International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 03, March-2015

Developing a Module Helping to Optimize the Cost of Construction of Residential Buildings using the Concept of Value Engineering

Thamarai Selvan. P
M.Tech - Construction Engineering and Management
SRM University
Kanchipuram, India

Jagannathan. P.
M.Tech (Ph.D)
Educational consultant
SRM University
Kanchipuram, India

Abstract **- Keeping the costs low with traditional cost management has been a commonly applied measure to improve competitiveness. However, keeping cost down alone is not enough, there is an increasing need for improve in schedule as well as efficiency and effectiveness. Value engineering is thus arguably of greater importance than cost management efforts. Value engineering is used to analyze the function of the materials and methods and to obtain its required functions at the lowest total cost without reducing the necessary quality of performance. This method saves money and ensures that projects are cost-effective, time-effective and or improves the quality of the project. The methodology consists of three stages. The first is pre workshop in which the value engineering team is formed and the collection of data from an organization is done. The second and core stage is workshop stage with five phases which are information, functional, creative, evaluation and presentation where best alternative recommendations are made. The last is post workshop stage where the recommendations from second stage will be implemented. The main aim of this thesis is to develop a Value Engineering methodology that leads to reduce cost and improve schedule of residential building projects for people in an applicable way that local professionals can understand and apply. An existing project data was collected for case study and it was studied and the methodology was applied for improvement of the project by saving the cost and improving schedule. The developed methodology forms the first step towards applying Value Engineering in local projects and it can easily be adapted to serve other sectors like infrastructure.**

I. INTRODUCTION

Keeping costs low with traditional methods has been a common practice to improve competitiveness. Saving money and also providing better value for the money is a concept that everyone emphasizes. Value Engineering is a practice whose goal is, always, to achieve value for money. A systematic and organized approach to provide the necessary functions in a project at the lowest cost. Value engineering recommends the replacement of materials, methods or techniques with less expensive alternatives, without lowering its functional standards. It is focused mainly on the functions of various techniques and materials, rather than their physical characteristics. Also aims to deliver measurable value improvements through cost reduction and or improve quality and also by improving the schedule of the project for the customer. These features cannot be avoided if a company is to continue meeting the rising expectations of its customer, who will always take their business to where they can get the highest quality at the lowest possible price".

A. Scope

The scope of this study is to analyze the concepts of value engineering over an existing residential building projects and obtaining the best alternatives by reducing the cost and also improving the schedule of the project to develop and prioritize value engineering concepts over the future projects. Value engineering techniques can be applied in logistics, material procurement, and design of services, construction methodology, and quality and inventory management. Thus, it is observed that the scope for application is present almost in every aspect of any industry.

II. METHODOLOGY

The methodology explains the procedure and sequence of steps that are framed to follow in the project. The methodology is divided into different steps, accordingly the project procedure is divided. The methodology is depicted in a flow chart format for easy understanding.

A. Literature collection and study

Various books papers and relevant literature regarding value engineering and value management in construction were collected and the concept was studied in depth. Seminars relating to value engineering were studied for thorough understanding of subject.

B. Selection of case study

With due permission of client a residential building project was selected for case study as this provides scope for value analysis and at the same time value engineering for the next repetitive project.

C. Data collection

All necessary and possible information regarding the project were collected by visiting the site office and company directly. The information includes financial and technical aspects of the projects. The data were collected though meetings, interviews and questionnaire with owner, consultant, contractor, architect and uses. Other information regarding alternative materials was collected from manufacturers and dealers.

D. *Interpretation of data*

From the chunk of the data available, useful data related to scope of the case were interpreted.

E. *Identification of feasible alternatives*

The areas where value engineering could be applied were identified for improving value. The other alternatives performing the same function at a lower cost and better attributes were recognized

F. *Recommendations / conclusion*

The scope and application of value engineering in a project was successfully implemented, which yielded improvement in the value of the under study.

III. QUESTIONNAIRE ANALYSIS

Questionnaire survey is conducted in order to find the knowledge about value engineering and implementation of value engineering by the local companies in the construction practice. From 20 members the results were collected which includes contractors, professionals, consultants and owners. In the analysis of questionnaire, it is found that almost every company is unaware of value engineering. They are very keen to increase revenue by incorporating cost management by substituted material without even considering the improvement in the quality. They are substituting material in place of other material which may be costlier than the substituting material. The companies are not aware of the aftermath of the usage of low cost material. The owners point is they do not want to try anything new without knowing the result of the alternatives for sure. .

IV. CASE STUDY

For the purpose of this study, data of the existing residential building project were collected. As per the scope of the research, the VE concept should be applied during the initial phases of the project in order to gain more benefit.

- The project name is "Nana Nani apartments – Block F" which is located in Coimbatore. This project is constructing by the company Sivasakthi builders.
- The project will be built on an overall area of 14195 square feet and the built-up area of 8760. The estimated cost of the project is 6 crores 60 lakhs.
- This block consists of five floor and terrace floor where the stilt floor is allocated for parking space and the other four for houses.
- Each floor consists of 8 houses of 2bhk with staircases on both sides and a lift in the middle. Open to sky spaces are also provided in every floors.

A. *Quality model*

Quality model is described as a quantitative description of the owner requirements. This model is done to know if the owner's requirement will be fulfilled as expected by analyzing the project data. This includes ranking of elements operational effectiveness, architectural performance, capital cost effectiveness, schedule, maintenance, user comfort and expandability from 2 to 10 as in 2 for very poor and 10 for very good.

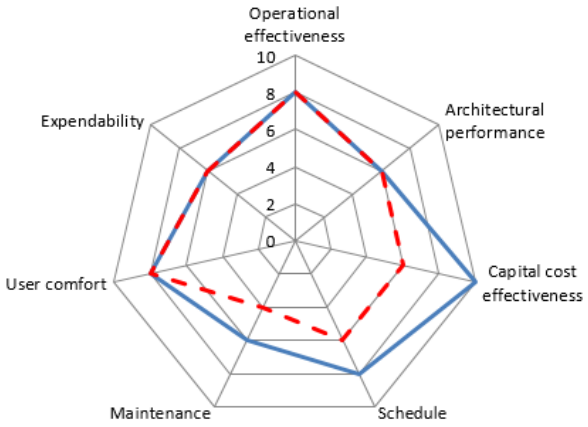

Fig. 1. Quality model

The Figure 1 shows the graphical representation of quality model in which the solid blue line represents the owner's expectation and the dotted red line shows the design parameters.

B. *Uniformat presentation*

Uniformat presentation of bill of quantities is done to find out the cost for separate works in the project. For buildings, the most common work breakdown structure for a construction cost model is based on the Uniformat system.

		COST (lakhs)	SITEWORK	PCC	RCC	BRICKWORK	PLASTERING	PUTTY	PAINTING	CARPENTRY	ELECTRICAL	PLUMBING	TILES	OTHERS	TOTAL
1.Foundations	1.1	Std foundation	1.36	1.49	11.42										13.99
	1.2	Sp. Foundation													
2.Basement	2.1	Basement filling	4.05												4.05
	2.2	Column pit filling	1.83												1.83
3.Stilt floor	3.1	Floor		5.2									8.45		13.65
	3.2	Column, Beam, Roof			41.25										41.25
	3.3	Outer walls				0.72									0.72
	3.4	Partition walls													
	3.5	Finishing					2.84	0.69	0.87						4.4
	3.6	Others								0.31	2.00				2.31
4.First floor	4.1	Floor											12.80		12.80
	4.2	Column, Beam, Roof			43.4										43.4
	4.3	Outer walls				6.93									6.93
	4.4	Partition walls				1.7									1.7
	4.5	Finishing					12.36	2.78	3.94						19.08
	4.6	Others								10.63	8.00	10.00			28.63
5.Second floor	5.1	Floor											14.34		14.34
	5.2	Column, Beam, Roof			44.28										44.28
	5.3	Outer walls				7.76									7.76
	5.4	Partition walls				1.91									1.91
	5.5	Finishing					13.85	3.11	4.42						21.38
	5.6	Others								11.91	8.96	11.20			32.07
6.Third floor	6.1	Floor											16.06		16.06
	6.2	Column, Beam, Roof			49.59										49.59
	6.3	Outer walls				8.69									8.69
	6.4	Partition walls				2.14									2.14
	6.5	Finishing					15.45	3.48	4.95						23.88
	6.6	Others								13.34	10.03	12.54			35.91
7.Fourth floor	7.1	Floor											17.99		17.99
	7.2	Column, Beam, Roof			55.55										55.55
	7.3	Outer walls				9.73									9.73
	7.4	Partition walls				2.39									2.39
	7.5	Finishing					17.31	3.90	5.54						26.75
	7.6	Others								14.94	11.23	14.04			40.21
8.Terrace	8.1	Floor												7.04	7.04
	8.2	Column, Beam, Roof			1.79										1.79
	8.3	Outer walls				2.77									2.77
	8.4	Finishing					1.77		0.56		0.10				2.43
	8.5	Others													
9.Others	9.1	Lift												12.00	12.00
	9.2	Staircase			3.2	1.8									5.00
	9.3	Water tanks			1.02	0.06	0.45								1.53
	9.4	Miscellaneous												23.50	23.50
		TOTAL	7.24	6.69	251.22	46.60	64.03	13.96	20.28	51.13	40.32	47.78	69.64	42.51	661.40

Fig. 2. Uniformat model

Figure.2 shows the uniformat bill of quantities in which the cost for each individual items in every work is mentioned in terms of lakhs.

V. IDENTIFICATION OF ALTERNATIVES

The main objective in this stage is to be creative and brainstorm alternate proposals and solutions. Many techniques are available to stimulate creative thinking that may be applied during this stage. In this study brainstorming technique is used. The items under consideration are external walls, partition walls, water tanks, windows, sunshades, parking floor, Terrace ceramic floor, plastering, putty and painting works.

A. Technique used

To find out the best alternative from many, evaluation will be done for each and every alternatives. This evaluation of alternatives is done by using the Decision Matrix Analysis technique. Decision Matrix Analysis is a useful technique to use for making a decision in which ranking of alternatives is done. It's particularly powerful where you have a number of good alternatives to choose from, and many different factors to take into account. This makes it a great technique to use in almost any important decision where there isn't a clear and obvious preferred option. To do the ranking of all the alternatives and find the best of them a simple methodology is carried out and the technique has its essence in the mutual comparison where each is compared with all others and points are given based on their differences from 1 to 3 where 1 is no difference and 3 is major difference. When the function A is evaluated with B, then A is evaluated with next function C and this is continued till all the functions are compared with all other functions and rated.

VI. EVALUATION OF ALTERNATIVES

For evaluation ranking is done to each and every alternative items based on seven different functions which are cost, schedule, aesthetics, maintenance, durability, availability and efficiency.

TABLE I. FUNCTION CODES

Code	Item
A	Initial cost
B	Schedule
C	Aesthetics
D	Maintenance
E	Durability
F	Availability
G	Efficiency

A. External walls

The external walls are done with fly ash bricks of 9" thickness. The alternatives considered are AAC blocks, hollow concrete blocks, solid concrete blocks and burnt bricks.

TABLE II. EVALUATION OF ALTERNATIVES FOR EXTERNALL WALLS

Criteria	A	B	C	D	E	F	G	
Weighted Score	12	11	6	2	2	1	3	
Alternatives								Total Score
Solid concrete block	4	4	4	3	4	4	3	143
	48	44	24	6	8	4	9	
Hollow concrete block	5	4	4	3	3	5	2	151
	60	44	24	6	6	5	6	
AAC blocks	4	5	4	4	5	4	5	154
	48	55	24	8	10	4	15	
Burnt Brick	4	3	4	3	5	5	3	135
	48	33	24	6	10	5	9	

After analyzing the alternatives of AAC blocks are considered for development. It is considered as it performs all the functions required with high thermal efficiency and high pace of construction. It gains a total score of 154.

B. Partition walls

The partition walls are done with fly ash bricks of 4.5" thickness. The alternatives considered for this are Burnt brick wall, ferrocement wall, plywood and hollow concrete block.

TABLE III. EVALUATION OF ALTERNATIVES FOR PARTITION WALLS

Criteria	A	B	C	D	E	F	G	
Weighted Score	12	11	6	2	2	1	3	
Alternatives								Total Score
Plywood	3	5	4	3	2	5	3	139
	36	55	24	6	4	5	9	
Hollow concrete block	5	4	4	3	3	5	2	161
	60	44	24	6	6	5	6	
Ferrocement	5	4	4	4	5	5	4	162
	60	44	24	8	10	4	12	
Burnt Brick	3	3	4	3	5	5	3	123
	36	33	24	6	10	5	9	

After analyzing the alternatives of ferrocement walls are considered for development. It is considered as it performs all the functions required high pace of construction. It gains a total score of 162**.**

C. Windows

The windows are done by using Sal wood. The alternatives considered are Aluminium windows, upvc windows, neem wood windows.

TABLE IV. EVALUATION OF ALTERNATIVES FOR WINDOWS

Criteria	A	B	C	D	E	F	G	
Weighted Score	12	11	6	2	2	1	3	
Alternatives								Total Score
Aluminum	5	5	3	2	3	5	2	154
	60	55	18	4	6	5	6	
UPVC	4	5	4	4	4	5	5	163
	48	55	24	8	8	5	15	
Neem wood windows	4	3	5	4	5	4	4	145
	48	33	30	8	10	4	12	

After analyzing the alternatives of UPVC are considered for development. It is considered as it performs all the functions required with high pace of construction. It gains a total score of 163**.**

D. Water tanks and sunshades

From The water tanks and sunshades are built by using M20 grade concrete. the alternatives are M15 concrete and ferrocement concrete.

TABLE V. EVALUATION OF ALTERNATIVES FOR WATERTANKS AND SUNSHADES

Criteria	A	B	C	D	E	F	G	
Weighted Score	12	11	6	2	2	1	3	
Alternatives								Total Score
M15 concrete	4	3	4	4	4	5	4	138
	48	33	24	8	8	5	12	
Ferrocement	5	5	4	3	3	5	4	168
	60	55	24	6	6	5	12	

After analyzing the alternatives of ferrocement concrete are considered for development. It is considered as it performs all the functions required high pace of construction. It gains a total score of 168**.**

E. Parking floor

The parking floor is finished with parking paver tiles. the alternatives for this are IPS floor, interlocking blocks, shahabad tiles, PCC floor.

TABLE VI. EVALUATION OF ALTERNATIVES FOR PARKING FLOOR

Criteria	A	B	C	D	E	F	G	
Weighted Score	12	11	6	2	2	1	3	
Alternatives								Total Score
IPS floor	4	4	3	3	4	4	3	139
	48	44	18	8	8	4	9	
PCC floor	3	3	3	5	5	5	4	124
	36	33	18	10	10	5	12	
Shahabad tiles	5	4	3	4	4	3	5	156
	60	44	18	8	8	3	15	
Interlock blocks	4	5	4	3	4	3	3	153
	48	55	24	6	8	3	9	

After analyzing the alternatives of Shahabad tiles floor walls are considered for development. It is considered as it performs all the functions required high pace of construction. It gains a total score of 156**.**

F. Ceramic floor in terrace

In terrace ceramic floor is used for the flooring. the alternatives for that are cement floor, red oxide floor, terracotta floor and mosaic floor.

TABLE VII. EVALUATION OF ALTERNATIVES FOR TERRACE FLOOR

Criteria	A	B	C	D	E	F	G	
Weighted Score	12	11	6	2	2	1	3	
Alternatives								Total Score
Cement floor	3	3	3	4	4	5	4	120
	36	33	18	8	8	5	12	
Terracotta floor	5	4	3	4	4	3	3	150

	60	44	18	8	8	3	9	
Red oxide floor	4	4	3	3	4	3	3	136
	48	44	18	6	8	3	9	
Mosaic floor	4	4	4	3	4	4	3	143
	48	44	24	6	8	4	9	

After analyzing the alternatives of Terracotta floor are considered for development. It is considered as it performs all the functions required high pace of construction. It gains a total score of 150**.**

G. Plastering

For plastering use of plaster pump is recommended which gives good result by reducing the labour cost and also the time required to complete the work. This method includes investment for plaster pump, so break even analysis have been calculated to find out whether the investment is profit or loss. The results showed that how much area should the machine has to cover per year in order to avoid the loss which can be easily covered by small companies. As per the result this method is considered as the profit.

H. Putty and Painting works

For putty and painting works spraying method is recommended in order to reduce the labour cost and time required. For this spraying machine is used which have the benefit of using it for both putty works and painting works. For this also break even analysis is calculated to find out whether the investment is profit or loss. according to break even analysis this method the investment is a good choice for this techniques. Nowadays labours costs are increasing regularly, so implement of this method benefits more than cost and time.

VII. RECOMMENDATIONS

The alternatives evaluated are applies on the project and savings and schedule improvement were done.

TABLE VIII. COST SAVINGS, SCHEDULE IMPROVEMENT AND REMARKS OF RECOMMENDED ALTERNATIVES

Sl.No	Proposed idea	(-)Reduction /(+) Increase in cost (Rs)	% improvement in schedule in specific work	Remarks
1	AAC blocks masonry for all external walls	+1,24,106	35	3 times lesser in weight, uniform dimension, thermal resistant, eco friendly
2	Ferrocement walls for partitions walls	-1,13,796	30	Cost effective, speedy process
3	UPVC windows	-1,01,280	18	Facilitate better use, increased life and reduce air conditioning cost
4	Ferrocement concrete for water tanks and sunshades	-59,355	50	Cost effective, speedy process, low materials used
5	Use of Shahbad tiles in parking and drive way area	-76,122	No change	Cost effective and same aesthetics can be achieved by good architectural design
6	Terracotta tiles in terrace area	-83,286	No change	Cost effective, breaks monotony, Aesthetically pleasing
7	Plastering pump for Plastering	-5,61,347	40	Cost effective, saves labour problems
8	Spraying method for putty and paint works	-3,22,783	30	Cost effective, saves labour problems
	Total savings of the project	11,93,863	26	

Table VIII shows the savings and improvement of schedule after the application of recommended alternatives in the collected projects and last column shows the advantages of using the recommended alternatives.

VIII. CONCLUSION

Value Engineering aims to deliver measurable value improvements through cost reduction and improve quality and enhance design features for the customer. This has been systematically applied in the architectural, structural and material components of the building. In this study alternatives used result not only in cost reduction but also improves schedule as well as the quality.

This proves the scope and application of Value Engineering in building construction is tremendous, from both the developers and buyers point of view. Until recent times, VE was applied only in large turnkey projects like waste water treatment plants. It is sincerely hoped that this study opens new dimensions in the construction industry for the purpose of providing the best facility ultimately to the end user.

REFERENCES

[1] Fallon., and Carlos, *Value Analysis to Increase Productivity*, John Wiley & Sons Inc, New York, 1991

[2] E.Heller, *Value management and cost reduction*, Addition willey publishing company, Philippines, 1971,

[3] Gokhram,P.R, *Value Engineering*, National Productivity Council, New Delhi, 1998.

[4] Kelly,J and Male.S, *Value Management in Design and Construction*, E&F.N.Spon, London, 1993.

[5] Krishnan.P. and Saxena.KR, *Value Engineering in Project Management*, Oxford IBH Publications, Oxford, 1994.

[6] Greve, Jhon,W, Frank W Wilson, *Value Engineering in Manufacturing*, Prentice Hall Inc, New Jersey. 1987.

[7] Norton R Brain, William,C, Mc Elligot, *Value Management Construction*, McMillan Press Ltd, London, 1995.

[8] Ahuja., Hira, N., and Michael A Walsh, *Successful Methods in Cost Engineering*, A Wiley Interscience Publication, New York, 2000