International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 9 Issue 10 ǁ 2021 ǁ PP. 41-46

Value Analysis of Revolving chair Wheel by Value Engineering: Case Study

Prof. R.M Belokar [1] Kamalpreet Singh (20202007)[2] Pulkit Sirohi (20210002)[3]
Rupender Parmar (20209005)[4]
Sitanshu Singh (20209006) [5] Mir Abid Muzaffar (20202014)[6]

1. *Prof. and Head, Workshop and skill development centre, Punjab Engineering College (Deemed to be University), Chandigarh*
2. *M-Tech, Dept. of Transportation Engineering, Punjab Engineering College (Deemed to be University), Chandigarh*
3. *M-Tech, Dept. of Materials and Metallurgical Engineering, Punjab Engineering College (Deemed to be University), Chandigarh*
4. *M-Tech, Dept. of Mechanical Engineering, Punjab Engineering College (Deemed to be University), Chandigarh*
5. *M-Tech, Dept. of Mechanical Engineering, Punjab Engineering College (Deemed to be University), Chandigarh*
6. *M-Tech, Dept. of Transportation Engineering, Punjab Engineering College (Deemed to be University), Chandigarh*

ABSTRACT:
This study aims to analyze the prospect of cost reduction through the value analysis technique. The manufacturing process of the revolving chair wheel (Castor) is analyzed to apply the value analysis technique to reduce cost. Value analysis is the study of the existing approach to reduce the cost incurred on manufacturing a product through process reengineering or design alteration without lowering the effect's performance regarding its essential functions. This study focuses on the design alteration of the caster by changing materials used for manufacturing and dimensions of various parts according. This study presents the functional and costs analysis of casters, and ideas are being proposed to reduce the cost of manufacturing per product.

KEYWORDS: *Value Engineering (VE), Castor, Job Plan*

Date of Submission: 17-09-2021 Date of acceptance: 02-10-2021

I. INTRODUCTION

Value Engineering (VE) is a systematic and creative method for reducing costs, increasing productivity, competitiveness, and improving quality. VE was developed by Lawrence D. Miles at General Electric Corp in the late 1940s. It is widely used in industry and government sector such as defence, transportation, construction and healthcare sector.

VE can be defined as an analysis of the different functions of a program, project, system, product or service aiming to improve its performance, reliability, quality, and safety. In other words, the team firstly identifies all necessary activities for the development of a product or service and then finds the most economical way to accomplish it.

VE is a process to determine the best value or the best relationship between worth and cost while ensuring the item or process performs the required essential function consistently even when it has the lowest life-cycle cost. Value Engineering aims to satisfy the user's need by modifying the procedure or a price reduction. The process of Value Analysis is used to identify all the necessary actions to develop a commodity or a service in the most economical way. Value can be increased by either a modification in the procedure or a cost reduction. VE is a systematic, low-cost approach to assessing the "value" of a project. Typically, VE on projects can be used to achieve cost reductions and save time.

1. Job Plan

a) **Information Phase** - The benefits from the VE workshop will depend, to a great extent, on the Correctness of information gathered. So, efforts can be directed towards those areas containing the greatest return on the investment time and must obtain accurate costs. If the project selected is a manufacturing process

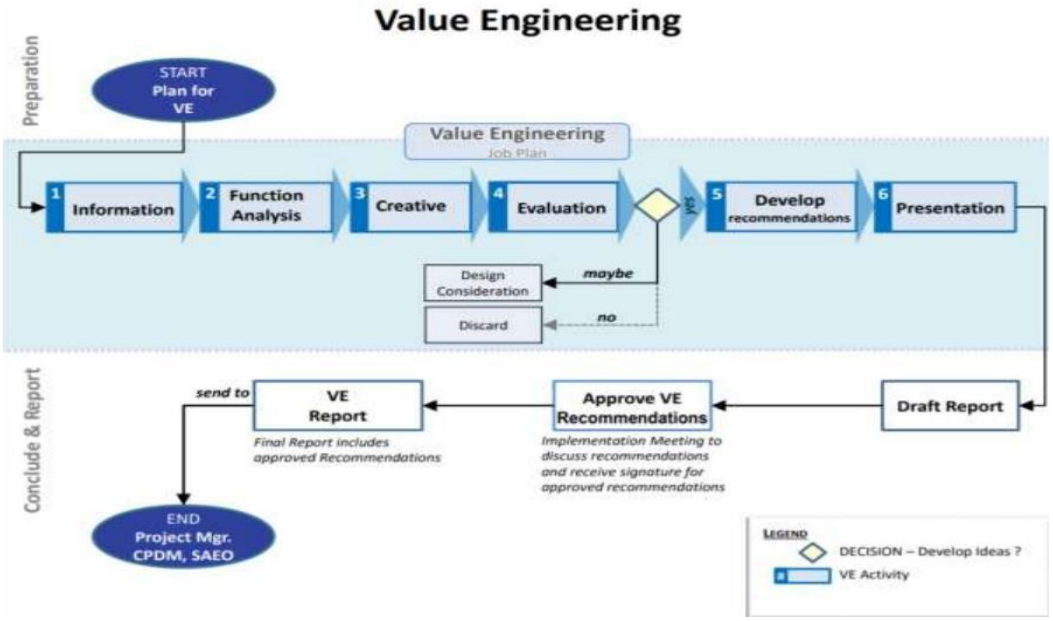
or an organizational / administrative system, a gap sequence flow chart with a time frame is also essential. The available information can be grouped into biological data, methods data, performance data, restriction data, cost data and statistical data.

b) **Functional phase -** Function is what makes an item WORK or SELL. It is defined in two words, an active verb and a measurable noun. Functions are classified into Basic and Secondary Functions. The primary function is a specific work in which a product or service is designed to "Contain Liquid". The Secondary Functions are those which support or arise during the performance of the Basic Functions. They could disappear if a different design approach is adopted to perform the Basic Function. In the example of the bottle, the design is such that it "Facilitate Drinking", its Secondary Function. Had the plan been different, like a loose polythene bag, then this function would have disappeared.

c) **Creative Phase** - During this phase of the job plan, the team attempted to generate alternate methods to answer "what else would do the job-function wise?" Answering the following three words will lead to an alternate idea: Eliminate, Combine, Rearrange. The widely used approach to search for alternatives is BRAINSTORMING.

d) **Evaluation Phase** - In this phase, the evaluation of ideas generated during the creativity phase is done. Out of all the ideas listed during Brainstorming, only those that seem to perform the primary function with at least some secondary functions will be taken up for further evaluation and development.

e) **Recommendation Phase** – This phase includes developing and refining alternatives selected from the Evaluation Phase. During this phase, the VE team should arrange for detailed testing and pay careful attention to developing convincing facts through implementation plans. The presentation of the recommendations by the VE teams is considered part of this phase.



2. Case Study

This paper deals with the Rotating wheelchair. The value engineering is applied to the Rotating wheelchair.

a. Information phase

A **caster** (or **castor**) is an undriven wheel that is designed to be attached to the bottom of a larger object ("vehicle") to enable that object to be moved.

Castor is used in numerous applications, including shopping carts, office chairs, hospital beds and material handling equipment. High capacity heavy-duty casters are used in many industrial applications, such as platform trucks, carts, assemblies, tow lines in plants.
In the given phase, detailed information regarding the costing of the castor is gathered from various castor wheel manufacturers such as Comfort castors and Apex castors. Castor manufacturing consists of 4 steps: manufacturing of wheel, manufacturing of bearings, manufacturing of shaft, and assembling of parts. Metal is the expensive element in manufacturing a castor that shares 50-60% of the total cost of a caster. The primary focus is kept on material and reduction in dimensions for the cost reduction.

b. Functional Phase

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

The castor is mainly divided into the following components: -

1. Central kingpin
2. Top plate
3. Stopper fork
4. Axle shaft
5. Bearing
6. Wheel centre
7. Wheel

Functional analysis of parts and processes

Sr no.	Part name	Quantity	Functional definition
1.	Central kingpin	1	Provide 360degree rotation. (B) Join assembly with the top plate. (S)
2.	Top plate	1	To attach castor to base. (B) Remains fixed (S)
3.	Stopper	1	Restrict the motion of the wheel. (S)
4.	Fork	1	Attached to axel shaft and top plates centre. (B) Provide clearance for wheel rotation provides strength to the assembly. (S)
5.	Axel shaft	1	Provide axis of rotation to the wheel. (B) Provide support. (S)
6.	Bearing	1	Reduce friction (B) Provide space for the shaft in between (S)
7.	Wheel	1	Provide motion. (B)
			Better design provide better strength and cosmetic look (S)

c. Creative Phase

In this phase we list all the possible alternatives regarding the concerned part. The main aim of this phase is to collect as many improvements as possible and to scrutinize the best idea for further analysis. All the opinions are listed down in the form of a creative worksheet, as shown in the table below.

Creativity ideas:
● A swivel wheel can be equipped with a locking system to lock the rotation when you need the object to be static. ● Remove stopper. ● Have a hollow shaft. ● Use roller bearing instead. It will be capable of handling more load compared to others. ● Fork thickness can be reduced. ● A hollow or honeycomb structured wheel may be used instead. ● The metal used in the fork and top plate may be replaced with hard plastic. ● Cylindrical wheels may be used, which are hollow inside. ● A ball-type caster may be used.
● Apply a coating of fluorescent paint on the outer casing (beneficial during the night).

d. Evaluation Phase

A swivel caster incorporates a wheel mounted to a fork. Still, an additional swivel joint above the fork allows the fork to freely rotate about 360°, thus enabling the wheel to roll in any direction. This makes it possible to quickly move the vehicle in any direction without changing its orientation. Swivel casters are sometimes attached to handles so that an operator can manually set their orientation.

The cost of an individual part of a caster is given in the table -

Sr. No.	Part	quantity	Cost in Rs
1	Centre kingpin	1	15
2	Top plate	1	15
3	Stopper	1	10
4	Axel shaft	1	15
5	Bearings set	1	20
6	Fork	1	30
7	Wheel	1	40

Total- Rs 145/-

Now when all the parts and their functions are considered in terms of their importance in maintaining a particular level of quality and performance, we came to some solutions that are already discussed in the creative phase.

So, solutions to be considered are: -

1. Removal of stopper
2. Use of cylindrical hollow wheel
3. Roller bearing to be used
4. Use a hard plastic fork

The new cost of parts after the above-suggested changes are: -

Sr. No.	Part	quantity	Cost in Rs
1	Centre kingpin	1	15
2	Top plate	1	15
3	Axel shaft	1	15
4	Bearings set	1	25
5	Fork	1	20
6	wheel	1	30

Total- Rs 120
Amount of Rs 25/- are reduced if the alternative solutions are implemented in the caster set.

e. Recommendation Phase

After analyzing the castors at different places, we can conclude some points which are mention below:

- A ball-type caster would be the best. In such cases, the ball allows unrestricted movement in every direction, but load gets concentrated at a single point in the ball it may damage the place where the chair is used.
- Cylindrical wheels are the best-suited options as the load spreads in the whole base of the cylinder, and it's not prone to damage the surface where the chair is used.
- A suitable castor should handle a good deal of weight; hence, double wheel casters are ideal because dual wheel casters can spread and distribute the load between the two wheels. It provides more inherent mobility.
- Exclusion of the stopper from the assembly is also a good solution when only a caster is used in an office chair because the weight of a person will also restrict the chair's motion until an external force is applied.

- The use of roller bearing will undoubtedly increase some cost, but they will allow the shaft an excellent friction-free rotation and more area of the slot where the shaft is sitting. Use of them will also enable the distribution of perpendicular load in a goof manner as compared to ball bearings.
- The use of a hard elastic fork will make it less robust than a metal one, but when used with a cylindrical wheel and roller bearings, it will not compromise the overall strength of the caster

.

- The inclusion of corrosion and abrasion testing factors in the testing protocol led to caster failures commonly seen in the field. Rotating elements like stem bearings lost their performance. There is multiple movable, folding and swinging parts on the wheelchair like brakes, footrests and armrests, which can be affected by corrosion exposure. Forks under strain fractured due to corrosion, and other wheelchair parts such as cross braces and back to seat connecting plates that are continuously under strain may suffer from decay. Tires have been a constant source of concern in LRS as they degrade faster on rough surfaces. Wheelchair experts have noted wheelchair failures caused due to environmental factors in the product testing matrix. Based on the significant effect of corrosion and abrasion on caster durability found in this study, testing wheelchairs and individual parts with these factors should be considered.

II. CONCLUSION:

In this paper, a short study of the rotating chair wheel is performed through various phases of import engineering. Moreover, a comparative analysis between some types of castors is also performed within the creative phase and the evaluation phase. Under the fierce competition in the modern technology industry, cost reduction is often the necessity of managers. Nevertheless, in consideration of device operation maintenance and system stability, the optimal device maintenance strategy could minimize the upkeep cost and maximize the system stability.

In the end, Value Engineering isn't only helpful but also necessary because:

- The project's functionality is additionally enhanced while also generating significant savings, both within the short and future.
- Cost estimates and scope statements are carefully reviewed to make sure that nothing has been overlooked or underestimated.

REFERENCES:

[1]. Caple, D. (2008), Emerging challenges to the ergonomics domain. Ergonomics, 51, 49-54, DOI: 10.1080/00140130701800985
[2]. Koskinen, I,(2006). Two solitudes: Designing as an approach to media studies. Nordicon Review 27(2), 35-47
[3]. Hughes - Stanton, C (1968). What comes after carna by the street? Design,230, February 1968, 42-43
[4]. Strati, A and demontoux, P.G.(2002), Introduction: organizing aesthetics. Human Relations, 55, 755-766, DOI: 10,1177/0018426702557001
[5]. Thrift, N,(2005) knowing capitalism. London, England Sage.
[6]. Olivares. J.(2011). A taxonomy of office chairs London, England, Phaiden
[7]. Noman D,(2004) Emotional design: why we love everyday things, New York, NY: Basic books.

Contributions-

Contributions of individual group members are

Name	SID	Branch	Contributions
Kamalpreet Singh	20202007	Transportation	Information, recommendation and function phase
Pulkit Sirohi	20210002	Metallurgy	Function, recommendation and evaluation phase
Rupender Parmar	20209005	Mechanical	Creative, recommendation and evaluation phase
Sitanshu Singh	20209006	Mechanical	Creative, function and function phase
Mir Abid Muzaffar	20202014	Transportation	Recommendation and Information phase