Evaluation of purchase intention of customers in two wheeler automobile segment: AHP and TOPSIS

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Abstract. Winning heart of customers is preeminent main design of any business organization in global business environment. This paper explored customer’s priorities while purchasing a two wheeler automobile segment using Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) as a multi criteria decision making tools to accomplish the research objectives. Study has been done to analyze different criteria to be considered during purchasing of two wheeler automobiles among respondents using structured questionnaire based on SAATY scale. Based on our previous work on empirical & fuzzy logic approach to product quality and purchase intention of customers in two wheeler- operational, performance, economic, brand value and maintenance aspects are considered as decision criteria of customers while purchasing a two wheeler. The study suggests high pick up during overtaking, petrol saving, reasonable spare parts price, unique in design and identity and easy to change gear as main criterion in purchasing process. We also found some leading two wheeler automobiles models available in Indian market using some objective function criterion in choosing some important characteristics like price, cylinder capacity, brake horse power and weight during purchasing process of two wheeler automobile in Indian market based on respondents perception.

1. Introduction

Human beings are good decision makers for their well being. In the process of decision making humans are cognizant for the implications of decisions taken under different environments - certainty and uncertainty. Consequences of some decisions may sometimes be positive or negative which shall reflect in business profit or loss. As process of decision making structured methodology is adopted, covering setting the goal of decision making, collecting relevant information, finding out different courses of anticipated results, by the decision chosen, and evaluating the final decision. The traditional process of decision making changes for different conditions i.e under certainty, uncertainty and mapping onto different levels of management (i.e top, middle and bottom)also taking structured and unstructured decisions in day to day business activities. When decision making is complex information plays a vital role in taking better decisions. This paper objective is purchase intention of a customer in two wheeler, which has multi criterion. In the Indian automobile industry, the two wheeler segment contributes the greatest volume amongst all of the segments at a size of Rs 100,000 million annually. The Indian automobile segment can be broadly categorized into three sub segments; scooters, motor cycles and mopeds, while some categories are formed by combination of two or more segments. The two wheeler segment has five players and most of the companies have foreign collaborators. The world's largest two wheeler manufacturer and seller, Hero Moto Corp, has an annual sales turnover of US 15 billion dollars. This is largely due to the significant growth of the Indian two wheeler industry, which has grown along with people's personal disposable incomes and is customary to have a continuing decisive percussion on India's economic growth in the coming years. Ten percent of India's annual GDP comes from the design and manufacture of automobiles and auto components with a
market value of US 145 billion dollars, and sector employment is expected to grow to 25 million people by 2016. Whenever we come across multiple decision criteria in the process of decision making, the concept of MCDM is used as a structured, scientific methodology in solving critical decision making problems. Because there is no unique solution for a case of multiple decision criteria which has impact by person’s perception in selecting the best criteria among the multiple criterions will differ from person to person. In solving this kind of decision making problem MCDM is one of the successful tools applied to different real world business problems and those decisions are used for sustainable business growth. In this study we have considered consumer behaviour while purchasing a two wheeler in Indian competitive two wheeler automobile market which is a common case of MCDM. The customer decided to purchase a new two wheeler. The criteria are comfort, safety, fuel, price etc. In this situation the Analytic Hierarchy Process is used. TOPSIS used to prioritize the AHP result. These two are tools of the MCDM methods.

1.1 Research objectives:
- To determine important criterion during purchasing process of two wheeler automobile segment in India
- To determine leading two wheeler automobile models using different technical characteristics based on respondents in the survey administered.

2. Literature Review

For evaluating various criterions using multi criteria decision making techniques, AHP and TOPSIS. The review considered the most cited academic publications regarding AHP and TOPSIS in selecting two wheeler as a purchase intention. The Boolean keyword combination “(MCDM or AHP, MCDM or TOPSIS) AND (Two wheeler Or Automobile)” was applied to conduct the literature search. Keywords such as MCDM, AHP, TOPSIS, AHP- Two wheeler, TOPSIS - Automobile TOPSIS - two wheeler were used to search the databases.

| Author(s)               | Finding/Significant contribution                                                                 |
|-------------------------|---------------------------------------------------------------------------------------------------|
| Karim (2016) [1]        | A prototype framework of AHP and TOPIS for machine selection using operational criteria of machine as decision criteria. |
| Deswal et.al (2015) [2] | Suggested to use concept of ideal best and ideal worst situations in selecting the suppliers using TOPSIS. Ideal worst solutions of supplier to be used for further improvement. |
| Sriyogi (2015) [3]      | Customers intend to purchase two wheelers; dimensions of quality are positively associated with the purchase decision. |
| Saurabh et.al (2015) [4]| Recommended a scheme for appraising and computing the CSFs by using Fuzzy-TOPSIS technique for Reverse logistics practice. |
| Valarmathi (2015) [5]   | An empirical study to understand post purchase behaviour of two wheeler, circumstances instigated are after sales service, pricing and new models among students as consumers. |
| Christopher et.al (2014) [6] | Using AHP propounded perfect paradigm for purchasing a car, used population: sample of Tamilnadu India. |

| Author(s)               | Finding/Significant contribution                                                                 |
|-------------------------|---------------------------------------------------------------------------------------------------|
| Nilashi et.al (2014)[7] | Application of TOPSIS to understand factors affecting the purchase intention on B2B websites. |
| Author(s)               | Finding/Significant contribution                                                                                                                                                                                                                                                                                                                                 |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Saravanan et.al (2014)  | AHP has been used to suggest best engineering institution (service orientation) for selecting a bachelors engineering course: student perspective.                                                                                                                                                              |
| Srikrishna et.al (2014) | Using TOPSIS for purchasing a car considering decision criterion: mileage, exterior aesthetics, and average durability.                                                                                                                                                                                                                                           |
| Remica et.al (2013)    | Application of Fuzzy AHP to enhance the quality of transcendence of an employee’s performance amplitude characteristics under fuzzy environment.                                                                                                                                                                                                                       |
| Srikrishna et.al (2012) | AHP as a tool to find prompt circumstances in excerpt of car brands in India flexibility and brand image are chosen as important criteria during pre purchase behaviour.                                                                                                                                                                                                 |
| Alexandre et.al (2011) | Adapted to AHP and Delphi Process to apprehend, resolve multiple aspects of project intricacy using a case of entertainment Industry.                                                                                                                                                                                                                                         |
| Lee et.al (2011)       | Pertinence of AHP to interpret the knowledge management observance behaviours among elementary school students.                                                                                                                                                                                                                                                         |
| Yousefi et.al (2010)   | Employed real data a provisional study by application of AHP, TOPSIS and DEA to aggrandize decision quality in six sigma project option.                                                                                                                                                                                                                                 |
| Sue Yoshi et.al (2009) | Combined AHP and DEA data of car rental as a case for appraisal of accounting, financial and operational aspects under multi criteria decision scenario.                                                                                                                                                                                                            |
| Metin et.al (2008)     | Fuzzy AHP accession is proferred to regulate the matched faulty comportment risk in work systems safety, frame of reference adopted real data of manufacturing company.                                                                                                                                                                                                                   |
| Chang et.al (2007)     | Employed AHP established a manufacturing quality output representation: silicon wafer slicing.                                                                                                                                                                                                                                                                       |
| Omkar Prasad et.al (2004) | Reviewed critically research on AHP suggested to use it with other techniques, for convoluted situations to achieve better economic results.                                                                                                                                                                                                                             |
| Chin Wei et.al (2005)  | Contemplated a schema to guesstimate advisable ERP Systems that seasonable into business objectives and game plan, testified using a real case.                                                                                                                                                                                                                              |
| Nagai et.al (2005)     | An exemplary AHP is systemized and enforced to a real case to facilitate business managers for a communications company in Hong Kong.                                                                                                                                                                                                                                     |
| Ngai (2003)            | Exercised AHP to understand proportionate antecedents that influence the druthers of the preeminent web site, five decision precedents were used.                                                                                                                                                                                                                       |
| Oliveira et.al (2003)  | MCDA as a successful tool in accomplishing cardinal top level decision areas which is influential in concluding business targets.                                                                                                                                                                                                                                           |
| Punj & Brooks (2002)   | The actions of decision making have significant consequence on concept of product development.                                                                                                                                                                                                                                                                       |
| Byun (2000)            | Evaluated post purchase behaviour of car using AHP successful in implementing various decision criterion made by consumer as a better and obvious decision maker.                                                                                                                                                                                                        |
| Badri (2000)           | For selecting best alternative among budget, hour, labour using adequate preference as Service quality perspective of control instruments.                                                                                                                                                                                                                           |
Identified considerable improvements of AHP: comfort adoption, job awareness, inherent firmness tests, applicable assessment ratio.

Appraisal of three software packages adopting AHP for exceptional pellucid choice.

Analysed factors predicting the consideration of single brand, satisfaction with the previous variables like socio demographic, low perceived risk etc. Investigated a few of the functional and computing concerns elaborated when AHP is applied in engineering appliance.

From the literature review to corroborate it has been observed that wide applications of AHP and TOPSIS are used in different areas of research covering purchasing behaviour, choosing the best machines, network management, knowledge management, purchase behaviour, strategic decisions, evaluation of software ERP products, safety factors of work system and purchase intentions on B2C. Especially when ever decision making in choosing different alternatives with different criterion on a common scale. However, we observed that using AHP and TOPSIS for evaluating a purchase intention of customers in two wheeler automobile segment for Indian market is scarce. In this study we have made an effort to evaluate a purchase intention of customers in two wheeler automobile segment using AHP results as inputs to TOPSIS.

3. Research Methodology

For accomplishing the research objective, we have used two multi criteria decision making techniques (MCMD). They are Analytical Hierarchy Process for the purpose of weighting the data, and final ranking to the model selected in the price band (two wheelers available in Indian Market) of Rs 39,000/- to Rs 65,000/- is done using TOPSIS. At first, customer’s criteria are selected on the basis of research work of Sriyogi (2015)[3]. A pair wise comparison data of precedent and sub-criteria was possessed over both online and offline survey is done by using a spread sheet model from group of experts.

After evaluating the criteria and sub-criteria and specifying their importance degree (weights), evaluated the alternatives with regard to each sub-criterion, which has been done by table above. In this stage the alternatives are compared with regard to each sub-criterion and considered scores as indicated in section 3.1

Same size of 59 comprising of customers, two wheeler service personnel, product managers and academicians. The data has been collected through online survey using google forms, as well as personnel interaction.

When criteria, sub-criteria and the substitutes have to be appraised, related by each decision maker and their individual seriousness of intensity have to be determined. In postliminary stride their category priority intensity has been computed.Categorical priority intensity of each precedent equals geometric average of separate attentive intensity of that criterion. Decision matrix is achieved as a conclusion of this phase. AHP and TOPSIS have been used to rank and preferenciate the alternatives. AHP method has been used for ranking in respect to appraisal of criteria and sub-criteria, and TOPSIS in order to ranking the opportunity with appreciation to their scope from ideal and negative ideal solutions.

3.1 Selection of decision criteria and sub-criteria

The following are the Key Criteria’s that are chosen for application of AHP, after consulting experts
in the field of automobile two wheeler segment and user.

Key Criteria’s

Operational Aspects[C1]
- High pick up during overtaking (HPUDO) [C11]
- Power to climb hilly areas (PCHA) [C12]
- Suitable and effective beam of light (SEBL) [C21]

Performance Aspects[C2]
- Ease of changing gears (ECG) [C22]
- No vibration at top speed (NVTS) [C23]
- Petrol saving (PS) [C31]

Economic Aspects[C3]
- Reasonable spare parts price (RSPP) [C32]
- Fuel saving, for long distance travel (FSLDT) [C33]
- High trade value (High trade value (HTV) [C41]

Brand value aspects[C4]
- Unique in design and identity (UDID) [C42]
- Suitable colour for motorcycle design (SCMD) [C43]
- Easy modifications and installation with many accessories (EIMACC) [C51]

Maintenance aspects[C5]
- Less service time at service station (LSTSS) [C52]
- Easy to service at any service station (EASSS) [C53]

Figure 1. Hierarchy Model used in AHP
**Table 1. Demographic profile**

| Age Group | Demographics | Frequency |
|-----------|--------------|-----------|
| 18-25     |              | 47        |
| 26-35     |              | 7         |
| 36-45     |              | 4         |
| > 45      |              | 1         |

| Education |             |           |
|-----------|--------------|-----------|
| UG        |              | 47        |
| PG        |              | 6         |
| Ph.D.     |              | 5         |
| Diploma   |              | 1         |

| Place     |             |           |
|-----------|--------------|-----------|
| City      |              | 35        |
| Town      |              | 20        |
| Village   |              | 4         |

| Employment|             |           |
|-----------|--------------|-----------|
| Student   |              | 44        |
| Government|              | 5         |
| Private   |              | 6         |
| Self Employed |           | 4         |

### 3.2 Analysis of collected data using AHP

Analytical hierarchical process a multi criteria decision making technique which we have chosen to find the contribution of the individual criteria towards the objective of purchasing a two wheeler, i.e., the factors affecting the buyer’s behaviour in choosing a particular manufacture and model. For a better decision making in a scientific approach researchers should generate priorities by decomposing the decision while applying the AHP Saaty,(2008)[30]. Figure 2 depicts algorithm of AHP used in this study step by step procedure.
**Figure 2.** Algorithm of AHP used in this study

Step 1: A pair wise comparison for the above criteria and sub criteria was collected through structured survey using SAATY scale.

Step 2: The average values of the responses collected through the survey are the inputs to the key criteria and sub-criteria pair wise comparison matrix.

Step 3: The above pair comparison matrix is normalized with the following method.

\[
\text{Normalization} = \frac{\text{each cell value of comparison matrix}}{\text{sum of corresponding column values}}
\]

Step 4: The contribution matrix is calculated as row average of normalized matrix.

Case 1: If the Contribution matrix is identical to all the columns of normalized matrix, the comparison matrix is consistent.

Case 2: If the Contribution matrix is not identical with the columns of the normalized matrix, CR (Consistency Ratio) is needed to be calculated.

If the CR \( \leq 0.1 \), one is expected to assume the pair wise comparison to be consistent.

Step 5:

1. Calculation of Consistency Ratio (CR)

\[
\text{Consistency index} = \frac{\lambda_{\text{max}} - n}{n - 1}
\]

2. Consistency index (CI) = \( \frac{\lambda_{\text{max}}}{n - 1} \)

   a. \( \lambda_{\text{max}} = \sum_{i=1}^{n} (\text{Product matrix}) \)
   
   b. Product matrix \([P] = \text{(number of decision criteria)} \times \text{[Contribution Matrix]}\)
   
   c. \( n = \text{Number of decision criteria} \)
   
   d. Relative index is chosen from the following table.

| \( n \) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-------|---|---|---|---|---|---|---|---|---|----|
| RI    | 0 | 0 | 0.58 | 0.9 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

Step 6: All above steps are applied to all five pair wise comparison matrix, then the corresponding Contribution values arranged in a descending order. That gives us the order of most determining criteria and sub criteria in descending order.
4. Results and discussions

4.1 Analysis of Key decision criteria using AHP

Pair wise comparison matrix.

| Criteria | C₁ | C₂ | C₃ | C₄ | C₅ |
|----------|----|----|----|----|----|
| C₁       | 1.0000 | 5.2143 | 4.4286 | 6.1053 | 5.272727 |
| C₂       | 0.1918 | 1.0000 | 5.7805 | 6.2941 | 4.945946 |
| C₃       | 0.2258 | 0.1730 | 1.0000 | 5.9362 | 5.25 |
| C₄       | 0.1638 | 0.1589 | 0.1685 | 1.0000 | 4.660377 |
| C₅       | 0.1897 | 0.2022 | 0.1905 | 0.2146 | 1.0000 |

Normalized matrix

| Criteria | C₁ | C₂ | C₃ | C₄ | C₅ |
|----------|----|----|----|----|----|
| C₁       | 0.565 | 0.773 | 0.383 | 0.312 | 0.250 |
| C₂       | 0.108 | 0.148 | 0.500 | 0.322 | 0.234 |
| C₃       | 0.127 | 0.026 | 0.086 | 0.304 | 0.248 |
| C₄       | 0.092 | 0.024 | 0.015 | 0.051 | 0.221 |
| C₅       | 0.107 | 0.030 | 0.016 | 0.011 | 0.047 |

Contribution matrix

| Criteria | Contribution |
|----------|--------------|
| C₁       | 0.456        |
| C₂       | 0.262        |
| C₃       | 0.158        |
| C₄       | 0.080        |
| C₅       | 0.042        |

As the values in the contribution matrix and normalised matrix are not equal, consistency is calculated.

Product Matrix

| Criteria | Product Value |
|----------|--------------|
| C₁       | 2.281984     |
| C₂       | 1.312199     |
| C₃       | 0.791692     |
| C₄       | 0.402308     |
| C₅       | 0.211818     |

Consistency Calculation

\[ \lambda_{\text{max}} = 5 \]
\[ \text{Consistency Index} = 0 \]
\[ \text{Relative Index} = 1.12 \]
\[ \text{Consistency Ratio} = 0 \]

As the value of CR < 0.1, the corresponding contribution is consistent.
4.2 Analysis of Sub decision criteria under operational aspects using AHP

Pairwise comparison matrix

| Criteria | C₁₁ | C₁₂ |
|----------|-----|-----|
| C₁₁      | 1.0000 | 6.35 |
| C₁₂      | 0.1575 | 1.0000 |

Normalized matrix

| Criteria | C₁₁ | C₁₂ |
|----------|-----|-----|
| C₁₁      | 0.863946 | 0.863946 |
| C₁₂      | 0.136054 | 0.136054 |

Contribution matrix

As the values in the contribution matrix and normalised matrix are equal the contribution is consistent.

Relative Contribution matrix:

| Criteria | Relative Contribution |
|----------|------------------------|
| C₁₁      | 0.270415 |
| C₁₂      | 0.042585 |

4.3 Analysis of Sub decision criteria under performance aspects using AHP:

Pairwise comparison matrix

| Criteria | C₂₁ | C₂₂ | C₂₃ |
|----------|-----|-----|-----|
| C₂₁      | 1.0000 | 4.655172 | 5.5 |
| C₂₂      | 0.2148 | 1.0000 | 5.4 |
| C₂₃      | 0.1818 | 0.1852 | 1.0000 |

Normalized matrix

| Criteria | C₂₁ | C₂₂ | C₂₃ |
|----------|-----|-----|-----|
| C₂₁      | 0.716008 | 0.79707 | 0.462185 |
| C₂₂      | 0.153809 | 0.171222 | 0.453782 |
| C₂₃      | 0.130183 | 0.031708 | 0.084034 |

Contribution matrix

| Criteria | Contribution |
|----------|--------------|
| C₂₁      | 0.658 |
| C₂₂      | 0.260 |
| C₂₃      | 0.082 |
Product Matrix

| Criteria | Product |
|----------|---------|
| C_{21}   | 1.975262|
| C_{22}   | 0.778813|
| C_{23}   | 0.245925|

As the values in the contribution matrix and normalised matrix are not equal, consistency is calculated.

Consistency Calculation:

\[ \lambda_{\text{max}} = 3 \]

Consistency Index = 0

Relative Index = 1.12

Consistency Ratio = 0

As the value of CR < 0.1, the corresponding contribution is consistent.

Relative Contribution Matrix:

| Criteria | Relative Contribution |
|----------|------------------------|
| C_{21}   | 0.202794               |
| C_{22}   | 0.079958               |
| C_{23}   | 0.025248               |

4.3.1 Analysis of Sub decision criteria under Economic aspects using AHP:

Pair wise comparison matrix

| Criteria | C_{31} | C_{32} | C_{33} |
|----------|--------|--------|--------|
| C_{31}   | 1.0000 | 6.387755 | 4.837838 |
| C_{32}   | 0.1565 | 1.0000 | 5.275862 |
| C_{33}   | 0.2067 | 0.1895 | 1.0000 |

Normalized matrix

| Criteria | C_{31} | C_{32} | C_{33} |
|----------|--------|--------|--------|
| C_{31}   | 0.733539 | 0.843012 | 0.435304 |
| C_{32}   | 0.114835 | 0.131973 | 0.474717 |
| C_{33}   | 0.151625 | 0.025015 | 0.089979 |

Contribution matrix

| Criteria | Contribution |
|----------|--------------|
| C_{31}   | 0.671        |
| C_{32}   | 0.241        |
| C_{33}   | 0.089        |

As the values in the contribution matrix and normalised matrix are not equal, consistency is calculated.

Product matrix

| Criteria | Product |
|----------|---------|
| C_{31}   | 2.011856|
| C_{32}   | 0.721525|
| C_{33}   | 0.266619|
Consistency Calculation

\[ \lambda_{\text{max}} = 3 \]
Consistency Index = 0
Relative Index = 1.12
Consistency Ratio = 0

As the value of CR < 0.1, the corresponding contribution is consistent.

Relative contribution matrix

| Criteria | Relative Contribution |
|----------|-----------------------|
| C_{31}   | 0.127418              |
| C_{32}   | 0.045697              |
| C_{33}   | 0.016886              |

4.3.2 Analysis of Sub decision criteria under Brand aspects using AHP:

Pair wise comparison matrix

| Criteria | C_{41} | C_{42} | C_{43} |
|----------|--------|--------|--------|
| C_{41}   | 1.0000 | 4.5    | 5.157895 |
| C_{42}   | 0.2222 | 1.0000 | 5.465021 |
| C_{43}   | 0.1939 | 0.1830 | 1.0000  |

Normalized matrix

| Criteria | C_{41} | C_{42} | C_{43} |
|----------|--------|--------|--------|
| C_{41}   | 0.706165 | 0.791838 | 0.443769 |
| C_{42}   | 0.156926 | 0.175964 | 0.470194 |
| C_{43}   | 0.13691 | 0.032198 | 0.086037 |

Contribution matrix

| Criteria | Contribution |
|----------|--------------|
| C_{41}   | 0.647        |
| C_{42}   | 0.268        |
| C_{43}   | 0.085        |

As the values in the contribution matrix and normalised matrix are not equal, consistency is calculated.

Product Matrix

| Criteria | Product |
|----------|---------|
| C_{41}   | 1.941772 |
| C_{42}   | 0.803083 |
| C_{43}   | 0.255145 |

Consistency Calculation

\[ \lambda_{\text{max}} = 3 \]
Consistency Index = 0
Relative Index = 1.12
Consistency Ratio = 0

As the value of CR < 0.1, the corresponding contribution is consistent.
Relative Contribution:

| Criteria | Relative Contribution |
|----------|------------------------|
| C_{41}   | 0.070551               |
| C_{42}   | 0.029179               |
| C_{43}   | 0.00927                |

4.3.3 Analysis of Sub decision criteria under Maintenance aspects using AHP

Pair wise comparison matrix

| Criteria | C_{51} | C_{52} | C_{53} |
|----------|--------|--------|--------|
| C_{51}   | 1.0000 | 5.162162 | 4.384615 |
| C_{52}   | 0.1937 | 1.0000 | 4.73913 |
| C_{53}   | 0.2281 | 0.2110 | 1.0000 |

Normalized matrix

| Criteria | C_{51}   | C_{52}   | C_{53}   |
|----------|----------|----------|----------|
| C_{51}   | 0.70334  | 0.809983 | 0.433102 |
| C_{52}   | 0.136249 | 0.156908 | 0.46812  |
| C_{53}   | 0.160411 | 0.033109 | 0.098778 |

Contribution matrix

| Criteria | Contribution |
|----------|--------------|
| C_{51}   | 0.649        |
| C_{52}   | 0.254        |
| C_{53}   | 0.097        |

As the values in the contribution matrix and normalised matrix are not equal, Consistency ratio is calculated.

Product Matrix

| Criteria | Product |
|----------|---------|
| C_{51}   | 1.946425 |
| C_{52}   | 0.761277 |
| C_{53}   | 0.292298 |

Consistency Calculation

\[ \lambda_{\text{max}} = 3 \]
Consistency Index \[ = 0 \]
Relative Index \[ = 1.12 \]
Consistency Ratio \[ = 0 \]

As the value of CR < 0.1, the corresponding contribution is consistent.

Relative Contribution

| Criteria | Relative Contribution |
|----------|------------------------|
| C_{51}   | 0.051905               |
| C_{52}   | 0.020301               |
| C_{53}   | 0.007795               |

Using AHP algorithm pair wise comparison has been conducted, values of pair wise comparison has
some valid findings, values have significance for a particular criteria when compared with other criteria, high values shows that particular criteria has more relative importance than other criteria chosen in the study. Using the normalized matrix, converted values on a common scaled of all different weighted responses from the survey respondents. This matrix is similar to pay off matrix in game theory as a relative value of the corresponding criterion in row and column at the pivot cell. Highest the values in the pivot cell indicates the importance on a scale of 0-1 range.

4.3.4 Output of AHP

As the contribution of individual criteria towards the objective is found, their arrangement in the descending order will give us the order of top priorities.

Table 2 Ranking of Sub criterion using contribution score

| Ranking | Sub Criteria | Contribution Score |
|---------|--------------|--------------------|
| 1       | HPUDO C11    | 0.270415           |
| 2       | SEBL C21     | 0.202794           |
| 3       | PS C31       | 0.127418           |
| 4       | ECG C22      | 0.079958           |
| 5       | HTV C41      | 0.070551           |
| 6       | EIMACC C51   | 0.051905           |
| 7       | RSPP C32     | 0.045697           |
| 8       | PCHA C12     | 0.042585           |
| 9       | UDID C42     | 0.029179           |
| 10      | NVTS C23     | 0.025248           |
| 11      | LSTSS C52    | 0.020301           |
| 12      | FSLDT C33    | 0.016886           |
| 13      | SCMD C43     | 0.00927            |
| 14      | EASSS C53    | 0.007795           |
4.4 About TOPSIS

TOPSIS is conceptualized by Hwang and Yoon in 1981, is a elementary ranking approach in appreciation and utilization. The common TOPSIS approach pursuit to determine substitutes that concurrently have the condensed distance from the positive ideal solution and the outermost distance from the negative-ideal solution. To administer this approach, aspect values must be numeric, perpetually increasing or decreasing, and have comparable units. Fig. 1 presents the stepwise procedure of Hwang and Yoon (1981) [31] for implementing TOPSIS

**Figure 4** Algorithm of TOPSIS used in this study

| Step | Description |
|------|-------------|
| 1    | Formation of specification matrix with above specified quantities criteria's |
| 2    | All the specifications are normalized, using the equation $r_{ij} = \frac{X_{ij}}{(\sum_{i=1}^{m} X_{ij})^2}$ |
| 3    | Computation of weighted matrix, using the equation $V_{ij} = w_i \cdot r_{ij}$ |
| 4    | Determination of conclusive ideal solution and negative ideal solution. |
|      | $A^+ = \{V_1^+, V_2^+, ..., V_n^+\}$ (Positive ideal solution) |
|      | $A^- = \{V_1^-, V_2^-, ..., V_n^-\}$ (Negative ideal solution) |
|      | $V_j^+ = \{\max, V_{ij} (j \in benefit attributes), \min, V_{ij} (j \in cost matrix)\}$ |
|      | $V_j^- = \{\min, V_{ij} (j \in benefit attributes), \max, V_{ij} (j \in cost matrix)\}$ |
| 5    | Calculation of separation measure. This indicates the distance between each element from ideal solution. |
|      | $S_i^+ = \sum_{j=1}^{n} (V_{ij} - V_j^+)^2$ |
|      | $S_i^- = \sum_{j=1}^{n} (V_{ij} - V_j^-)^2$ |
| 6    | Proportionate proximity to the quintessential solution is calculated as following. |
|      | $C_i = \frac{S_i^-}{S_i^- + S_i^+}$ |

(Source: Hwang and Yoon (1981))
4.4.1 AHP outputs as Inputs to TOPSIS

TOPSIS is a multi-objective decision making technique which is adopted for the purpose of ranking of various model of different manufactures under consideration.

Figure 5. Selection criteria of two wheeler manufacturer’s using survey questionnaire administered

From the above chart it is interpreted that the top 10 player in two wheeler Indian market as per our survey are: Royal Enfield, Honda, Harley Davidson, Hero, Suzuki, Bajaj, KTM, TVS, Kawasaki and Mahindra. Out of these, for doing analysis using TOPSIS, the top four manufacturers were chosen but in top four manufacturers, the first and third ranked manufacturers does not have any model in the price band of Rs 39,000 to 65,000/-. Hence the next preferences manufacturers were chosen for the study.

Table 3 The top four manufactures chosen:

| S.NO. | MANUFACTURER |
|-------|--------------|
| 1.    | Honda        |
| 2.    | Hero         |
| 3.    | Suzuki       |
| 4.    | Bajaj        |

4.4.2 Selection criterion for TOPSIS application

The criteria’s for the TOPSIS are selected on the basis of result from the AHP analysis, whose ranking are as in table. As TOPSIS method requires the quantitative aspects for the direction of evolution. The successive criteria are chosen.

| Criteria | Equivalent quantitative aspects | Objective function Attribute (A)& Cost(C) perspective |
|----------|---------------------------------|------------------------------------------------------|
| HPUDO    | Breaking horse power            | Maximization (A)                                     |
| PS       | Mileage                         | Maximization(A)                                      |
| RRSPP    | Price                           | Minimization(C)                                      |
| UDID     | Weight                          | Minimization (C)                                     |
| ECG      | Cylinder Capacity               | Maximization (A)                                     |
### Table 4  Weightage criterions: AHP Vs TOPSIS

| S.No | Criteria | AHP Weightage | TOPSIS Weightage |
|------|----------|---------------|------------------|
| 1.   | HPUDO    | 0.270415      | 52.47            |
| 2.   | PS       | 0.127418      | 24.33            |
| 3.   | RRSP     | 0.045697      | 8.86             |
| 4.   | UDID     | 0.042585      | 8.26             |
| 5.   | ECG      | 0.029179      | 5.66             |

### Table 5. Objective function parameters chosen among different criterion for different brands of two wheeler automobile manufacturers considered in study.

| Name of two wheeler automobile model | Objective function and Parameters chosen |
|-------------------------------------|-----------------------------------------|
|                                     | Minimize | Maximize | Maximize | Maximize | Minimize |
|                                     | Price    | CC       | Mileage  | Bhp      | Weight   |
| Honda Activa                       | 51117    | 109.19   | 66       | 8        | 103      |
| Honda Dio                          | 52876    | 109      | 66       | 6        | 105      |
| Honda Activa                       | 54609    | 109.9    | 61       | 8        | 108      |
| Honda Activa 125                   | 61134    | 124      | 54       | 8.6      | 111      |
| Honda CD 110                       | 51429    | 110      | 83       | 8.25     | 107      |
| Honda Dream Neo                    | 53254    | 110      | 84       | 8.25     | 105      |
| Honda Dream Yuga                   | 56392    | 108      | 84       | 8        | 108      |
| Honda CB  Shine                    | 60467    | 125      | 65       | 10       | 120      |
| Bajaj Ct -100                      | 42111    | 99.27    | 89       | 8.1      | 108      |
| Bajaj Platina                      | 44525    | 99       | 90       | 8.2      | 113      |
| Bajaj Discover                     | 55290    | 124      | 82       | 10.9     | 121      |
| Hero HF Dawn                       | 39478    | 97       | 83       | 7.7      | 109      |
| Hero HF Deluxe                     | 40255    | 97       | 83       | 7.7      | 110      |
| Hero HF Deluxe Eco                 | 47235    | 97       | 65       | 8.1      | 112      |
| Hero Splendor Pro                  | 47025    | 97       | 90       | 8.2      | 109      |
| Hero Splendor Plus                 | 49768    | 97.2     | 81       | 8.2      | 112      |
| Hero Passion Pro                   | 55040    | 109      | 86       | 8        | 116      |
| Hero splendor Smart                | 54359    | 109.15   | 75       | 9.3      | 115      |
| Hero Pleasure                      | 50240    | 97.2     | 63       | 6.91     | 110      |
| Hero Duet                          | 51231    | 110.9    | 45       | 8.31     | 116      |
| Hero Maestro Edge                  | 52040    | 110      | 51       | 8.31     | 110      |
| Hero Super Splendor                | 55565    | 124      | 75       | 9        | 120      |
| Hero Glamour                       | 56553    | 124      | 55       | 8.9      | 129      |
| Hero Ignitor                       | 60891    | 125      | 55       | 11       | 129      |
Table 6. The average values of relative closeness and ranks for different models as preferred two wheelers considered by respondents in the study.

| Model                  | Relative closeness | Ranking order |
|------------------------|--------------------|---------------|
| Hero HF Deluxe         | 0.68367            | 1             |
| Hero HF Dawn           | 0.68066            | 2             |
| Hero Splender Plus     | 0.65714            | 3             |
| Bajaj CT-100           | 0.65523            | 4             |
| Hero Glamour F1        | 0.65217            | 5             |
| Bajaj Pulsar 135       | 0.63540            | 6             |
| Honda CD 110           | 0.61755            | 7             |
| Hero Super Splender    | 0.61456            | 8             |
| Bajaj Discover         | 0.60456            | 9             |
| Honda Dream Neo        | 0.59671            | 10            |
| Honda Dream Yuga       | 0.58480            | 11            |
| Honda CB Shine         | 0.58201            | 12            |
| Hero Splender I Smart  | 0.58021            | 13            |
| Hero HF Deluxe Eco     | 0.56682            | 14            |
| Hero Passion Pro       | 0.56429            | 15            |
| Suzuki Assess 100      | 0.53810            | 16            |
| Honda Activa           | 0.53578            | 17            |
| Hero Ignitor           | 0.52786            | 18            |
| Hero Pleasure          | 0.52588            | 19            |
| Suzuki Slingshot Plus  | 0.52224            | 20            |
| Honda Activa 125       | 0.52078            | 21            |
| Honda Dio              | 0.52042            | 22            |
| Suzuki Swish 125       | 0.51843            | 23            |
| Suzuki Lets            | 0.50452            | 24            |
| Suzuki Assess 125      | 0.49448            | 25            |
| Bajaj Platina          | 0.49367            | 26            |
| Hero Glamour           | 0.49064            | 27            |
| Hero Splender Pro      | 0.48992            | 28            |
| Honda Activa           | 0.47084            | 29            |
| Suzuki Hayate          | 0.46668            | 30            |
| Hero Duet              | 0.45524            | 31            |
| Hero Mastro Edge       | 0.44815            | 32            |
| Bajaj Discover 150s    | 0.42033            | 33            |

Conclusions:

Using AHP and analysis of results it has been observed that high pick up during overtaking (HPUDO) Suitable and effective beam of light(SEBL),petrol saving(PS),ease of changing...
gears(ECG) high trade value (HTV) are been top decision criteria as outputs of AHP while purchasing two wheelers automobile in Indian markets as per respondents in his study. However, our methodology to evaluate the purchase intention of customers in two wheelers using both AHP as well as TOPSIS to implicate more crisp results. We have used the AHP output decision criteria (HPUDO, SEBLS, PS, ECG and HTV) as inputs for TOPSIS to better understand and suggest the two wheeler automobile manufacturer’s which models are preferred during purchase intention, from TOPSIS application by respondents considering the Minimization parameters: Price, weight and maximization parameters : cylinder capacity, mileage, brake horsepower as objective functions. It has been found that Hero model (HERO HF DELUXE, HERO HF DAWN, HERO SPLENDER PLUS) were top ranked output from TOPSIS. Thus this study made an attempt to suggest customer purchase intentions as criterion and customer’s attitude towards purchasing two wheeler automobiles that are available in India has been presented. This work could be used as path finder for product designers, R&D engineers of Indian two wheeler automobile manufacturers for sustainable business growth. Application of TOPSIS is absolutely competent and the method is observed to be quite capable as computing is accessible to appraise and preferred appropriate registered criteria from an inclined group of opportunities. This approach adopts the part of the treated criteria with their proportionate attention in order to reach the concluding estimate of the substitute two wheeler automobile models.

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