ANALYSIS OF VALUE ENGINEERING IN BUILDING CONSTRUCTION

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ABSTRACT:

Value management (VM) is a useful method to use when dealing with issues such as budget and schedule challenges arising in the construction industry. However, little research has been done to measure the performance of VM studies, which has made many potential users reluctant to use VM.

Value engineering can be applied in all possible areas of project logistics; material procurement, use of alternative materials, structural design, architectural planning, design of services, construction methodology, energy efficiency etc. due to restricted time frame and man power, we are going to concentrate on energy efficiency and use of alternative materials. There is always a scope to improve value, interns of materials value or the worth. The main objective is to provide all necessary functions at a lowest cost. It also includes: to implement Value Engineering in construction industry, to study for viable alternatives that can improve the value of the structure, to understand and compare the cost saving attained after conducting value engineering study with that of conventional one, Recommendation of best alternatives to the organization of case study. It is used to improve quality, increase reliability and availability and customer satisfaction and to achieve the best value at lowest life cycle cost.

Keywords: Value engineering, architectural planning, design of services, construction methodology.

INTRODUCTION:

One of the primary drivers of economic expansion is the construction industry. With over 32 million workers, it is India's second largest employer after agriculture. In India, 38% of gross domestic investment and 5% of the country's GDP are attributed to the construction industry. There are four main categories within the construction industry: infrastructure (54%), industrial (36%), residential (5%), and commercial (5%). The construction industry is estimated to be worth Rs. 2400 billion. The industry had previously grown at a rate of over 10%, but the recession caused this growth to slow. It's looking up again right now (Kelly,J., and Male,S 1993).

The building sector serves as a gauge of a country's progress. Today, after agriculture, the construction sector employs the greatest number of skilled and semiskilled workers and is crucial to the economy of our country (Krishnan, P., and Saxena, KR 1994). There is a greater need for residential and commercial space as a result of labor migration and an increase in business opportunities. It is estimated that there is an 8.89 million unit shortage of urban housing (Ahuja 2000). Currently, 30 million people are employed in the housing and construction sectors, and 250 different industries are either directly or indirectly related to the construction sector.

A methodical and planned approach to delivering the required functions for a project at the most affordable price (Gokhram,P.R 1998). Value engineering encourages the replacement of more costly materials and techniques with less costly ones without compromising functionality (Heller,E, 1971). It ignores the physical characteristics of the various materials and components in favor of concentrating only on their functions (Best et al., 1999).

Value engineering seeks to provide quantifiable value gains for the client by lowering costs, raising quality, and improving design elements (Fallon., and Carlos 1991). If a business wants to stay up to date with the ever-increasing expectations of its customers, who will always drive them to the place where they can get the best value for the money, these disciplines cannot be disregarded (Greve et al., 1987).

Value engineering is a methodology that examines the function of the goods and services in order to obtain the functions that the user needs at the lowest possible total cost without compromising the performance quality (Green, SD., and Popper 1990). Value engineering is frequently mistaken for cost-cutting measures used in the building sector.

Value engineering differs from traditional cost cutting in that it focuses on lowering costs while enhancing functionality and using less energy in the form of labour, materials, and equipment (Miles., Lawrence, D 1972). Production engineers employed value engineering in the beginning to lower manufacturing costs (Brayant, J 1992). It was discovered, nevertheless, that the advantages of Value Engineering are significantly higher when multidisciplinary engineering teams are involved, as this would also have an impact on the design team, as is typically the case in the construction industry (Gage,WL 2000).

MATERIALS AND METHODS:

This report focuses on Value engineering in two aspects. The first part is an exhaustive review of VE in the field of alternate building materials and energy efficiency. The second part is a study of implementation of VE in a green building.The concept of value engineering bringing to light that value is added to the project not by replacing with a cheaper material but by using a more economical, functional much better life cycle cost.

The Essence of Value Engineering:

Value Engineering is not just good engineering, it is not a suggestion program or a routine plan review, but a new, fresh look at problems starting from basic functional requirements, an independent approach to the project. Therefore, the user must also recognize that Value Engineering entails a certain amount of expense that must be justified by potential cost savings. Accordingly, the need for change in standards, concepts or plans must be recognized and a distinct opportunity for financial rewards in terms of life cycle cost savings must warrant the added project engineering cost of a Value Engineering effort.

Value Engineering and Value analysis are the two main subsets of Value Management. Concentrating on the relationship between value to the customer, function and cost and so providing a better product or service for less cost. Value Analysis focuses on ‗find and fix' solutions for existing products and processes. Reduction of unnecessary cost and improvements in functionality are high priorities.

Working Mechanism of Value Engineering Study:

The systematic approach is the JOB PLAN. During the 5 basic steps in the job plan, being the informative phase, speculation phase. Judgment phase, development phase, recommendation phase, the plan goes though scrutiny and the best possible solution is arrived.

SELECTION OF CASE:

In our project we have selected the building for case study as Akshaya Today residential apartments, which is located at OMR. They have adopted a green building concept with proper system and procedures. The performance of the building will also be monitored by an Intelligent Building Management System (IBMS). The Akshaya Today residential apartment at OMR has a total Land area of 901692 sq.ft and there are totally 5 blocks with 2134 units present in this project and we are going to take E block as a case and this block consist of 12 floors with basement and ground floor for car parking and 360 units present in this block with the total floor area of 1,32,880 sq.ft.

Entire waste water in the building is treated biologically through a process called the Root Zone Treatment System. Output water has low BOD and COD values and this water is good for irrigation purposes. 35% reduction in portable water use, low flow water fixtures, Waterless urinals, Use of storm water & recycled water for irrigation, Sustainable Site, Minimum disturbance to the site, Extensive erosion and sedimentation control measures to prevent erosion, Impervious areas like terraces, parking etc., result in absorbing heat and radiating it into the building.

This is minimized through the roof gardens covering 55% of the roof area. Rain water harvesting. Pervious paver blocks which help in storm water seepage into the ground have been installed in pedestrian areas and parking, Energy Efficiency, 50% savings in overall energy consumption than a normal building, 88% reduction in lighting consumption, Use of aerated concrete blocks for facades, which reduces 15—20% load on air conditioning, Double glazed glass with excellent thermal properties, State of the art BMS for real time monitoring of energy consumption, Renewable Energy, Harvesting of solar energy – 20% of the buildings energy requirement is catered to by solar photovoltaic, The solar PV should have an installed capacity of 23.5 KW, Average generation should be 100 – 125 units per day.

Materials & Resources used for the study:

80% of the materials used are either recycled or recyclable. Fly ash based bricks, Recycled glass and ceramic tiles, Recycled wood, More than 50% of construction waste recycled within the building or sent to other sites, Indoor Environment Quality, Indoor air quality continuously monitored, Materials selected so as to have no adverse health impact on the occupants, Adequate amount of fresh air into the building and control of air quality through carbon dioxide monitoring, fresh air drawn into the building through wind towers, as and when required, Use of low volatile organic compound carpets, paints, adhesives and sealants, 90% of the building day light & 75% occupants access to outside view.

RESULTS AND DISCUSSIONS

Various aspect of information phase and Functional Analysis Phase-techniques like NEFR (Numerical Evaluation of Functional Relationship)

INFORMATION PHASE

The first phase of VE is called Information Phase. In this phase all the pertinent aspects of the project were studied. This phase involves defining the project, obtaining the background information, limitations and constraints during design and execution and sensitivity to cost involved in owning and operating a facility. The primary purpose is to obtain as much information as possible, of the project design.

The VE study should try to find the rationale used by the designers for the development of the project and the assumptions and design criteria established for selecting materials and equipments to perform the required functions. The intention is not to criticize but to come up with different alternatives aiming at reduction of project cost.

Several areas of information needed for the VE study during the information phase could are as follows. Design Criteria (System requirement), Site Condition, Background of the project, Available resources, Requirements resulting from public participation. The above information allows the VE study to empathize with the design and other criteria that defined the project development.

FUNCTION ANALYSIS PHASE

Functional analysis is the primary component of VE. It forces one to broaden the understanding of the project more comprehensively, by simulating intense discussion. A discussion is similar to ―out of the box‖ thinking.

Typical evaluation criteria for assessing value are:Initial cost, Energy cost, Return on profit, Functional performance, Reliability, Ease of maintenance, Quality, Saleability, Regard or Aesthetics and Environment owner requirements Safety.

IMPLEMENTATION OF FUNCTIONAL ANALYSIS

All the components of the building under consideration were listed, with their quantities and cost. The individual components were analyzed for their functionality. A number of functions for each component were elucidated and based on the type of function it performs; they were designated as ―B‖ for basic or ―S‖ for secondary function Table 1-3.

In this Speculation Phase all items are considered and the various alternatives for each have been tabulated and next phase is Evaluation Analysis Phase.

IMPLEMENTATION OF INVESTIGATION OR EVALUATION PHASE IN CASE STUDY

After using the technique of Brainstorming, various alternatives were evaluated in this phase using Complex Democratic Approach (Table 4-6).

After analyzing the alternatives of ―Siporex‖ blocks are considered as the valuable one. It is considered as it performs all the functions required with high thermal efficiency and high pace of construction. It gains a total score (or) value of **238.38**. The rate is Rs. 90/block (Table 7-8).

DEVELOPMENT AND RECOMMENDATION

With the completion of the Evaluation Phase the next phase, which is the most important phase, is approached – the Development and Recommendation Phase, where only the practical proposals are approved and the remaining alternatives are disposed.
The recommendations formulated are given a fair and through evaluation. As many recommendations are provided as practicable. Management must them decide, based on all available information, whether or not to approve the recommendation. This is usually the last phase of a standard VE Job plan.

Applying this to our case study, by the end of the Judgment Phase, the alternatives were frozen and all the changes in improving value were finalized. VE being a systematic study, the finalized ideas are examined by suitably weighing their pros and cons. The main objective of this phase is to develop the idea selected into practicable proposals and then suggest those changes in the plan (Table 9).

The many ideas that have evolved from the Evaluation Phase are meticulously developed in this Phase. With the development of proposals and by projecting the increased and decreased values as shown in table, the VE study comes to an end.

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Table 1. FUNCTIONAL DEFINITION WORKSHEET

Sl. No	Description	Quantity	Unit	Cost Rs.	Function	Kindof Function
1	Total brick masonry work	9846	Sq.m	1,29,96,720	Exclude Elements Divide Space :ilitate Use	B S B
2	:al RCC work	10452	Cu.m	6,27,12,000	Facilitate Function Hide Defects	B B S
3	Internal Plastering	12050	Sq.m	14,46,000	Improve aestheticsrevent WaterHide Defects	S
4	External Plastering	9040	Sq.m	21,69,600	Improve aesthetics relevant Water	B
5	Doors (MS Frame with glass shutter, fittings & joinery)	L.S	Nos	87,00,000	Control Access Connect Spaces	B S
6	Water proofing work	L.S		24,00,000	Prevent Water	B
7	Flooring	12345	Sq.m.	1,48,14,000	Increase Life Facilitate Use Improve Aesthetics	B B S
8	Painting (Internal)	12050	Sq.m.	12,05,000	Improve Appearance Hide Defects	B S
9	Painting (External)	9040	Sq.m.	9,04,000	Improve Appearance Hide Defects	B S
10	indows & Glazing	L.S	Nos	1,17,00,000	Provide Ventilation Provide Light	BS
11	Grills & Railings	L.S		40,50,000	Provide Safety Provide Appearance	B S
12	lumbing Works		L.S	28,00,000	:onvey Fluid	B
13	lectrical Works		L.S	47,00,000	rovide Light Provide Points mprove Safety	B S S
14	e fighting Works		L.S	16,00,000	Provide safety	B

	15	Solar panels		L.S	1,20,00,000	Harness Renewable Source	B
	16	Lift Works	4	Nos	40,00,000	Transport Vertically Increased Comfort Provide safety	B S S
	Total = 14,81,97,320						

Table 2 NEFR WORKSHEET

Key Letter	Function
A	Facilitate Function
B	Exclude Elements
C	Hide Defects
D	Control Access
E	Prevent Water
F	Increase Life
G	Improve Appearance
H	Provide Ventilation
I	Provide Safety
J	Convey Fluid
K	Provide Light
L	Harness Renewable Source
M	Transport Vertically.

Table 4 Evaluation Criteria for External Walls

Code	**Item**
A	Initial Cost
B	Aesthetics
C	Maintenance
D	Durability
E	Strength to Weight ratio
F	Water Repellant
G	Workability
H	Progress rate in construction
I	Sound Absorption
J	Material Availability
K	Consistency of Availability
L	Thermal Conductivity

	B	C	D	E	F	G	H	I	J	K	L	Total Score
A	A3	C1	D2	E2	A1	G2	H3	I1	J2	A2	L2	6
	B	C2	D3	E4	F3	G3	H2	I2	B2	K2	L3	2
		C	D3	C2	F2	C3	C2	I2	J2	K3	L1	10
			D	D3	D4	D2	H1	D2	J3	D2	D1	22
				E	E3	G2	E3	E2	E1	K2	E2	17
					F	F2	H2	I1	J2	K2	L3	7
						G	G2	G2	G1	G2	L2	14
							H	H2	H2	H1	L2	13
								I	I3	I2	L1	11
									J	K2	L2	9
										K	K3	14
											L	16

4 – Major Preference

3 – Medium Preference

2 – Minor Preference

1 – No Preference

Table 3 Speculation Worksheet

AAC Blocks External Walls	**Ventilators**	**Aluminium Sliding Window**	**Staircase Foyer**	**Ceiling Plastering (POP)**	**Paver Blocks**	**Ducts Cover**
_Siporex‘ block	Sliding window	MS Window	Separating staircase and lift and putting then flush with each other at the entry points.	Cement Mortar Plastering	Patent stone Flooring	Concrete and Brickwork
Solid Concrete Block	Fixed window and Louvered ventilator	_UPVC‘ Window	Separating the staircase and the lift and putting them flush with the external wall.	No Plastering	Shahabad Tiles	Jalli work
Hollow Concrete Block	Retaining Ventilator and Removing window		Separating the staircase and the lift and putting them opposite to each other, with the lift enclosure being retained in the current location.		Cement concrete Flooring	Kudappa slabs
Burnt Brick Masonry			Separating the staircase and the lift and putting them opposite to each other, with the staircase enclosure being retained in the current location.		Brick coba Flooring	Glazings
						Brickwork and Kudappa

Table 5 Weighted Evaluation Criteria for External Walls

Item	**Code**	**Raw Score**	**Weighted Score**
Initial Cost	A	6	2.72
Aesthetics	B	2	1
Maintenance	C	10	4.54
Durability	D	22	10
Strength to Weight ratio	E	17	7.72
Water Repellant	F	7	3.18
Workability	G	14	6.36
Progress rate in construction	H	13	5.90
Sound Absorption	I	11	5.00
Material Availability	J	9	4.09
Consistency of Availability	K	14	6.36
Thermal Conductivity	L	16	7.27

Table 6 Weighted Matrix Sheet for External Walls

Criteria	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	
Raw Score	6	2	10	22	17	7	14	13	13	9	4	16	
Weighted Score	2.72	1	4.54	10	7.72	3.18	6.36	5.9	5.0	4.09	6.36	7.27	
Alternatives													**Total Score**
Siporex‘ block	2	4	3	4	4	4	4	4	4	2	4	4	238.38
	5.44	4	13.62	40	30.88	12.72	25.4	23.6	20	8.18	25.44	29.1	
Solid concrete block	3	3	3	2	2	4	2	3	4	3	4	3	183.32
	8.16	3	13.62	20	15.44	12.72	12.7	17.7	20	12.7	25.44	21.8	
Hollow concrete block	3	3	3	3	3	3	3	3	3	3	4	3	198.62
	8.16	3	13.62	30	23.16	9.54	19.0	17.7	15	12.2	25.44	21.8	
Burnt Brick	4	2	2	2	3	3	3	2	3	4	2	3	171.2
	10.8	2	9.08	20	23.16	9.54	19.0	11.8	15	16.3	12.72	21.8	

Table 7 Weighted Evaluation Criteria for Service Ducts Cover

Item	**Code**	**Raw Score**	**Weighted Score**
Initial Cost	A	12	5.45
Aesthetics	B	22	10
Maintenance	C	8	3.63
Durability	D	5	2.27
Progress rate in construction	E	10	4.54
Strength	F	7	3.18
Material Availability	G	3	1
Heat of moisture Resistivity	H	5	2.72

Table 8 Weighted Matrix Sheet for Service Ducts Cover

Criteria	A	B	C	D	E	F	G	H	
Raw Score	12	22	8	5	10	7	3	5	
Weighted Score	5.45	10	3.63	2.27	4.54	3.18	1	2.72	
Alternatives									**Total Score**
Concrete and Brickwork	2	4	3	4	3	4	3	4	111.09
	10.9	40.0	10.89	9.08	13.62	12.72	3.0	10.88	
Jalli work	3	3	3	3	2	3	3	3	93.83
	16.35	30.0	10.89	6.81	9.08	9.54	3.0	8.16	
Kadappa slabs	4	1	4	2	3	3	4	4	88.9
	21.8	10.0	14.52	4.54	13.62	9.54	4.0	10.88	
Glazing	4	4	4	3	4	3	4	4	125.71
	21.8	40.0	14.52	6.81	18.16	9.54	4.0	10.88	
Brickwork and Kadappa	3	2	3	4	3	3	4	3	91.64
	16.35	20.0	10.89	9.08	13.62	9.54	4.0	8.16	

Table 9: Development and recommendation in case study

S. No	Proposed idea	(-)Reduction / Increase in cost (Rs)	Remarks
1	rex‖ blocks masonry for all external walls	+860400	2/3rd weight of AAC blocks, uniform dimension, thermal resistant, eliminates leaching
2	Retaining the ventilator and removing the window part of the unit of the window wall	+68796	light but not wind.
3	–UPVC‖ windows	-595283	Facilitate better use, increased life and aesthetically excellent.
4	Separating the staircase and the lift and putting them adjacent, flush with each other at the entry points.	-805000	Development Authority requirements
5	No ceiling plastering (POP)	-123450	Increase in vertical floor space
6	Shahabad tiles in parking area	-603260	Shahabad tiles provide all the functions of Interlocking Blocks. The same aesthetics can be achieved by good architectural design
7	High performance glazing for service duct	+31640	Aesthetically pleasing
8	Solar panels in elevation	-200000	10-20% Less consumption of electricity
Total Savings Rs 13,66,157.00 (Material alone)			