Volume 4 Issue 1 July 2016 ISSN: 2321 – 788X

A STUDY ON APPLICATION OF VALUE ENGINEERING IN RESIDENTIAL BUILDING PROJECTS

M. Ravish[1] and K. Vinoth[2]

[1]M.E (CEM), Department of Civil Engineering,
Mahendra Institute of Engineering and Technology, India
[2]Assistant Professor, Department of Civil Engineering,
Mahendra Institute of Engineering and Technology, India

Abstract

Value engineering is a combination of technical and economic subjects. It is committed with the lowest life cycle cost and reliable completion of the functions required by the user. Value engineering is essentially a process which uses function analysis, team- work and creativity to improve value. Value Engineering can be applied during any stage of a project's design development cycle. It has an important influence and function to promote the traditional product value innovation, cultivate and develop the enterprise's core competitiveness, and promote national economic and social sustainable development. This project analyzes the current situation of construction project management and problems based on an overview of relevant theory of value engineering and construction project management. It Points out the importance of value engineering. Finally analyzes the application of value engineering to construction projects in various stages of the life cycle.

Introduction

The construction industry is the second largest industry after agriculture in India. It makes a significant contribution to the national economy and provides employment to large number of people. The use of various new technologies and deployment of project management strategies has made it possible to undertake projects of mega scale. In its path of advancement, the industry has to overcome a number of challenges. However, the industry is still faced with some major challenges, including housing, disaster resistant construction, water management and mass transportation. Recent experiences of several new mega-projects are clear indicators that the industry is poised for a bright future. It is the second homecoming of the civil engineering profession to the forefront amongst all professions in the country. The construction industry has contributed an estimated Rs.6708 billion in 2011-12. The industry is fragmented, with a handful of major companies involved in the construction activities across all segments; medium sized companies specializing in niche activities; and small and medium contractors who work on the subcontractor basis and carry out the work in the field. In 2011, there were slightly over 500 construction equipment manufacturing companies in all of India. The sector is labor-intensive and, including indirect jobs, provides employment to more than 35 million people.

Value Engineering (VE) is an intensive, interdisciplinary problem solving activity that focuses on improving the value of the functions that are required to accomplish the goal, or objective of any product, process, service, or organization.

Value = Function/Cost

Historical Background

The process of value engineering was developed during World War II by Lawrence Miles, an electrical engineer for General Electric Company, in response to material shortages created by the war. The war production effort still required products to be manufactured but the material shortages forced the specification of different materials. Lawrence Miles discovered that many of the products being produced with the substituted materials performed the equivalent function of the original product and at a reduced cost. In reviewing these cost reductions, Miles determined that if an organized team approach was established to review product designs and specifications, unnecessary costs within the production of a product could be eliminated. In the 1950‘s, Miles developed the organized team approach known as the job plan which has become the framework to any formal value engineering study.

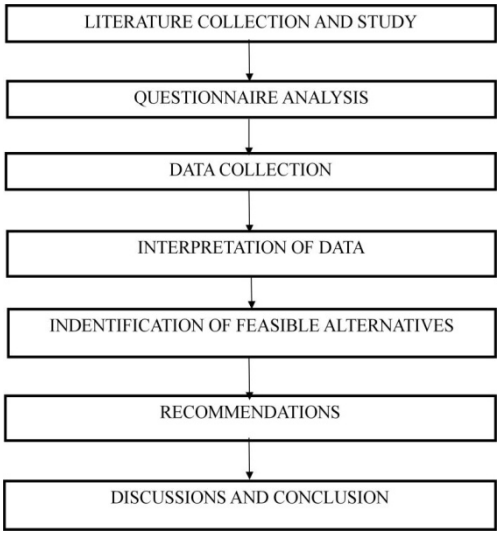
Research Methodology

This elucidates 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. Value Engineering is a proven management technique using a systematized approach to seek out the balance between the cost, reliability and performance of a project or a product. The program seeks to improve the management capability of people and to promote progressive change by identifying and removing unnecessary cost. It has several techniques that serve as the tool kit of the value analyst. There are three stages in VE which are

- Pre – workshop
- Workshop
- Post – workshop

Pre – workshop stages involves the value study, selection of case study and collection it‘s data. Workshop stages consists of five phases which are informative phase, speculation phase. Judgment phase, development phase, recommendation phase, where the plan goes though scrutiny and the best possible solution is arrived at. In post-workshop, the suggestion and implementation for future project will be done.

Method used for conducting the study is shown in figure below:



Project Details of Study

This discusses about the case study of residential building (Nana Nani phase-3 Apartment) located at Dhaliyur, Coimbatore. This project is recently completed building and necessary data shown in Appendix B has been collected from the organization required for this study. Table 1 shows the basic details of the project. This building includes parking plus four floors and terrace with total area of 47,718.00 sq.ft. The total cost for construction of this building is Rs.6,61,82,000.00 and the duration of this project is eleven months. This particular project was considered for case study, because all the floors are typical. Thus the scope for application of value engineering is very high. The recommendations given for this project could be considered for other project units to achieve maximum value. The drawings and the detailed cost estimation of this project were collected. The more details required for this study will be collected from the organization through meeting or interview.

Table 1 Basic Details

Client	Nana Nani apartments
Contractor	Sivasakthi builders
Type of contract	Lump sum contract
Total area	47,718 sq ft
Cost of the project	Rs.6,61,82,000.00
Project duration	11 months

Details of Case Study

Table 2 Area details

Numbers of floors	Five floors
Stilt floor area	8760 sq ft
First floor area	9739.5 sq ft
Second floor area	9739.5 sq ft
Third floor area	9739.5 sq ft
Fourth floor area	9739.5 sq ft
Type of structure	RCC

The above table 2 shows the total number of floors in the project. The stilt floor is used as a parking facility for the building which is made of 8760 sq ft. The first floor is made of 9740 sq ft and other three floors are typical as the first floor in design and space. Terrace is also included in the building design above fourth floor. The structure is rcc type structure.

The cost of each floor will be shown in table 5.1 below. Although except stilt floor every floor are same in design but the cost of the floors from one to four was different because of lifting charge of materials increases for every upper floors.

Result and Discussion

General

The chapter provides an insight into various aspects of information Phase and Functional Analysis Phase – techniques like Decision matrix analysis are used with the procedures involved with implementation of the same in the case study.

Investigation 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 (Topology, Soil condition, Soil boring, Surrounding areas, Photographs)
- Background of the project
- Available resources
- Requirements resulting from public participation
- Breakup of cost estimated.
- Architectural, structural, service and other drawings

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. There are many evaluation criteria for assessing value which are Initial cost, Energy cost, Return on profit, Functional performance, Reliability, Ease of maintenance, Quality, Sale ability, Regard or aesthetics and Environment owner requirements Safety. Quality model is described as a quantitative description of the owner requirements. Quality models have been a research topic for several decades and a large number of quality models have been proposed 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, 4 for poor, 6 for average, 8 for good and 10 for very good. The Figure 1 below shows the graphical representation of quality model of the case study in which the solid blue line represents the owner‘s expectation collected by interviewing the owner and the dotted red line shows the design parameters which is done by analyzing the case study.

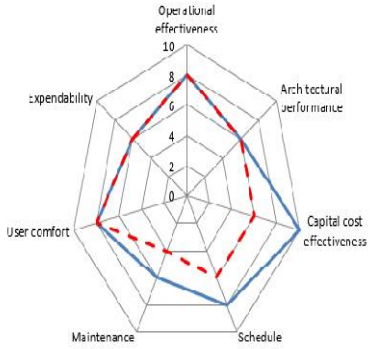


Figure 1 Quality Model

Implementation of Functional Analysis

All the components of the building under consideration were listed, with their cost as in uniformat presentation.

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.

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. Table 1 below shows the proposed Uniformat cost model and its relationship with the traditional master format. Each item in the Uniformat is estimated and may include many elements of the master format.

Techniques used in Functional Analysis

Functional Analysis Phase disintegrates the system or project into small components and searches for function that each facility or element performs.

As explained earlier, the project can be based on hierarchy of function level. But in large complex projects, this gets increasingly difficult. Also in many cases, there may be unnecessary functions with respect to the scope of study.

The techniques used for functional analysis phase is

- Decision matrix analysis

Decision Matrix Analysis

This is a technique, which is based on the concept of Function Analysis for the purpose of evaluation of the functions. Through this technique the interrelationship among the function and their hierarchical older can be very well identified.

After the function defined has been done and the function definition worksheet is ready, this technique starts. In our case study we have followed this technique for doing our analysis.

To do the ranking of all the alternatives and the 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.

Major difference in preference : 3
Minor difference in preference : 2
No difference in preference : 1

In decision matrix analysis technique, all the functions that were performed by various elements of the building were listed as shown in table. Each one of the criteria was

compared with all other criteria and they were scored based on the priority in comparison with others. For example, initial cost having the symbol A was compared with schedule having the symbol B. To facilitate foundation was given more priority compared to exclude elements. Hence a rating —A1 was given. The magnitude of priority was thought of to be 1. Hence, in the intersection of A and B, A1 was indicated. Once the scoring for the entire criterion was determined, all the scores of individual symbols were added to get the total raw score and a ranking based on the scores. To derive the weighted score, the lowest raw score was given 1, the highest was given 10. All other criteria scoring in-between were interpolated to get the weighted score as shown in below table.

Table 2 Function Codes

Code	Item	Weighed score
A	Initial cost	12
B	Schedule	11
C	Aesthetics	6
D	Maintenance	2
E	Durability	2
F	Availability	1
G	Efficiency	3

The Table 2 above shows the codes for each functions used to rank the alternatives and their weighed score is also mentioned. The weighed scores for these functions are calculated by comparing with each other alternatives as shown in the table 3 below.

Table 3 Evaluation of Functions

	A	B	C	D	E	F	G
A		A1	A2	A2	A2	A3	A2
B			B2	B2	B2	B3	B2
C				C1	C1	C3	C1
D					D1	D1	G1
E						E2	F1
F							G2
G							

Speculation of Case Study

The main objective in this phase is to be creative and brainstorm alternate proposals and solutions. Many techniques are available to stimulate creative thinking that may be applied during this phase. These techniques foster the concept of creativity in the human minds through psychological approach.

This chapter describes various creative techniques used in the Value Engineering, and implementation of creativity in the case study. The various alternatives that can perform the same function that were identified in the case study are indicated.

Implementation of Speculation Phase in Case Study

In our Value Engineering study of the Speculation Phase, we have used the Brainstorming Technique. For each item and function separate worksheets have been prepared. Constant ranking of ideas is done at every stage. Alternative methods are tabulated in the worksheet of each item and the quantity of ideas is alone taken in to consideration. The worksheet for each item and function are tabulated as follows. Items under consideration are external walls, partition walls, windows, water tanks and sunshades, parking floor, terrace floor, plastering, painting and putty works.

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 of. 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.

Development and Recommendation in Case Study

Table 4 Proposals of Value Engineering for the Case Study

S. No	Proposed idea	(-)Reduction /(+) Increase in cost (Rs)	% of improvement in schedule	Remarks
1.	AAC blocks masonry for all external walls	+1,24,000	35	3 times lesser in weight, thermal resistant, eco friendly
2.	Ferrocement walls for partitions walls	-1,14,000	30	Cost effective, speedy process

3.	UPVC windows	-1,01,000	18	Facilitate better use, increased life and reduce air conditioning cost
4.	Ferrocement for water tanks and sunshades	-59,000	50	Cost effective, speedy process, low materials used
5.	Use of Shahabad tiles in parking and drive way area	-76,000	No Change	Cost effective and same aesthetics can be achieved
6.	Terracotta tiles in terrace area	-83,000	No Change	Cost effective, Aesthetically pleasing
7.	Plastering pump for Plastering	-5,61,000	40	Cost effective, saves labour problems
8.	Spraying method for putty and paint works	-3,23,000	30	Cost effective, saves labour problems
Total savings of the project		**11,94,000**	**26**	

The many ideas that have evolved from the Evaluation Phase are meticulously developed in this Phase. Table 4 shows the savings and improvement of schedule after the application of recommended alternative material and techniques in the collected projects and last column shows the advantages of using the recommended specific alternatives. The last row shows the total savings and improvement in schedule of the total project after the application of recommended alternatives.

Conclusions and Scope for Future Work

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. The alternatives and currently existing facilities were evaluated by conducting a fairly detailed rate analysis, technical feasibility and aesthetic survey. The key areas where Value Engineering has been applied are External walls, Partition walls, Windows, Water tanks and sunshades, Parking floor, Terrace floor, Plastering and Painting and putty works With the development of the proposals and by projecting the increased values, the Value Engineering study comes to an end.The external walls have been replaced by high quality, durable and light weight AAC blocks. It provides increased comfort to user of the building as they are thermal resistant; meaning the temperature inside is lesser compared to

external temperature. The partition walls, water tanks and sunshades has been replaced by durable, less thickness, less corrosion, fire resistant and water resistant ferrocement. UPVC windows have been recommended as they have increased life, provide 100% opening, reduces air condition cost, extremely beautiful compared to sal wood windows. The materials are not only changed also the techniques are changed. For plastering plaster pump and for painting and putty works spraying method is used which reduced labour cost and time. These are some of the value-engineered elements that are believed to provide more comfort to the ultimate user without compromising on the quality, time or cost. 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, value engineering 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. Abdulaziz S and Al-Yousefi (2009), "Value Engineering application benefits in Sustainable Construction"
2. Akintola Omigbodun (2001)," Value Engineering and Optimal Building Projects" Journal of Architectural Engineering, June 2001, P.40-43
3. Amiruddin Ismail et al., 2010. "Value Engineering Application in Highway Projects" American J. of Engineering and Applied Sciences 3 (4): P.699-703, ISSN 1941-7020
4. Amit sharma and Dr.R.M.Belokar (2012), "Implementation of Value Engineering" IJMFSMR, Vol.1, No.3, ISSN 2277 3622
5. Amit Sharma and R.M. Belokar (2012), "Achieving Success through Value Engineering" Proceedings of the World Congress on Engineering and Computer Science 2012 Vol II, WCECS 2012, October 24-26, 2012, San Francisco, USA
6. Amruta Chougule et al., 2014. "Application of Value Engineering Technique to a Residential Building" IJIRAE, ISSN: 2349-2163, Volume 1, Issue 12
7. Ayodeji Emmanuel Oke and Deji Rufus Ogunsemi (2009), "Value Management in the Nigerian Construction Industry" Second International Conference on Advances in Engineering and Technology
8. Chougule Mahadeo Annappa and Dr. Kallurkar Shrikant Panditrao (2014), "Application of Value Engineering for Cost Reduction of Household Furniture Product" IJIRSET, Vol. 3, Issue 10, P.77-83
9. Chung-Fah Huang et al., 2011. "Applying Value Engineering to Evaluate the Use of Concrete in an Underground Railway Construction Project" IEEE, 978-1-61284-459-6/11
10. Dr. Michael A. McGinnis et al., 2005. "Value Analysis and Value Engineering"
11. Dr.V.Paranthaman and V.Bharathi (2014), "Application of Value Engineering In Building Construction" Indian Journal Of Applied Research, Volume 4, Issue: 4, ISSN - 2249-555X, P.135-138

12. Eng. Abeer Khalid Mansour and Dr. Mohammed Abueusef (2015), "Value Engineering in Developing Countries" International Conference Data Mining, Civil and Mechanical Engineering (ICDMCME'2015), P.101-104, Bali (Indonesia)
13. Eng. Dina Mahmoud Mansour et al., 2013. "Value Engineering Analysis in the Construction of Box-Girder Bridges" IJLTET, Vol. 2 Issue 4, ISSN: 2278-621X
14. F. Rangelova and M. Traykova (2014),"Value Management in Construction Project" Project Management in Construction, P.429-434
15. Francisco Loforte Ribeiro (2009),"Appraisal Of Value Engineering In Design In Portugal" Association of Researchers in Construction Management, Vol. 1, 277-86.
16. Hongping Wang and Xuwei Li (2013)," The Application of Value Engineering In Project Decision-Making" Journal of Chemical and Pharmaceutical Research, 2013, 5(12):714-720
17. Ibrahim M. Mahdi et al., 2015. "State of the Art Review on Application of Value Engineering On Construction Projects: High Rise Building" IJIRSET, Vol. 4, Issue 5,
18. Jillian K Seidel (2012),"Value Engineering Trends in the Construction Industry" Construction Systems Management Program of the Ohio State University, P.1-14, Journal of Traffic and Transportation Engineering, ISSN 2328-2142, USA
19. Larry Jung-Hsing Lee et al., 2009. "Application Of Value Engineering And Six Sigma Methodologies To The ERP Systems Implementation"
20. Michael D. Dell'Isola (2003), "Value Analysis" Supplemental Architectural Services, P.1-10
21. Miss Apurva J Chavan (2013),"Value Engineering In Construction Industry" IJAIEM, Volume 2, Issue 12, ISSN 2319 – 4847, P.18-26
22. Nayana Tom and V. Gowrisankar (2015), "Value Engineering In Residential House Construction" IJCIET, Volume 6, Issue 6, Pp. 46-52
23. Ong Hock Tek (2009), "Quality And Value Management In Construction" Pro-Value Management, Malaysia
24. R Bharat (1994), "Value Engineering - A New Concept In Reducing Cost Of Burn Care" Dept. of Burns and Plastic Survey, P.59-62
25. Rahim Aminzadeha et al., 2011. "Development Value Engineering Modeling in Construction Transportation" Australian Journal of Basic and Applied Sciences, 5(12): 397-402, 2011, ISSN 1991-8178
26. Senay Atabay and Niyazi Galipogullari (2013),"Application of Value Engineering in Construction Projects" Dec. 2013, Volume 1, No. 1 (Serial No. 1), pp. 39-48
27. Seyed Ali Mousavi Dehmourdi and Tareq Poormehdi Ebrahimi (2014), "Value Engineering and Reason of Unnecessary Cost in Construction Industry" IJSETR, ISSN 2319-8885 Vol.03,Issue.12, Pages:2699-2702
28. Srinath Perera et al., 2003. "Application Of Value Management In Construction" Built-Environment-Sri Lanka -Vol. 04, Issue 01:2003
29. T. Watson (1997), "The Use of Value Engineering Techniques in the LHC Civil Engineering Contracts"
30. Tobias Walk (2012), "Value Engineering Approach to Increase Cost Efficiency" Technical Report Engineering and Construction, P.50-53