A STUDY ON USING VALUE-ENGINEERING FOR BUILDING A MANAGEMENT SYSTEM FOR EVALUATING THE SECURITY-PROJECTS

SHAIK AFSHA TABASSUM[1], P.RAVI[2]

[1] M.Tech Student, Dept. of Civil Engineering inGlobal College of Engineering and Technology, Rayalapanthulapalle, KADAPA, AP.

[2]Assistant professor, Dept. of Civil Engineering, Global College of Engineering and Technology, Rayalapanthulapalle, KADAPA, AP

ABSTRACT:

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 thecountry

Construction projects are implemented in different countries with heavy costs and some of the projects have been relatively or absolutely unsuccessful and even faced with irreversible losses after construction. Maybe, it is due to complexities related to projects or other social- economic phenomenon. The present study revealed that value engineering can be used as a helpful tool from the beginning of studies to the end of designing, constructing, exploiting, and maintaining processes and overcome civil designs' challenges and complexities. Value engineering is a method experienced in management that has an organized approach. Value engineering has a systematic and cooperative mechanism to analyze function and systems with the aim of achieving desirable function with the least costs. This study has attempted to briefly introduce concepts and executive process of value engineering in construction projects. Also, the study has attempted to investigate conventional methods of evaluating projects function and compare them convergence with value engineering to improve projects. Based on the research findings, it can be found that if we can expect to achieve projects objectives by spending the least cost and ensure the efficacy of investment in construction projects management sector as a main challenge of development plans in the third world countries through using engineering in appropriate time periods and in differentphases.

I. INTRODUCTION

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.

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

VE is a systematic, low-cost approach to assessing the "value" of a project. Typically, VE on projects can be used to gain the following benefits

- cost reductions;
- time savings (schedule savings);
- quality improvements;
- isolation of design deficiencies.

THE BENEFITS OF A VALUE ENGINEERING WORKSHOP

The time invested in a value engineering workshop produces impressive results. Held during the initial planning stages, the time spent on the workshop has little impact on the final project schedule and redesign costs. The independent team brings a fresh perspective to the project based on their professional construction experience. Clients who defined the initial criteria for value in the information phase experience increased satisfaction with the finished product at a reduced overall project cost. In the end, the project generally has fewer changes and delays throughout the construction process and greater functionality and value for the end client.

Although value engineering began as a cost-saving measure, it is becoming a valued project management technique that addresses all aspects of the building lifecycle from the initial construction through the sustainability of sourced materials and utility efficiency of the final project. The project team can bring positive environmental and social impact solutions to the table including methods for reducing the carbon footprint of transportation, building, and operation as well as suggestions that positively affect the safety and wellness of the surrounding community.

SIGNIFICANCE OF THE STUDY

Ascertaining the final price and the definite date of the project completion and implementation of the projects as EPC which provides the ground for assurance of the finalized price of project and the time for completing is among the needs of today's market. The reason for the turning of this project to EPC is also the same project.

On the other hand, the most important aim in the project management is the completion of the project with minimum cost and in the specified time with observing the qualitative issues and without implementation difficulties. Since value engineering is a group work and have systematic method that by collecting views and evaluating it and finally choosing best idea can lead to reduction of costs with increase or at least maintenance of quality, so using a combination of value and risk engineering in EPC projects became necessary and identifying barriers to it and removing them becomes important which is the subject of this research.

Now, if we could apply the EPC process in the hydroelectric power plant of Kohkilooyeh and Boyer Ahmad as a sample of civil project, we may see good results including easier implementation, reduction of costs, reducing time and increasing quality. Managers of civil projects at different levels talk about the importance and necessity of value engineering and risk engineering, but it is less seen they use value engineering and risk engineering in their projects. In a few projects, either the value engineering or risk engineering is used. Conducting either of them as implementing it separately cause that each of them does not have the required efficiency. And in practice, the project managers pay less attention to them. If a process could be used in which both value engineering and risk engineering could be included and this joint process, by a team is managed and implemented, not only the efficiency of each is increased but also it leads to more use in implementing projects.

In general, the aim of doing this research project is to analyze the results of using the value engineering project as a management tool in order to continuously optimize the projects either from the aspect of cost reduction, time reduction and, or increase the quality and other necessary indicators of implementation such as quality, feasibility, speed, and security so that, by using the results of this study, we can create an applied pattern to use in civil projects.

OBJECTIVE OF THE PROJECT:

Value engineering is often done by a step by step methodology. The following is the step by step procedure used:

Visit a site

- Identify all the functions, cost, time taken by individual elements in a Project.
- Prepare a Checklist for each and every element.
- Prepare a Tabular Format to note down all the information regarding every element.
- Process the data collected in PRIMAVERA
- Identify the main elements among them.
- Develop alternative solutions for delivering those functions
- Generate a report from PRIMAVERA comparing the variation obtained after using alternative materials

II LITERATURE REVIEW

- Apurva studied on Value Engineering in

Construction Industry. This paper presents the basic fundamental of Value Engineering and its different phases that can be implemented in any construction industry in general to optimize its value. The material is chosen such that the cost is reduced without affecting the value of the product and its design. A study by Amruta

- Chouguleet.al., on Application of Value Engineering Technique to A Residential Building –Case Study. They have applied values engineering in a residential building. The application of Pareto Law 20/80 states that around 20 % of the functions constitute around 80% of the cost. These functions (20%) are the subject of value engineering. Likewise they observed that the first 6 items (out of 16) forms 61.53% of the total cost. As a conclusion, the area of value engineering analysis and study will be controlled by the first six functions. Further, they told that we can do analysis of these functions and suggest alternatives and calculate cost model after application of value engineering technique.
- Another study on Application of Value Engineering in Road Construction Project by SayaliDhayalkar and HemanshuAhirehave discussed the concept of Value Engineering and the effective implementation on road construction project. Their application of Pareto Law 20/80 states that around 20 % of the functions constitute around 80% of the cost. These functions (20%) are the subject of value engineering. Likewise it was observed that the first 3 items (out of 13) forms 73.3% of the total cost. As a conclusion, the area of value engineering analysis and study will be controlled by the first three functions.
- Rane and Attarde studied on Application of Value Engineering in Commercial Building Projects. Their methodology is composed of three main stages. The first stage is the Pre-Study of the Value Engineering. The second stage is the Value Study which is the core of Value Engineering study and it is composed of five phases, the Information phase, Function Analysis Phase, Creative Phase, Evaluation Phase and the Presentation phase. The third stage is the Post Study. The objective during post-study activities is to assure the implementation of the approved value study change recommendations. In this study, the principles of Value Engineering and the application in construction projects is explained, and by taking case study on commercial building as the sample project, practices of Value Engineering in this project are described. They concluded that the area of value engineering analysis and study will be controlled by the functions.
- Li Ning carried out a study on Cost Control Application Research of Value Engineering in the Design Phase of Construction Project. In his paper, based on this perspective, applies value engineering to the project design to meet the requirements of continuously put forward the development of the real estate design and makes the value engineering meet the requirements of developing value engineering theory at the same time.
- Stephen Mansfield and Philip D. Udo-Inyang, Application of Value Engineering within the Construction Industry The current perception and application of value engineering was established through a survey questionnaire sent to various members of the construction industry which asked detailed questions on the participants' knowledge and experience with value engineering. Results were analyzed which indicated that the majority of the survey participants do not participate in value engineering studies and do not understand the true concept of value engineering even though eighty-four percent of the participants stated positively that value engineering is performed on the projects in which they are members of the project team.
- "Construction projects in the United Arab Emirates are no different from the point of views of having to react to change. Hence 'change orders' or 'variations' to planned works are a common occurrence", Nadem.
- Kelly, Male and Graham, recognised that while the greatest benefits of Value Engineering accrue during the design phase, the site operations stage is also recognised as relevant, particularly the construction project planning stage. As 'changes' during construction will almost certainly require adjusting the project plan, the case for reviewing Value Engineering at this stage becomes a logical consequence.

III METHODOLOGY OF VALE ENGINEERING AND TECHNIQUES

RESEARCH METHODOLOGY

It has been understood from the literature review that selecting the ways of analyzing VE plays an important role. The value engineering is a set of procedure or an immense performance related application to it in the construction job site. Further, the project development and success mainly depends on the methodology that is selected to attain the objective. Clearly identify the problem(s) to be solved, and gather information on the background, functions and requirements of the project. Clearly identify the problem(s) to be solved, and gather information on the background, functions and requirements of the project. Understanding the basic concept of value engineering is the important term in correlating the process of value engineering methodology. The orientation also deals with the process of applying in industries and analyzing it in better predominant manner, In this study, a set of questions were put together as a full format and it has been correlated into a questionnaires. The questions are only based on the awareness that every construction industries posses on value engineering and how VE is implemented in their industry, how team members are selected for VE, Benefits of implementing VE , training or workshop in VE, etc. Steps involved in the delegation of authority involving in the industry. After preparation of questionnaire a pilot study was conducted to find out any problem in the prepared questionnaire

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

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 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.

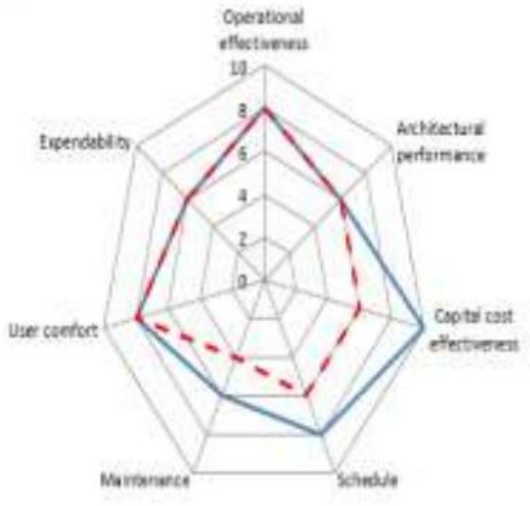


Fig.: Quality model

VALUE ANALYSIS

Lawrence Miles conceived of Value Analysis (VA) in the 1945 based on the application of function analysis to the component parts of a product. Component cost reduction was an effective and popular way to improve "value" when direct labor and material cost determined the success of a product. The value analysis technique supported cost reduction activities by relating the cost of components to their function contributions.

Value analysis defines a "basic function" as anything that makes the product work or sell. A function that is defined as "basic" cannot change. Secondary functions, also called "supporting functions", described the manner in which the basic function(s) were implemented. Secondary functions could be modified or eliminated to reduce product cost.

As VA progressed to larger and more complex products and systems, emphasis shifted to "upstream" product development activities where VA can be more effectively applied to a product before it reaches the production phase. However, as products have become more complex and sophisticated, the technique needed to be adapted to the "systems" approach that is involved in many products today. As a result, value analysis evolved into the "Function Analysis System Technique" (FAST) which is discussed later.

FUNCTION ANALYSIS SYSTEM TECHNIQUE

Function Analysis System Technique is an evolution of the value analysis process created by Charles Bytheway. FAST permits people with different technical backgrounds to effectively communicate and resolve issues that require multi-disciplined considerations. FAST builds upon VA by linking the simply expressed, verb-noun functions to describe complex systems.

FAST is not an end product or result, but rather a beginning. It describes the item or system under study and causes the team to think through the functions that the item or system performs, forming the basis for a wide variety of subsequent approaches and analysis techniques. FAST contributes significantly to perhaps the most important phase of value engineering: function analysis. FAST is a creative stimulus to explore innovative avenues for performing functions.

The FAST diagram or model is an excellent communications vehicle. Using the verb-noun rules in function analysis creates a common language, crossing all disciplines and technologies. It allows multi-disciplined team members to contribute equally and communicate with one another while addressing the problem objectively without bias or preconceived conclusions. With FAST, there are no right or wrong model or result. The problem should be structured until the product development team members are satisfied that the real problem is identified. After agreeing on the problem statement, the single most important output of the multi-disciplined team engaged in developing a FAST model is consensus. Since the team has been charged with the responsibility of resolving the assigned problem, it is their interpretation of the FAST model that reflects the problem statement that's important. The team members must discuss and reconfigure the FAST model until consensus is reached and all participating team members are satisfied that their concerns are expressed in the model. Once consensus has been achieved, the FAST model is complete and the team can move on to the next creative phase.

FAST differs from value analysis in the use of intuitive logic to determine and test function dependencies and the graphical display of the system in a function dependency diagram or model. Another major difference is in analyzing a system as a complete unit, rather than analyzing the components of a system. When studying systems it becomes apparent that functions do not operate in a random or independent fashion. A system exists because functions form dependency links with other functions, just as components form a dependency link with other components to make the system work. The importance of the FAST approach is that it graphically displays function dependencies and creates a process to study function links while exploring options to develop improved systems.

CREATING A FAST MODEL

The FAST model has a horizontal directional orientation described as the HOW-WHY dimension. This dimension is described in this manner because HOW and WHY questions are asked to structure the logic of the system's functions. Starting with a function, we ask HOW that function is performed to develop a more specific approach. This line of questioning and thinking is read from left to right. To abstract the problem to a higher level, we ask WHY is that function performed. This line of logic is read from right to left.

There is essential logic associated with the FAST HOW-WHY directional orientation. First, when undertaking any task it is best to start with the goals of the task, then explore methods to achieve the goals. When addressing any function on the FAST model with the question WHY, the function to its left expresses the goal of that function. The question HOW, is answered by the function on the right, and is a method to perform that function being addressed. A systems diagram starts at the beginning of the system and ends with its goal. A FAST model, reading from left to right, starts with the goal, and ends at the beginning of the "system" that will achieve that goal.

The FAST diagram can be expanded into a lower level of abstraction in the area under investigation. The steps involved are as follows:

1. Use QFD to translate higher-level customer needs to subsystem technical characteristics.
2. Create FAST diagram at lower level of abstraction for targeted mechanism/subsystem.
3. Prepare a FAST diagram & develop the product concept in conjunction with the QFD concept selection matrix
4. Dimension the system in the FAST diagram into assemblies/parts or identify the assemblies/parts needed to perform the given function.
5. Develop value analysis matrix at a lower level of abstraction for the targeted subsystem. The "what's" or system requirements/function in the value analysis matrix are derived from either a customer (vs. technical) FAST diagram or by selecting those function statements that correspond to the customer needs or technical characteristics in the subsystem planning matrix.
6. Complete the value analysis matrix and identify high cost to value mechanisms by

comparing the mechanism target costs to the mechanism estimated/actual costs

Case study

Value engineering is applied to the shreenath enclave offices complex, nashik by using following value engineering job plan phases.

- Information Phase
- Creative Phase
- Evaluation Phase
- Development Phase
- Presentation Phase

A. Information phase:

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 users.

B. Creative phase:

In our value engineering study of the creative phase, we have used the brainstorming techniques. During brainstorming the various problems are identified that may affect the cost, time, quality and quantity of work and also durability of construction. These problems were mainly identified on the basis of construction material cost saving without compromising the quality of work. The main problems identifies were,

1. As river sand is the basic component for preparation of concrete for r.c.c work, as it is required in bulk quantity in the construction project. But from the recent study in the nashik region, it has been found that there is shortage for availability of river sand because of various reasons due to which price for river sand has hiked.

2. For any concrete structure, reinforcement is as important as concrete also it is required in huge quantity in construction project. So, in the overall material cost reinforcement costing is considered as a major cost. To overcome these identified problems various alternative value engineering technique are analyzed and quantified for achieving benefits in the terms of cost reduction, quality of work and time saving.

Ve techniques that can be adopted are,

1. As river sand has shortage for its availability so use of crush sand can be an alternative as it is much cheaper than river sand. Investigation carried out by varying 0 to 100% replacement of natural sand with manufactured sand with increment of 20 % and in critical zone the increment is of 10 % in m25 mix. The compressive strength was determined at 7, 14 and 28 days.

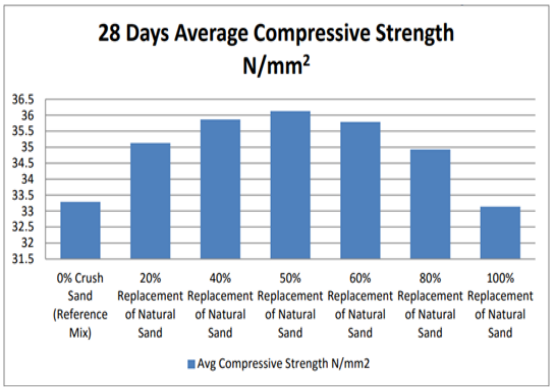
2. For reducing the quantity of reinforcement at the execution stage, use of reinforcement couplers can eliminate the method of lapping of bars. Moreover, reinforcement couplers give higher strength than lapping of bars at a feasible cost. Investigation carried out for 16, 20 and 25 mm diameter samples by calculating ultimate tensile stress by using universal testing machine.

C. Evaluation phase:

1. Use of crush sand instead of river sand the experimental work of use of crush sand instead of river sand was initiated with characterization of the locally available materials used for the making of concrete. Prior to starting the experimentation, mix design of m25 were carried out as per is 10262-2009. Design mixes as shown in table 4.1 the standard cast iron cube moulds of size 150 x 150 x 150mm are casted and compacted on vibrating table. The compressive strength of specimens is determined after 7, 14 and 28 days. The change in compressive strength of the sample for 28 days is shown in table 1.2 respectively. A graphical representation of this result is shown in graph

Comparison of compressive strength for 28 days

Concrete Mix Crush Sand : Natural Sand	Average Compressive Strength (Mpa)	% of Variation With Respect to Control Concrete
00:100 (Reference Mix)	33.29	-
20:80	35.13	5.53
40:60	35.87	7.75
50:50	36.13	8.53
60:40	35.79	7.51
80:20	34.93	4.93
100:00	33.14	-0.45



M25 Concrete mixes with varying % of crush sand for 28 days

Average tensile test result for 16,20 and 25 mm diameter rebar for splicing

Results				Requirement as per I.S. 1786-2008
Diameter of Bar	16	20	25	
ID Mark	SHREE OM-500 TMT	SHREE OM-500 TMT	SHREE OM-500 TMT	
Sectional Weight (kg/m)	1.581	2.441	3.831	
Cross sectional Area (mm^2)	201.47	310.96	488.02	
Gauge Length (mm) 5.65√A	80.00	100.00	125.00	
0.2% Proof Stress Obtained (N/mm2)	547.70	522.10	548.77	> 500
Ultimate tensile stress (N/mm^2)	638.07	618.87	642.90	> 545
% Elongation	17.76	16.19	16.21	> 12
Distance of Fracture from Centre of Coupler (mm)	20.80	25.80	32.04	
Remark	Bar broken outside the splice joint	Bar broken outside the splice joint	Bar broken outside the splice joint	

V CONCLUSIONS

It resulted that, using 50% crush sand in concrete for R.C.C. work instead of river sand; cost is reduced by 3.90% for 1 Cu.m. of designed M25 mixes of concrete. Instead of using lapping of bars, use of reinforcement couplers resulted that cost is reduced by 47.95% for 16 mm diameter bars, 49.39% for 20 mm diameter bars and 58.09% for 25 mm diameter bars. The results showed that the use of coupler instead of lapping of bars can be considered one of the most important methods of the new construction techniques, which achieves the best savings in the cost and time. The case study indicates that the proposed value engineering technique can be successfully applied to a real construction project. The proposed technique greatly assists the decision making process to the owner, designer, and the contractors. In addition, this method can be used for the evaluation and selection of any construction system by following the procedure presented in this research.

1. Value Engineering is a proven management technique that can make valuable contributions to value enhancement and cost reduction in construction industry.
2. Value engineering can improve decision-making that leads to optimal expenditure of owner funds
3. Best time for conducting value engineering study is during the design and planning stage of project
4. Information phase very important, decisions on idea selection may vary upon the relevancy of the information collected.
5. Functional Analysis Systems Technique (FAST) diagramming tool provide systematic roadmap to identify main functions of project.
6. Value engineering is not just about reducing the costs, but increasing the design standards, making it easier to build the project and saving time and money.
7. Value Engineering application deliver better quality, faster completion, environmentally friendly practices, and less waste generation. 8. About 5% to 10% reduction in construction cost can be achieved using value engineering in building construction.

REFERENCES

- Ahmed AlBughdadi, AmrFathy, Ibrahim Abotaleb, Mohamed Abdelghany, RachaRahwan, (2015), "Value Engineering Applications to Improve Value in Residential Projects", Conference Paper, May 27–30, 2015.
- DarshanParakhiya, Jitendra Patel (2017), "Application of Value Engineering in Construction Project: Case Study on Residential Project in Ahmedabad", International Journal for Scientific Research & Development (IJSRD), ISSN: 2321- 0613, Volume 5, Issue 2
- Ferry Firmawan, Fadil Othman, KhairulzanYahya (2012), "Improving Project Performance and Waste Reduction in Construction Projects: A Case Study of a Government Institutional Building Project", International Journal of Technology, ISSN 2086-9614, Volume 2, PP 182-192.
- Abdulaziz S and Al-Yousefi (2009), "Value Engineering application benefits in Sustainable Construction"
- AkintolaOmigbodun (2001)," Value Engineering and Optimal Building Projects" Journal of Architectural Engineering, June 2001, P.40-43
- 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