Value Engineering in Construction Projects

The Purpose of Preparing this Research is to Changing the engineer's address from a metaphorical engineer to a consulting engineer

Prepared by: Diyari Abdoul Ali

ID Cart 6171

Abstract:

The current economic conditions have entailed the use of rational method and techniques and research and application of new techniques by utilizing advancements in technology in the field of Construction as well as in every field. Excess cost control requires to be maintained throughout the project life of building beginning from the initial stages of design. Scrutinizing the project well and considering all possible alternatives particularly in design stage are important for achieving optimum cost. In this study, how the principles of VE (value engineering) are applied in construction projects is explained.

Introduction

This Research deals with several concepts that will help improve value in the design and construction phases of a project. These are value engineering, constructability, and quality management. The essence of each of these concepts is as follows:

• Value engineering — To deliver the required functions of a component or product at lowest cost while meeting quality, performance, and reliability specifications.

• Constructability — To integrate construction knowledge and experience in project planning, design, and execution to better achieve project outcomes.

• Quality management — To deliver quality with the view of customer satisfaction in all operations.

Each of these concepts involves systematic approaches and will require some changes in management perspectives to fully realize the benefits from their implementation. The key principles for each of these concepts will be elaborated in turn.

VE (value engineering) was developed at General Electric Corp. during World War II and is widely used in industry and government, particularly in areas such as defense, transportation, construction and healthcare.

VE is an effective technique for reducing costs, increasing productivity and improving quality. It can be applied to hardware and software; development, production and manufacturing; specifications, standards, contract requirements and other acquisition program documentation; and facilities design and construction.

VE is defined as “an analysis of the functions of a program, project, system, product, item of equipment, building, facility, service or supply of an executive agency, performed by qualified agency or contractor personnel, directed at improving performance, reliability, quality, safety and life cycle costs”. It may be successfully introduced at any point in the life-cycle of products, systems, or procedures.

VE is a technique directed toward analyzing the functions of an item or process to determine “best value”, or the best relationship between worth and cost. In other words, “best value” is represented by an item or process that consistently performs the required basic function and has the lowest life-cycle cost. In this context, the application of VE in facilities construction can yield a better value when construction is approached in a manner that incorporates environmentally-sound and energy-efficient practices and materials. Because “costs” are measurable, “cost reduction” is often thought of as the sole criterion for a VE application and indeed it is primarily addressed in this document. However, the real objective of VE is “value improvement” and that may not result in an immediate cost reduction.

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

VE is not cost cutting. VE is a systematic method to improve the "value" of goods or products and services by using an examination of function. Value, as defined, is the ratio of function to cost (Eq. (1)). Value can, therefore, be increased by either improving the function or reducing the cost.

$$\text{Value} = \frac{\text{Function (desired performance)}}{\text{Overall costs}}$$

Reasons for poor value can be that: lack of information, decisions based on wrong beliefs, habitual thinking, negative attitudes, reluctance to seek advice, shortage of time, changing technology, lack of a yardstick for measuring value, old specifications and poor human relations.

Value engineering gets closer to cost control because it looks at ways to reduce costs on specific items or activities. However, it does not look at the total project picture or check the daily performance, it focuses only on specific items in the design, procurement or construction area.

Basic Concepts

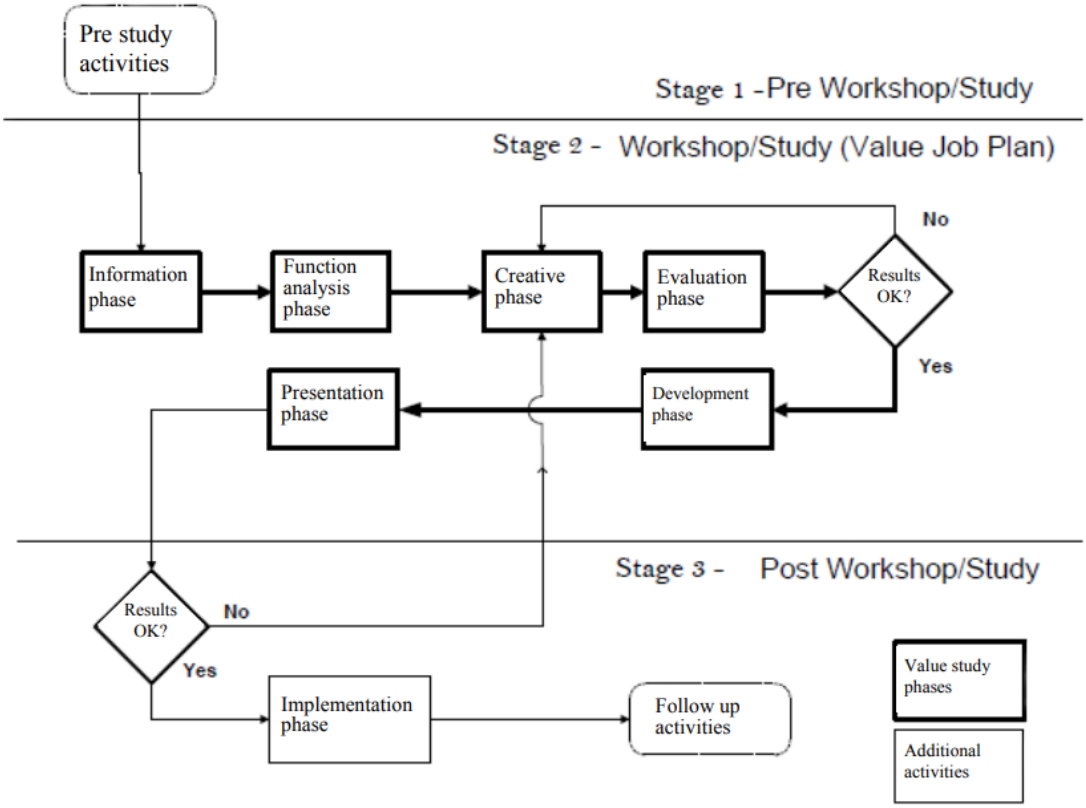
The concept of value engineering (VE) was born out of necessity almost immediately after World War II when, as a result of wartime shortages, substitute materials were used in innovative designs that offered better performance at lower costs. Much of this happened in the General Electric Company under the attention of Harry Erlicher, the Vice President of Manufacturing. Eventually, in 1947, Lawrence Miles, a staff engineer with the company, was assigned to formalize the approach. The program saved millions David K.H. Chua National University of Singapore of dollars for the company. To replicate the success, value engineering became a mandatory requirement in the Armed Services Procurement Regulations (ASPR) in 1962. Subsequently, it was introduced to two of the largest contracting companies in the U.S., namely, the U.S. Army Corps of Engineers and the U.S. Navy Bureau

of Yards. Eventually, its use spread to other companies and contracting agencies posing similar successes.

Essentially, VE is a systematic approach to eliminate any unnecessary cost of an item that does not add to its required function. It does not simply reduce cost by using cheaper substitutes or lesser quantities. Instead, its methodology centers on the following questions: What must it do? What alternative material or method can perform the same function equally well? This is function analysis: the principal component in VE. Thus, in a construction project, VE involves analyzing the functional requirements of components, subsystems, and even construction methods.

The other aspects of VE are cost and worth. Total cost is the objective to be minimized in any value engineering exercise, while worth represents the minimum costs to achieve the required functions. Worth forms the means for generating alternatives and serves as the baseline against which various alternatives can be compared. Any reduction in unnecessary cost represents the savings achieved.

Methodology and Approach:



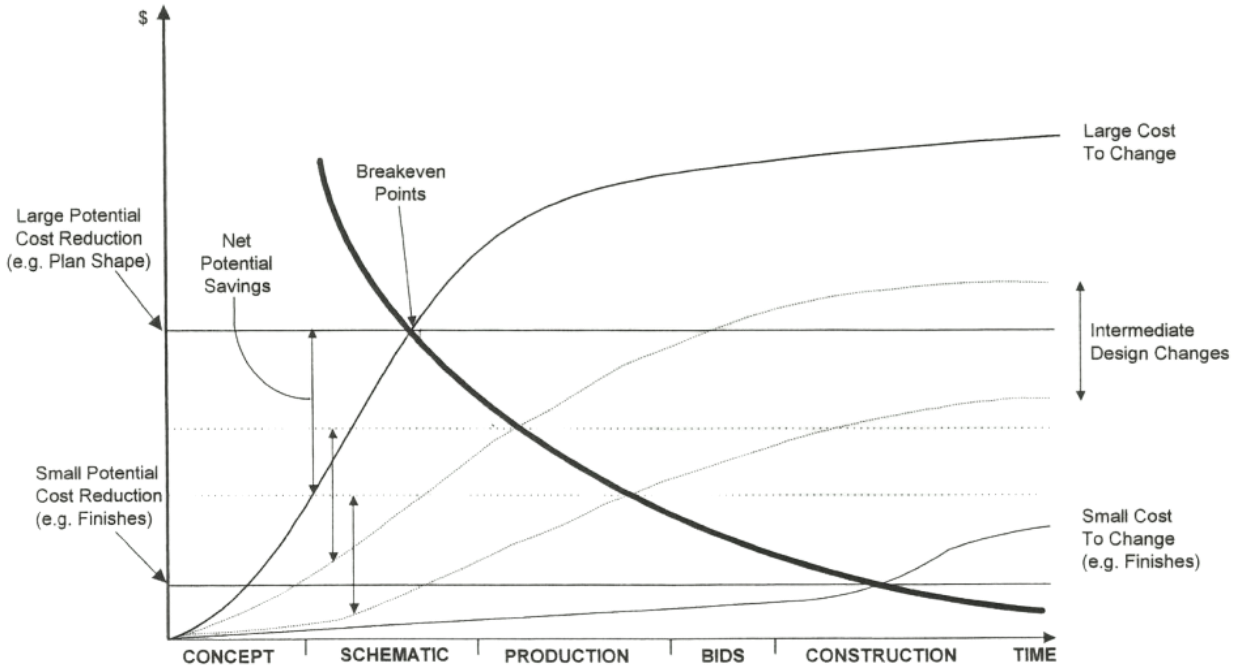
VE Job Plan consists of the following sequential phases (Fig. 1).

The value methodology is a systematic process following the Job Plan and is applied by a multidisciplinary team to improve the value of a project through the analysis of functions, The team leader should have additional VE experience as a team member of VE Project studies.

When to Apply Value Engineering VE should be performed as early as possible—before commitment of funds approval of systems, services, or design—to maximize results.

Contribution of potential savings from VE applications is much greater at earlier stages of a project, as illustrated in Fig. 2. When VE is applied later, two things increase: the investment required to implement any changes and resistance to changes.

VE is neither just good engineering, nor a suggestion programme, nor a routine project or plan review; it is carried out in independent analysis of the project. It must be recognized that VE entails a certain amount of additional expense that must be justified by potential cost saving. Accordingly, the need for a change in criteria, concepts, or plans must be recognized. A distinct opportunity for financial rewards in terms of life-cycle cost savings must warrant the added project engineering cost of a VE effort.



Usage of VE in Construction Sector Companies in the construction sector have a better chance of getting jobs when they use the resources of the country in which they work reasonably, keep their costs at the lowest level and decrease their offer price in comparison with their rivals. But the low offer price is not the only factor for a specific company to get the job. Project must have a high "value". Value has different meanings for the producing company, owner, user or the designer. The builder company tries to finish the construction with the lowest cost to obtain high profit. Owner wants to get the biggest income from the building. User wants to be able to perform his works easily, while the designer gives more importance to his creation's aesthetics or functions.

Purpose, time, quality and cost of every activity that will be realized during the construction process must be determined or estimated beforehand. Owner or user wants to know which feature they will have after the building is completed and with what cost they will have it.

Because construction process has many components such as concept, design and drawing details of the project, construction etc., and it is a long-term production, the risk of completion of construction in time, based on the estimated costs (first investment + usage cost) by providing features such as quality, durability, usefulness, continuity, feasibility, compliance, image and management convenience, increases.

Suitable precautions are taken by predetermination of problematic areas via various project plannings and scheduling techniques. But none of these methods includes an examination in terms of the "value". After a building is completed or during the construction stage, comparing the building value with the costs that occur during its construction is not thought about.

Although many buildings were built with high costs, desired functions were not provided. There is absolutely no direct proportion between a building's costs and provided benefits. In value engineering rationalist evaluation techniques are used considering the target features, and unnecessary costs are determined to be eliminated from the project, so that a building's value is increased and resources (money, material and workforce) are not wasted.

Some methods that increase the value in construction sector are explained as follows.

1. Reducing Construction Production Costs In constructions, especially in functions with high production costs, the costs can be reduced without sacrificing construction's quality or disregarding customer's requests, by using different materials and/or different methods.

   Materials, equipment's and stipulated production methods in the specification and projects may become old according to current day or be out of date. In case the suggestion of the contractor for making changes is accepted by the employer, a much more economical solution will be provided for both sides. Carrying out production with better quality by using the suggested methods, in other words improving the quality may be a more economical solution.

2. Finishing the Job before Time Schedule Finishing the job earlier provides economic benefits in term of reducing general costs. By comparing the cost of job acceleration and the reduced general costs, it can be decided to complete the job earlier.

   It may not be necessary to accelerate the production speed to finish a job earlier. It may be possible to start earlier for such a condition to exist, these conditions may be considered to happen:

   - ❖ Finishing the project designing before the schedule, especially for the jobs at the beginning;
   - ❖ Having the units ready in the worksite for usage beforehand, which are necessary for operation;
   - ❖ Obtaining necessary construction permits and making construction site deliveries before the delivery of projects which are necessary to start the job earlier;
   - ❖ Providing pre-financing before advance payment;
   - ❖ Having the necessary personnel ready for the start-up in a short time at the worksite;
   - ❖ Using a subcontractor at the start of the job if necessary.

Usually, finishing the job earlier results in additional costs. The additional cost should be less than the cost reduction in total due to finishing the job earlier. Finishing the job earlier as the result of scheduling to an earlier date with the decision of management is out of the scope of value engineering.

3. Quality Improvement and Correction Quality and value are related with each other one-to-one. Job is not being in compliance in terms of own quality of production and measurement tolerances as defined by the specifications results in these, in general terms:

3.1 In terms of production quality:

- ❖ Determination of project drawing/production and repair method for reconstruction or repair of defects that occur in productions within guarantee period;
- ❖ Realization of product repair/reconstruction;
- ❖ Giving guarantee period for performed repair process/reconstruction.

3.2 In terms of measurement tolerances:

- ❖ Reconstruction of products with the abovementioned methods;
- ❖ Reconstruction of products that are damaged because of reconstruction process;
- ❖ In case the mistakes are out of tolerance values but very close to such values, product can be accepted by the employer. But there may be deductions for last payments in return for excellence in addition to acceptance approval in the quality control minutes.

The amounts deducted in return for excellence can be huge. As it can be understood from the results, additional costs with significant amounts can be in question. Moreover, company will experience a loss of prestige. The most economical production is the production carried out at the quality level demanded on the specifications.

4. Reducing Mistakes and Deficiencies in Project Drawings to Minimum Quality of the projects is one of the factors that affect construction's quality most. The effect of the projects with errors which are not suitable for application on the construction process is negative, while projects

without errors or with small errors are suitable for application have positive effect at the same force. It is obligatory to control the drawn projects during the phase of drawing and before the application. One of the methods, applied to reducing project design and drawing errors to minimum or zero is designing three dimensional projects. Therefore, the mistakes, which may occur in the architecture or carrying system, will be prevented from the start.

Thanks to some of the current computer programs, and drawings can be prepared and with material and unit definitions, quantity lists can be obtained automatically based on these drawings in order to determine material quantities to be used, with zero mistakes.

One of the methods reducing project preparation time to minimum is simultaneous engineering application. In simultaneous engineering, it is taken as a basis to simultaneously form the projects, which are formed classically with consecutive stages and with the participation of all project partners. So that the mistakes in project drawing can be prevented and time will be saved by avoiding making returns to previous stages because of project mistakes.

Material and measurement tables in the sheets shall be prepared without any mistake as they are the most important guides for the works of implementers. Using the most economical sizes and systems for construction elements during project designing, contributes to reach suitable values in terms of costs. With this purpose, optimization methods that minimize construction costs can be used during the design.

From the experts' point of view, the Owner need the developer to study Value engineering in the following cases:

• If there is a problem with the overhead of the product or project.

• In case of interest in achieving the highest possible quality with proof of duty.

• When interested in improving product, project or operational performance.

• When there is a desire to reduce the project or output or operational burden without affecting the primary task of the final output.

- When in need of increased production.
- When necessary to improve or develop the design or product.
- When you need to get rid of a lot of errors or production-related operations.
- Emphasis on improving employee performance and focusing on production.
- When necessary to identify the fault factor by the institutions and how to update it.... etc.

Value Engineering Horizons:

- Some resistance to the methodology and results of Value studies.
- Lack of freedom in the efficiency and experience of crew members.
- There is a negative impression by some officials.
- The difficulty of adjusting the job opportunities that are usually new before the start of the study.
- Not revealing the instinct of the project or its goals or Requirements.

Results

Competition among the companies in construction sector increases day by day. Companies in competition are addressing their customers with innovations, conveniences, low prices and quality to compete with each other. But these mentioned factors are not creating sharp steps for competition, as they are subject to laws, standards and specifications. VE is one of the leading methods for competition by getting free from these elements. VE application directly affects each element in quality-time-cost triangle.

Conclusions

Success of a project, deciding on where and how a project will be built, completion of the structure according to desired design and building quality, within determined time and cost limits, are all possible with good estimations and solutions. Realism of estimations is completely in direct proportion to success. Carrying out correct estimations is closely based on the knowledge level of the team. Value engineer assumes regulating and analyzing duties to increase the value of the project while preventing unnecessary costs.

It is not possible to apply VE on each project a company produces. Much more successful value engineering studies can be carried out on complex and big projects which have high potential of restoring the investment. Of course, value engineering works have a cost, therefore this project shall be big enough to meet this cost and obtain profit.

The purpose of value engineering is not just reducing the costs, increasing the design standards, making it easier to build the project and saving time and money. VE must create a balance between all the needs of the project.

Purpose of VE shall be determined in direction of company purposes. Every person that joins for VE shall be embraced. There should be no one in the team who thinks in the opposite of project management, or who is suspicious in the benefits of VE.

The highest performance in VE is achieved especially when the purpose is mainly increasing the value rather than reducing the costs.

Production methods developed with VE are carried out to reduce the costs of a product without sacrificing the quality, keeping the cost fixed by increasing the quality or shortening the production time. It shall be never forgotten that VE works are not just the savings of contractor but also savings that are made in the project in direction of the contractor's and the customer's interests. Contractor's own saving is a kind of economical saving.

When the projects in the world are taken into account for which VE is used; we can see that most of them are applied on civil engineering constructions.

Because analyses show that contribution of potential savings from VE applications is much greater at earlier stages of a project.

When VE applications are regularly carried out in any Site in construction sector, it will be seen that the competition between the companies will increase and prices will become lower. More importantly, systematic working and the quality will increase in addition to them.

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