REDUCING MATERIAL COST IN
FABRICATED PARTS FOR TWO WHEELERS
THROUGH VALUE ANALYSIS TECHNIQUE

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Abstract

Global competition made industries to focus on competitive edge for achieving company goal by improving value to customer. Manufacturing high quality products with low cost will facilitate in achieving competitive edge to the organization. Value Analysis Value Engineering tool is used in industries for quality improvement, productivity improvement, cost reduction, improvement in product value.

Aim of this project was to reduce the material cost by 15% in two wheeler products. This has been attempted using a job plan approach from Value Analysis technique. Data collection and analysis revealed the potential cost reduction area / subsystem of vehicles. Function analysis and function worth analysis was employed to explore gap between value and worth of the subsystems. The value gap was then considered for generation of various concepts and alternatives. These ideas were scrutinized using solution prioritization and feasibility ranking. Product 1 was fuel tank in moped and Product 2 was ignition coil mounting brackets in motorcycle. In fuel tank silver brazing operation for joining fuel outlet adaptor to tank and in ignition coil mounting brackets for mounting were found more cost than their worth. Fuel tank adaptor joining was replaced with copper brazing operation; there by 10% material cost was reduced. Mounting brackets count was reduced from 3 to 1 number, there by 8% of material cost was reduced. Projects were implemented on pilot lot basis for shop floor validation.

Cumulatively 18% of material cost was reduced with annual savings of around Rs. 50 lakhs to the organization.

Abbreviations

BOM  Bill Of Material  
CES  Cambridge Material Selector  
DFM  Design For Manufacturing  
DFA  Design For Assembly  
FAST  Function Analysis System Technique  
ROI  Return On Investment  
VAVE  Value Analysis / Value Engineering

1. INTRODUCTION

In the global competition companies are struggling to achieve competitive edge. Many European and US major automotive manufacturers pursued automotive market through differentiation strategy. Then Japanese firms are able to capture market by providing value to the customers with high level of product quality with lesser product cost. In this scenario value analysis and value engineering is used as an important weapon for reducing cost of the product and increase quality of the product and also enabling freedom to access all required function. With the usage of VA/VE technique companies are able to do cost management and this technique increased value to firm because it is good to improve profit of the company by reducing cost of manufacture rather increasing the price of the product.

VA/VE technique or approach can be used to optimise cost of product in the initial design of the product and also to reduce cost of running product by analysing cost drivers and reducing cost by recommending alternatives to produce the products. VA/VE technique is developed in 1940s by Mr. Larry Miles at General Electric. Mr. L.D. Miles, Father of Value Engineering introduced this technology which revolves around Function and only Function during fag end of World War II. [1]

Value Management has emerged in recent years as the most effective management technique for achieving quick results in cost reduction and to solve business problems related to profitability, quality, competitiveness, substitution of scarce materials, import substitution, export promotion, low productivity etc. The single objective of modern value analysis is to deliver to the user/customer the required functions at minimum cost. The focus of the process is on harnessing teams of key employees to identify problems and then apply the appropriate problem-solving systems. [2]

Value Engineering has a special relevance to Indian Industry, which is plagued by high material costs, low profitability, outdated designs and many other ills and could be the panacea for achieving substantial cost reduction and other benefits. This project has been chosen as a part of my academic project at TVS Motor Company Ltd., to compare and assess the Theory (suggested by VE Gurus) and Practice. It also aims at establishing value analysis as an ongoing system that will be formally applied to all problems of the organization that concern cost and function. Through this value study on the Fuel System, and chassis system, the degree of certainty, to which, the VE Job Plan is applicable to solve real-life problems in TVS Motor Company has been identified. However, through an integrated approach, various techniques of reengineering the process and the component under study have been identified and implemented on pilot lot basis.

1.1 Organization Information - TVS Motor Company

TVS Motor Company is the third largest two wheeler manufacturer in India and among the top ten in the world, with annual turnover of more than USD 1 billion in 2008-09 and is the flagship of the USD 4
billion TVS group. TVS group has 30 companies and commands a strong presence in manufacturing of two-wheelers, auto components and computer peripherals, financial services. TVS Motor Company founded in 1978 with launch of first two seat vehicle in India. TVS Motor Company currently manufactures a wide range of products from mopeds to racing inspired motorcycles. TVS Motor Company manufacturing two wheeler and three wheeler to Indian market and exports its products to around 50 countries. [3]

TVS Motors now successfully established their presence in each segment of two wheelers. It is the only two wheeler manufacturer in India to get the prestigious Deming Prize in recognition of its distinctive performance improvement through the application of Total Quality Management (TQM) practices. TVS Motor Company has 4 manufacturing plants, (Hosur in Tamilnadu, Mysore in Karnataka, Nalagarh in Himachal Pradesh – India and Karawang – Indonesia) refer figure 1.1 for the plants with product manufacturing details.[4]

![Fig. 1 TVS Motor Company Plants](image)

### 2. PROBLEM STATEMENT

The costs of commodities are increasing drastically and the industries are finding ways to manage cost and be competitive in the market. The automotive parts are manufactured using high cost materials like plastics (Petroleum products), various synthetic rubber, Aluminium, steel, copper, silver, tungsten etc. for some applications. The usage of high cost material has to be optimized or alternative material to be explored for reducing cost of material and their by increasing value to the customer.

The problem behind the situation is, commodity prices are not controllable and it is market driven. Challenge to TVS-M is to do cost management to ensure acquisition cost or material cost within specified target and also bottom line to be improved. In this background “To reduce material cost in fabrication part of two wheeler through value analysis technique” evolved to achieve company goal.

#### 2.1 Aim of The Project

To reduce material cost, in two wheeler fabricated parts by 15% collectively using Value Analysis technique. (refer figure 1.2)

![Fig. 2 Cost reductions proposed](image)

#### 2.2 Objectives

- To do literature survey about value analysis/value engineering approach and other company practice
- To collect and analyse the data on two wheeler models, sub assemblies to identify the potential for material productivity
- To determine Cost, Function and worth of existing process and part
- To determine alternative approaches to reduce material cost
- To do manufacturing feasibility study, Cost impact and Functional aspects.
- To implement and validate on pilot basis

#### 2.3 Methodologies Adopted to Meet the Objectives

- Literature survey done about value analysis/value engineering for the selected project through journals, books, manuals and related documents
- Using Pareto chart, priority matrix and brainstorming found cost ratio and selected subsystem to generate idea
- Using cost and function analysis technique found worth of current parts and process
- Alternative process or design was selected using brainstorming and CES software
- ROI calculation and feasibility study was carried out for implemented idea
- Validation carried out on prototype and implementation on pilot lot basis

### 3. DATA COLLECTION AND ANALYSIS

#### 3.1 PREPARATION PHASE: product selected
Fig. 3 Products Volume manufacture in TVSM

Inference: Selected high volume products i.e. XL Super (40%) and Star city (14%) (refer figure 1.3)

3.2 Part Selection – Product 1

Fig. 4 Funnelling of vehicle parts

Inference: In Each level of the product grouped and with highest cost contribution taken for Value Analysis application (refer figure 1.4).

Fig. 5 BOM of Fuel Tank

Inference: With the breakdown of vehicle level fuel tank selected for value analysis technique application (refer figure 1.5)

Fig. 6 FAST Diagram of Fuel tank

Fast diagram refer figure 1.6 shows the basic and secondary functions of the fuel tank. Fuel tank is required to carry fuel and supply fuel to engine through carburetor at the time of suction. Basic function of fuel tank is to store fuel and leak proof container. Secondary function of fuel tank is good aesthetic.

3.3 Function worth analysis – Product 1

Fig. 7 Comparison of cost of part with Specification

Inference: Observed 16% more process cost was paid for fuel tank. (Refer figure 1.7)

Fig. 8 Tank processes cost contribution

Hence process cost of fuel tank was stratified to find out potential area to reduce cost refer figure 1.8 Silver brazing cost is contributing to 44% of the process cost of fuel tank. Hence target was taken for finding out alternative process for joining of adaptor to fuel tank, which can replace silver brazing process.
Fig. 9 Function Worth analysis

The function worth analysis concludes the value gap is 16% of fuel tank part cost. Hence with the target cost reduction of 16% was taken to find alternative method or process to reduce material cost.

3.4 Value Gap – Product 1

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3.5 Creative Phase – Product 1

The value gap of 16% cost of fuel tank has to be addressed in the creative phase by finding out alternative means to reduce cost of the function and without reducing value to the customer. As per analysis silver brazing process is found more cost among all the processes, refer figure 1.8. The alternative processes/ideas to reduce process cost are generated using brainstorming technique along with the field experts. The ideas are:

1. Reduce silver content in the brazing ring
2. Change design of adaptor as other two wheeler
3. To change process for silver brazing to other
   a. MIG Brazing
   b. MIG Welding
   c. Copper brazing
   d. Projection welding
   e. TIG welding

CES Education pack was developed by Granta Design and it has 3 levels of materials and process database. For the given project Level 3 is used for identifying alternative process.

Inference: Brazing and soldering process are recommended for alternative processes

3.6 Feasibility ranking – Product 1

Inference: MIG Welding, Copper Brazing, MIG Brazing, Soldering process are selected. Based on feasibility ranking four ideas are selected for concept approval

3.7 Solution Priority Matrix – Product 1

Inference: MIG Welding and Copper Brazing process are selected

3.8 Implementation Phase – Product 1

Alternative ideas/processes are evaluated and pilot lot received with both MIG welding and copper brazing process. Both processes are found suitable for mass production. Copper Brazing operation found suitable for mass production due to shorter leadtime for implementation and faster ROI

3.9 ROI calculation – Product 1

Inference: Copper Brazing process was selected for final implementation.

4. PREPARATION PHASE – PRODUCT 2

Same as product 1 in product 2 also vehicle breakdown was made to find out high cost contribution and frame selected for brainstorming for generating potential idea for application value analysis technique.
Brainstorming made based (refer figure 1.14) on benchmarking of competitor vehicles.

4.1 Ideas from brainstorming – Product 2

The ideas generated from brainstorming were prioritized using Johari Window (refer figure 1.15) and selected an idea for value analysis application.

4.2 Idea selected

Brackets used for mounting IG Coil was found potential cost reduction idea and taken up for analysis. Figure 1.16 shows details of product selected for value analysis application.

4.3 Function Analysis Phase

Table 1. Frame types and their functions

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Part Name</th>
<th>Function</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Frame Bracket (A)</td>
<td>Hold Intermediate Bracket (B)</td>
<td>25%</td>
</tr>
<tr>
<td>2</td>
<td>Intermediate Bracket (B)</td>
<td>Hold IG Coil bracket (C)</td>
<td>25%</td>
</tr>
<tr>
<td>3</td>
<td>IG Coil bracket</td>
<td>Hold IG Coil</td>
<td>50%</td>
</tr>
</tbody>
</table>

4.4 Function Worth

Figure 1.18 shows function worth analysis

Value = Worth/Cost  
= 5/20  
= 0.25  
Analysis shows the function cost was costlier than function worth. The calculation (refer figure 1.18) was made and found potential to reduce cost.

4.5 Value Gap

The product of function cost and function worth is the value gap. The function cost is 100% and the function worth is only 25%. Hence the value gap is 75% of the total function cost.

4.6 Creative Phase

In creative phase, alternative product designs were done and the value gap cost was taken as target cost to do product design (refer figure 1.19). The brackets were
designed to address three functions as described in function analysis.

![Fig. 19 Concept proposals](image)

### 4.7 Evaluation Phase

Design for manufacturing and assembly approach was used to select alternative bracket design for concept approval. Table 1.2 shows the existing design assembly index.

**Table 1. Assembly index of existing design**

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Numbers</th>
<th>Theoretical part count</th>
<th>Assembly Time (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bracket A</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Bracket B</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Bracket C</td>
<td>1</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>IG Coil Screws</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Screw A</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Screw B</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Nut</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8</strong></td>
<td><strong>3</strong></td>
<td><strong>42</strong></td>
</tr>
</tbody>
</table>

![Fig. 20 Assembly index comparison](image)

**Fig. 20 Assembly index comparison**

### 4.8 Recommendation

Proposal 3 was recommended based on supplier input for manufacturing and handling constraints. Even though assembly index for proposal 2 and 3 found same refer figure 1.20 and with the cost for manufacturing analysis figure 1.21 shows proposal 2 is less cost for manufacturing. Based on previous failure modes observation for two point mounting and with supplier feasibility input proposal 3 recommended for proto evaluation.

### 4.9 Prototype sample evaluation

Based on DFM analysis proposal 3 bracket selected for prototype part development. Prototype sample 3 numbers was manufactured and tested to evaluate strength and manufacturing issues (refer figure 1.22) for sample. Sample tested with assembled condition and found acceptable for implementation.

![Fig. 21 Cost of manufacturing comparison](image)

**Fig. 21 Cost of manufacturing comparison**

**Fig. 22 Samples of product 2**

### 5. RESULTS AND DISCUSSION

#### 5.1 Results of Product 1

Alternative process for joining adaptor to fuel tank was selected and implemented on pilot lot basis. The process of silver brazing was replaced by copper brazing process for joining adaptor to fuel tank. 10% of material cost was reduced. Refer figure 1.23 and 1.24 for before and after implementation.
5.2 Results of product 2

Alternative design of bracket was made and implemented on pilot lot basis. In place of three brackets for mounting IG coil on vehicle frame was redesigned and reduced three brackets to one bracket. The cost reduction achieved from the alternative design was 8% of material cost. Refer figure 1.25 and 1.26 for before and after implementation.

5.3 Cumulative result of material cost

Process change and part design changed in fabricated part of two wheelers and implemented on pilot lot basis. The material cost was reduced by 18% cumulatively (refer figure 1.27).

5.4 Benefits from the project

The aim of this project was to reduce material cost. The project delivered beyond cost reduction as a result of project implementation, details are given in the figure 1.28.

6. CONCLUSIONS

- Analysis of function and understanding of customer requirement has facilitated to approach the problem in a systematic way so that finding solution systematically.

- **Product 1 : Fuel tank**
  a. Copper brazing improved durability of the joint by 100% compare to silver brazing which was used for production.
  b. Cost of joining operation was yielded 10% of cost reduction.

- **Product 2 : Mounting brackets**
  a. Number of parts reduced for mounting an electrical part, there by reduced assembly time by 5 sec. And store area used for storing intermediate brackets is avoided.
  b. Cost of mounting brackets was reduced by 8%
  
- Material cost was reduced by 18% cumulatively.

6.1 Recommendation for future work

- Fuel tank is manufactured using other process like soldering in the neck portion of the component. The soldering process cost more than copper brazing, hence this process can be analyzed for potential cost saving.
Horizontal deployment to other motor cycles to mount IG Coil has to analyze.

Yield improvement to be made by improving handling of material from Tier one to TVS-M

7. REFERENCES


