

# The Importance of Value Engineering in Expanding Engineering Industries and Achieving Sustainable Development

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**Abstract** - The study concentrated on the connection between theoretical approaches in their various dimensions and the performance of engineering industries institutions in an attempt to find a close link between the knowledge and application of human resources to the principles of value engineering with the performance of engineering projects that lead to the achievement of the institution's objectives. During this investigation, two major concerns will be discussed, one about survival, growth, and competitiveness about the situations surrounding the engineering industry establishments, and whether it will necessitate the implementation of value engineering principles. The second concern is about human resources in engineering projects of all sizes have the complete or required knowledge of the concept/principles of Value engineering. To answer these two issues, the notion of value engineering, its different aspects, and its contribution to accomplishing the organization's goals were examined whether it will reduce costs, improve quality, reduce waste and delivery time, increase output, sales, and profits, and strive to build factory workers' talents, skills, and culture on modern manufacturing/management systems.

**Keywords:** value engineering, function, cost, performance, engineering industries.

## I. INTRODUCTION

Various obstacles are being faced in the corporate environment as a result of the proliferation of many modern quality systems that attempt to give the greatest products to customers with the best designs at the lowest feasible cost. This is done to provide added value to the customer, which leads to higher customer satisfaction. As a result, numerous establishments aim to research client needs in order to work on the necessity of their availability in the product using the

most current methods that always seek to achieve the process of continuous development.

In light of the intense competition faced by organizations and their products, whether in the form of goods or services, the primary goal of any organization has become the ability to attract the greatest number of customers, by studying the requirements and desires of customers in order to provide a high-quality product that can satisfy the desires of customers without other competitors' products.

Because of the high expenditures of design and development, the higher the quality of the product, the higher its price, prompting many firms to look for ways to save costs, taking into consideration the realization of all consumers' wishes and requirements in the product, as well as the elimination of undesirable specifications by customers during the product design stage, which results in the manufacture of a product at the lowest possible cost.

The study's problem is the search for a method that results in the provision of a high-quality product that only fulfills the desired needs and specifications of consumers at the lowest possible cost.

The value engineering strategy is one of the value management approaches used by industrial firms to get a competitive edge for their product. It is one of the most successful techniques of strategically controlling the performance of the institution without compromising its objectives and project operations while attaining the highest standards of quality and satisfaction of the project beneficiary by lowering the value of the product. It is also one of the most effective cost-cutting strategies.

The value engineering approach is a very scientific strategy that deals with numerous tasks logically and sequentially through scientific analysis. A specific, systematic set of mental and scientific efforts carried out by a work team

consisting of groups of different disciplines that are commensurate with the nature of the projects dealt with by value engineering analysis by dividing the project into parts or raw materials and analyzing their functions.

Following the identification and classification of the tasks performed by these activities, using ideas and alternatives that are comparable with and achieve the prior functions at an appropriate cost while retaining the same performance and required degree of quality.

### 1.1 Problem Statement

Engineering industries and their products contribute to environmental concerns through resource depletion, energy consumption, air pollution, and waste generation, resulting in negative environmental and sustainability repercussions. Sustainability issues arising from engineering sectors have not been adequately addressed by any known or defined instrument in Egypt, hence exacerbating the problem.

### 1.2 Research Objectives

The objectives of this paper are to promote ways in which value engineering can be used as a tool for sustainable development, thereby mitigating the negative consequences of engineering industry operations that have resulted in sustainability difficulties in Egypt's engineering industry.

The following are the objectives of this paper:

- a) To investigate value engineering concepts and approaches.
- b) Identifying the many advantages of value engineering.
- c) To demonstrate the value engineering concept's applicability and synergy with sustainable development in engineering sectors.

## II. WHAT ARE VALUE ENGINEERING AND ITS CONCEPTS?

Value engineering is defined as "the conscious methodical use of a set of methodologies that identify needed functions, establish values for these functions, and build alternatives to execute these functions at the lowest possible cost." Various synonyms for the same approach have been used, including 'Value Management,' 'Value Analysis,' and 'Value Control.' Value Analysis is defined by Kelly and Male (1993) as "an organized method to providing the necessary services at the lowest cost" or "an organized approach to the discovery and elimination of needless expense." They also propose other definitions for Value Engineering, the most valid of which is 'an examination of alternative construction materials and methods to save money without having a significant impact on the program, maintenance, or

appearance, chosen on a priority basis.' The Value Engineering concept's essence is to optimize the value supplied to the owner.

Value engineering is defined by Ramus, Birchall, and Griffiths (2006) as a procedure aimed at providing an organized, systematic process of technical appraisal of a developing project, product, or process in order to eliminate unnecessary costs and add value while maintaining or improving quality, scope, and performance.

According to Ramus, Birchall, and Griffiths (2006), value is a complex term; It is a measure of worth - which is a relative estimate of something's usefulness in relation to the cost paid for it. This can be expressed as a function as seen below:

"Value (V) = Function (F)/Whole life cost (C) or what you get (or want)/what you pay".

Where V represents value, F represents the sum of overall function performance, and C represents the cost paid for it. The F & C relationship demonstrates that the lower the cost for optimum function, the greater the value.

As a result, value can be increased by either lowering costs or improving function.

## III. LIFE CYCLE COSTING (LCC)

Life cycle costing is a technique for evaluating the long-term financial implications of competing for technical designs in order to select the best overall solution. Life cycle costing can be employed independently or in conjunction with a VE exercise. It can be especially useful in determining the economic value of various design concepts in terms of building or installation costs as well as ongoing operating and maintenance costs. Quantity surveyors typically play an important role in determining life cycle costs or providing data for others to use. (2017 RICS Guidance Note).

### Cost

The cost of an object is the sum required to make it, or the price paid to obtain the item. As a result, if we compare two similar things, the one that costs less will have a higher value.

### Function

The Function is the reason why the item exists. Some components may be expensive but serve little purpose in the project; these are the items that should be prioritized during the Value Engineering process since they bring little or no value to the project.

In general, Quantity Surveyors/construction professionals must maintain a good balance between cost and function while using a Value Engineering technique in order to acquire the best value. Any expenditure that is neither functional nor useful must be eliminated.

#### IV. VALUE ENGINEERING METHODOLOGY

A multidisciplinary team uses VE research to improve its value. SAVE International establishes seven successive processes for conducting successful VE research. The stages are divided into three (3) categories: pre-workshop, workshop, and post-workshop. The phases are listed below:

- 1) The phase of information
- 2) Function analysis
- 3) Creativity
- 4) Evaluation
- 5) Development
- 6) Presentation
- 7) Implementation

The methodology of the SAVE worldwide VE research is shown here, encompassing stages and phases:

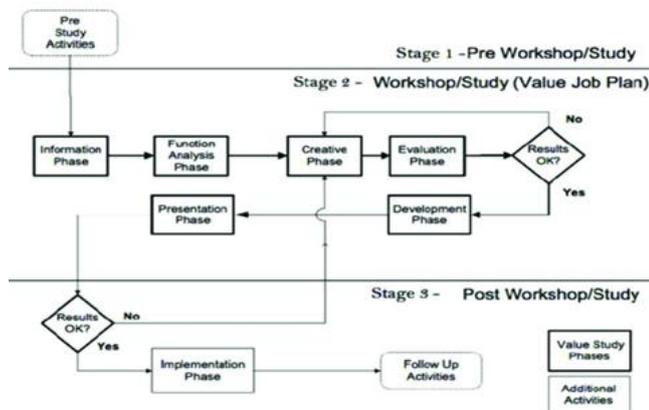


Figure 1: S.A.V.E Int. value study process flow diagram

#### Value Engineering Advantages

- To discover the optimum design alternative, value engineering is performed.
- To save expenses Identifying challenges and developing solutions.
- To improve quality, dependability, availability, and customer satisfaction.
- Saving time.

#### Sustainable Development and Sustainable Engineering

Sustainable development is defined as "development that meets the requirements of the present without jeopardizing future generations' ability to meet their own needs." (AIA,

2006). It is the necessary balance of economic advancement and environmental conservation for future life.

Sustainable development encompasses a wide range of topics, including environmental quality, economic limits, social equality, and cultural concerns (Hajek 2002). Sustainable construction, on the other hand, refers to the use of sustainable development in the construction business. Sustainable building may alternatively be defined as "the production and responsible maintenance of a healthy built environment based on resource efficient and ecological principles" (Hill and Bowen 1997).

#### The Synergy of Value Engineering and Sustainable Engineering

Value Engineering (VE) is an effective cost-cutting and quality-improvement strategy. Value engineering not only influences project cost and quality but has also been shown to have a positive impact on the environment and the global trend of green construction in the sense that value engineering considers both the original cost and the life cycle costs of any particular project.

The following procedures are taken into account during the project to implement sustainability principles:

- The use of nonrenewable energy resources should be reduced.
- Protection and conservation materials should be used.
- Appropriate designs and solutions are created.

As indicated in figure 1, the link between Value Engineering (VE) and Sustainable Construction (SC) might be accomplished during the information, creativity, and assessment phases of the SAVE International Standard VE Job Plan.

All elements of the task plan are essential and must be completed in order. The number of activities performed in each phase may vary depending on the study topic or time constraints, but the outcome at the end of each phase determines the reliability and quality of the VE performance.

New data and information obtained during a study may necessitate the study team to return to prior phases or activities.

#### The VE-SC Relationship Will Be Explained in the Following Order

- Each phase of the VE Job Plan is described briefly.
- Describe the VE activities in each phase
- Summarizing the problems to be considered in Sustainable Engineering.

- Define the VE-SC synergy by outlining each phase's proposed outcome.

### **Pre-VE Workshop Study Phase**

This includes preparing for the VE. Workshop/pre-study activities are included in VE activities include the following:

- Acquire project data and information.
- Obtain important papers such as the scope of work definition, drawings, specifications, reports, and project estimates.
- Determine and prioritize strategic concerns.
- Determine the study's scope and objectives, then create a study timeline.
- Conduct competitive benchmarking studies.
- Identify members of the Value team.
- Calculate the project's Life Cycle Cost (LCC).
- Collect relevant customer/user information about the project.
- Clearly define the requirements for successful VE study results with senior management.

The outcome of the pre-study should demonstrate a clear understanding of what senior management needs to address, what the strategic priorities are, and how improvement will increase organizational value. During this phase, a decision is made as to whether subsequent phases are likely to yield enough value to justify the cost of the study within the parameters set. At this time, it may be appropriate to increase or decrease study parameters.

## **V. WORKSHOP STUDY (VALUE JOB PLAN)**

### **1. Information phase**

During this phase, the team tries to figure out why the project exists and who or what it is supposed to produce. The VE team gathers project data, presents original design or product concepts, and comprehends the scope of the project. Schedule, price, budget, risks, and other non-monetary concerns are researched until the team is satisfied with the project's concept, what it intends to produce, and who its ultimate customers are. This step also involves activities such as site visits and, if necessary, meetings with the project team. Project documents like plans, drawings, specifications, and reports are obtained and familiarized with by the VE team.

It is critical to do the following at the start of your VE research:

- Understand the context and decisions that affected the design's creation.
- Define the owner's aim and the project's controlling principles.

- To investigate project cost, schedule data, and energy models.

The following VE activities will be carried out here:

- The original design concepts are presented by the Project Team.
- Determine the program's issues and restrictions.
- Verify the most recent project concept.
- Visit the site or facility.
- Confirm success criteria.

To ensure sustainable growth, the following concerns concerning sustainability could be tackled at this stage:

- Minimizing resource use and utilizing renewable/recyclable resources.
- Natural environment preservation.
- Pursue excellence in the built environment.
- Creating as little trash as possible.
- Aim towards lean construction.
- Taking into account people and their surroundings.
- Provide flexibility and the ability to adapt to future user changes.

The outcomes of the information phase should be able to bring all team members to a basic level of understanding of the project. This contains tactical, operational, and subject-specific details.

### **2. Function Analysis Phase**

During this phase, the team considers functions and the costs associated with each function.

Preparing the function analysis aids in the generation of various ideas that lead to recommendations for project improvement and/or cost reductions. The functional understanding establishes the baseline for identifying and benchmarking alternatives and misalignments, as well as setting the agenda for innovation.

The following VE activities must be completed here:

- Identify functions of project systems and components.
- Identify high-potential sustainable engineering concerns for discussion.
- Sort the functions into groups.
- Create function models.
- Choose functions to focus the creative phase.

The following concerns concerning sustainable engineering will be covered here:

- Determining the functions of the sustainable engineering issues identified during the information phase.
- Dimension the function model using cost drivers and sustainable engineering performance characteristics.
- Choose a function related to sustainable engineering to focus on during the creativity phase.

Function Phase outcomes should be able to validate that the project meets the project's need and purpose. Give a more in-depth grasp of the project. Determine which function(s) to concentrate on in order to improve the project.

### 3. Creative Phase

This step entails coming up with new ideas and listing them from a project standpoint. The VE team performs essential project functions. Creative suggestions and brainstorming generate a large number of ideas. Everyone on the squad is encouraged to participate.

During this stage, no ideas can be evaluated. The VE team is looking for a large number of ideas that can be grouped and screened in the next phase. Many of the ideas generated during the creative phase are the result of work done during the function analysis and pre-study phases.

VE actions to be undertaken here include the following:

- Establishing regulations to preserve the developing creative environment.
- Generating alternate ideas that may improve value.

The following sustainable engineering topics will be explored here:

- Avoiding pollution and preserving and improving biodiversity.
- Conserving water resources and optimizing the use of renewable resources
- Reduce the use of raw materials and energy while increasing resource efficiency.
- Reduce the number of harmful emissions and waste produced.

Outcomes from the Creative Phase should include a wide range of ideas that provide a wide range of possible alternative ways to perform the function.

### 4. Evaluation Phase

This phase evaluates ideas developed during the creative phase to answer the question, "Is this better than what we had before?" The team's thinking is judgmental throughout this period. The concepts are ranked by the VE team. Those considered to be irrelevant or unworthy of further

investigation are dismissed; ideas with the greatest potential for cost savings and improvements are chosen for development. In some circumstances, a weighted evaluation is used to account for project impacts other than costs (both capital and life cycle). The VE team would ideally like to evaluate all appealing ideas, but time constraints frequently limit the number of ideas that can be developed during the workshop. As a result, the team focuses on the ideas with the highest ranking.

This phase is intended to isolate and prioritize the most important concepts.

The following VE activities will be carried out here:

- Develop a shared understanding of all ideas.
- Discuss the impact of proposals on project, cost, and SC performance factors.
- Establish evaluation criteria and rank, select, and prioritize ideas for further development.

The following sustainable engineering concerns will be explored here:

- Ideas that enhance sustainability/sustainable construction are prioritized.
- Maximizing resource efficiency and optimizing operational and maintenance methods.
- Increase the project's serviceability, longevity, and dependability over its full life cycle.
- Minimizing the use of nonrenewable energy, as well as protecting and preserving water.

This stage's typical outcome should be a focused list of ideas that contribute to the improvement of quality, sustainability, functionality, and performance.

### 5. Development phase

The VE team solves the question, 'Will it work?' throughout the development process. The team is back in analytical mode and must validate the concepts that have been chosen as better alternatives to the original. Also, research each designated idea to see if it can be expanded into a workable solution. The development includes the recommended design, capital and life cycle cost comparisons, and a descriptive assessment of the benefits and drawbacks of the proposed recommendations.

Preparation of alternative designs and life cycle cost comparison of original and proposed designs are among the VE activities to be undertaken here with the following:

- Describe the recommended design modification.

- Sustainable engineering concerns should be evaluated and refined.
- Each recommendation is accompanied by a description, sketches, basic design concepts, technical data, and cost estimates.
- Selected concepts are turned into proposals so that the project owner and other stakeholders understand the proposal's aim and advantages to the project.

Low-risk, medium-risk, and high-risk scenarios are generated and serve as the minimum foundation upon which senior management will be presented with alternatives that satisfy the pre-Study strategic objectives.

## 6. Presentation phase

During this phase, recommendations are presented in the form of a report. Client, consultant, and other stakeholder representatives comprise the presentation team. Members of the VE team outline the recommendations and foundations that were implemented during the development process. The VE report is distributed to the client and designers. This is where the client and designer of the VE report begin their evaluation. After considering the client's feedback, a preliminary proposal implementation action plan is created.

VE tasks to be completed here include:

- Preparing a presentation and related documentation.
- Ensure that management receives complete and objective information from which to make sound judgments.
- Outline an expected implementation timeline.

The phase of Presentation: the result should ensure that management and other key stakeholders understand the rationale behind the VE proposals. Present a preliminary VE Proposal implementation action plan as well.

## 7. Implementation phase

Following the release of the VE preliminary report, management and the project team must digest and agree on the VE ideas to be adopted, as well as how and when they will be executed. Additional research and information may be required in some cases. Management is responsible for implementing alternatives, with assistance from the project and VE teams.

The following VE activities will be carried out here:

- Examine the preliminary report.
- Hold implementation meetings to determine the fate of each VE proposal.
- Create action plans for the accepted alternatives and detail the reasoning behind them.

- Reject alternatives and obtain implementation commitments
- Set a timetable for reviewing and implementing each VE proposal.
- Monitor value achievement as a result of adopted alternatives.
- Validate the advantages of the executed change.
- Establish and manage an implementation plan to ensure that new practices are embedded.

The phase of implementation: The outcome should describe how the project has changed as a result of the VE Study. These are usually alternatives to the original concept or base case of a study that will be incorporated as changes in future design or product development activities by the project development.

## 8. Post-VE Study Phase

The finalization of the VE Report in order to incorporate the VE ideas generated during the workshop is part of the post-study stage of a VE study. The designer then replies to the proposals by accepting and incorporating them into the project design, rejecting them, or requesting more research. Typically, the designer documents these decisions for the Owner in the form of a VE Report addendum with justification for proposal responses. The designer's response also includes a summary of the cost savings and/or additions as a result of the study, as well as the required redesign costs.

The following VE activities will be carried out here:

- Prepare a report detailing the study's findings, lessons learned, and other items to be recorded and/or tracked throughout implementation.
- Determine where possibilities were squandered.
- Identify and understand the causes of innovation roadblocks.
- Consider the value of study and how the experience has helped you develop new skills.

Individuals become better value creators as a result of reflecting on theories they held before the value research. Comparing how things turned out and determining how that knowledge changes how they thought their own beliefs in the first place is a critical stage in learning that will help the company grow better at controlling the way it manages innovation.

## VI. CONCLUSION

According to the findings, value engineering is a potent problem-solving tool that can cut costs while maintaining or enhancing performance and quality standards. Value

engineering can improve decision-making, resulting in the most efficient use of owner funds while satisfying specified function and quality levels. The VE process's success is due to its ability to identify opportunities to eliminate unnecessary costs while ensuring quality, dependability, performance, and other critical factors that meet or exceed customer expectations. Life Cycle Costing (LCC), function modeling, strategic problem solving, "Lean" concepts, idea management, and action planning are some of the tools and techniques used by the VE Methodology to help us plan for better Sustainable Engineering. VE methodology and techniques could be regarded as an essential component of sustainability studies. Sustainable Engineering is concerned with the project's social, economic, and environmental implications. So, for environmental protection, cost optimization, and social improvement, VE offers powerful tools and techniques to achieve engineering industries' sustainability. This paper discussed the conceptual linkage between value engineering and Sustainable Engineering, as well as how VE can be used as a tool for sustainable development in the construction industry. It also shows how sustainability issues can be addressed methodologically and effectively by following a systematic approach of synergy between Value Engineering and Sustainable Engineering practices, which leads to achieving the best value over the life of a project. It highlights the connection between the SAVE International Standard VE Job Plan tools and strategies for better planning for Sustainable Engineering throughout the project's early stages.

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