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Application of Value Management Techniques in a Flyover Project: A Case Study

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ABSTRACT: In the construction industry, value for money involves completing a project on time; control cost and provides a level of quality that meets the need of the end-user. Value Management (VM) is a proven technique to enhance the value and optimize the cost in the project. VM Job plan is an organized plan which was done by 6 phases of value management. In this study, the effectiveness of applying value management techniques in a flyover project was analyzed. The various alternative materials were taken into account for the job plan analysis to provide suitable alternative using various techniques in VM. After providing the alternative material for the project, the cost was optimized and the value was enhanced. Hence, through the Value Management technique, the unnecessary cost has been optimized and value of the building has been increased

Keywords:-Value management, VM job plan, cost, value.

I.INTRODUCTION

Value management is a structured, formulated team approach to identifying the functions of a project, product, or service with recognized techniques and providing the necessary functions to meet the required performance at the lowest overall cost. VM has been recognized as one of the most efficient methodologies for achieving ‘‘best value-for-money’’ for clients. Value management comprises of three stages:

- Value Planning
- Value Engineering
- Value Analysis

Value planning expands from Inception to scheme design completion. Value engineering expands from detailed design to construction completion. Value analysis is about the activity of post-occupancy evaluation. There are six phases in the value management job plan are as follows:

- Information phase
- Functional phase
- Creativity phase
- Evaluation phase
- Recommendation phase

AIM OF THE WORK

The aim of the research is to evaluate the effectiveness of applying the value management process and technique in an ongoing project - Case study of flyover project. Whether the process of the Value management being applied in construction projects in the construction industry without compromising the quality and provide the benefits claimed, and whether potential improvements can be achieved.

OBJECTIVE OF THE WORK

The objectives of the work are as follows

1. To study the non-value added attribute in the project by analyzing currently used construction material in the flyover project.
2. To study the effectiveness of applying Value management technique in the project using FAST diagram and Evaluation matrix method.
3. To optimize the cost and increase the value of the project.
4. To analyze using VM job plan and Life cycle cost.

SCOPE OF THE WORK

To address the objectives stated above, the following data collection elements are employed:

1. To remove unnecessary cost and enhance quality, safety and performance over the life span of projects by optimizing the cost of the project

II.METHODOLOGY

The methodology for the project was constructed in the form of flow diagram, consisting of all the steps to be performed in consecutive order. The process involves in brief study on VM and its impact on construction project and then the

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study area was defined and identified the factors which are causing poor functional value of materials. After the identification of the factors, the data related to factors were collected. With the help of collected data, analysis using Life cycle cost and Value Management job plan has been obtained. Based on the obtain result, the suitable suggestion has been given to enhance the quality and performance of the building.

The flow process of methodology is shown in figure 1.

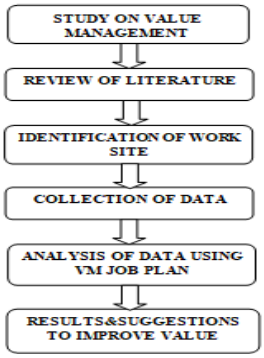

Fig.1:-Methodology for the Project

STUDY AREA

The area of the study was performed in a flyover which was located in Madurai-Cochin road of NH 49 extension. This road connects the major commercial towns like Usilampatti, Aandipatti, Bodinayakanur, Theni and also it connects the major tourists place like Vaigai dam, Munar etc. Furthermore, the information has been collected from the work site for the further analysis is shown in Table 1.

Table 1.Basic details about the worksite

Preparation of design	2018
Start of construction	2019
Completion of construction	1 year
Delay in time of project	11 months
Status of the project	On-going

The necessity of the flyover project in that location is as follows:

- This location is pointed as an accident vulnerable due to the unconditional junction of Thirunagar and Palkalai nagar road with NH road.
- Sabarimala devotees will enormously increase the traffic during the time period of November-June.
- The special economic zones IT Park are located in this stretch which adds more important to that road.

III.ANALYSIS OF THE DATA

The analysis of data has been done by using the value management job plan and its various techniques in each phase**.**

1. INFORMATION PHASE

This phase is the initial phase of VM job plan. In this phase, the basic information were gathered which help to perform the other phases of the job plan. The basic details of the flyover are as follows:

The study area is a “Flyover project” located at Madurai-cochin road, NH 49 extension.

Total cost of the project: 52 crores

Project status: On-going project

Delay of project: 11 months

2. FUNCTIONAL PHASE

This phase is to better understand the project through the perspective function of project. It has been conducted to verify the lower functional value of the material used in the construction process of the flyover. The functional phase is to be performed by considering the conventional materials from the project. In this phase, Verb-Noun description was performed to determine the project functions. FAST diagram also performed to identify the primary objective, design criteria, all time function and need of the project. Cost-worth analysis was calculated using Value gap ratio; the materials which have the values of greater than 1 are taken into account as a poor functional material. Those materials are taken for the further analysis of the value management process.

A.FAST DIAGRAM FOR FLYOVER

FAST-Functional Analysis System Technique is a diagramming tool showing the logical relationships between the functions of a project, product, process or service based on the questions how? and why? It is used to certify if, and illustrate how, a proposed solution achieves the needs of the project, and to identify unnecessary, duplicated or missing functions. Fast diagram for the flyover project was shown in Annexure I-Figure 2.

B.COST-WORTH ANALYSIS

Cost -to-worth is the unique method which helps to pinpoint the unnecessary cost areas in the project. It is the relationship between cost and worth.

$$\text{Cost-to-worth} = \frac{\text{Cost}}{\text{Worth}}$$

The criteria for the cost-worth analysis is that, If C/W value is larger than1 then that material has a potential to save cost.

VALUE GAP

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The ratio between existing cost of the material and worth of the material is defined as the value index.

$$\text{Value index} = \frac{\text{Existing cost}}{\text{Worth of the material}}$$

Annexure I-Table 2 shows the material value gap and its rank. For each materials the alphabetical keyword were allotted to perform the further analysis of value management process in a proper manner.

3. CREATIVITY PHASE

This phase is to generate many ideas to provide the alternative material for the existing material to perform a function specified. From the previous phase analysis, using the value gap ranking process, the materials such as Strip seal expansion joint, Gravel, Granular sub base have values greater than 1. So, alternative for these materials are need to be provided by analyzing the various literatures regarding materials and by brainstorming process. The sets of alternatives are provided in Annexure I-Table 3.

4. EVALUATION PHASE

In this phase, the alternative materials chosen from the creative phase was analyzed. Life cycle costing is to calculate the value of the building. The LCC analyses the total cost of the project through its life span and also amount of cost saved due to alternate material is calculated. Also, Evaluation matrix and Analytical hierarchy process was also used to choose the best alternative material using matrix calculation and super decision software respectively.

A.ANALYSIS OF LIFE CYCLE COSTING

Life cycle costing is a method assisting in estimating of the total cost related to constructing, operating and maintaining a construction project over a period of time. Life cycle costing is particularly useful for the estimating total costs at the early stage of a project.

$$LCC = Cc + Co + Cm + Cr$$

Where,

Cc - Construction cost
Co - Operation cost
Cm - Maintenance cost
Cr - Replacement cost

In this formula, for this project operation cost is 4% of construction cost, maintenance cost is 25% of construction cost and zero replacement cost because it's an ongoing project.

Analysis of LCC based on estimated cost of the project.

$$LCC = Cc + Co + Cm + Cr$$
$$= Rs.671316000$$

Analysis of LCC after providing alternative material

$$LCC = Cc + Co + Cm + Cr$$
$$= Rs.\ 192718418.3$$

B.PRESENT VALUE FOR THE FLYOVER

The Present value is a commercial formula used generally to evaluate the current day value of the property which will be earned behind time.

$$\text{Present Value} = \frac{Ct}{(1+r)^t}$$

Where,

C_t= cost per in the year
r = rate of discount

The analysis of present value of the flyover has been calculated for up to 50 years, by assuming the entire life span of the flyover as 50 years. The value of the flyover before and after the application of value management concept as tabulated in Annexure I-Table 4.The present value of the flyover shows the gradual decrease in every year.

C.EVALUATION MATRIX

The evaluation matrix may be a summary of the ratings of many individuals and it allows promising ones. The opinions were measured on the basis of 1-Excellent; 2-Very good; 3-Good; 4-Poor. The resultant evaluation matrix shows in Annexure I-Table 7.

D.WEIGHTED CRITERIA MATRIX

This matrix is to determine weightage for each parameter that can be used to calculate the total value of alternative and existing material in evaluation matrix. Table 5 shows the key letter for each parameter. Here the opinions are measured on the basis of 3- Major difference in importance; 2-Medium difference in importance; 1- Minor difference in importance; 0- Equal difference in importance. The weighted criteria matrix is shown in Annexure I-Table 6.

E.AHP ANALYSIS USING SUPER DECISION SOFTWARE

Analytical hierarchy process (AHP) is a popular multi objective tool of decision analysis which is a powerful yet simple method for decision making. It is a fundamental concept in the efficient use and implementation of quantitative decision models, whose purpose is to evaluate the stability of an optimal solution under changes in parameters. Analytical hierarchy process (AHP) has been analyzed using software named Super Decision software of version 3.2.

From the analysis of analytical hierarchy process with the help of super decision software and evaluation matrix, the suitable alternative

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material have been analyzed for the material which has a highest potential of saving cost from the total cost of project. The suitable alternatives analyzed are shown in Annexure I-Table 8.

5. DEVELOPMENT PHASE

In this phase, the shortlisted ideas developed into alternative which increase the value of the project. The results can be represented in the form of drawings, graphs with supported calculation and information about the materials. From the evaluation phase, it is identified that Alternative1 is better than existing material as shown in Table 8.So, the alternative 1 material are recommended to implement in the project which helps to optimize cost as well as helps to improve the functions of the material. Percentage of increase or decrease in value of flyover with alternative material compared to existing materials was tabulated in Annexure I-Table 9. The graphical representation of comparison of the present value of flyover is shown in Annexure 1-Figure 3.

6. RECOMMENDATION PHASE

In this phase, the suitable alternative chosen from the above phase will be implemented in the construction process. Hence, alternative 1 has been taken for the implementation process in the construction process of the flyover. By Replacing those existing material with Alternative materials, the cost of the project was optimized. At the initial stage of the project, the total costs of the materials were Rs.155, 739,347. After replacing existing material increase or decrease in value of building with alternative material compared to existing to materials .With Alternative materials, the cost has been optimized of Rs.149,394,122. Hence, the cost of the project has been optimized up to 4%. Hence, the value of the building has also been enhanced up to 50% by the end of 50th year as per planned life cycle of building.

IV.SUMMARY

By using VM job plan and its various techniques in each phase of job plan. The unnecessary cost caused by the materials of the project was determined and the material which causes the non efficient cost are replaced by the suitable alternative material which provides the same function of existing material by optimizing the cost and by improving the value of the project. Figure 4 shows the result of the analysis.

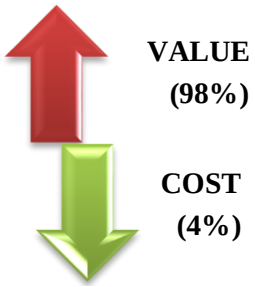

Figure 4.Result of the analysis

V.CONCLUSION

From the analysis of flyover project by value management technique, it has been identified that some of the materials such as Expansion joint, Gravel, Granular sub base used in the construction process were influencing unnecessary cost to the total cost of project. Those materials were taken into account for further analysis to provide suitable alternative using various techniques. The suitable alternatives chosen from the development phase will be recommended in the construction process. Hence, Alternative 1(Fingerplate joint, Glass cullet, Rubber aggregate) has been chosen to implement in the flyover project. By replacing those existing material with alternative material, the cost of the project was optimized. After providing alternative material, again LCC was calculated and the cost of the project has been optimized up to 4% and the value of the building has also been enhanced up to 98% by the end of 50th year. Hence, through the Value Management technique, the unnecessary cost has been optimized and value of the building has been increased.

VI.RECOMMENDATIONS

The recommendations to improve the knowledge of Value management in construction industry are as follows:

- Conducting Seminars and educating the industry to apply VM in projects.
- Perform some workshops on value management.
- Conduct short courses on VM.
- Implement some regulation for application of VM for some projects (make it mandatory for public sector investment projects).
- Introduce any team to observe and regulate the application of VM.
- Follow up and get the knowledge from other developing countries as to know how they are successful in application of VM.

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ANNEXURE 1

Figure.2 FAST diagram for the Flyover Project

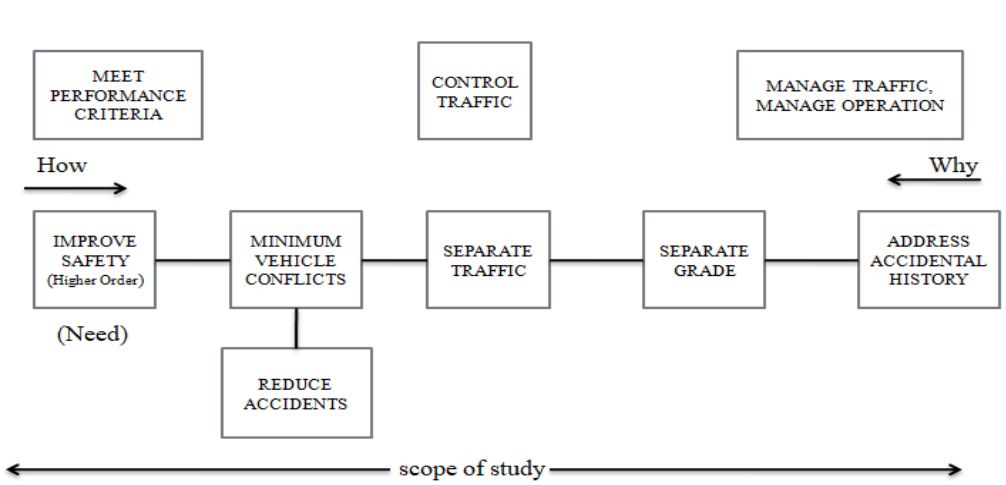

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Table.2 Cost-Worth Analysis Table

KEY WORD	MATERIAL	ESTIMATED COST (in Rs)	CURRENT COST (in Rs)	VALUE GAP (3/4)	RANK
A	PCC	2858588	2893043.77	0.95	6
B	RCC	16817389	17016392	0.94	7
C	Elastomeric bearing	145229.00	3801283.2	0.04	16
D	GI drainage spouts	6446.00	16000.00	0.40	15
E	Strip seal expansion	965519.00	387625.00	2.49	2
F	Steel work	41094038	42061900	0.97	5
G	Polyster geogrid	915491.2	972709.4	0.94	7
H	Gravel	57204062	18183660.6	3.14	1
I	Filter media	13571362	15943991.65	0.85	11
J	Granular sub base	8249527.995	4240143.00	1.94	3
K	Tack coat	261846.00	382868.96	0.68	14
L	Prime coat	802479.00	884157.96	0.90	10
M	Dense bituminous macadam	11499236.00	14446175.9	0.79	12
N	PVC pipe	146746.00	158934.00	0.92	9
O	Pier protection wall	64151.00	86690.40	0.74	13
P	Emulsion paint	1137237.70	1206324.00	0.98	4

Table.3 Alternative Material for Analysis

Existing material	Alternative 1	Alternative 2	Alternative 3
Strip seal expansion joint	Finger plate expansion joint	Asphaltic plug joint	Bolt down expansion joint
Gravel	Rubber aggregate	Fly ash aggregate	Synthetic aggregate
Granular sub-base	Glass cullet	Recycle concrete	Steel slag

Table.4 Present Value of the Flyover

Year	Value of flyover (before VM) (in Rs)	Value of flyover (after VM) (in Rs)
5^{th}	108,804,916.90	63,926,989.31
10^{th}	48,696,020.90	30,436,471.00
15^{th}	13,115,254.23	14,491,200.29
20^{th}	3,532,319.28	68,99,449.06
25^{th}	951,356.28	32,84,917.50
30^{th}	256,227.90	15,63,991.97

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35th	69,009.62	7,44,636.93
40th	18,586.29	3,54,531.33
45th	5005.83	1,68,796.98
50th	1348.20	80,366.44

Table.5 Key Letter for Each Parameter

Parameter	Cost	Strength	Durability	Functionality	Abrasion	Impact
Keyword	M	N	O	P	Q	R

Table.6 Weighted Criteria Matrix

	N	**O**	**P**	**Q**	**R**	**Total score**	**Final score**
M	**N_3**	**O_3**	**P_3**	**Q_3**	**R_3**	**0**	**1**
	N	**O_3**	**P_3**	**N_3**	**N_3**	**9**	**10**
		O	**P_3**	**O_2**	**O_3**	**11**	**12**
			P	**P_3**	**P_3**	**15**	**16**
				Q	**Q_2**	**5**	**6**
					R	**3**	**4**

Table.7 Resultant Evaluation Matrix

Parameters	**M**	**N**	**O**	**P**	**Q**	**R**	**Total**	**Rank**
weight	1	10	12	16	6	4		
Existing material								
Strip seal joint	1	20	36	16	12	12	97	10
Gravel	1	20	24	32	12	16	114	7
Granular sub base	1	30	36	32	12	12	113	8
Alternative 1								
Fingerplate joint	3	40	48	64	12	16	183	2
Rubber aggregate	3	40	48	64	24	12	191	1
Glass cullet	2	30	36	48	18	12	136	3
Alternative 2								
Asphaltic plug joint	2	30	36	32	12	8	120	6
Fly ash aggregate	2	30	36	48	12	12	130	4
Recycle concrete	3	30	36	32	12	12	125	5
Alternative 3								
Bolt down expansion joint	1	20	24	16	6	8	75	12

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Synthetic aggregate	1	20	24	48	12	8	105	9
Steel slag	1	20	24	32	12	4	93	11

Table 8.Result from Evaluation Matrix and AHP Sensitivity Analysis

EXISTING MATERIAL	SUITABLE ALTERNATIVE MATERIAL
Strip seal expansion joint	Finger plate expansion joint
Gravel	Rubber aggregate
Granular sub-base	Glass cullet

Table 9.Comparison of the Present Value of the Flyover

Year	Value of flyover (before VM) (Rs)	Value of flyover (after VM) (Rs)	% increase or decrease in value of flyover with alternative material compared to existing materials (%)
5th	108,804,916.9	63,926,989.31	-41.5
10th	48,696,020.9	30,436,471.00	-37.49
15th	13,115,254.23	14,491,200.29	+9.49
20th	3,532,319.28	68,99,449.06	+48.8
25th	951,356.28	32,84,917.50	+71.03
30th	256,227.90	15,63,991.97	+83.6
35th	69,009.62	7,44,636.93	+90.7
40th	18,586.29	3,54,531.33	+94.7
45th	5005.83	1,68,796.98	+97.03
50th	1348.2	80,366.44	+98.3

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Figure 3.Graph of Comparison of Present Value of Flyover