Value Analysis of Rack & Pinion

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ABSTRACT   *In today's manufacturing era we are surrounded with new quality initiatives. The main aim of such systems is to provide improvement in the quality in the least appropriate costs to satisfy the customer needs. This states the need of VE/VA in the organization which are striving for the improvement in the quality.*
Initially in this project all the information related to the product were collected and the functions of various parts were defined in Noun and Verb forms according to the rules of value analysis job plan. Later all the primary functions were compared for their relative importance and their percentage weight factor were found out. After then function cost matrix was developed which shows percentage cost associated with each function. Then VIP index was found out which was used to identify poor value functions which were further carried to next stage of developing creative ideas. All the creative ideas were evaluated systematically. At the end it was seen that a considerable amount of cost can be saved.

2 Introduction

Value Analysis (and Value Engineering) is a systematic, formal and organized process of analysis and evaluation. Value Analysis (VA) is considered to be a process, as opposed to a simple technique, because it is both an organized approach to improving the profitability of product applications and it utilizes many different techniques in order to achieve this objective. The techniques that support VA activities include 'common' techniques used for all value analysis exercises and some that are appropriate under certain conditions (appropriate for the product under consideration). The VA approach is almost universal and can be used to analyze existing products or services offered by manufacturing companies and service providers alike.[1]

3 Aims and Objectives

The aim of value analysis is to identify poor value high cost function of the components. Also to identify and eliminate the unnecessary cost so that overall cost of rack & pinion can be reduced.

4 Methodology
3 Value analysis job plan

The Value Analysis technique is systematic and scientific approach of cost reduction. It is the powerful tool for cost reduction. It consists of seven phase and these phase have various technique. (Mudge).[2]

3.1 General phase: It is considered as foundation of value engineering job plan. It makes use of techniques such as use of good Human Relations, inspire team work, work on specifics, overcome roadblocks and to apply good business judgment.

3.2 Information phase: In this phase we collect all the information required for value analysis job plan from a company. This includes the cost and material details of each component of Rack & Pinion assembly, their vendor details etc. Various components are:

1. Gear rack
2. Pinion
3. Bearing
4. Retaining ring
5. Pinion stem washer
6. Handle grip
7. Rear clutch cone sleeve
8. Rack and pinion housing
9. Grease fitting
10. Pinion spring

3.3 Function phase

The next stage of the VA exercise is to commence the analysis of the product by identifying systematically the most important functions of a product or service. This is known as functional analysis. Function phase is considered as heart of Value Analysis Job Plan. Success of entire plan depends on this phase.[3,4]

3.3.1 Evaluate functional relationship

From FDW (Function Definition Worksheet), there are total 13 primary functions and each function is denoted by an alphabet, which are as follows:

Function Notation

FUNCTION	NAME
A	Transfer Motion
B	Change Motion
C	Provide Seal
D	Provide Support
E	Provide Force
F	Prevent Damage
G	Facilitate Locking
H	Transmit Torque
I	Permit Retention
J	Fix Location
K	Absorb Vibration
L	Facilitate Housing
M	Join Parts

3.3.2 Function rating grid

In function rating grid, one function is compared with other function and according to the importance they are allotted 1 or 0. By this procedure we can clearly see functional importance. The decreasing order of functional importance of all the functions is given below.

A > B > C > D > M > L > F > E > H > G > I > J>K

3.3.3. Numerical evaluation matrix

In Pair wise comparison, two functions are compared at a time and most important is written in a box along with the weight of importance given to them as accordingly:

1-Minor difference of importance

2-Medium difference of importance

3-Major difference of importance

Numerical Evaluation Matrix

A	B	C	D	E	F	G	H	I	J	K	L	M
A	A2	A2	A3	A3	A3	A3	A3	A2	A3	A3	A3	A2
	B	B1	B2	B3	B2	B3	B3	B3	B2	K3	B2	B2
		C	C2	C2	C3	C3	C2	C3	C3	C3	C2	C1
			D	D3	D3	D3	D3	D2	D1	D3	D2	D1
				E	F1	E2	E1	E2	E2	E1	L2	M2
					F	F2	F2	F2	F2	F3	L1	M2
						G	H1	G1	G2	G2	L2	M3
							H	H2	H1	H2	L1	M2
								I	I2	I2	L1	M2
									J	J2	L2	M2
										K	L3	M2

3.3.4. Function weight matrix

Name	Function	Weight	Adj. weight	% weight
Transfer motion	A	32	33	18.13
Change motion	B	26	27	14.84
Provide seal	C	24	25	13.74
Provide support	D	21	22	12.08
Join parts	M	15	16	8.79
Facilitate housing	L	14	15	8.24
Prevent damage	F	12	13	7.14
Provide force	E	8	9	4.95
Transmit torque	H	6	7	3.85
Facilitate locking	G	5	6	3.29
Permit retention	I	4	5	2.75
Fix location	J	2	3	1.65
Absorb vibration	K	0	1	0.55

Once the weights of each function is found out the following check of consistency are applied-

1. No two functions should have same weight: It can be seen from above table that no two functions have same weight.
2. One function must have zero weight: Function M (Absorb vibration) has zero weight
3. Matching customer requirement- The Primary customer required function is "Transfer motion" and secondary is "Change motion" and lastly customer required function is "join parts".

3.3.5. Function cost matrix
In this, component cost is distributed among functions according to its importance. For example "a product" cost Rs. 85, which is distributed among its function like Accommodate component is of high importance given Rs. 50 and remaining three func-

tions Provide Support, Provide Protection, Provide Strength cost around Rs.35, which is secondary function of that product. Thus, percentage cost of each functions were taken out.

3.3.6. Selection of function for creativity phase
In the table-4.7 for each function % cost and % weight are written and the Value Improvement Potential (VIP) index is found out, which is the ratio of % cost to % weight. And those functions whose VIP is greater than 1 are considered as Potential area for value improvement.[5,6]

Functions	% Cost	% Weight	VIP index	Remarks
A	25.053	18.13	1.381	PV & HC
D	22.955	12.08	1.908	PV & HC
L	11.311	8.24	1.37	PV & HC
K	2.46	0.55	4.474	PV

3.4. Creativity phase or Speculation 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 which allows all the members of the team to participate and for some strange yet ultimately commercial ideas to be promoted amongst the team. 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.[7,8]

Techniques of creativity phase
1. Establish positive thinking
2. Develop creative ideas

3.5. Evaluation & Investigation phase
The objective of the Evaluation Phase of the Value Engineering Job Plan is to analyze the results of the Speculation Phase, review of the various alternatives, and select the best ideas for further expansion and main objective of investigation phase is to develop workable and saleable solutions. During speculation, judgmental thinking was prohibited so as not to inhibit the creative process. The ideas are now critically evaluated. Creative Judgment is referred to as praising the idea with positive attitude with the aim of making idea work.

3.6. Recommendation phase
This corresponds to the finishing phase of the Value Engineering Job Plan. After completion of the Investigation phase, finally developed idea is now clear in the mind. In this phase, the team presents its ideas to the management for approval. So the fruit of all the phases lies in successful accomplishment of this phase. The proposal must be carefully planned, correctly stated and firmly carried through to successful implementation. Presentations are factual, concise, and acknowledge contributors. Various roadblocks to implementation should be anticipated. Generally the rate at which proposals are generated is higher than the rate at which they are implemented. Team must divest its energy to convert proposals to installation so that there is a balance between proposed saving and installed savings. Delay in implementation due to lack of resources must be reduced. An approved implementation plan, with realistic scheduling and well defined responsibilities for action, is executed. Benefits are maximized and delays are minimized by anticipating misconceptions and resistance. Aggressive follow-up and timely reporting are conducted. This phase consists of the following three techniques.

➢ Present Facts
➢ Present Costs
➢ Motivate Positive Action

3.6.1 Recommendations:

After having all the phases of value analysis job plan, the following suggestions are made to company:

1. Replace the existing Rack & Pinion housing made up of STKM 12 A with the plastic rack & pinion housing.
2. Replace the spring used in Rack & Pinion system with the neoprene rubber with three layers.

4. Results:

Comparison of present and suggested components

S. NO:	Present component	Suggested component	Estimated saving in costs(Rs.)
1	Rack & Pinion housing(STKM 12 A)	Plastic Rack & Pinion housing	9.23
2	Spring	Neoprene rubber with three layers	0.90
	Total		10.13

Total saving: 10.13 per components

5. Conclusion:

Value analysis of rack and pinion was carried out with systematic approach. After carrying all the steps in value analysis job plan, certain recommendations were made which if implemented can result in considerable cost saving in the company annually. There is no any implementation cost as no design changes were made and no new machines were procured to implement the changes.

REFERENCE

1. Rich N. And Howleg M., (2000) Value analysis and Value engineeringINNOREGIO: dissemination of innovation and knowledge management technique. | 2.Mc Cumber, W.H., (1997) Value System Analysis: Application to team Motivation. | 3. Gamil B. Girgis., (1989) Computer Aided Life-Cycle Engineering: International SAVE (society of American value engineers) conference 1990. | 4.James J. O. Brain (Value analysis in design and construction. McGraw Hills book co. | | 5. Kaufman J., (1989) Value Management — Productivity at Its Best: International SAVE (Society of American Value Engineers) conference 1990. | | 6. Robert E. Gibbs., (1989)Value Engineering Expert System: International SAVE (Society of American Value Engineers) conference 1990. | | 7. Tie-shan Z. And Wei H., (2009) The application of VE in Business Decision making evaluation of technology selection.