Value Analysis for Cost Reduction in Lead Pencil Manufacturing: A Case Study

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***Abstract*- The aim of this study is to analyze the prospect of cost reduction through value analysis technique. Manufacturing process of conventional lead pencil is analyzed to apply the value analysis technique in order to reduce cost. Value analysis is the study of existing process to reduce the cost incurred on the manufacturing of a product through process reengineering or design alteration without reducing the performance of the product regarding to its basic functions. This study focuses on the design alteration of the lead pencil by changing materials used for manufacturing of the pencil. This study presents the functional and cost analysis of lead pencil and ideas are proposed to reduce the cost of manufacturing per product. Through newly proposed ideas, cost saving per pencil is expected to be 25% of the previous manufacturing cost.**

***Index Terms*- Value Analysis, Cost reduction, Pencils, Cost Saving, Function Analysis.**

I. INTRODUCTION

Value Engineering establishes the relationship between worth and cost of a product by analyzing its functions to determine the best value. When a product performs its required functions consistently at a lowest life cycle cost while maintaining the quality termed as best value of that product. Value engineering is the set of actions performed while the product is in design & development stage. On the contrary, value analysis is a procedure adopted for the cost reduction and process improvement for the existing product. Value of a product is defined by the ratio of the functions performed by the product to the cost of that product. It has been proved that Value analysis is capable of reducing costs by 25% to 45% or even more without affecting its quality.

The manufacturing process at lead pencil roughly includes cutting and shaping of wood, inserting lead into wood, painting of wood and printing of wood and finally fixation of the metal cap along with the eraser. A survey is conducted to gather the data about current costing of the pencil to explore the areas where improvement is possible along with the functional analysis of the various parts and processes to study their importance in the process. In the technical terminology of the value engineering, this phase is known as orientation phase.

In order to reduce the cost incurred on the manufacturing of the lead pencil, the detailed study of current costing is undertaken to identify the possible areas of improvement. The overall study showed that the small design aspects are capable of producing significant impact on the cost of manufacturing and are need to be carefully studied. The ideas presented in this manuscript propose slight change in the design of the product through changing the shape and paint used during manufacturing of the pencil. The potential of the ideas is also explored in this text through expected reduction in the cost of manufacturing. Further, the existing and newly proposed costs are compared to estimate the cost saving per piece. The process of cost reduction through value analysis is explained step by step through this manuscript.

II.VALUE ENGINEERING AND VALUE ANALYSIS

According to the Society of American Value Engineering (SAVE) "value engineering is the systematic application of recognized techniques which identify the function of a product or services, establish a monetary value for the function and provide the necessary function reliably at the lowest overall cost.

The objective of value analysis is not only to degrade or cheaper the products but to improve its value by reducing cost. Value analysis is applied to the

existing product in order to improve its value. Whereas, Value Engineering is applied to the product at the design stage and therefore ensures prevention rather than elimination. The value analysis should be applied at the proper time and correct phase of product life cycle to get expected results.

III.PHASES OF VALUE ANALYSIS

i. Orientation Phase

In this phase, functional analysis of various parts and processes is carried out to segregate them into basic and secondary functions. The segregation is done based on the individual function and their functional contribution to assembly. Basic function is what a product or process must do to work or sell and the customer is willing to pay for, followed by secondary functions that support that basic function. Secondary functions can be modified or eliminated to reduce product cost. The pencil is mainly divided into following components:-

1. Wood
2. Lead
3. Metal cap
4. Eraser
5. Paint

The functional analysis is also presented in Table. 1, based on their contribution to the assembly.

The numbers indicated in the functional evaluation table indicate:-

- Major Performance = 3
- Medium Performance = 2
- Minor Performance = 1

Table. 1 Functional Analysis of Parts and Processes

SR. NO	PART NAME / DESCRIPTION	QUANTITY	FUNCTIONAL DEFINITION		PART		ASSEMBLY	
			VERB	NOUN	BASIC	SECONDARY	BASIC	SECONDARY
1	LEAD	1	MAKE	MARK	✓		✓	
2	WOOD	1	PROTECT	LEAD	✓			
			PROVIDE	STRENGTH	✓			
			SUPPORT	ERASER		✓		
3	METAL CAP	1	HOLD	ERASER	✓			
4	SHAPING OF WOOD	1	PROVIDE	GRIP	✓			
			IMPROVE	APPEARANCE		✓		
5	PRINTING	1	DISPLAY	INFORMATION	✓			
6	SHINING PAINT	1	IMPROVE	APPEARANCE	✓			
7	ERASER	1	REMOVE	MARKS	✓			

ii.Information Phase

In the information phase, the detailed information regarding the costing of the pencil is gathered from the survey of the production line. The pencil manufacturing consists of overall 5 stages. As a unit, the current manufacturing cost of the pencil per piece is ₹ 4/-. Wood and paint are the two expensive elements in the manufacturing of a pencil which share 37.5% of the total cost of a pencil. The primary focus is kept on these two elements for the cost reduction. The detailed costing of the parts and processes is presented in the following table.

Table. 2 Detailed Costing of Parts and Processes

SR. NO.	PART NAME	QUANTITY	COST IN Rs.
1	LEAD	1	0.50
2	WOOD	1	1.00
3	META CAP	1	0.25
4	SHAPING OF WOOD	1	0.50
5	PRINTING	1	0.50
6	SHINING PAINT	1	0.50
7	ERASER	1	0.75
		TOTAL	4.00

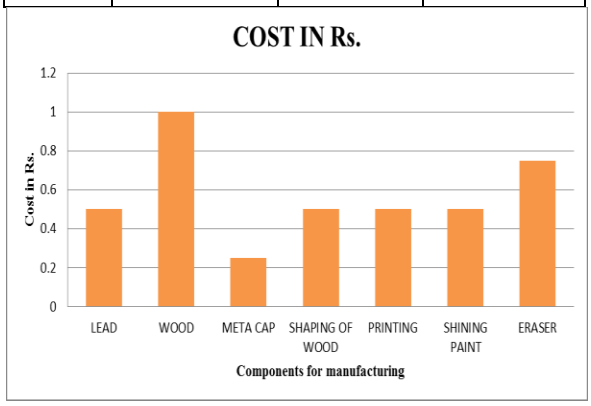

Fig. 1 Components Vs. Cost graph

Table. 3 Comparison of Functional Weightage and Cost

Key Letter	Part	Function	Weight	% Cost
A	LEAD	MAKE MARK	9	12.5
B	WOOD	PROVIDE STRENGTH	9	25
C	META CAP	HOLD ERASER	8	6.25
D	SHAPING OF WOOD	PROVIDE GRIP	3	12.5
E	PRINTING	DISPLAY INFORMATION	3	12.5
F	SHINING PAINT	IMPROVE APPEARANCE	1	12.5
G	ERASER	REMOVE MARKS	3	18.75

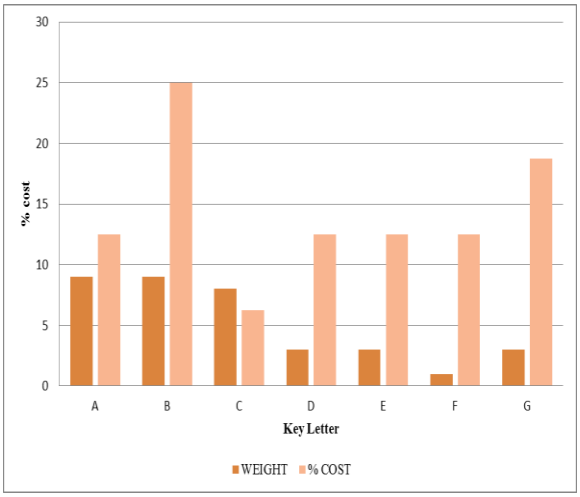

Fig. 2 Comparison of Functional Weightage and Cost

iii.Creative Phase

This phase is concerned with, "What are the other options which could satisfy the same functions" of the handle assembly. Many ideas are generated and discussed in the brain storming session. Following ideas were generated during this phase.

1. Change in the design (round shape)

Instead of using the hexagonal shaped wood for the body of pencil, the round shaped design can be incorporated to reduce the manufacturing time and thereby, manufacturing cost.

2. Eliminate glitter paint (use normal paint)

Glitter paints are expensive and great care is to be taken while applying is on the wood. Instead of that, the normal paints can be used to save the cost.

After discussing on the ideas put forth, the function cost worth analysis is performed on the product to estimate the effectiveness of the newly proposed ideas.

Table. 4 Function Cost Worth Analysis

FUNCTION		EXISTING COST	WORTH TENTATIVE ALTERNATIVE	ESTIMATED COST	VALUE GAP	RANKING
VERB	NOUN					
MAKE	MARK	0.50	NO CHANGE	0.50	0	
PROTECT	LEAD	1.00	MEDIUM QUALITY WOOD	0.50	0.50	I
HOLD	ERASER	0.25	PLASTIC	0.15	0.10	IV
PROVIDE	GRIP	0.50	MAKE CIRCULAR	0.25	0.25	II
DISPLAY	INFORMATION	0.50	NO CHANGE	0.50	0	
IMPROVE	APPEARANCE	0.50	NORMAL PLAIN PAINT	0.35	0.15	III
REMOVE	MARKS	0.75	NO CHANGE	0.75	0	
TOTAL		4.00		3.00	1.00	

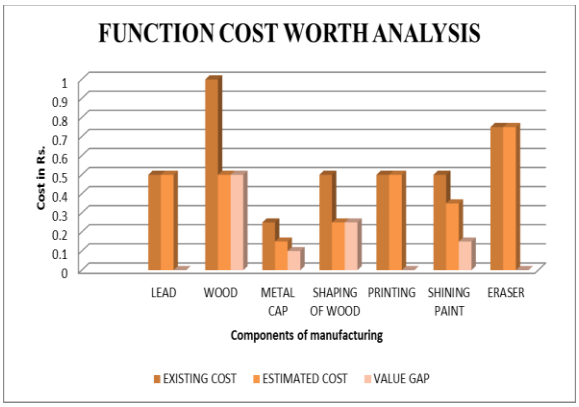

Fig. 3 Function Cost Worth Analysis

iv.Evaluation Phase

In the evaluation phase, the costing of the new ideas is done considering the monthly demand of 5000 pieces. The percentage saving and total per order is also calculated.

- Saving per product = ₹ 1/-
- % saving per product = 25 %
- Monthly demand = 5000
- Actual monthly overall cost = ₹ 20000 /-
- New monthly overall cost = ₹ 15000/-
- Total monthly saving = ₹ 5000/-

Table. 5 Comparison of Existing and Estimated Cost

PART NAME	EXISTING COST	ESTIMATED COST	VALUE GAP
LEAD	0.5	0.5	0
WOOD	1	0.5	0.5
METAL CAP	0.25	0.15	0.1
SHAPING OF WOOD	0.5	0.25	0.25
PRINTING	0.5	0.5	0
SHINING PAINT	0.5	0.35	0.15
ERASER	0.75	0.75	0

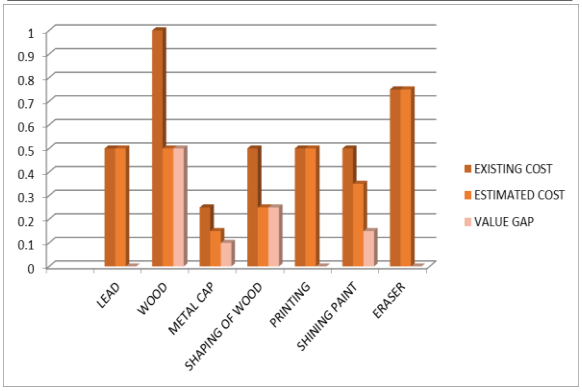

Fig. 4 Comparison of Existing and Estimated costs

IV. CONCLUSION

With the proposed design changes, it is expected to reduce the cost for the manufacturing of the one piece of pencil by 25%. It is a huge reduction in the cost. The saving expected per order is ₹ 5000 /- which will be utilized for the additional manufacturing of nearly 1700 extra pencils. Along with the direct monetary benefit, the manufacturing process is also made simpler which will result in the lesser production time. It will be possible to manufacture more products with the same given time for a batch. The new design will also give the product more aesthetic look which will be more appealing to the customers. New ideas are also expected to achieve more customer satisfaction along with the performance improvement and cost reduction.

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