 12.8079%
- MILEAGE 17.2414%
- SERVICING FACILITIES 17.734%
- COMFORT AND CONVENIENCE 52.2167%

Calculations:

HIERARCHY FOR THE CAR SELECTION PROBLEM

SELECT THE BEST CAR

CRITERIA	COST	SERVICING FACILITIES	COMFORT AND CONVIENCE	MILEAGE

DECISION ALTERNATIVES	MARUTI SUZUKI A-STAR (VXi)	HYUNDAI EON(SPORTZ)	CHEVORLET BEAT (LS)	TOYOTA ETIOSLIVA (J)

Cost:

```
                           LESS
                            ↑
         EON
        (SPORTZ)
       BEAT (LS)
      A-STAR (VXi)
     ETIOS LIVA (J)
                           MORE
```
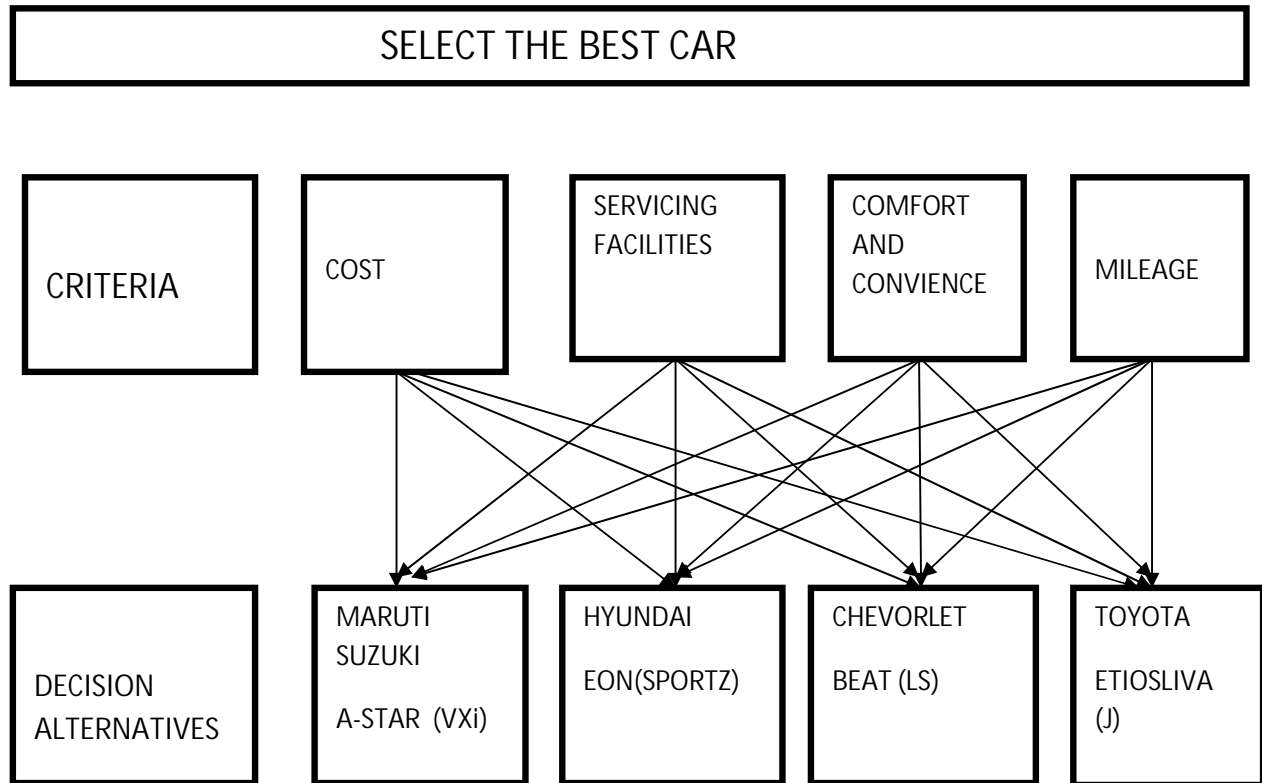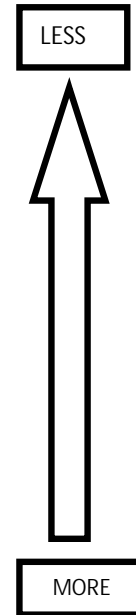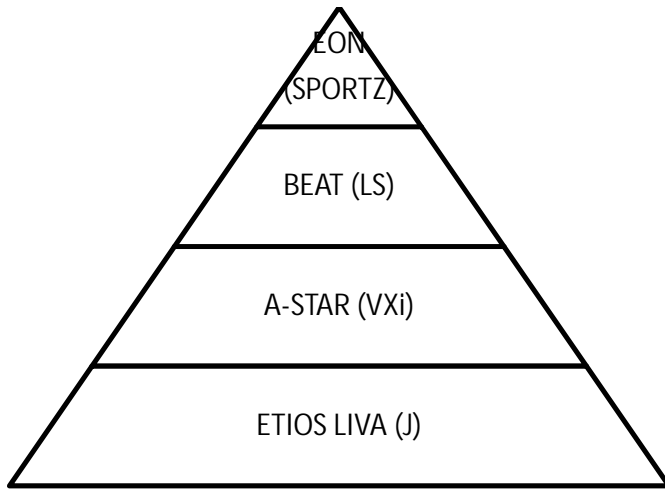
- Forming a pair wise comparison matrix:

 In terms of price A-star is strongly preferred to Etios liva,

 And Eon is very strongly to A-star and strongly to beat, extremely to Etios liva .

 Now beat is very strongly preferred to   Etios liva

- Pair with comparison maruti for cost :

	A-STAR (VXi)	EON (SPORTZ)	BEAT (LS)	ETIOS LIVA (J)
A-STAR (VXi)	1	1/7	1	5
EON (SPORTZ)	7	1	5	9
BEAT (LS)	1	1/5	1	7
ETIOS LIVA (J)	1/5	1/9	1/7	1

- Normal maruti for cost :

  Divide each entry in the pair wise comparison matrix by its corresponding column sum.

  For example: (1+7+1+1/5) = 46/5

	A-STAR (VXi)	EON (SPORTZ)	BEAT (LS)	ETIOS LIVA(J)
A-STAR (VXi)	5/46	45/458	7/50	5/22
EON (SPORTZ)	35/46	315/458	35/50	9/22
BEAT (LS)	5/46	63/458	7/50	7/22
ETIOS LIVA (J)	1/46	35/458	1/50	1/22

- Priority vector for cost :

The priority vector is determined by averaging the row entries in the normalised matrix.

Converting to decimal we get,

A-STAR (VXi): (5/46 + 45/458 + 7/50 + 5/22)/4 =   0.1435

EON (SPORTZ): (35/46 + 315/458 + 35/50 + 9/22)/4 =   0.6394

BEAT (LS): (5/46 + 63/458 + 7/50 + 7/22)/4   =   0.1761

ETIOS LIVA (J): (1/46 + 35/458 + 1/50 + 1/22)/4   =   0.0409

- Checking consistency:

     Multiply each column of the pair wise comparison matrix by its priority.

$$0.1435 \begin{bmatrix} 1 \\ 7 \\ 1 \\ 1/7 \end{bmatrix} + 0.6394 \begin{bmatrix} 1/7 \\ 1 \\ 1/5 \\ 1/9 \end{bmatrix} + 0.1761 \begin{bmatrix} 1 \\ 5 \\ 1 \\ 1/7 \end{bmatrix} + 0.0409 \begin{bmatrix} 5 \\ 9 \\ 7 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.6154 \\ 2.8925 \\ 0.73378 \\ 0.1658 \end{bmatrix}$$

- Divide these no. by their priorities to get:

     0.6154/0.1435 = 4.2885
     2.8925/0.6394 = 4.5237
     0.73378/0.1761 = 4.1668
     0.1658/0.0409 = 4.0537

- Check consistency:

     λ = (4.2885 + 4.5237 + 4.1668 + 4.0537)/4 = 4.2581
     compute the consistence index, CI for 3 terms by

     CI = (λ- n)/ (n-1)
     ⇨ (4.2581-1)/(4-1)
     ⇨ 0.0860
     Compute the consistency ratio, CR by CI/RI,
     Where,
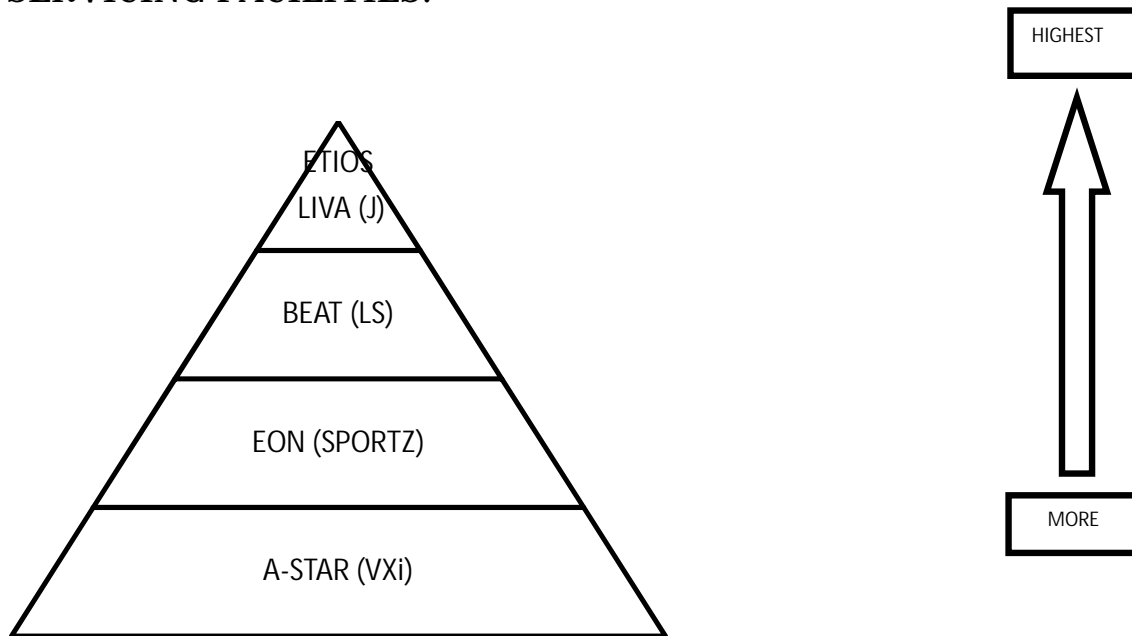   RI = 0.90 , for n = 4
       Where, n= no. Of alternatives
     CR = CI/RI
     ⇨ 0.0860/0.90
     ⇨ 0.0955

     Since, the consistency ratio, CR is less than 0.10, this is well within the acceptable range for consistency.

SERVICING FACILITIES:

HIGHEST

ETIOS
LIVA (J)

BEAT (LS)

EON (SPORTZ)

A-STAR (VXi)

MORE

- Forming a pair wise comparison matrix:
    In term of servicing facilities Maruti is strongly preferred to Hyundai and very strongly
    preferred to Chevrolet and extremely to Toyota
    Now, Hyundai is moderately preferred to Chevrolet and strongly to Toyota
    And also Chevrolet is equally preferred to Toyota
    Toyota is equally preferred to Chevrolet.

- Pair wise comparison matrix for servicing facilities:

	A-STAR (VXi)	EON (SPORTZ)	BEAT (LS)	ETIOS LIVA (J)
A-STAR (VXi)	1	5	7	9
EON (SPORTZ)	1/5	1	3	5
BEAT (LS)	1/7	1/3	1	1
ETIOS LIVA (J)	1/9	1/5	1	1

- Normalised matrix for servicing facilities:
  Divide each entry in the pair wise comparison matrix by its corresponding column sum.
  For example: for Cornell sum =1+1/5+1/7+1/9 = 458/315

	A-STAR (VXi)	EON (SPORTZ)	BEAT (LS)	ETIOS LIVA (J)
A-STAR (VXi)	315/458	75/98	7/12	9/16
EON(SPORTZ)	63/458	15/98	3/12	5/16
BEAT(LS)	45/458	5/98	1/12	1/16
ETIOS LIVA(J)	35/458	3/98	1/12	1/16

- Priority vector for servicing facilities:

The priority vector is determined by averaging the row entries in the normalised matrix. Converting to decimal we get;

A-STAR (VXi):   (315/458 + 75/98 + 7/12 + 9/16) = $\boxed{0.6497}$

EON (SPORTZ):   (63/458 + 15/98 + 3/12 + 5/16) = $\boxed{0.2132}$

BEAT (LS):   (45/458 + 5/98 + 1/12 + 1/16) = $\boxed{0.0737}$

ETIOS LIVA (J): (35/458 + 3/98 + 1/12 + 1/16) = $\boxed{0.0632}$

- Checking consistency:

    Multiply each column of the pair wise comparison matrix by its priority.

    Divide these no. By their priority to get:

    2.8004/0.6497 = 4.3102

    0.88024/ 0.2132 = 4.1287

    0.30078/0.0737 =4.0811

    0.2517/0.0632 = 3.9825

- Check consistency:

    Average the above results to get λ

    λ = (4.3102 + 4.1287 + 4.0811 + 3.9825)/4 = 4.1256
    Compute the consistence index, CI, for 3 terms by
    $CI = (λ - n)/ (n-1)$
    ⇨ (4.1256-1)/(4-1)
    ⇨ 0.0418
    Compute the consistency ratio, CR by CI/RI
    Where,
    RI = 0.90 , for n = 4
        Where, n= no. Of alternatives, CR = CI/RI
    ⇨ 0.0418/0.90
    ⇨ 0.046

    Since, the consistency ratio, CR is less than 0.10, this is well within the acceptable range for consistency.

COMFORT AND CONVENINCE:
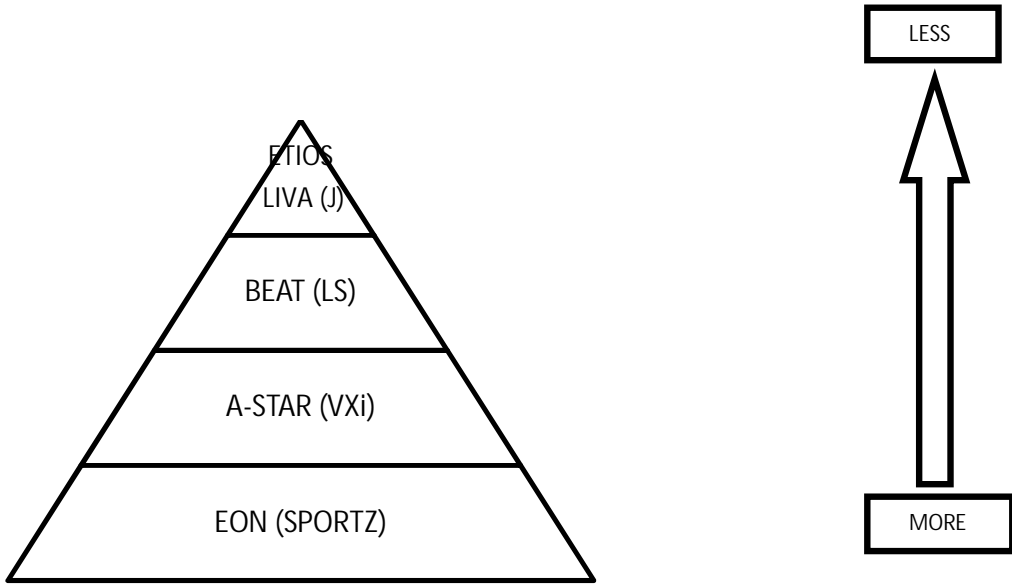
- Forming a pair wise comparison matrix:

  In term of servicing facilities A-star(vxi) is equally preferred to beat (Ls) and preferred to moderately to Etios liva (J)
  Now Eon (sportz) is strongly preferred to A-star (vxi) and very strongly to Beat (Ls)

       And also extremely preferred to Etios liva

- Pair with comparison comfort and convenience :

	A-STAR (VXi)	EON (SPORTZ)	BEAT (LS)	ETIOS LIVA (J)
A-STAR (VXi)	1	1/5	1	3
EON(SPORTZ)	5	1	7	9
BEAT(LS)	1	1/7	1	3
ETIOS LIVA(J)	1/3	1/9	1/3	1

- Normalised matrix for servicing facilities:
  Divide each entry in the pair wise comparison matrix by its corresponding column sum
  For example: (1+5+1+1/3)=22/3

	A-STAR (VXi)	EON (SPORTZ)	BEAT (LS)	ETIOS LIVA (J)
A-STAR (VXi)	3/22	63/458	3/28	3/16
EON(SPORTZ)	15/22	315/458	21/28	9/16
BEAT(LS)	3/22	45/458	3/28	3/16
ETIOS LIVA(J)	1/22	35/458	1/28	1/16

- Priority vector for servicing facilities:
  The priority vector is determined by averaging the row entries in the normalised matrix.
  Converting to decimal we get:

  A-STAR (VXi) : (3/22 + 63/458 + 3/28 + 3/16)/4 = 0.1421

  EON (SPORTZ) : (15/22 + 315/458 + 3/28 + 3/16)/4 = 0.6705

  BEAT(LS): (3/22 + 45/458 + 3/28 + 3/16)/4 = 0.1323

  ETIOS LIVA(J): (1/22 + 35/458 + 1/28 + 1/16)/ 4 = 0.055

- Checking consistency:

  Multiply each column of the pair wise comparison matrix by its priority.

$$0.1421\begin{bmatrix}1\\5\\1\\1/3\end{bmatrix}+0.6705\begin{bmatrix}1/5\\1\\1/7\\1/9\end{bmatrix}+0.1323\begin{bmatrix}1\\7\\1\\1/3\end{bmatrix}+0.055\begin{bmatrix}3\\9\\3\\1\end{bmatrix}=\begin{bmatrix}0.5735\\2.7966\\0.5351\\0.2209\end{bmatrix}$$

- Divide these no. By their priority to get

  0.5735/0.1421 = 4.0358

  2.7966/0.6705 = 4.1709

  0.5351/0.1323 = 4.0445

  0.2209/0.055 = 4.0163

- Check consistency:

  Average the above results to get λ

  λ = (4.0358 + 4.1709 + 4.0445 + 4.0163)/4 = 4.066875
  compute the consistency ratio, CI, for 3 terms by

  $$CI = (λ - n)/ (n-1)$$

  ⇨ (4.06687-1)/(4-1)
  ⇨ 0.0222
  Compute the consistency ratio, CR by CI/RI,
  Where,
  RI = 0.90 , for n = 4
   Where, n= no. Of alternatives
  CR = CI/RI
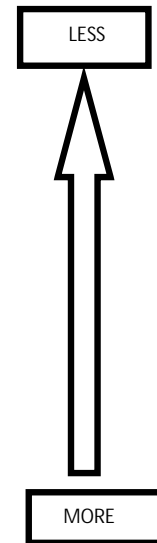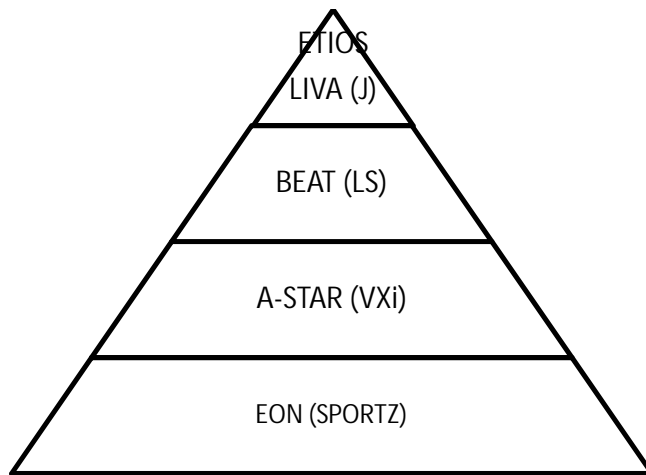 ⇨ 0.0247/0.90
  ⇨ 0.0247

  Since , the consistency ratio, CR is less than 0.10, this is well within the acceptable range for consistency.

MILEAGE:

- Forming a pair wise comparison matrix:

  In term of mileage A-star(vxi) is equally preferred to Beat (Ls) and strongly preferred to Etiosliva (J)

  Eon (sportz) is moderately preferred to A-star (vxi) and equally preferred to beat (Ls)

  And also extremely preferred to Etios liva

  Now beat (Ls) equally preferred to A-star (vxi), and moderately to etios liva (J).

- Pair with comparison mileage :

	A-STAR (VXi)	EON (SPORTZ)	BEAT (LS)	ETIOS LIVA (J)
A-STAR (VXi)	1	1/3	1	5
EON(SPORTZ)	3	1	1	7
BEAT(LS)	1	1/5	1	3
ETIOS LIVA(J)	1/5	1/7	1/3	1

- Normalised matrix for mileage:

Divide each entry in the pair wise comparision matrix by its corresponding column sum.
For example: (1+3+1+1/5)= 26/5

	A-STAR (VXi)	EON (SPORTZ)	BEAT (LS)	ETIOS LIVA (J)
A-STAR (VXi)	5/26	35/176	3/22	5/16
EON(SPORTZ)	15/26	105/176	15/22	7/16
BEAT(LS)	5/26	21/176	3/22	3/16
ETIOS LIVA(J)	1/26	15/176	1/22	1/16

- Priority vector for mileage:
The priority vector is determined by averaging the row entries in the normalised matrix.
Converting .

A-STAR (VXi):   (5/26 + 35/176 + 3/22+5/16)/4 = $\boxed{0.2100}$

EON(SPORTZ) : (15/26 + 105/176 + 15/22 + 7/16)/4 = $\boxed{0.5732}$

BEAT (LS): (5/26 + 21/176 + 3/22 + 3/16)/4 = $\boxed{0.1588}$

ETIOS LIVA (J): (1/26 + 15/176 + 1/22 + 1/16)/4 = $\boxed{0.0579}$

- Checking consistency :

  Multiply each column of the pair wise comparison matrix by its priority.

$$0.2100 \begin{bmatrix} 1 \\ 3 \\ 1 \\ 1/5 \end{bmatrix} + 0.5732 \begin{bmatrix} 1/3 \\ 1 \\ 1/5 \\ 1/7 \end{bmatrix} + 0.1588 \begin{bmatrix} 1 \\ 5 \\ 1 \\ 1/3 \end{bmatrix} 0.0579 \begin{bmatrix} 5 \\ 7 \\ 3 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.8493 \\ 2.4025 \\ 0.65714 \\ 0.2347 \end{bmatrix}$$

- Divide these number by their priorities to get:

  0.8493/0.2100 = 4.0442

  2.4025/0.5732 = 4.1913

  0.65714/0.1588 = 4.1381

  0.2347/0.0579 = 4.0535

- Check consistency:
  Average the above to get λ

  λ = (4.0442 + 4.1913 + 4.1381 + 4.0535)/4 = 4.1067
  compute the consistence index, CI, for 3 terms by

  CI = (λ - n)/ (n-1)
  ⇨ (4.1067-1)/(4-1)
  ⇨ 0.0355
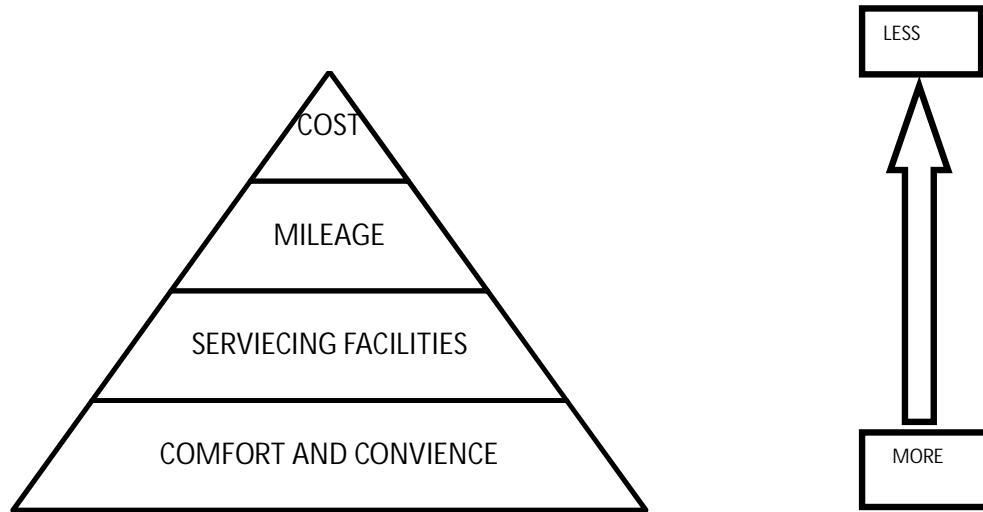 Compute the consistency ratio, CR by CI/RI,
  Where,
  RI = 0.90, for n = 4
   Where, n= no. Of alternatives
  CR = CI/RI
  ⇨ 0.0355/0.90
  ⇨ 0.0395, since, the consistency ratio, CR is less than 0.10, this is well within the acceptable range for consistency.

As per rating from survey that in terms of criteria,
Mileage is moderately preferred to cost, and equally preferred to servicing facilities.
Servicing facilities is strongly preferred to cost, and equally to mileage.
Now, comfort and conveience is extremely preferred to cost, very strongly preferred to
mileage and servicing facilities.

- Pair wise comparison:

	Cost	mileage	servicing facilities	comfort and convience
cost	1	1/3	1/5	1/9
Mileage	3	1	1	1/7
Servicing facilities	5	1	1	1/7
Comfort and convenice	9	7	7	1

- Normalised matrix :

Divide each entry in the pair wise comparison matrix by its corresponding column sum.

	Cost	mileage	servicing facilities	comfort and convince
Cost	1/18	1/28	1/46	7/88
Mileage	3/18	3/28	5/46	9/88
Servicing facilities	5/18	3/28	5/46	9/88
Comfort and convenice	9/18	21/28	35/46	63/88

- Priority vector for criteria:
    The priority vector is determined by averaging the row entries in the normalised matrix.
    Converting to decimal we get;

Cost: $(1/18 + 1/28 + 1/46 + 7/88)/4$ = $\boxed{0.048}$

Mileage: $(3/18 + 3/28 + 5/46 + 9/88)/4$ = $\boxed{0.121}$

Servicing facilities: $(5/18+3/28+5/46+9/88)/4$ = $\boxed{0.148}$

Comfort and convince: $(9/18+ 21/28 + 35/46 +63/88)/4$ = $\boxed{0.681}$

28

- Checking consistency:

    Multiply each column of the pair wise comparison matrix by its priority.

$$0.0481 \begin{bmatrix} 1 \\ 3 \\ 5 \\ 9 \end{bmatrix} + 0.1211 \begin{bmatrix} 1/3 \\ 1 \\ 1 \\ 7 \end{bmatrix} + 0.1489 \begin{bmatrix} 1/5 \\ 1 \\ 1 \\ 7 \end{bmatrix} + 0.6816 \begin{bmatrix} 1/9 \\ 1/7 \\ 1/7 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.1939 \\ 0.5116 \\ 0.6078 \\ 3.0045 \end{bmatrix}$$

- Divide these number by their priorities:
    0.1939/0.0481 = 4.0311
    0.5116/0.1211 = 4.2246
    0.6078/0.1489 = 4.0819
    3.0045/0.6816 = 4.4080

- Check consistency:
    Average the above results to get λ

    λ = (4.0311 + 4.2246 + 4.0819 + 4.4080)/4 = 4.1864
    compute the consistence index, I, for 3 terms by
    CI = (λ - n)/ (n-1)
    ⇨   (4.1864-1)/(4-1)
    ⇨   0.0621
    Compute the consistency ratio , CR by CI/RI,
    Where,
    RI = 0.90 for n = 4
     Where, n= no. Of alternatives
    CR = CI/RI
    ⇨   0.0621/0.90
    ⇨   0.0690

    Since, the consistency ratio, CR is less than 0.10; this is well within the acceptable range for consistency.

- Overall priority vector:

	Cost	mileage	servicing facilities	comfort and convnience
Priority vector For criteria	0.0481	0.1211	0.1489	0.6816

	Cost	mileage	servicing facilities	comfort and convnience
A-start (vxi)	0.1435	0.2100	0.6497	0.1421
Eon (sportz)	0.6394	0.5732	0.2132	0.6705
Beat (Ls)	0.1761	0.1588	0.0737	0.1323
Etios liva(J)	0.0409	0.0579	0.0632	0.055

A-star(vxi)	(0.0481×0.1435)+ (0.1211×0.2100)+(0.1489×0.6497)+(0.6816×0.1421)	=	0.2259
Eon(sportz)	(0.0481×0.6394)+ (0.1211×0.5788)+(0.1489×0.2132)+(0.6816×0.6705)	=	0.5895
Beat (LS)	(0.0481×0.1761)+ (0.1211×0.1588)+(0.1489×0.0737)+(0.6816×0.1323)	=	0.1288
Etios liva (J)	(0.0481×0.0409)+ (0.1211×0.0579)+(0.1489×0.0632)+(0.6816×0.055)	=	0.0558

Thus,

Hyundai Eon (sportz) is appears to be the overall best as per calculate

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CONCLUSION

After solving this car selection problem with AHP method
I have found that Hyundai Eon is overall the best available option.
And buyer gets the maximum satisfaction with their decision if
they purchases Hyundai Eon.