# COST REDUCTION USING VALUE ANALYSIS FOR AUTO RICKSHAW STEERING BAR

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**Abstract—** Value Engineering defines a process in which the value of the product can be increased by significantly decreasing its cost to achieve a long-term profitability plan of a company. In this study, Value Engineering Job Plan (VEJP) has been used to reduce the cost and improve value of Auto rickshaw steering bar. The study revealed the poor value areas for which the alternatives were developed and evaluated. Finally, changes in design were proposed which led to 1.54% of cost saving and ease of manufacturing that helped yield a four-fold increase in the production.

**Keywords—** Value Engineering Job Plan, Auto rickshaw steering bar and cost saving.

## I. INTRODUCTION

Most product cost reduction in industry occurs during new product introduction. However, for some firms, a case can be made that product cost reduction efforts can be devoted towards products already in sustained production. These firms face a set of business conditions that often prevent exhaustive product cost reduction. The most serious problem faced by the industry today is the problem of rising cost. In the past decade, the two great problems confronting the industry are:-

- The high cost of equipment.
- The achieving of suitable reliability.

The common denominator of these two problems is complexity of design. As a product design becomes more and more complex, the development and manufacturing costs rise not at a linear relationship, but an exponential rate. In other words, doubling the complexity may triple or quadruple the cost. Other factors such as field operation and maintenance also rise accordingly. These cost and reliability problems assume ever increasing importance to the government and industry as modern devices become highly technical in nature **(Singh, 2007).** The basic philosophy of value engineering was therefore to eliminate the cost which did not contribute to the performance of the required function. This has been proven by many researcher such as- **Thome (2008)** proposed the implementation of cost reduction function that focuses on products in the sustaining manufacturing phase of the product lifecycle. The ways of value engineering in new product development may not be always suitable because they may pose a hindrance to the NPI (new product introduction). It was concluded that sometimes, new product introduction is more important than value engineering, so it is taken care of at later stages.

**Jariri and Zegordi (2008**) studied that cost in design process is an important issue. The methods and tools like Quality function deployment (QFD) and value engineering (VE) and target costing (TC) are the vital approach to design cost management. This study was based on the price, functionality, and quality using the inventive problem-solving and integration techniques. The research proposed that the second matrix of QFD in the best choice for VE approach.

**Zhang et al. (2009)** developed a more systematic creativity phase for the implementation of value engineering. The researchers developed the value engineering knowledge management system (VE-KMS). By applying this theory of creativity, they made the creativity phase more systematic, organized and problem focused. This attempt enhanced the creativity power of value engineers and the value engineering study and consequently enhanced the efficiency and effectiveness of the study.

**Sharma and Belokar (2012)** indicated the basic fundamentals of value engineering. The author studied how the different phases of value engineering could be implemented in any product to optimize its value and discussed an example of bath fitting products in which the material of construction was changed. The change made was following the value engineering methodology. The material chosen was such that its cost was reduced without affecting the value of the product and its design. Various alternatives were evaluated on the tool: - decision matrix thus finally concluding the best possible alternative.

**Hume and Gabel (2014)** studied the creativity phase of the Value Engineering Job Plan. The authors focus on embracing creativity and innovation. The fundamental questions asked includes how else the functions may be performed and talks about the various roadblocks to creativity. The authors suggested that Creativity is defined as the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others.

From the literature review it was observed that value engineering concept was mostly applied on very large

products or machines or big assemblies but very less study has been conducted on small automobile components. Due to this reason, it has been decided to carry study on auto rickshaw steering bar. This study attempts reduce cost of cost of Auto rickshaw steering bar through value analysis is a systematic manner and results are highly encouraging.

This study was conducted involved in the manufacturing of automotive components for two wheeler and three wheeler vehicles. The product ranges include components for various vehicles manufactured by Bajaj, Vespa and Hero Honda. Out of the range of products, Bajaj auto rickshaw steering bar is one of its major production and was chosen as the component of study. This was chosen because of the following reasons:-

- The present assembly of the auto rickshaw steering bar is such that it starts functioning improperly after some time and thus it suffers more wear and tear.
- The present work also has some issues regarding Steering play.
- Due to improper fitting techniques, the present assembly has to suffer through breakage in chassis.
- And last but not the least reason is because of its high cost and lag in production due to fitting problems.

The goal of present work is to develop a methodology for conducting value analysis study on the auto rickshaw steering bar that would make efficient use of available resources and improve the overall value of the assembly.

## II. IMPLEMENTATION OF VALUE ANALYSIS JOB PLAN

### *2.1 Phase 1- General Phase*

This phase describe the general guidelines which are followed in all other phases. Different researcher's work has been taken as reference and company's official has been taken into consideration while selecting the project, which was the main activity in this phase. The project has been considered based upon the following guidelines.

- It must have at least 3 different subassemblies
- It must be in current usage
- It must have 8 to 16 components or actions
- No major changes in the item should be in process
- It should be something on which changes can be made after the process of recommendations
- Its purpose or functions should be properly definable and understandable

Auto rickshaw steering bar was taken for study which satisfied the above mentioned considerations.

### *2.2 Phase 2- Information Phase*

In this phase, all the data and information related to the project was collected. All the guidelines of general phase were very much used in the information phase.

1) Secure the facts

The first step was to secure all relevant data and information regarding the company like its various products, units, the number of employees, organization chart etc.

The industry has 50 employees and the company is involved in the manufacturing of various components for Bajaj, Hero Honda, Vespa, Axel, Ape and Suzuki. For the manufacturing of the various components the company is involved in various processes such as Boring, Turning, Chamfering, Tempering, Grinding, Radius, Checking (quality), Packing (with rust proof oil). Each of these processes is used in the manufacturing of various components of the assembly. Each one of it has its own value of cost and some value of scrap.

2) Manufacturing Process Information for the Selected Assembly.

The manufacturing process for auto rickshaw assembly for Bajaj auto rickshaws can be understood in the following manner. The assembly involves five components i.e.

1) Lower cup
2) Lower cone
3) Upper cup
4) Upper cone check nut
5) Plain check nut

The manufacturing process of each of the above mentioned components involves a series of stages comprising of different operations to be performed on each stage. The cost involved in each and every stage is also mentioned in brief of each and every component.

**Table 1 Part/process and their respective cost for different components**

| Part | Process | Cost (in Rs) | Total cost (in Rs) | Scrap cost |
|---|---|---|---|---|
| Lower cup | Raw material | 16.50 | 25.70 | 1.75 |
| | Bore | 0.40 | | |
| | External turning | 1.25 | | |
| | Internal radius turning | 1.35 | | |
| | Tempering | 1.20 | | |
| | Coloring | 0.75 | | |
| | Final radius | 2.00 | | |
| | Grinding final | 1.00 | | |
| | Diesel wash, oil dip(rust proof oil), packing and lubricating | 1.00 | | |
| | All transportations | 0.25 | | |

| | | | | |
|---|---|---|---|---|
| Lower cone | Raw material | 7 | 12.85 | 1.50 |
| | Bore | 0.25 | | |
| | External radius turning | 0.75 | | |
| | Face turning | 0.50 | | |
| | Chamfering | 0.10 | | |
| | Tempering | 1 | | |
| | Coloring | 0.50 | | |
| | Radius | 1.50 | | |
| | Final bore | 0.50 | | |
| | Diesel wash, oil dip(rust proof oil), packing and lubricating | 0.50 | | |
| | Transportation | 0.25 | | |
| Upper cup | Raw material | 7 | 12.35 | 1.50 |
| | Bore | 0.25 | | |
| | External turning | 0.75 | | |
| | Internal radius turning | 0.75 | | |
| | Chamfering | 0.10 | | |
| | Tempering | 1 | | |
| | Coloring | 0.50 | | |
| | Radius | 0.75 | | |
| | Grinding | 0.50 | | |
| | Diesel wash, oil dip(rust proof oil), packing and lubricating | 0.50 | | |
| | Transportation | 0.25 | | |
| Upper cone | Raw material | 4.50 | 7.75 | 1.15 |
| | Bore | 0.15 | | |
| | External radius turning | 0.50 | | |
| | Face thickness | 0.25 | | |
| | Slotting | 0.25 | | |
| | Threading | 0.25 | | |
| | Tempering | 0.50 | | |
| | Coloring | 0.25 | | |
| | Radius | 0.75 | | |
| | Diesel wash, oil dip(rust proof oil), packing and lubricating | 0.25 | | |
| | Transportation | 0.10 | | |
| Plain check nut | Raw material | 11.50 | 13.45 | 1.65 |
| | Bore | 0.25 | | |
| | External turning | 0.35 | | |
| | Face turning | 0.25 | | |
| | Slotting | 0.45 | | |
| | Threading | 0.40 | | |
| | `Diesel wash, oil dip(rust proof oil), packing and lubricating | 0.25 | | |

The total cost incurred by the company in the manufacturing of all the parts of the assembly comes out to be Rs /- 72.10. The company also sells the scrap received from all the above processes for each part for Rs /- 7.55. So the net cost incurred by the company:

Net cost=total cost- value of the scrap

= 72.10-7.55

= 64.55

### *2.3 Phase 3 – Function Phase*

It is the function phase or analysis that is mainly responsible for differentiating and distinguishing the value engineering technique from all other cost reduction techniques. In the function phase the functions of the components under the study are defined.

"Function is defined basically which makes a product work or sell", "It is a want to satisfy a user's requirement". The function is certainly the end result which the customer wants. It is the requirement, the goal or the objective that one desires to accomplish. It is actually what one pays for.

The key to value engineering is, the determination and identification of what exactly the user or customer wants from a product, i.e. the function. For this it is important to keep in mind that the customer buys the function, or the satisfaction is derived with the use of it. This is purely customer's concern. He is least interested in knowing how it was accomplished.

#### *2.3.1 Defining the Function*

The functions of all the parts of the Bajaj auto rickshaw steering bar assembly were defined. Functions were classified as primary and secondary at the part level. To define the function closely, certain basic established guidelines and rules were used.

Function of all the components of the Bajaj auto rickshaw steering bar assembly are defined in functional definition work sheet in Table 3.11.

**Table 2 Functional definition work sheet**

| Sno | Part | Function Definition | | Function Level | | | |
|---|---|---|---|---|---|---|---|
| | | | | Part | | Assembly | |
| | | Verb | Noun | Primary | Secondary | Primary | Secondary |
| 1 | Lower Cup | Guide | Movement | √ | | √ | |
| | | Provide | Support | √ | | | √ |
| 2 | Lower Cone | Guide | Movement | √ | | √ | |
| | | Provide | Support | √ | | | √ |
| 3 | Upper Cup | Adjust | Bearing | √ | | √ | |
| | | Provide | Support | √ | | | √ |
| 4 | Upper Cone | Adjust | Bearing | √ | | √ | |
| | | Provide | Support | √ | | | √ |
| 5 | Plain Check nut | Provide | Locking | √ | | √ | |
| | | Ensure | Stability | √ | | √ | |
| 6 | Ball Bearings | Maintain | Separation | | √ | | √ |
| | | Reduce | Friction | | √ | | √ |
| | | Facilitate | Motion | | √ | | √ |

The auto rickshaw steering bar assembly is a chassis component. It connects the steering bar of the auto rickshaw with its front tier. This assembly is used to control the steering bar whether how much tight or lose it will be and also it guidelines the movement of the steering bar as well as the front tier.

### 2.3.2 *Numerical Evaluation of Functional Relationships*

To decide the importance of a function, following weight factors are considered and allotted to the function depending on the difference and variation of importance between them. Determining the difference of importance and variation between function involves an intense thoughtful process which is decided through a collective and coordinated view points of all the team members.

Weight Factors '1' Difference in importance-Minor
'2' Difference in importance-Medium
'3'Difference in importance- Major

If function A is less important than function B by a medium difference, in the box, it is written as 'B2'. In the similar way all the functions are compared with each other function. Hence, this is how the table is completed and total weight factor for each function is calculated. Then the adjusted weight is calculated by adding 1. This is done because no function can be allotted 0 weights as in case of G. After that percentage importance is calculated for each function. Numerical evaluation of functional relationship of various functions of auto rickshaw steering bar assembly is given in table 3.12.

**Table 3 Numerical Evaluation of functions**

| | | B | C | D | E | F | G | H | Total Wt. | Adj. Wt. | %age Adj. Wt |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | A2 | C1 | D1 | E1 | A2 | A2 | H1 | 6 | 7 | 13.46 |
| | | B | C1 | D | E2 | B2 | B2 | H1 | 4 | 5 | 9.62 |
| | | | C | D2 | C1 | F2 | C1 | C1 | 5 | 6 | 11.54 |
| | | | | D | D1 | D1 | D2 | D1 | 11 | 12 | 23.08 |
| | | | | | E | E2 | E2 | E1 | 8 | 9 | 17.31 |
| | | | | | | F | F1 | H3 | 3 | 4 | 7.69 |
| | | | | | | | G | H2 | 0 | 1 | 1.92 |
| | | | | | | | | H | 7 | 8 | 15.38 |
| | | | | | | | | | | 52 | 100.00 |

| Key Letter | Function |
|---|---|
| A | Guide Movement |
| B | Provide Support |
| C | Adjust Bearing |
| D | Provide Locking |
| E | Ensure Stability |
| F | Maintain Separation |
| G | Reduce Friction |
| H | Facilitate Motion |

| Evaluation Weight Factor | |
|---|---|
| 1 | Minor Difference |
| 2 | Medium Difference |
| 3 | Major Difference |

To confirm that the numerical evaluation is correct, following checks on consistency were carried out and were found to be satisfactory.

1) The data obtained from numerical evaluation should exactly match the customer's requirement
2) Weight factor of least important function must be 0 i.e. Function G
3) No two functions should have equal weight
4) No loop formation should be there

Using numerical evaluation, table, functional relationship graph for the percentage weights of importance is drawn as shown in figure 3.8.

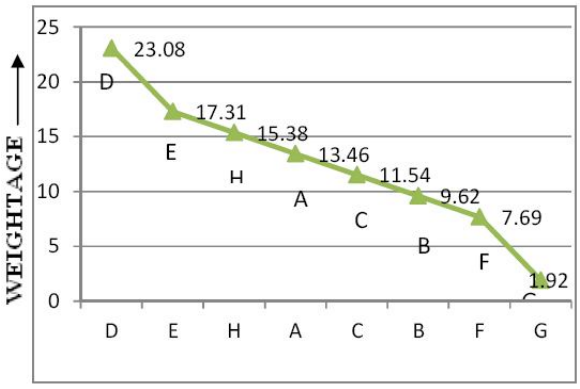



**Figure 1: Functional Relationship Chart**

The function having the maximum weight age is given more importance and the one with the lowest weight age is given least importance. Rest of the functions lying in between the maximum and the minimum are given importance depending upon their weight age

### *2.4 Phase 4 – Creativity Phase*

Till now the product had been considered in its original form. Nothing had been done on the component to improve the quality or reduce the cost as per customer's requirement and functional requirements. On the basis of VEJP, functions are identified as poor value functions. These have now been considered in creative phase for improvement.

a) Detachment from the existing solution: - one should focus on the functions not on the existing design or solutions.
b) Complete or full confidence: - one should have firm belief of something new and better could be developed, as existing design is of poor value.

### *2.4.1 Develop Creative Idea*

Functions that are considered for creativity phase are taken separately by making groups of parts and the poor value functions. The brain storming and consulting the team members were the techniques used to develop creative idea.

Creative worksheet:

1. To cover the upper cone and upper cup with a cover so as to protect it against dust.

2. To use two plain check nuts instead of one to avoid steering play.
3. To change the shape of upper cone so that it properly fits into the dust cover. That is to remove threads and slots from upper cone so that it directly fits to the steering bar rod.
4. To introduce grooving and taper chamfering in the lower cup and the upper cup to help it against fitting problems

### *2.5 Phase 5 – Evaluation Phase*

The objective of the evaluation phase of the value engineering job plan is to thoroughly analyze the results produced in the creativity phase by reviewing the various alternatives to select the best idea for improvement in the value. The ideas listed are discussed for their performance and efficient cost. The skillful application is triggered for the prevention and elimination of the unnecessary cost of the development, keeping in mind or ensuring that the product is not at all cheapened or degraded i.e. making sure that there is no reduction in durability or compromise with the ease of operation or other aspect, below the requirement or specifications of customer. This phase employs following techniques.
Evaluate the ideas
Establish cost on all ideas

#### *2.5.1 Evaluation of the Ideas*

**Table 4. Ideas and their explanation for existing problems**

| S. No | Problem | Idea/Solution | Explanation of the ideas |
|---|---|---|---|
| 1 | Initially only one plain check nut is used in the present assembly and no matter how tightly it is fitted into the rod, it loosens up after some time due to which the steering bar has to suffer play. | Split the plain check nut into two parts that is the idea of using two plain check nuts instead of 1. That is to split the 14mm plain check nut into two 7 mm check nuts each. | The idea behind splitting the plain check nut is that due to splitting there will be no chance of steering play as the plain check nuts will never loosen up. The process behind this is the one plain check nut is slightly hammered in the clockwise direction and the other plain check nut is slightly tighten up in the anti-clockwise direction. |
| 2 | The upper cone and upper cup are harmed against dust with time. Due to this reason it starts functioning improperly and thus it suffers more wear and tear. | Protecting the upper cone and upper cup with a cover known as dust cover. | The upper cone and upper cup are protected with a cover known as the dust cover to protect it against any kind of harm to it and thus assure proper functioning. The dust cover not only protects the parts from dust but also protects it from water from going inside the parts while in rain or when the auto is being washed. |
| 3 | Presently the shape of upper cone is not appropriate to protect it from dust. It has threads and slots that do not let it fit into the dust cover. | Changing the shape of upper cone so that it fits into the dust cover | To adjust the upper cone in the dust cover its shape has to be changed such that it fits properly into the dust cover. The threads and the slots are removed for this purpose. |
| 4 | Initially the manufacturing of lower cup and upper cup is such that there remains a danger of breakage in the chassis while fitting due to which it has to suffer through the fitting problems. The next problem is that in the present manufacturing the wastage in the grinding wheel is more. And the component also has to suffer radius in the corner. | Changing the shape of the lower cup and upper cup by introducing a groove and radius chamfering in it. | Some little changes are made in the shape of the upper cup and lower cup where groove is introduce so as to avoid the breakage in the chassis while fitting and thus improving fitting techniques. Also another type of chamfering is done instead of tapper chamfering which is known as radius chamfering. It also helps in the less wastage of the grinding wheel. |

#### *2.5.2 Establishing Cost on All the Ideas.*

The new ideas involve some changes in the existing process of manufacturing the respective part of the assembly for which the idea has been evolved. The new process involves different costs related to the manufacturing of that part. Below is the table describing the new processes and their related new costs for each part for which a new ideas has been evolved.

**Table 5** Establishing cost for modified upper cone and plain check nut

| S. NO | PART (NEW) | PROCESS (NEW) | COST (IN Rs) | Total cost (in Rs) | Scrap |
|---|---|---|---|---|---|
| 1 | Upper cone | Raw material | 5 | 8.40 | 1.35 |
| | | Bore | 0.25 | | |
| | | External turning | 0.50 | | |
| | | Face turning | 0.25 | | |
| | | Tempering | 0.65 | | |
| | | Coloring | 0.25 | | |
| | | Radius | 0.75 | | |
| | | Grinding | 0.35 | | |
| | | Packing | 0.25 | | |
| | | Transportation | 0.15 | | |
| 2 | Plain check nut | Raw material | 2 x 4.25 | 5.9 x 2 =11.80 | 2 x 1 =2 |
| | | Bore | 2 x 0.15 | | |
| | | External turning | 2 x 0.35 | | |
| | | Face turning | 2 x 0.25 | | |
| | | Slotting | 2 x 0.30 | | |
| | | Threading | 2 x 0.25 | | |
| | | Packing | 2 x 0.25 | | |
| | | Transportation | 2 x 0.10 | | |

## III. RESULTS AND DISCUSSION

The major changes are done in the upper cone and the plain check nut. Only minor changes (grooving and radius chamfering) are done in the lower cup and the upper cup which requires no changes in the old cost and the processes i.e. the new lower cup and the new upper cup has same processes and same costs of manufacturing. The only benefit provided by the grooving and radius chamfering is the less wastage of the grinding wheel and improving fitting techniques i.e. the chances of the breakage of the chassis reduces.

Firstly, with the old technique (without grooving and radius chamfering), the grinding wheel had to be changed after 1 month. With this new technique (with grooving and radius chamfering) the grinding wheel would need to be changed after one and a half month i. e. wastage of the grinding wheel will be reduced by 1.5 times. The dust cover which is needed to protect the upper cone and the plain check nut is made up of plastic and is easily available from the market at the cost of 75 paisa per piece. So the total cost for the manufacture of all the parts of the assembly is the sum of the new costs of the parts which have been changed and the cost of those parts which have not been changed or the parts which have been changed but there is no effect on their costs.

Total cost= cost of new lower cup + cost of lower cone + cost of new upper cup + cost of new upper cone + cost of dust cover + cost of the new plain check nut

= 25.70 + 12.85 + 12.35 + 8.40 + 0.75 + 11.80= 71.85

The company also sells the scrap received from all the above processes for each part for Rs /- 8.1. So the net cost incurred by the company:

Net cost=total cost- value of the scrap

= 71.85-8.10 = Rs/- 63.75

Moreover with this new technique of manufacturing the grinding wheel is less wasted. The cost of 1 grinding wheel is Rs/- 1800. Currently the company can manufacture 3000 assemblies on 1 grinding wheel. Following the VEJP the manufacture of atleast 4500 assemblies could be possible on 1 grinding wheel. That is the cost of manufacturing the parts on the grinding wheel was 0.60 per assembly. With the new technique the cost of grinding falls to 0.40 paisa per assembly. That is a profit of Rs/- 0.20 is obtained per assembly. Therefore the grinding operation in the lower cup and the upper cup reduces to Rs/- 0.10 each. So, the modified grinding cost of the lower cup and upper cup is Rs/- 25.60 and Rs/- 12.25 respectively. So the final net cost incurred by the company to manufacture an assembly is:-

Net total cost= 63.75-0.20

= Rs/- 63. 55

**Table 6. Comparison between the old cost and new cost**

| S.No. | Part | Cost(Rs) (old) | Cost (Rs.)(new) | Difference in costs |
|---|---|---|---|---|
| 1 | Lower cup | 23.95 | 23.85 | +0.10 |
| 2 | Lower cone | 11.35 | 11.35 | +0.0 |
| 3 | Upper cup | 10.85 | 10.75 | +0.10 |
| 4 | Upper cone | 6.60 | 7.05 | -0.45 |
| 5 | Plain check nut | 11.80 | 9.80 | +2.0 |
| 6 | Dust cover | ……. | 0.75 | -0.75 |
| Total | | 64.55 | 63.55 | +1 |

## CONCLUSIONS

The following conclusions have been drawn from the proposals and are presented with costs and specifications.

1. Following the VEJP led to saving of Re 1 per piece for the Bajaj auto rickshaw steering bar assembly which led to 1.54% of saving and the average annual saving of Rs/- 240,000.
2. The improvement in the manufacturing process of the lower cup and the upper cup reduces the grinding wheel wastage by 1.5 times and also reduces the chance of breakage in the chassis
3. Use two plain check nuts instead of one to avoid steering play.
4. Change in shape of upper cone leads to properly fits into the dust cover.
5. Introduction of grooving and taper chamfering in the lower cup and the upper cup help to improve fitment.
6. Splitting the plain check nut into two parts avoids steering play and the modified upper cup makes it easy to fit into the dust cover.
7. By protecting the upper cup and upper cone with the dust cover, the life of the auto rickshaw steering bar increases as it is protected from dust, dirt and water.

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