Value Analysis for a Mumbai Local Train: A Case Study

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Abstract- In today's scenario, every Industry is trying to reduce the selling prices and weight of their products. Every department of the organization is looking forward to cut the costs at every stage of the product cycle, right from the purchase of the raw material till the product is dispatched in the market. Manufacturing of some metals produce certain toxic substances and gases like Fugitive Dust, Metal Oxides, Fluoride, Aldehydes, and Chlorides. So, use of metals should be reduced by obtaining the same or more functionality by using some other materials or techniques. In this case study, Value Methodology is applied to Mumbai local trains to reduce their cost and weight considerably. Also safety of the passengers is increased. As local trains passenger's density in Mumbai is the highest in the world, of the order 4500 passengers /9 car rake, in the peak time. Every passenger does not get handles to hold. Many passengers hold the handles and don't move in, resulting in fall of passengers who lean outside of the running train. Hence, an idea is suggested, which says that handles should be removed from the train compartments and the rods on which handles are mounted should be lowered so that passengers can hold the rod. By adapting the handle less arrangement weight got decreased by 2,304 kg and cost decreased by Rs 3,02,400 (approx.) of a 12 car rake.

Index Terms- Value Engg, Cost reduction, Weight reduction, Passenger Safety, Material Saving.

I. INTRODUCTION

The Mumbai Suburban Railway is a suburban rail system serving the Mumbai Metropolitan Region. It is operated by Indian Railways' two Zonal Western Railways (WR) and Central Railways (CR). The system carries more than 7.24 million commuters daily. It has the highest passenger density of any urban railway system in the world. The trains plying on its routes are commonly referred to as local trains or simply as locals by Mumbaikars. Spread over 465 km, the suburban railway operates on 1500 V DC / 25000 V AC power supply from overhead catenary lines. The suburban services are run by electric multiple units (EMUs). 191 rakes (train sets) of 9-car, 12-car & 15-car composition are utilized to run 2342 train services, carrying 6.94 million passengers per day. If annual ridership (2.64 billion) is taken into account, the Suburban rail would be the second busiest rapid transit system in the world. Due to the geographical spread of the population and location of business areas, the rail network is the principal mode of mass transport in Mumbai. As Mumbai's population swelled, frequent overcrowding has become a serious issue, and numerous safety concerns have been raised over the years. A metro system and a monorail system are under construction in Mumbai to ease the travelling conditions on the suburban network. Due to its extensive reach across the Mumbai Metropolitan Region, and its intensive use by the local urban population, the Mumbai Suburban Railway suffers from some of the most severe overcrowding in the world. Over 4,500 passengers are packed into a 9-car rake during peak hours, as against the rated carrying capacity of 1,700 [1]. This has resulted in what is known as *Super-Dense Crush Load* of 14 to 16 standing passengers per square meter of floor space. Trains on the suburban line are on average more than 4 minutes apart, contributing to the problem of overcrowding. The impending introduction of new higher speed rakes may help address the issue.

On an average, 3,700 people die annually on the Mumbai Suburban Rail network. A query filed by Chetan Kothari under the Right to Information (RTI) has revealed that over the past 10 years (2002–2012), more than 36,152 lives have been lost on tracks and 36,688 people have been injured [2].This is believed to be the highest number of fatalities per year on any urban or suburban railway system. Most of the deaths are of passengers crossing the tracks on foot, instead of using the footbridges provided for going from one platform to another, and are hit by passing trains, falling from the running trains. Some passengers die when they sit on train roofs to avoid the crowds and are electrocuted by the overhead electric wires, or hang from doors and window bars. These figures are from past, however the rate has declined recently. To reduce the risk of such fatalities, automatic doors will be installed on all rakes by 2016 along with longer platforms and more frequent trains.

According to The Times of UK, Mumbai's local railway network was one of the deadliest in the world: a record 17 people died every weekday on the city's suburban railway network in 2008 [3].

In order to increase safety of the local train commuters and reduce cost of the trains, present case study on railway handles is undertaken. It has problems & potentials, which can be well understood by the survey conducted on it. This phase is known as an Orientation phase in the language of Value engg. All other phases or steps involved in the analysis are explained one after other in this text.

II. PHASES

A. ORIENTATION PHASE/ LITERATURE SURVEY:

In this phase, experiences of different local train commuters are noted. 1. "My first finger skin got cut in the handle and the rod junction, when I tried to hold the rod." *Mr. Rakesh Tripathi*.

2. "I don't get chance to get in 9:15 Kalyan- CST local at Mumbra because people hold the handles & don't move in." *Mr. Usama Ansari. 3*. "People irritate me by making noise with the handles." *Mr.Shramik Bawkar*. "Sometimes handles are missing or occupied, my height is 5'4" & I can't catch the top bamboo, hence I end up with catching my colleague's shoulder" *Mr. Ansari Furqan. 5.* "When compartment is empty handles only talk" *Mrs.Vani.B.* These are the problems encountered by the five individuals, which are documented. The present case study is the solution to the problems mentioned above.

Weight of the handle assembly is around 0.8 kg which can be reduced in order to decrease its weight & cost without, compromising safety of the passengers.

In order to start the value analysis, Handle assembly is studied for its need and different functions of each components of the assembly. Functional matrix of the same is prepared which is shown in Table I and for different parts is shown in the Table II. In the last column of the two Tables I & II, function type is shown i.e. Basic function or Secondary function. 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.

VERB	NOUN	TYPE (B/S)
Support	Hand	B
Allow	Hand	S
Produce	Less noise	S
Prevent	Movement (X & Y)	S
Have	Strength	S

Table I: Functional Matrix for Handle Assembly

Component	Verb	Noun	Type* (B/S)
Clip	Fasten	Handle & Rod	B
	Allow	Bolt	S
	Embrace	290 deg circumference	S
Bush	Avoid	Contact	B
	Distribute	Pressure on the rod	S
	Prevent	Rust	S
Nut & Bolt	Fasten	Clip & Handle	B
	Have	Shear strength	S
	Withstand	Repeated loading	S
Restrictor plate	Prevent	Motion (X-direction)	B
	Allow	Screws	S
	Embrace	1/4th circumference	S
Restrictor plate screws	Fasten	Restrictor plate & Rod	B
	Penetrate	Rod	S
Handle	Support	Hand	B
	Fit	Clip	S
	Allow	Screw	S
Rod	Support	Handle	B
	Fit	T – hub	S

*B- Basic Function S- Secondary Function

Table II: Functional Matrix for Various Parts

Secondary functions can be modified or eliminated to reduce product cost.

The main Advantages of handle less arrangement are load will be uniformly distributed over the rod surface and Weight of the each compartment and train will get reduced considerably and considerable amount of material will get saved.

In order to perform the value analysis a team is formed comprising five members, specialists from different domains. After defining the problem and identifying the scope in the orientation phase, now, the next phase is information phase.

B. INFORMATION PHASE

In this phase, information regarding the value engineering project is gathered by the value engineering team. I.e. the handle assembly's validity is 240 per car & 2880 for a 12 car train, they are attached on the rod at an interval of one foot and the cost of the handle is Rs105 (Approx.)

C. CREATIVE PHASE

Theme of this phase is, "Which are the other alternatives for the same functions" of the handle assembly. Many ideas are generated and discussed in the brain storming session.

D.BRAIN STORMING SESSION

In this session every member of the committee is encouraged to generate ideas and weirdest ideas are also encouraged. Many ideas are generated and top five ideas are listed below 1.Use leather handles which are presently used in BEST (Mumbai's local road transport) buses. 2. Use plastic handles (Bakelite) which can be used for publicity purpose also 3.Use one screw for one restrictor plate. 4. Make the handle straight (eliminate curvature) 5. Eliminate handle assembly and lower the rod, on which handles are mounted.

After the Brain storming technique, the Function Cost worth analysis matrix is prepared, which is shown below in Table III.

Verb	Noun	Existing Cost Rs	Tentative Alternative	Estimated Cost	Value Gap	Rank
Support	Hand	42	Eliminate	0.00	42	I
Allow	Bolt	3	Eliminate	0.00	3	V
Position	Clamp	25	Eliminate	0.00	25	II
Reduce	Noise	2	Eliminate	0.00	2	VII
Restrict	Motion	12	Eliminate	0.00	12	III
Position	Restrictor Plate	4	Eliminate	0.00	4	IV
Position	Clip & Handle	2.5	Eliminate	0.00	2.5	VI

Table III : Cost Worth Analysis Matrix

After preparing the Function Cost worth analysis matrix the feasibility matrix is prepared which is shown in Table IV below.

Ideas	State of the art	P.O.I	C.T.D	T.T.I	P.C.B	Total
	10.Off the shelf 2.New tech	10.High chance 1.No chance	10.Low cost 1.High cost	10.No time 1.Max time	10.High 1.low	
1	7	7	6	8	6	34
2	9	7	5	8	7	36
3	5	9	10	9	1	34
4	5	9	9	8	1	33
5	10	10	10	10	10	50

Table IV : Feasibility Matrix

P.O.I- Probability of Implementation
C.T.D- Cost required To Develop it.
T.T.I- Total Time Required For Implementation
P.C.B- Probability of Cost Benefit

From the feasibility matrix the following two ideas are finalized -Idea 2 and Idea 5.

E. EVALUATION PHASE

In this phase four different parameters are considered for evaluating the two proposals (Idea 2 & Idea 5) with the existing one. The parameters are a) Rigidity b) Light weight c) accessibility d) Appearance.

F. RECOMMENDATION PHASE

In this phase the best identified idea is recommended by the Value Engg team. Based on the Evaluation matrix team suggested that the IDEA 5 is better than the existing and the Idea 2. The cost benefit analysis for IDEA 5 with the existing one is tabulated in the Table V below.

Parameter Wightages	**Rigidity**	**Light Weight**	**Accessibility**	**Appearance**	**Total**
Existing	3	1	4	4	12
Idea 2	3	4	4	4	15
Idea 5	5	5	5	5	20

Five point scale- 5. Excellent 4.Very Good 3. Good 2. Fair 1. Poor

Table V**:** Evaluation Matrix

Sr. No	**Parameters**	**Existing**	**Idea 5**
1	Price	105	0.00
2	Components (no's)	9	0.00
3	Reduction in weight	--	0.8 kg

Table VI: Cost Benefit Analysis

III. CONCLUSION

With the handle less arrangement in a local train its weight will get reduced by 2,304 kg per rake and 44,0064 kg /191 rakes & this much of material got saved, that means no need to manufacture this much material. Hence, less pollution. Costs of one handle is Rs. 105 (approx.) and for one rake Rs. 3, 02400/ 12 cars and Rs. 5, 77, 58,400/ 191 rakes. With this amount two 12 car trains can be bought. As handles are eliminated passengers wouldn't block the passages and passengers falling ratio from the trains will get reduced. There is one limitation of this arrangement that rods are generally made of stainless steel and are smooth. When passenger holds rods, hands may slip. Therefore, checkered plate arrangement can be provided on the rod which will give grip to passengers.

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