Achieving Success through Value Engineering: A Case Study

Amit Sharma, R.M. Belokar, *Member, IAENG*

***Abstract*— In this paper we have discussed the concept of Value Engineering, its job plan and the effective implementation of it through a case study. Efforts have been put into the articulation of the paper to make it coherent which can be easily perceivable. A case study has been discussed in this paper involving a part used in the medical instruments. The material is chosen such that the cost is reduced without affecting the quality of the product. The best feasible solution from the available alternatives is chosen through the feasibility ranking table. Through the application of Value Engineering profits are maximized without hindering the reliability of the product. With the effective utilization of the technique the final outcomes comes out to be a successful showcase of value engineering.**

***Keywords*— Functional Analysis, LCC, Job Plan, Value Engineering, Value Index, ₹ (Indian National Rupee)**

I. Introduction

Value Engineering is an organized/systematic approach directed at analyzing the function of systems, equipment, facilities, services, and supplies for the purpose of achieving their essential functions at the lowest life-cycle cost consistent with required performance, reliability, quality, and safety[1]. Society of Japanese Value Engineering defines VE as: "A systematic approach to analyzing functional requirements of products or services for the purposes of achieving the essential functions at the lowest total cost" [2].

Value Engineering is an effective problem solving technique. Value engineering is essentially a process which uses function analysis, team- work and creativity to improve value [3]. Value Engineering is not just "good engineering." It is not a suggestion program and it is not routine project or plan review. It is not typical cost reduction in that it doesn't "cheapen" the product or service, nor does it "cut corners."

Value Engineering simply answers the question "what else will accomplish the purpose of the product, service, or process we are studying?"[4]. VE technique is applicable to all type of sectors. Initially, VE technique was introduced in manufacturing industries. This technique is then expanded to all type of business or economic sector, which includes construction, service, government, agriculture, education and healthcare [5].

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Amit Sharma is with the Department of Production Engineering in PEC University of Technology Chandigarh (phone:+919041293477; e-mail:amiter84@gmail.com).

R.M. Belokar, is with the Department of Production Engineering in PEC University of Technology, Chandigarh (Corresponding author phone: +91-172-2753287; email:rajbelokar@gmail.com, rmbelokar@pec.ac.in).

II. History of Value Engineering

During World War II, many manufacturers were forced to use substitute materials and designs as a result of critical material shortages. When the General Electric Company found that many of the substitutes were providing equal or better performance at less cost, it launched an effort (in 1947) to improve product efficiency by intentionally and systematically developing less costly alternatives. Lawrence D. Miles, a staff engineer for General Electric, led this effort. Miles combined a number of ideas and techniques to develop a successful methodological approach for ensuring value in a product. [6] The concept quickly spread through private industry as the possibilities for large returns from relatively modest investments were recognized. This methodology was originally termed *value analysis* or *value control*. In 1957, the Navy's Bureau of Ships became the first Department of Defense organization to establish a formal VE program. Miles and another General Electric employee, Raymond Fountain, set up the Bureau of Ships program to help reduce the cost of ship construction, which had nearly doubled since the end of World War II. The Bureau of Ships asked that the technique be called "Value Engineering" and staffed the office with people under the general engineer position description.

III. What Value Engineering Isn't

Value Engineering is not just "good engineering." It is not a suggestion program and it is not routine project or plan review. It is not typical cost reduction in that it doesn't "cheapen" the product or service, nor does it "cut corners." Value Engineering simply answers the question "what else will accomplish the purpose of the product, service, or process we are studying?" It stands to reason that any technique so useful should be applied to every product, and at each stage of the normal day-to-day development of a highway product. This is not the case. The practice of VE entails a certain amount of expense, that must be justified by potential cost savings. Accordingly there must be a recognized need for change and a distinct opportunity for financial benefit to warrant the added cost of a VE effort.

IV. USING LIFE-CYCLE COSTING WITH VALUE ENGINEERING

The concept of economic analysis, which is used in life-cycle costing, requires that comparisons be made between things similar in nature. In value engineering all alternatives can be compared using life-cycle costing because the alternatives for each project component are defined to satisfy the same basic function or set of functions. When the alternatives all satisfy the required function, then the best value alternative can be identified by comparing the first costs and life-cycle costs of each alternative.

For many projects there is a viable sustainable development alternative or enhancement. Sustainable development may include more recycled material contents, require less energy or water usage, reduce construction waste, increase natural lighting, or include other opportunities that contribute to an optimal facility. The value engineering methodology can provide for the identification of alternatives, sustainable or eco-efficient design features, and traditional design features, on an equal playing field for comparison. Comparison of alternatives, or the process for identifying the best value alternative, is accomplished using life-cycle costing along with first-cost estimates. Life-cycle costing will in most cases be able to accurately estimate the first-cost and the full life-cycle cost differentials of each alternative. [7]

At this point tradeoffs and decisions can be made to balance environmental performance with total cost (i.e., initial, recurring, and nonrecurring) reliability, safety, and functionality. When all alternatives are compared equally (i.e., “apples to apples”), sustainable development technology and integration can then be fully evaluated for performance in the acquisition process.

V. ROADBLOCKS TO COST EFFECTIVENESS

The practice of VE doesn't imply that there may be intentional "gold plating," conscious neglect of responsibility, or unjustifiable error or oversight by the design team. VE simply recognizes that social, psychological, and economic conditions exist that may inhibit good value.
The following are some of the more common reasons for poor value:

1. Lack of information, usually caused by a shortage of time. Too many decisions are based on feelings rather than facts.
2. Wrong beliefs, insensitivity to public needs or unfortunate experience with products or processes used in unrelated prior applications.
3. Habitual thinking, rigid application of standards, customs, and tradition without consideration of changing function, technology, and value.
4. Risk of personal loss, the ease and safety experienced in adherence to established procedures and policy.
5. Reluctance to seek advice, failure to admit ignorance of certain specialized aspects of project development.
6. Negative attitudes, failure to recognize creativity or innovativeness.
7. Over specifying, costs increase as close tolerances and finer finishes are specified. Many of these are unnecessary.
8. Poor human relations, lack of good communication, misunderstanding, jealousy, and normal friction between people are usually a source of unnecessary cost. In complex projects, requiring the talents of many people, costs may sometimes be duplicated and redundant functions may be provided [8].

VI. VE JOB PLAN

The Job Plan [9, 10] consists of the following sequential phases

A. *Orientation Phase*

In the orientation phase, the project is selected and those who are going to work the problem are familiarized with it [11].

B. *Information Phase*

The team is made familiar with the present state of the project. All team members participated in a functional analysis of the project as a whole, and then of its component parts, to determine the true needs of the project. Areas of high cost or low worth are identified [12].

C. *Functional Phase*

‘Function’ can be defined, as the use demanded of a part of a product and the esteem value that it provides. These functions therefore make the product work effectively or contribute to the ‘salability’ of the product. Functional analysis outlines the basic function of a product using a verb and a noun such as ‘boil water’ as in the case of our kettle [13].

D. *Creative Phase*

This step requires a certain amount of creative thinking by the team. A technique that is useful for this type of analysis is brainstorming. This stage is concerned with developing alternative, more cost effective ways of achieving the basic function. All rules of brainstorming are allowed, and criticism needs to be avoided as it could cease the flow of ideas. Simply list down all ideas, not regarding whether they sound apparently ridiculous.

E. *Evaluation Phase*

In this phase of the workshop, the VA team judges the ideas developed during the creative phase. The VA team ranks the ideas. Ideas found to be irrelevant or not worthy of additional study are disregarded; those ideas that represent the greatest potential for cost savings and improvements are selected for development. A weighted evaluation is applied in some cases to account for project impacts other than costs (both capital and life cycle). Ideally, the VA team would like to evaluate all attractive ideas but time constraints often limit the number of ideas that can be developed during the workshop. As a result, the team focuses on the higher ranked ideas. This phase is designed so that the most significant ideas are isolated and prioritized [14].

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F. *Development Phase*

In the development phase, final recommendations are developed from the alternatives selected during the analysis phase. Detailed technical and economic testing is conducted and the probability of successful implementation is assessed.

G. *Presentation Phase*

The presentation phase is actually presenting the best alternative (or alternatives) to those who have the authority to implement the proposed solutions that are acceptable. It includes preparing a formal VECP or value engineering proposal (VEP) that contains the information needed to reach a decision and implement the proposal.

H. *Implementation And Follow Up*

During the implementation and follow-up phase, management must assure that approved recommendations are converted into actions. Until this is done, savings to offset the cost of the study will not be realized [15, 16].

VII. CASE STUDY

In this paper we have considered a medical instrument manufacturing company, Aadarsh Instruments, located in Ambala, for analysis which runs export business of medical microscope. This firm is producing different types of microscopes which they export to various countries around the globe. All of the products manufactured here are conforming to the international standards. It is an ISO certified company. One of their model SL250 have a component named Focus Adjustment Knob for Slit Lamp in microscope. This microscope has found application in the field of eye inspection.

Value Engineering is applied to the Focus Adjustment Knob. The steps used for this purpose are as follows:-

1. Product selection plan
2. Gather information of product
3. Functional analysis
4. Creativity Worksheet
5. Evaluation sheet
6. Cost analysis
7. Result

Steps followed during the analysis are given below:

1. *Plan For Product Selection*

Product selected is Focus Adjustment Knob for Slit Lamp in microscope which is used to adjust the focus of lens for magnification purpose. The present specifications of this part and its material used are costlier than the average industry cost. Value of this product can be increased by maintaining its functions and reducing its cost or keeping the cost constant and increasing the functionality of the product.

2. *Obtain Product Information*

Product specifications are:

i. Material – Aluminum Bronze Alloy
ii. Diameter of base plate –30 mm
iii. Thickness of plate--3 mm
iv. Cost of the scrap is – ₹ 293/Kg
v. Pieces Produced annually – 8000
vi. Process used – C.N.C. indexing milling
vii. Cycle time—2.5 min
viii. Anodizing—2/min
ix. Material cost—65 gm
x. Total Present cost – ₹ 29.99/piece
{Note: $(USD) 1 = ₹ (INR) 56}

3. *Functional Analysis of Present Functions*

TABLE I
FUNCTIONAL ANALYSIS

Name	Basic Function Verb	Basic Function Noun	Secondary Function Verb	Secondary Function Noun
Focus Adjustment Knob	Index	Lens	Fix	Gear tooth

4. *Develop Alternate Design Or Methods*

During brainstorming these ideas were listed:-

i. Change design
ii. Change material
iii. Use plastic
iv. Make it lighter
v. Change the production process
vi. Use nylon indexing unit

5. *Evaluation Phase*

For judging the ideas, the following designs were considered:

A. Function
B. Cost
C. Maintainability
D. Quality
E. Space

Each of these design criteria was given a weight age factor. This was carried out as follows: each of the above criteria was compared with others, and depending on their relative importance, three categories were formed, viz. major, medium, and minor. A score of 3, 2 and 1 respectively was assigned to each of the levels. The details are as given in the Table II:

TABLE II
WEIGHTAGE ANALYSIS

Weight age analysis	Points
Major difference	3
Medium difference	2
Minor differences	1

TABLE III
PAIRED COMPARISON

	B	C	D	E	SCORE
A	B2	A2	A1	A3	6
	B	B2	B1	B3	8
		C	D2	C2	2
			D	D3	5
				E	0

From the above paired comparison we get the following result

TABLE IV
ATTRIBUTES

Symbol	**Attribute**	**Score**
A	Function	6
B	Cost	8
C	Maintainability	2
D	Quality	5
E	Space	0

The above ideas were discussed and the best feasible ideas were separated which were:-

a. Change the material to steel
b. Use Nylon unit
c. Use existing material

TABLE V
FEASIBILITY RANKING

	A	**B**	**C**	**D**	**E**	**Score**	**Rank**
Ideas	6	8	2	5	1		
a	1/6	2/16	1/2	1/5	3/3	32	III
b	3/18	2/16	2/4	2/10	1/1	49	I
c	1/6	2/16	2/4	1/5	2/2	33	II

6. *Cost Analysis*

TABLE VI
COST EVALUATION

Item	**Material cost (₹)**	**Machining cost (₹)**	**Anodizing cost (₹)**	**Total cost/Pc (₹)**
Focus Adjustment Knob	19.04	7.30	3.65	29.99
Nylon index unit	11.60	6.80	-	18.40
Part Eliminated	-	-	-	-
Difference /part	9.44	12.72	6	11.59

7. *Result*

The total savings after the implementation of value engineering are given below:

- Cost before analysis – ₹ 29.99/-
- Total Cost of nylon knob –₹ 18.40/-
- Saving per product – ₹ 11.59/-
- Percentage saving per product – 38.64 %
- Annual Demand of the product – 8000
- Total Annual Saving – ₹ 92,720/-
- Value Improvement - 62.98 %

VIII. CONCLUSION

Value engineering methodology is a powerful tool for resolving system failures and designing improvements in performance of any process, product, service or organization. Its application results in significant improvements to quality and reliability by focusing the team's attention on the functions that are contributing most to the problems, and the most likely causes of these problems. Then, the team develops ways to improve these root causes of the problems, and ways to fix the problems that have occurred along with means to prevent their reoccurrence.

In the Case Study discussed above we have used the concept of Value Engineering to analysis the focus adjustment knob of microscope and with the critical evaluation of it we were able to increase the value of the product by substituting another material in place of the one that is currently in use. The various advantages have been observed in terms of cost reduction, increase in overall production, reduction in manpower, and reduction in scrap. In future we can alter the design of the product and integrate this technique with various other prevailing industrial engineering tools which will bring down the cost by substantial margin and thereby increasing the value of the product.

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