# VALUE ANALYSIS - SPRAY ASSEMBLY OF PLASTERING SPRAY GUN MACHINE

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*Abstract:* Customer satisfaction is the key to success of industries. During product design stage main focus of designer on technical parameters and constraints and design variables. All parts and assemblies are not having same critical to quality (CTQ) characteristics therefore designers should also work on specific area related to cost for customer delight by using value engineering (VE). Based on different need level of customer like expecters, spoken, unspoken and exciters, value engineering team analyze different design parameters and selection of material by using functional evaluation technique and cost matrix. Different guidelines of value engineering principles are used to analyze on spray assembly of plastering spray gun machine used in wall plastering application.

***Keywords*** **– Customer delight, Material properties, Functional evaluation, Cost matrix.**

## I. INTRODUCTION

Success of organizations depend on the performance of various department like marketing, product development, production, finance, human resource etc. Some department have active role in success where as some departments play crucial role in success story of organization by helping to increase the effectivity of other department. In current industrial scenario, where customer loyalty is only defined by customer satisfaction. Customer satisfaction depends on two major factor product quality and value for money. Therefore, product development team has active as well passive role to make product as per customer requirement. Functions and product quality parameters are taken in consideration during design stages but various organization often forget to apply value engineering concept which affects the customer satisfaction. Value analysis provide a deep understanding of customer satisfaction by analyzing value for their money. Value is the ratio of function of product and cost paid by customer. To increase value of product two activity can be utilized either increase the function of product which has direct relation with value or reduce cost of product which is inverse relation with value. Value analysis and cost cutting are two different activities used to increase value of product. By utilizing cost matrix and different parameters like material cost, processing cost and assembly cost, analysis is done for utilization of function. Without compromising the quality, extra cost is reduced to make product more valuable to customer. The objective of value analysis is to provide only required function and quality by lowering or eliminating unnecessary cost.

## II. LITERATURE SURVEY

**Amit Narwal et al.[1]** presented a case study on value analysis based on sheet metal. Market competitiveness is measured using value analysis of same type of parts. **Marjan Leber et al. [2]** discussed conjoint and value analysis and their importance during product development stage as well as developed product stages to lower the cost of product. **Ignacio Cariaga et al. [3]** analyzed the integration of value analysis and quality function deployment (QFD) and use of function analysis and system technique (FAST) in decision making. **Jing Tao et al. [4]** discussed about enhancement of life-cycle of product by using value engineering and sustainable value modeling analysis. **Amit Kumar Kundu et al. [5]** developed product by using different design concepts of systematic and morphological design theory. The functional design variables are defined during product development. **Satish M. Silaskar et al. [6]** discussed principles of value engineering in weight Optimization of valve for cost effectiveness. **Kamal Patel et al. [7]** discussed that the application of VE to New Product Development (NPD) can enhance the products value by increasing performance without increasing the cost and affecting the quality, saleability or maintainability. **Ainul Farahin Binti Abdullah et al. [8]** presented how utilization of Value analysis Value Engineering (VAVE) methodology in new product development. Optimization of value is processed by using Functional Analysis System Technique (FAST) which is integral part of VAVE methodology. **Yin et al. [9]** discussed about improving the architecture of product development process (PDP) is an effective approach to improve PDP performance. Use of quality function deployment (QFD) to understand critical to quality (CTQ) parts and assembly balance the cost and product performance.

## III. VALUE ANALYSIS METHODOLOGY

The value engineering methodology is very unique in nature and can easily be applied during any stages of product life-cycle. The methodology of value engineering is finalized by a value team leader based on function analysis from product or component or assembly. It is performed as per following flow process:

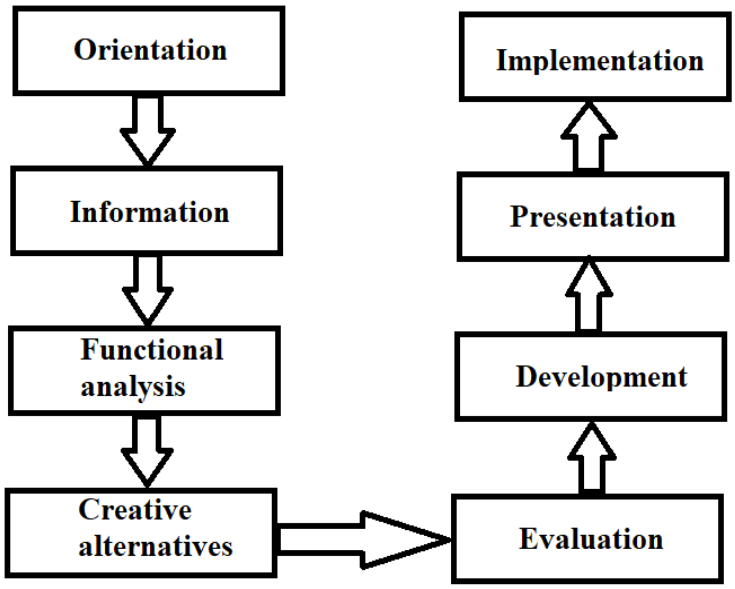


**Fig. 1 Value analysis methodology**

i. **Orientation Phase**: Analyze the problem and prepare for the value study.

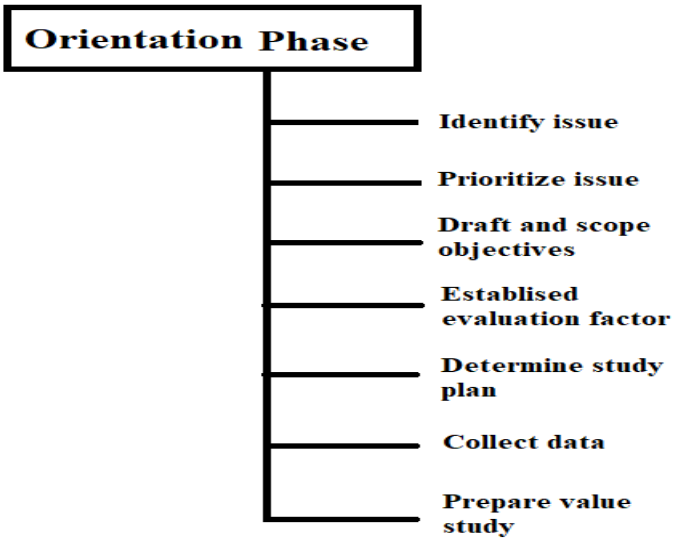


**Fig. 2 Constituents of Orientation Phase**

**ii. Information Phase**: The phase is critical due various defining action like scope, target value and team building
**iii. Function Analysis Phase**: Recognize and confirm most suitable area for value analysis.
**iv. Creative Phase**: Brainstorming part of the whole process, this stage creates lots of alternatives.
**v. Evaluation Phase**: The phase of data analysis for decision making.
**vi. Development Phase**: The conclusion process for analysis and presentation of final data.
**vii. Presentation Phase**: To get a commitment to follow the best suitable option.
**viii. Implementation Phase**: This phase related to final decision making for adopting best decision to implement.

**Value analysis tools and techniques applied on spray assembly plastering spray gun machine-**

**3.1 Functional analysis worksheet is prepared for the different parts of the assembly-**

| Part Name | Sub-part/ Description | Qty | Function | | Part | | Assembly | |
|---|---|---|---|---|---|---|---|---|
| | | | Verb | Noun | Basic | Secondary | Basic | Secondary |
| Spraying unit | Housing | 1 | Provide | Strength | √ | | √ | |
| | Bush | 4 | Connect | Parts | | √ | | √ |
| | Cover Plate | 1 | Increase | Flexural capacity | | √ | | √ |
| | Nozzle | 4 | Supply | Material | | √ | | √ |
| | Bolt | 5 | Support | Housing | | √ | | √ |

**Table 1 Functional analysis worksheet of Holding and flow of mixture unit**

**Costing of different units**

| Unit | Part | Quantity | Cost in Rs. |
|---|---|---|---|
| **Spraying unit** | Housing | 1 | 1600 |
| | Bush | 4 | 640 |
| | Cover Plate | 1 | 280 |
| | Nozzle | 4 | 160 |
| | Bolt | 5 | 80 |
| | **Total** | | **2760** |

**Table 2 Costing of different units**

**3.2 Functional Evaluation of each part is done-**

| | | | | | | |
|---|---|---|---|---|---|---|
| A | A3 | A3 | A3 | A3 | 12 | 13 |
| | B | B2 | B2 | B2 | 06 | 07 |
| | | C | C1 | C1 | 02 | 03 |
| | | | D | D1 | 01 | 02 |
| | | | | E | 00 | 01 |

| Weight Factors (Like A**1**, A**2**, A**3**) | | |
|---|---|---|
| 1 | 2 | 3 |
| Minor difference in importance | Medium difference in importance | Major difference in importance |

| Unit | Key Letter | Part | Function | Weight | %Cost |
|---|---|---|---|---|---|
| **Spraying Unit** | A | Housing | Provide Strength | 13 | 57.97% |
| | B | Bush | Connect Parts | 07 | 23.18% |
| | C | Cover Plate | Increase Flexural capacity | 03 | 10.14% |
| | D | Nozzle | Supply Material | 02 | 5.79% |
| | E | Bolt | Support Housing | 01 | 2.89% |

**Table 3 Functional Evaluation of each part is done**

**3.3 Creative phase-**

By using creative phase activity analysis is done on spray assembly of existing product plastering spray gun machine. This is used for cost function analysis of different parts of particular sub-assembly. Design of different parts can be modified by using value analysis technique. With the help of comparative study selection of material is done in this phase without affecting functionality.

- **Comparative analysis of Housing –** Spraying unit part Housing is used to accommodate nozzle and parts. Material from holding unit is transferred to housing of spray unit by gravitational force and high-pressured air from pressure regulator unit sprays the mixture to the wall. Housing of wall plastering Semi-Automatic spray gun was made of LM6 material. In this comparative analysis we compare all the alternative materials which are suitable to replace LM6. In respect of these comparisons of mechanical properties, chemical compositions, physical properties and cost analysis with all alternative materials is done. Data for comparison is collected with the help of some research papers and some standard datasheets which was tested before.

- **Comparison of Mechanical Property Specification-** Table is prepared and pie chart is generated for better comparison results. Mechanical properties of existing material (LM6) like 0.2% Proof Stress Tensile Stress, Elongation %, Impact Resistance, Brinell Hardness, Endurance Limit, Modulus of Elasticity and Shear Strength is compared with different alternative materials.

| Grade | | 0.2% Proof Stress ($N/mm^2$) | Tensile Stress ($N/mm^2$) | Elongation (% ) | Impact Resistance Izod (Nm ) | Brinell Hardness (HB) max | Endurance Limit($5\times10^7$ cycles; $N/mm^2$) | Modulus of Elasticity( $\times10^3$ $N/mm^2$) | Shear Strength ($N/mm^2$) |
|---|---|---|---|---|---|---|---|---|---|
| **LM 6** | **Sand cast** | **60-70** | **60-70** | **5** | **6.0** | **50-55** | **51** | **71** | **120** |
| LM4 | Sand cast | 70-110 | 70-110 | 2-3 | 1.4 | 65-80 | 75 | 71 | 150 |
| | Chill cast | 80-110 | 80-110 | 2-4 | 2.1 | 70-90 | 85 | 71 | 165 |
| LM5 | Sand cast | 90-110 | 90-110 | 3 | 7.9 | 50-70 | 54 | 71 | 140 |
| | Chill cast | 90-120 | 90-120 | 5 | 12.6 | 60-70 | 100 | 71 | - |
| **LM9** | **Sand cast** | **95-120** | **95-120** | **3-5** | **6.0** | **75-85** | **70-100** | **71** | **120** |

| Grade | | 0.2% Proof Stress ($N/mm^2$) | Tensile Stress ($N/mm^2$) | Elongation (% ) | Impact Resistance Izod (Nm ) | Brinell Hardness (HB) max | Endurance Limit($5\times10^7$ cycles; $N/mm^2$) | Modulus of Elasticity( $\times10^3$ $N/mm^2$) | Shear Strength ($N/mm^2$) |
|---|---|---|---|---|---|---|---|---|---|
| **LM 6** | **Sand cast** | **65** | **75** | **5** | **6.0** | **53** | **51** | **71** | **120** |
| LM4 | Sand cast | 90 | 155 | 2 | 1.4 | 73 | 75 | 71 | 150 |
| | Chill cast | 95 | 140 | 3 | 2.1 | 80 | 85 | 71 | 165 |
| LM5 | Sand cast | 100 | 155 | 3 | 7.9 | 65 | 54 | 71 | 140 |
| | Chill cast | 105 | 225 | 5 | 12.6 | 65 | 100 | 71 | - |
| **LM9** | **Sand cast** | **108** | **190** | **4** | **6.0** | **80** | **85** | **71** | **120** |

**Table 4 Comparison between Mechanical Property Specifications of Housing material**

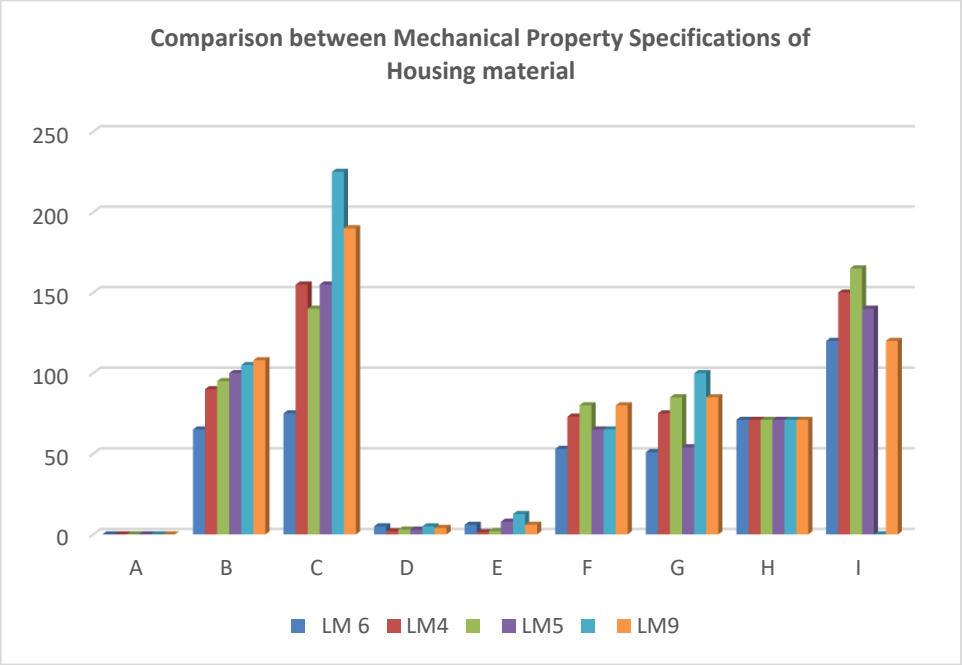


**Fig. 3 Comparison of Mechanical Property Specification**

| | |
|---|---|
| A | Cast |
| B | 0.2% Proof Stress ($N/mm^2$) |
| C | Tensile Stress ($N/mm^2$) |
| D | Elongation (% ) |
| E | Impact Resistance Izod (Nm ) |
| F | Brinell Hardness (HB) max |
| G | Endurance Limit($5\times10^7$ cycles; $N/mm^2$) |
| H | Modulus of Elasticity($\times10^3$ $N/mm^2$) |
| I | Shear Strength ($N/mm^2$) |

- **Comparison of Composition Specification (%)-**Table is prepared for better comparison results. Chemical properties of existing material (LM6) like Composition Specification of C,Mn,Si, P,S,Cr,Mo,Ni,Cu and N compared with different alternative materials.

| Grade | Cu | Mg | Si | Fe | Mn | Ni | Zn | Pb | Sn | Ti | Al | Additional Element | Other Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **LM6** | **0.1** | **0.10** | **10.0-13.0** | **0.6** | **0.5** | **0.1** | **0.1** | **0.1** | **0.05** | **0.2** | **Re** | **0.05** | **0.15** |
| LM4 | 2.0-4.0 | 0.20 | 4.0-6.0 | 0.8 | 0.2-0.6 | 0.3 | 0.5 | 0.1 | 0.1 | 0.2 | Re | 0.05 | 0.15 |
| LM5 | 0.1 | 3.0-6.0 | 0.3 | 0.6 | 0.3-0.7 | 0.1 | 0.1 | 0.05 | 0.05 | 0.2 | Re | 0.05 | 0.15 |
| **LM9** | **0.20** | **0.2-0.6** | **10.0-13.0** | **0.6** | **0.3-0.7** | **0.1** | **0.1** | **0.1** | **0.05** | **0.2** | **Re** | **0.05** | **0.15** |

**Table 5 Comparison between Composition Specifications (%) of Housing Material**

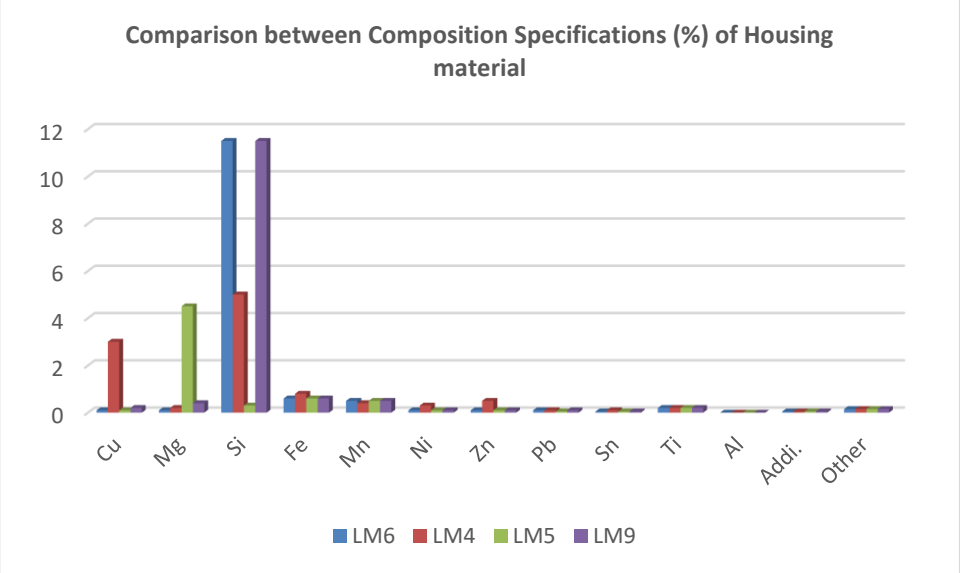


**Fig. 4 Comparison between Composition Specifications (%) of Housing Material**

- **Comparison of Physical Properties-** Table is prepared and pie chart is generated for better comparison results. Physical Properties of existing material (LM6) like Density, Mean Coefficient of Thermal Expansion, Thermal Conductivity, Specific Heat, Electrical conductivity and Freezing Range compared with different alternative materials.

| Grade | Coefficient of Thermal Expansion (per at 20-100 ˚ C) | Thermal Conductivity (watt/$cm^2$/cm/˚C at 25˚C) | Electrical Conductivity (% copper standard at 20 ˚C) | Density ($g/cm^3$) | Freezing Range(C) Approx |
|---|---|---|---|---|---|
| **LM6** | **0.000020** | **0.34** | **37** | **2.65** | **575-565** |
| LM4 | 0.000021 | 0.29 | 32 | 2.75 | 625-525 |
| LM5 | 0.000023 | 0.33 | 31 | 2.65 | 642-580 |
| **LM9** | **0.000022** | **0.35** | **38** | **2.68** | **575-550** |

**Table 6 Comparison between Physical Properties of Housing material**

- **Comparison of Cost of materials-** Comparison of input cost is most important step in the Value analysis. Customer satisfaction and producibility of any organization directly depend on the cost of product and these costs need to be analyzed by using proper tools with comparison of different alternatives materials available at market. Table and bar chart are prepared to analyzed cost of raw material of Housing.

| Grade | LM6 | LM4 | LM5 | LM9 |
|---|---|---|---|---|
| Cost (per Kg) | 180 | 135 | 160 | 140 |

**Table 7 Comparison between Costs of Housing material**

**3.4 Function- Cost -Worth -Analysis:**

| **Sr. No.** | **Function** | **Existing Product** | | | | **New Product (Value analyzed)** | | | **value gap** | **% value gap** |
|---|---|---|---|---|---|---|---|---|---|---|
| | Part name | Qty | Mat. | Cost per unit | Total Cost | Mat. | Cost per unit | Total Cost | | |
| 1 | Housing | 1 | LM6 | 225 | 225 | LM9 | 175 | 175 | 50 | 22.22% |
| 2 | Bush | 4 | SS304 | 60 | 240 | SS304 | 60 | 240 | 0 | 0% |
| 3 | Cover Plate | 1 | SS304 | 20 | 20 | SS304 | 20 | 20 | 0 | 0% |
| 4 | Nozzle | 4 | SS201 | 20 | 80 | SS201 | 20 | 80 | 0 | 0% |
| 5 | Bolt | 5 | SS201 | 16 | 80 | SS201 | 16 | 80 | 0 | 0% |
| Total | | | | | 645 | | | 595 | | |

**Table 8 Function- Cost -Worth -Analysis**

**3.5 Evaluation phase-**

Parameters

a) Rigidity

b) Light weight

c) Durability

d) Appearance

- Alternative I- Change material LM6 to LM9 of different components of product

| | **B** | **C** | **D** | **RAW SCORE** | **FINAL SCORE** | |
|---|---|---|---|---|---|---|
| **A** | A3 | A2 | A2 | 07 | 7 | 8 |
| | B | B2 | B2 | 04 | 4 | 5 |
| | | C | C1 | 01 | 1 | 2 |
| | | | D | 00 | 1 | 1 |

| **Parameter Weightage Alternative** | **Rigidity** | **Light Weight** | **Durability** | **Appearance** | **Total** |
|---|---|---|---|---|---|
| | 8 | 5 | 2 | 1 | |
| **Existing** | 4<br>32 | 3<br>15 | 3<br>6 | 3<br>3 | 56 |
| **Alternative-I** | 5<br>40 | 4<br>20 | 4<br>8 | 3<br>3 | 71 |

| **5** | **4** | **3** | **2** | **1** |
|---|---|---|---|---|
| Excellent | Very Good | Good | Fair | Poor |

**Table 9 Evaluation phase**

**3.6 Recommendation Phase-**

| Sr. No. | Parameter | Existing Material Cost | Alternative-I |
|---|---|---|---|
| 1 | Housing | 225 | 175 |
| 2 | Bush | 240 | 240 |
| 3 | Cover Plate | 20 | 20 |
| 4 | Nozzle | 80 | 80 |
| 5 | Bolt | 80 | 80 |
| | **Total (in Rs.)** | **645** | **595** |

**Table 10 Recommendation Phase**

**Fig. 5 Sample Product:** Plastering spray gun machine **(M/s Lakshmi Machine Tools, Indore)**

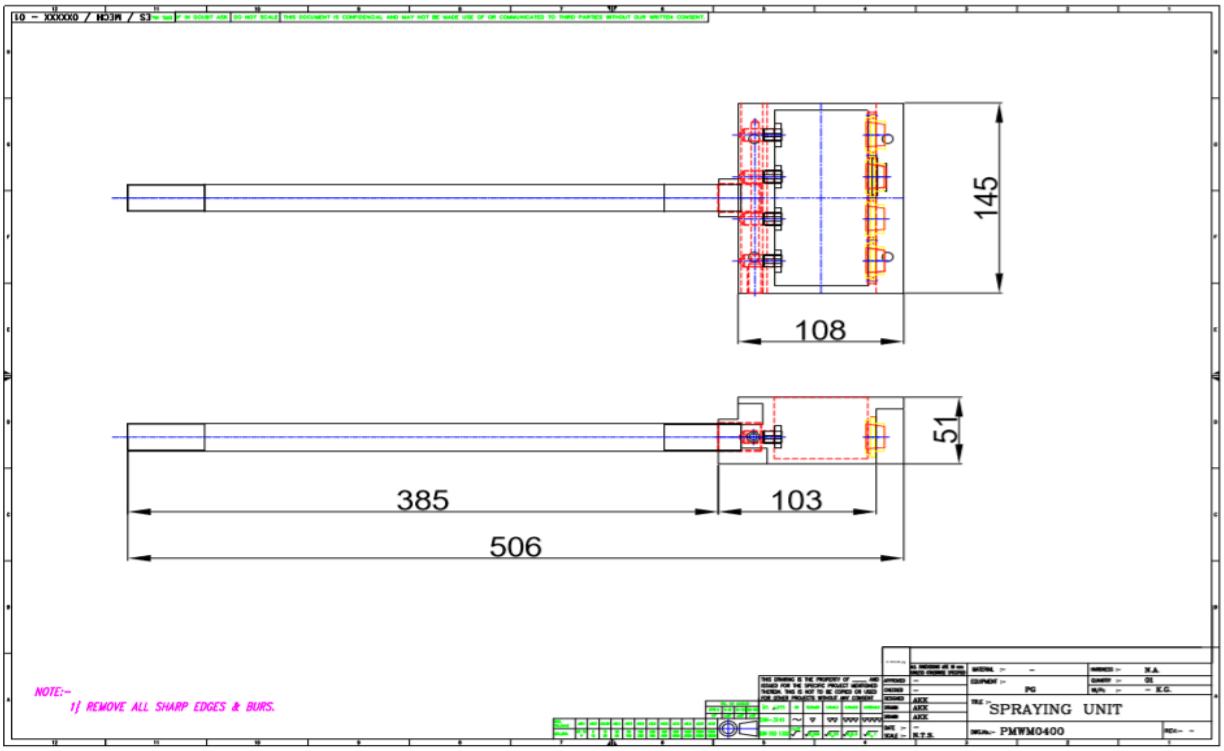


**Fig. 6 Sample Product:** Spray assembly of plastering spray gun machine **(M/s Lakshmi Machine Tools, Indore)**

### 3.7 Conclusion and Future Scope-

1. Value engineering is successfully implemented for the cost reduction without the change in the product quality.
2. The total saving in raw material per product for specific component material by implementation of above recommendations are 22.22% for alternative I.
3. Other Industrial Engineering techniques can be used for further improvement in the product.

## IV. ACKNOWLEDGMENT

We are very grateful to management of M/s Lakshmi Machine Tools, Indore for their co-operation and Support for providing organizational information for this analysis.

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