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Improving Profitability through Value Engineering: A Case study

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Abstract - **Value Engineering is a function-oriented technique that has proven to be an effective management tool for achieving improved design, construction, and cost-effective solution for many engineering problems. It is one of the most effective techniques known to identify and eliminate unnecessary costs in product design, testing, manufacturing, construction, operations, maintenance, procedures and practices. This paper is an attempt to highlight the application of value engineering techniques towards profitability improvement. The paper discusses a case of fabrication industry mainly dealing with different security cabinets. The paper illustrates how the value engineering efforts resulted into the positive impact on the profitability of the company.**

Keywords: **Value Engineering, Profitability, Security Safes, Concrete Filled Door Safes, Locking Mechanism**

I. Introduction

Value Engineering is the systematic application of recognized techniques by multidiscipline team(s) that identifies the function of a product or service; establishes a worth for that function; generates alternatives through the use of creative thinking; and provides the needed functions, reliably, at the lowest overall cost (VE Manual, 2004).

Value engineering is a systematic approach aimed at achieving the desired functions of a product, a process, a system or a service at minimum overall cost, without in any way affecting the quality, reliability, performance and safety (Bharat, 1994).

Value Engineering may be defined in other ways, as long as the definition contains the following three basic precepts (VE Manual, 2004).

a. An organized review to improve value by using multi-disciplined teams of specialists knowing various aspects of the problem being studied.
b. A function oriented approach to identify the essential functions of the system, product, or service being studied, and the cost associated with those functions.
c. Creative thinking using recognized techniques to explore alternative ways of performing the functions at a lower cost, or to otherwise improve the design.

The objective of value engineering approach is to provide a means for total cost control anywhere in the product life cycle. It stresses on the reduction or elimination of the cost that does not contribute to function, quality, life or aesthetics. This is done without compromising in any way on the quality and reliability of the product.

Further, value engineering can also be defined as “An organized effort directed at analyzing the function of system, equipment, installation, operation, maintenance, repairs, replacement or services for the purpose of achieving the required function at the lowest possible cost of effective ownership consistent with performance reliability, quality and maintainability.”

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?”. Value Engineering doesn’t nibble at costs to make the item “cheaper”, as occurs in normal cost reduction. Instead, the VE approach determines the worth of the basic function, without regard to its applications, sets a target cost, and finds the design alternative(s) meeting all needs at a lower overall cost. Typically, a VE study may generate recommendations to eliminate ten to thirty percent of the project’s construction costs. The designer usually accepts about half of these recommendations, providing savings of at least five percent. The cost of the VE effort (including any redesign) is usually less than ten per cent of the implemented savings (VE Manual, 2004).

Value Engineering, if applied meticulously, can bring outstanding improvements. As evident from one of the cases reported (Dasgupta and Mujumdar, 2000), the organization has reported 58.6% growth in the savings by application of VE techniques in their different projects.

The VE technique is effective in overall improvement and hence due importance is also given by the academic fraternity in terms of including it in required details in the syllabus at different levels as per the requirements. One such example to cite is the one-day conference sponsored by SAVE International and the Miles Value Foundation to help academics create new opportunities for postgraduate education in the fields of Value management and Value Engineering. (Woodhead, 2001).

In the current market scenario, the manufacturing firms have to develop a product that is affordable to the customer and at the same time the product has to satisfy the customer in respect of quality. Therefore, product design must be optimized with regard to cost, design requirements and value considerations of the customer (Durga Prasad *et al,* 2011).

Value Engineering (VE) is a cost control approach that thoroughly examines the relationship between the function of a product and its cost. It can be used during the design stage of a product. Quality Function Deployment (QFD) is a customer-driven product development technique. It is a four phase structured methodology to translate the customer needs in to design requirements, and subsequently into parts characteristics, process plans, and production requirements associated with its manufacture (Hassan *et al,* 2009).

Value engineering (VE) is a methodology used to analyze the function of the goods and services and to obtain the required functions of the user at the lowest total cost without reducing the necessary quality of performance (Heggade, 2002).

This paper illustrates the application of VE techniques to reduce cycle time of drilling operation and thus improvement in overall productivity.

This paper highlights the efforts that thoroughly examine the relationship between the function of a product and its cost and thus improve the profitability of the firm. The paper discusses a case of fabrication industry mainly dealing with different security cabinets. The paper illustrates how the value engineering efforts resulted into the positive impact on the profitability of the company.

II. CASE EXPLANATION

A. The Company

The concern is medium size industry engaged in manufacturing higher security products like bank safes, vaults, safe deposits lockers and fire resistant cabinets. The broad product range includes fire and burglary resistant safes of a variety of grades and sizes, strong room doors, strong room accessories and vaults, safe deposit lockers and safe cum safe deposit lockers, fire resistant filling cabinets, record cabinets, diskette cabinets and computer data cabinets. The company caters to the needs of different banks, financial institutions, insurance companies and other industries with their specific requirements. The industry is well equipped with all required manufacturing facilities, such as machine shop with CNC machines, tool room, fabrication shop etc.

B. General Phase

The main objective of the general phase carried was to select a project for value engineering study. The salient points that were considered for the selection of the product for the project were

a. All the required detailed information about the product must be available i.e. product sales, product demand, flow process chart etc;

b. The product have maximum effect on the sales and profits of the company;

c. The company is in agreement for carrying out value engineering on the product;

d. All the persons directly or indirectly concerned with the product unanimously agree for value engineering.

Keeping above points in mind the details of the monthly production of different products of the company was analyzed as indicated in figure 1.

As seen from the figure the production of CFDS (Concrete Filled Door Safe) is the maximum as compared to other products. The firm is making different models of CFDS, for example, 675, 800, 1050 etc. CFDS 675 means safe with height 675 mm. For selecting the particular model of CFDS for value engineering application, sales figures of the different models of CFDS were considered for a financial year as shown in figure 2.

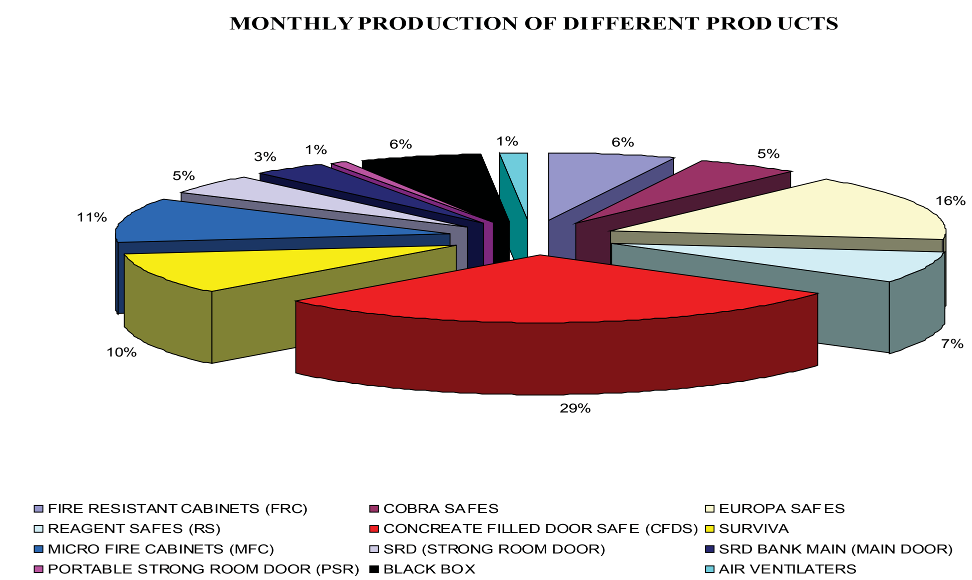

Figure 1 Monthly production of different products

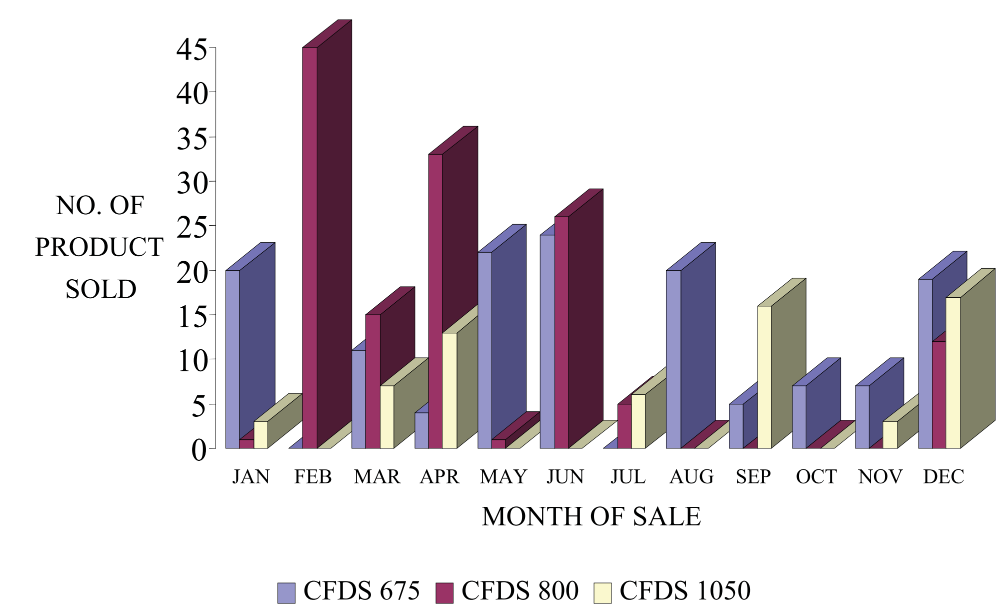

Fig. 2 Annual Sales of CFDS

As seen from the figures 1 and 2 it can be concluded that production of CFDS is more compared to all the products of the company and amongst CFDS, the model CFDS-675 is contributing more to the bottom-line of the firm. Based on this CFSD-675 was selected for the application of value engineering to improve profitability of the concern. The objective of applying value engineering was to improve profitability by reducing cost without compromising the basic function of safety.

The CFDS -675 consists of following principle parts:-

a. OUTER CORE (3.15 mm THICK HOT ROLLED CARBON STEEL)

b. INNER CORE (5 mm THICK HOT ROLLED CARBON STEEL)

c. CONCREATING

d. LOCKING MECHANISM

Now comparing the following main parts with each other and relatively ranking them based on the following criteria:

a. The contribution in performing the basic function i.e. safety of the valuables kept in safe;

b. The scope of improvement i.e. not constrained by the standards (In safes most of the standards are constrained by BIS);

c. The cost of the component with respect to the cost of the product;

d. Ease of manufacturing and assembling to product.

Judging the parts of CFDS based on above parameters and giving relative ranking to them in the scale of 1 to 4 (1: Fair, 2: Good, 3: Very good, 4: Excellent) and summing them up. The results of comparison are depicted in the Table I.1

Table 1 Judging The Main Parts of CFDS on Different Criterion

PARTS OF CFDS	*CONTRIBUTION TO BASIC FUNC.*	*SCOPE OF IMPROVEMENT*	*COST OF COMPONENT W.R.T. TO PRODUCT*	*EASE OF MANU.*	*TOTAL*	*RANKING*
O.C	1	3	1	3	8	*4*
I.C	2	2	2	4	10	*2*
CON	3	1	4	1	9	*3*
L.M.	4	4	3	2	13	*1*

(O.C. = OUTER CORE, I .C. = INNER CORE, CON = CONCREATING, L.M. = LOCKING MECHANISM)

From the Table I it is clear that out of the four principal components locking mechanism is most important as far as contribution to basic function and scope of improvement is concerned. Hence the cost reduction efforts were concentrated on locking mechanism.

C. Information Phase

The objective of information phase is to gather all the required information of the product that will enable further investigation so that cost reduction or process/product improvements can be possible. The product in question falls under BB class of safe as per Bureau of Indian Standards (BIS) which requires following conditions to be met (Table II).

Table II Requirements for the product in question as per BIS

Sr no	Parts	Remarks
1	Outer body, Inner body, Back, door, Hinge, Bolt work, Internal fixtures etc	Steel of any grade conforming with requirement of carbon and mangenese of IS 1079
2	Drill resistant armour plate	Carbon steel (IS 513) case hardened to minimum 55 HRC and case depth of minimum o.25 mm
3	Handle and other fittings	Cast brass or tin bronze or mild steel powder coated or stainless steel or ABSs
4	Body of lock	Cast brass (IS 1079) or zinc plated/powder coated steel of any of the grades
5	Lock levers	Brass
6	Lever spring	Phosphorous bronze wire
7	Keys	Non-magnetic stainless steel
8	Door	➢ Door shall be made of mild steel plates as per class B ➢ In closed position the gap at any place between door edge and the body shall not be more than 1 mm ➢ In the secured position the door shall not have a play of more than 1 mm in direction in which it opens.
9	Hinges	➢ Pivot type ➢ Allow the door to move without friction ➢ Mechanisms for oiling of hinges shall be provided
10	Bolts	➢ Mounted on secure base ➢ Door slides on which door slide should be min 5 mm thick ➢ Bolt slide smoothly when handle is moved ➢ Single piece bolts having equivalent shear are of sliding permissible equal to 2/3 height of engagement in body
11	Locks	Dual control type minimum 5 mm engagement with locking bars of bolt work
12	Levers	➢ Main lock must contain minimum of 8 levers ➢ They may not be of same thickness but should be smooth on both face so to obtain parallelism ➢ Minimum thickness of lever is 1.2 mm ➢ The friction should be minimum and each lever should have two slots for passage of main and auxiliary bolt pin

D. Function Phase

Step 1

The first step in the function phase is to define function into combination of verb and noun. Since the focus is on locking mechanism which remains closed under coversheet, sell functions are not considered here. Table III illustrates work functions in verb and noun manner.

Step 2

The second step is to draw FAST diagram of the locking mechanism, and its various subassemblies to further clarify the functions of various parts.

Table III Work Functions of Locking Mechanism

Parts	Work function	
	Verb	Noun
Lock strap1	Facilitate	Locking
	Holding	Eccentric
	Facilitate	secondary lock
Lock strap2	Facilitate	Locking
	Fix	lock feed
Eccentric	Convert	Motion
	Move	Lockstrap1
Bolt holder	Hold	Shooting bolts
Spindle	Transmit	Torque
Cover strap	Hold	Eccentric
Stopper	Stopping	Lockstrap1

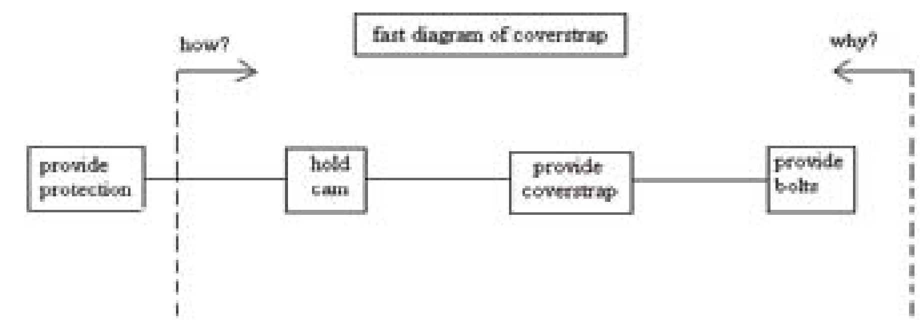

Fig. 3 FAST Diagram of Locking Mechanism

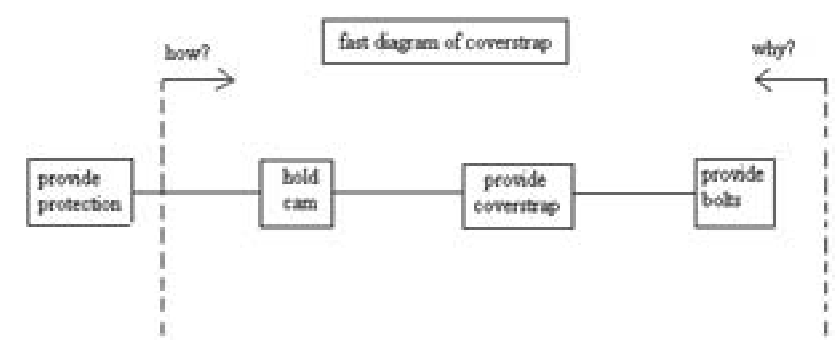

Fig. 4 FAST Diagram of Cover strap

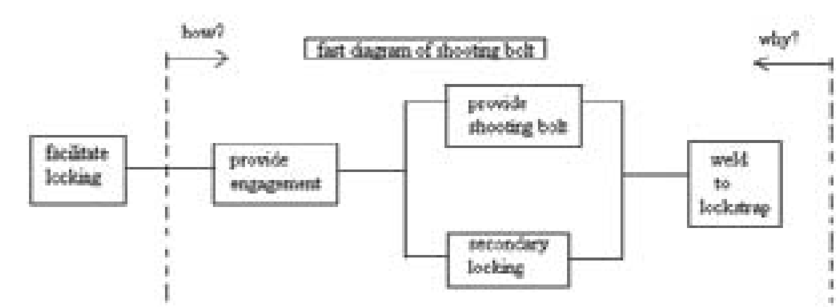

Fig. 5 FAST Diagram of Shooting bolt

Step 3

The third step is to draw fast cost diagram of the locking mechanism and its various sub assemblies.

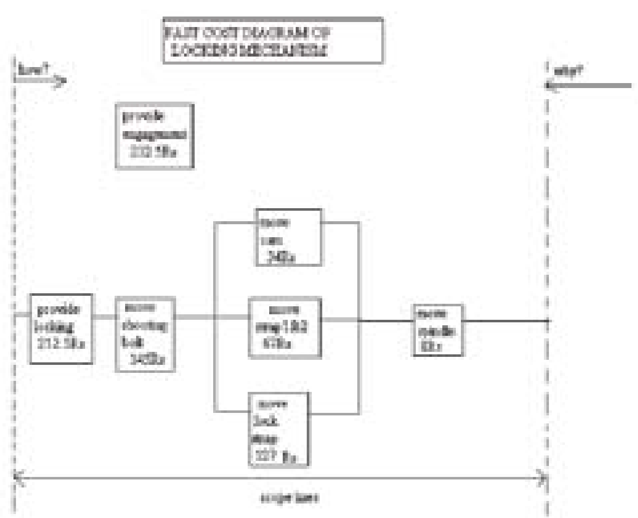

Fig. 6 FAST-COST Diagram of Locking Mechanism

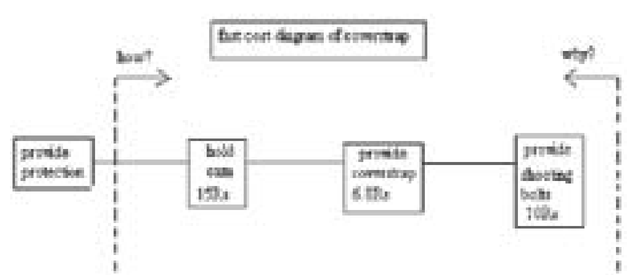

Fig. 7 FAST- COST Diagram of Cover strap

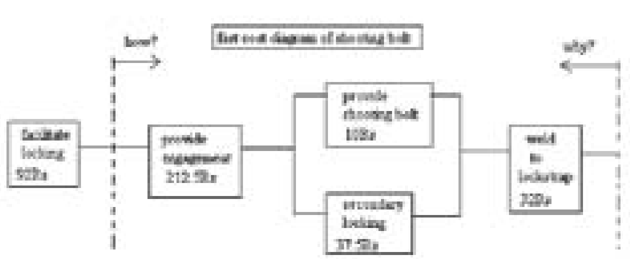

Fig. 8 FAST- COST Diagram of Shooting bolt

E. Creative Phase

In this phase all the possible ideas were listed down .from value improvement prospective. Stress has been laid on the quantity of ideas rather than the quality of the ideas. The ideas are listed in Table IV.

Table IV Possible improvement ideas as Generated During Creative phase

PROJECT	VALUE ENGINEERING ON THE LOCKING MECHANISM OF CONCRETE FILLED DOOR SAFE -675
SR.NO	IDEA
1	Removal of the cover strap
2	Use of stopper from scrap
3	Removal of dead shooting bolt and substitute by 5 mm thick strip from scrap
4	Reduction of thickness of strap
5	Use of plastic cover strap
6	Use of hard plastic cam
7	Use of expand metal over spindle in place of cover strap
8	Increase in thickness and reduce the length of strap 1 and strap 2
9	Removal of lock strap and use of circular pipe of equivalent length
10	Alternate locking mechanism
11	Modification in stopping mechanism

The ideas generated during creative phase would then be evaluated and investigated based on various criterions in the next phases.

F. Evaluation Phase

The ideas listed in the creative phases were evaluated in this phase on various criterions.

Step 1

The ideas were filtered in the long term and short term goals as shown in Table V.

Table 5 Filtering of ideas into long and short term goals

SR.NO	IDEA	SHORT TERM	LONG TERM
1	Removal of the cover strap	√	
2	Use of stopper from scrap	√	
3	Removal of dead shooting bolt and substitute by 5 mm thick strip from scrap	√	
4	Reduction of thickness of strap	√	
5	Use of plastic cover strap	√	
6	Use of hard plastic cam		√
7	Use of expand metal over spindle in place of cover strap	√	
8	Increase in thickness and reduce the length of strap 1 and strap 2		√
9	Removal of lock strap and use of circular pipe of equivalent length	√	
10	Alternate locking mechanism		√
11	Modification in stopping mechanism	√	

Step 2

Based on the brain storming sessions with all the concerned with the product in question, all short term ideas were selected for further weighted evaluation and factor comparison which can lead to value improvement.

Table 6 Designating ideas for weighted evaluation

SR.NO	IDEA	SHORT TERM	LONG TERM
1	Removal of the cover strap	√	
2	Use of stopper from scrap	√	
3	Removal of dead shooting bolt and substitute by 5 mm thick strip from scrap	√	
4	Reduction of thickness of strap	√	
5	Use of plastic cover strap	√	
6	Use of hard plastic cam		√
7	Use of expand metal over spindle in place of cover strap	√	
8	Increase in thickness and reduce the length of strap 1 and strap 2		√
9	Removal of lock strap and use of circular pipe of equivalent length	√	
10	Alternate locking mechanism		√
11	Modification in stopping mechanism	√	

The shortlisted ideas were further refined based on the weightings of different criterion as shown in Table VII.

Table 7 Weighted evaluation chart

CRITERION	WEIGHT	PROPOSALS							
		A	B	C	D	E	F	G	H
TECHNOLOGICAL LEVEL	5	10	8	7	8	10	8	5	7
		50	40	35	40	50	40	25	35
COST OF IMPLEMENTATION	15	10	9	7	9	9	7	6	7
		150	135	105	135	135	105	90	105
POTENTIAL BENEFIT	15	9	10	9	8	10	8	7	9
		135	150	135	120	150	120	105	135
SAFETY	40	7	8	7	6	9	9	8	8
		280	320	280	240	360	360	320	320
ADHERENCE TO QUALITY STD.	25	8	9	8	7	8	8	7	9
		200	225	200	175	200	200	175	225
TOTAL	**100**	**815**	**870**	**755**	**710**	**895**	**825**	**715**	**820**

Table 8 shows the ideas listed in descending order based on the weighted evaluation. The proposals with higher weight age will be investigated in the next phase.

Table 8 Ranking of Ideas as per Weighed Evaluation

IDEA	DESIGNATION	RANK	POINTS
Use of plastic cover strap	E	1	895
Use of stopper from scrap	B	2	870
Use of expand metal over spindle in place of cover strap	F	3	825
Modification in stopping mechanism	H	4	820
Removal of the cover strap	A	5	815
Removal of dead shooting bolt and substitute by 5 mm thick strip from scrap	C	6	755
Removal of lock strap and use of circular pipe of equivalent length	G	7	715
Reduction of thickness of strap	D	8	710

G. Investigation Phase

Here applicability of the proposals emerged from previous phase were investigated.

Proposal 1: Use of plastic cover strap

Use of Coverstrap: the design department has given justification that it is used to withstand any axial stress on the cam in case of any hammering, but as identified during value engineering analysis that before the whole locking mechanism a 15cm of high grade concrete is applied to the inner case. Due to this most of the stress will get transferred on the concrete, and since the adhesion of cement is very high it will not let the spindle move axially. So there are two options

1. Remove Coverstrap

If we remove the cover strap than the reduction in safe value won't be there. So the safe value will remain unchanged whereas there is substantial increase in cost value.

Cost saving: Rs 8/-

Percentage saving in locking mechanism: 8/212.5 =3.71%

Since this locking mechanism is common in all the CFDS models, total cost saved on the annual basis.

Total cost saved: (cost saving in each component)*(total number of CFDS produced)

(8)*(402) =3216 Rs./annum.

2. Use Plastic Coverstrap

If at all the management feels that cover strap is still required than we can use plastic cover strap.

Cost of plastic cover strap: Rs. 2.30

Net saving: 8-2.3 = Rs. 5.70

Percentage saving in locking mechanism:

5.7/212.5 =2.68%

Since this locking mechanism is common in all the CFDS models, total cost saved on the annual basis.

Total cost saved: (cost saving in each component)*(total number of CFDS produced)

= (5.7)*(402) = 2291.40 Rs/annum

Proposal 2: Use of stopper from scrap

Stopper is used to limit the movement of the shooting bolt. Stopper is a vendored item. Here it is suggested the use of 10mm scrap which is sold on the weight basis for stopper.

Present resisting area of stopper = (12)*(12) =144mm^2

If we use two 10 mm strap then resisting area

$$= (10*7) + (10*7) = 140 \text{ mm}^2$$

Since stopper is not subjected to any impact stress or stress of high intensity, it is felt that this proposal can be applicable.

Cost of stopper = Rs. 9/-

Cost of using stopper from scrap:

manufacturing cost + cost of scrap = (Rs. 3/-) (approx)

Net saving in the cost = (9-3) = Rs. 6/-

Percentage saving in locking mechanism: 6/212.5 =2.82%.

Total cost saved: (cost saving in each component)*(total number of CFDS produced)

= (6)*(402) =2412Rs/annum

Proposal 3: Use of expand metal over spindle in place of cover strap:

Cost of cover strap: Rs. 6.8

Cost of expanded metal strap: Rs. 4.5

Cost saving by using expanded metal strap: (cost of cover strap)-(cost of expanded metal + welding cost)

= (Rs. 6.8)-(4.5+5) = Rs. - 2.7

Therefore this proposal is not applicable in practical terms. Hence the proposal will not be promoted to the recommendation phase.

Proposal 4: Removal of dead shooting bolt and substitute by 5 mm thick strip from scrap.

Cost of dead shooting bolt: Rs 10/-

Cost of using 5 mm thick scrap as dead shooting bolt = (cost of scrap+ manufacturing cost) = (4+12) = Rs.16/-

Net saving in cost = (3*cost of each shooting bolt)-(cost of using scrap) = (3*10)-(16) = Rs. 14/-

Percentage saving in locking mechanism:

14/212.5 =6.58%

Total cost saved: (cost saving in each component)*(total number of cfds produced)

= (14)*(402) = 5628 Rs/annum

The above investigated proposals are summed to indicate the net saving in the locking mechanism. The results are tabulated as in Table IX.

Table 9 Net Value Addition through Value Engineering Exercise

PROJECT	VALUE ENGINEERING ON THE LOCKING MECHANISM OF CONCRETE FILLED DOOR SAFE -675	
NET VALUE ADDITION THROUGH VALUE ENGINEERING EXERCISE		
SR NO	PROPOSAL	TOTALSAVING IN RS/ANNUM
1	Use plastic cover strap	3216
	Remove cover strap	2291.40
2	Use of stopper from scrap	2412
3	Removal of dead shooting bolt and substitute by 5 mm thick strip from scrap	5628
TOTAL SAVING IN LOCKING MECHANISM		10,331.40

H. Recommendation Phase

The modified locking mechanism as per the results of investigation phase were worked out and recommended to the management for implementation. The previous and modified designs are shown in Fig. 9a & 9b. Considering the trade secret of the firm, a representative block diagrams are presented here.

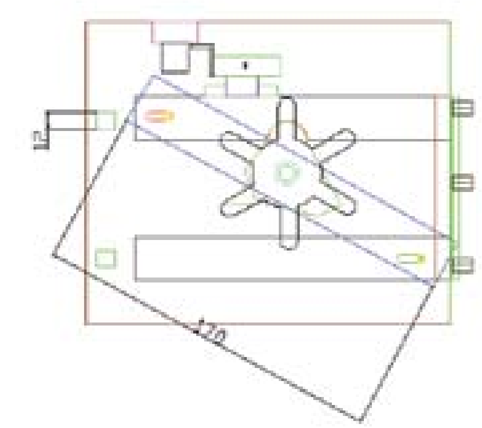

Fig. 9a Present Design of Locking Mechanism

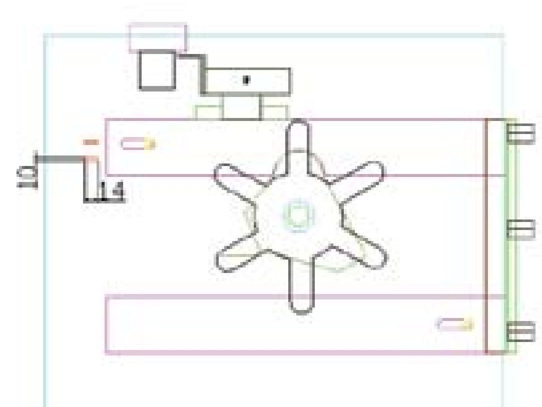

Fig. 9b Proposed Design of Locking Mechanism

III. Conclusion

As evident from the present case study, value engineering can be used to fruitfully design/modify any product on the basis of functional requirement and thereby cost effective solution can be achieved. As observed through above case explanation, the basic objective of modifying the present design to improve the bottom-line with the help of value engineering techniques was successfully achieved. The value engineering efforts resulted in saving of Rs. 10,331.40 / annum to the company. This created a considerable positive impact on the bottom-line of the company with minimum one time modification in the existing design. The case explanation of this paper can serve as a useful roadmap for other industries for application of VE techniques on their products either to improve up on the functions or to reduce cost or both of them.

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