

# VALUE ENGINEERING IN CONSTRUCTION INDUSTRY

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## ABSTRACT

**Value engineering** (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. Value can therefore be increased by either improving the function or reducing the cost. It is a primary tenet of value engineering that basic functions be preserved and not be reduced as a consequence of pursuing value improvements.

In the United States, value engineering is specifically spelled out in Public Law 104-106, which states "Each executive agency shall establish and maintain cost-effective value engineering procedures and processes."

Value engineering has for its purpose the efficient identification of unnecessary cost, i.e., cost which provides neither quality nor use nor life nor appearance nor customer features. It focuses the attention of engineering, manufacturing, and purchasing on one objective – equivalent performance for lower cost. It results in the orderly utilization of low cost alternative materials, low cost alternative processes including new processes, and abilities of specialized suppliers to procure items at lower costs.

Lawrence D. Miles is the pioneer of this technique. He wrote the book - Techniques of Value Analysis and Engineering - in 1961. His designation at that time was Manager, Value Service, General Electric Company. He published the first article on value analysis in 1949 in American Machinist.

**KEYWORDS:** Value, Goods, Analysis

## 1.INTRODUCTION

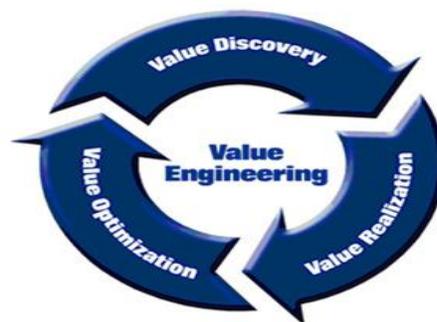
Value engineering began at General Electric Co. during World War II. Because of the war, there were shortages of skilled labour, raw materials, and component parts. Lawrence Miles, Jerry Leftow, and Harry Erlicher at G.E. looked for acceptable substitutes. They noticed that these substitutions often reduced costs, improved product, or both. What started out as an accident of necessity was turned into a systematic process. They called their technique "value analysis".

Value engineering is sometimes taught within the project management or industrial engineering body of knowledge as a technique in which the value of a system's outputs is optimized by crafting a mix of performance (function) and costs. In most cases this practice identifies and removes unnecessary expenditures, thereby increasing the value for the manufacturer and/or their customers.

The Society of American Value Engineers (SAVE) was formed in 1959 as a professional society dedicated to the advancement of VE through a better understanding of the principles, methods, and concepts involved. Now known as SAVE International, SAVE has grown to over 1,500 members and currently has over 350 active Certified Value Specialists (CVS) in the U.S. Requirements for registration as a CVS were developed by SAVE at the request of the U.S. General Services Administration in the early 1970's.

VE can be applied at any point in a project, even in construction. However, typically the earlier it is applied the higher the return on the time and effort invested. The three main stages of a project and VE's application are described below.

**On Time, On Budget, On Value**



**Best-Run Business**

Figure1 : Value Techniques

## 2. CONCEPT

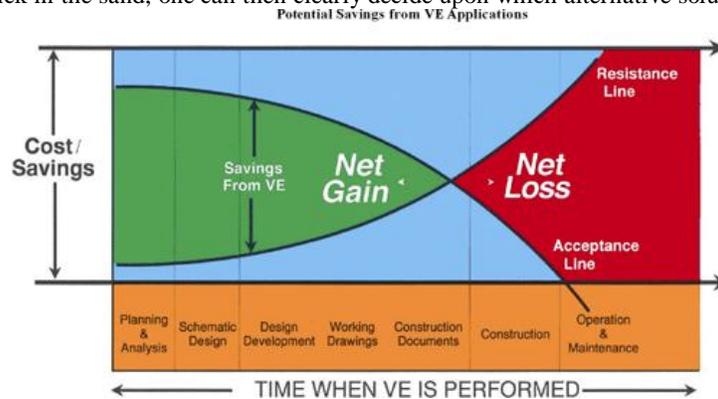
The concept evolved from the work of Lawrence Miles who, in the 1940's was a purchase engineer with the General Electric Company (G. E. C). At that time, manufacturing industry in the United States was running at a maximum capacity to supply the allies with arms. There were shortages in steel, copper, bronze, nickel, bearings electrical resistors, and many other materials and components. G. E. C wished to expand its production of turbo supercharger for B24 bombers from 50 to 1000 per week.

Miles was assigned the task of purchasing the materials to permit this. Often he was unable to obtain the specific material or component specified by the designer, so Miles reasoned, "if I can not obtain the product, I must obtain an alternative which performs the same function". Where alternatives were found they were tested and approved by the designer. Miles observed that many of the substitutes were providing equal or better performance at a lower cost and from this evolved the first definition of value engineering.

VE follows a structured thought process that is based exclusively on "function", i.e. what something "does" not what it is. For example a screw driver that is being used to stir a can of paint has a "function" of mixing the contents of a paint can and not the original connotation of securing a screw into a screw-hole. In value engineering "functions" are always described in a two word abridgment consisting of an active verb and measurable noun (what is being done - the verb - and what it is being done to - the noun) and to do so in the most non-prescriptive way possible. In the screw driver and can of paint example, the most basic function would be "blend liquid" which is less prescriptive than "stir paint" which can be seen to limit the action (by stirring) and to limit the application (only considers paint.) This is the basis of what value engineering refers to as "function analysis".

Value engineering uses rational logic (a unique "how" - "why" questioning technique) and the analysis of function to identify relationships that increase value. It is considered a quantitative method similar to the scientific method, which focuses on hypothesis-conclusion approaches to test relationships, and operations research, which uses model building to identify predictive relationships.

Value engineering is also referred to as "value management" or "value methodology" (VM), and "value analysis" (VA). VE is above all a structured problem solving process based on function analysis—understanding something with such clarity that it can be described in two words, the active verb and measurable noun abridgement. For example, the function of a pencil is to "make marks". This then facilitates considering what else can make marks. From a spray can, lipstick, a diamond on glass to a stick in the sand, one can then clearly decide upon which alternative solution is most appropriate.



- **The Value Expression:**

$$\text{VALUE} = (\text{FUNCTION} + \text{QUALITY} + \text{PERFORMANCE}) / (\text{COST} + \text{TIME})$$

### 2.1 THE JOB PLAN

Value engineering is often done by systematically following a multi-stage job plan. Larry Miles' original system was a six-step procedure which he called the "value analysis job plan." Others have varied the job plan to fit their constraints. Depending on the application, there may be four, five, six, or more stages. One modern version has the following eight steps:

- 2.1.1 Preparation
- 2.1.2 Information
- 2.1.3 Analysis
- 2.1.4 Creation
- 2.1.5 Evaluation
- 2.1.6 Development
- 2.1.7 Presentation
- 2.1.8 Follow-Up

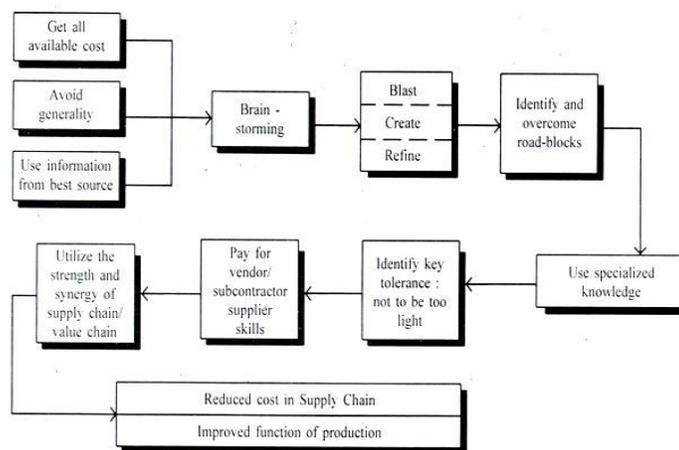
Four basic steps in the job plan are:

- Information gathering - This asks what the requirements are for the object. Function analysis, an important technique in value engineering, is usually done in this initial stage. It tries to determine what functions or performance characteristics are important. It asks questions like; What does the object do? What must it do? What should it do? What could it do? What must it not do?
- Alternative generation (creation) - In this stage value engineers ask; What are the various alternative ways of meeting requirements? What else will perform the desired function?
- Evaluation - In this stage all the alternatives are assessed by evaluating how well they meet the required functions and how great will the cost savings be.
- Presentation - In the final stage, the best alternative will be chosen and presented to the client for final decision.

## 2.2 DIFFERENT TASKS THAT ARE UNDERTAKEN BY VALUE ENGINEER:

### Preparing And Administering Maintenance Programs

- 2.2.1 Forecasting Expenditure Flows.
- 2.2.2 Advising On Cost Limits And Preparing Budgets.
- 2.2.3 Advising On Cash Flow Forecasting.
- 2.2.4 Advising On Life Cycle Costing.
- 2.2.5 Cost Analysis.
- 2.2.6 Cost Benefit Analysis.
- 2.2.7 Estimating
- 2.2.8 Evaluating Alternative Designs.
- 2.2.9 Undertaking Feasibility Studies.
- 2.2.10 Investment Appraisal
- 2.2.11 Measuring And Describing Construction Work But Only In Terms Of Cost Planning.



**Figure3 : Methodology Of Value Engineering**

## 3. VALUE ANALYSIS

### 3.1 MANUFACTURING:

Systematic analysis that identifies and selects the best value alternatives for designs, materials, processes, and systems. It proceeds by repeatedly asking "can the cost of this item or step be reduced or eliminated, without diminishing the effectiveness, required quality, or customer satisfaction?" Also called value engineering, its objectives are (1) to distinguish between the incurred costs (actual use of resources) and the costs inherent (locked in) in a particular design (and which determine the incurring costs), and (2) to minimize the locked-in costs.

### 3.2 PURCHASING:

Examination of each procurement item to ascertain its total cost of acquisition, maintenance, and usage over its useful life and, wherever feasible, to replace it with a more cost effective substitute. Also called value-in-use analysis

In value analysis Functions may be broken down into a hierarchy, starting with a basic function, for which the customer believes they are paying, and then followed by secondary functions, which support that basic function. The purpose of functions may be aesthetic or use, and basic functions may be either or both of these. For example, a coat may have a use function of making you warm and an aesthetic function of 'looking attractive'.

#### **WHEN TO APPLY VALUE ANALYSIS:**

- New designs are being introduced.
- Rate of return on investment is reducing.
- Reduction in sales of the product manufactured by the company.
- The cost of manufacturing/tooling per unit is rising.
- Competitors' products are sold at comparatively cheaper rates.
- Cost of raw material is increasing disproportionately to the volume of production.
- The firm is unable to meet delivery promises.
- Complaints from the customers regarding performance of the product.

#### **4. VALUE ANALYSIS TECHNIQUES:**

Miles provided 13 ideas as value analysis techniques.

- 4.1 Avoid generalities
- 4.2 Get all available costs
- 4.3 Use information from the best source
- 4.4 Blast create and refine
- 4.5 Use real creativity
- 4.6 Identify and overcome roadblocks
- 4.7 Use industry experts to extend specialized knowledge
- 4.8 Get a dollar sign on key tolerances
- 4.9 Utilize vendors' available functional products
- 4.10 Utilize and pay for vendors' skills and knowledge
- 4.11 Utilize specialty processes
- 4.12 Utilize applicable standards
- 4.13 Use the criterion, "would I spend my money this way?"

##### **• The Right Way To Use The Techniques**

- Choose appropriate techniques to value engineer the specific product.
- Arrange the techniques in best order for the particular job.
- Use each technique imaginatively and effectively.
- Use the techniques iteratively until useful information is developed to the extent that direction for decision and action is available.
- To use the techniques an analyst requires special knowledge.
- Value engineer is not a functional designer. He will have access to functional designers as needed in his value work. Hence his knowledge is not specialized to particular areas like mechanical engineering, electrical engineering, automobile engineering, or aerospace engineering. Knowledge required for high-grade value work is extremely broad.

The specialized knowledge required in value improvement work consists of information on materials, processes, functional products, sources of functional knowledge, approaches to function performance, and practical ideas for economical function performance.

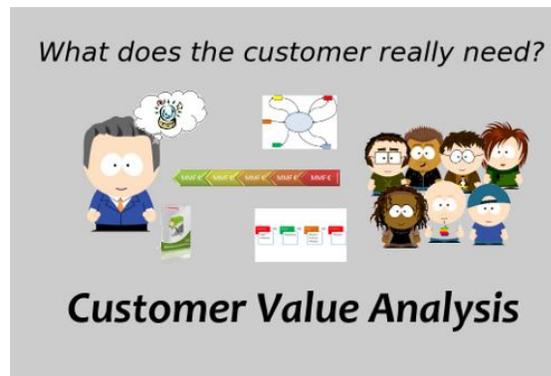
It is important that the value engineer's library of special knowledge contains a comprehensive volume of trade knowledge backed by efficient means for a quick recall of needed information. Value engineer also needs well-organized references to a maximum number of persons of special skills that may be consulted in connection with each problem.

Value engineers need develop a database having the association between properties of materials and costs apart from material and its cost. Similarly a database that shows the relationship between the properties of products produced by various processes and the cost of each process, including the material used is also valuable.

Value Analysis contains the process and techniques we've used to [exploit](#) and [elevate](#) the analysis bottleneck and [subordinate](#) it to development again. Now the development team can continue to improve, because the Customer can

keep up. The companies where we've applied Customer Value Analysis are always surprised by how much value their teams can deliver. How do they do it? They

- Identify the high value needs
- Derive the leanest possible implementation that satisfies the needs, by taking small steps and really understanding the situation
- Challenge constraints and assumptions to find breakthrough solutions
- Describe the solutions with User Stories and Acceptance Criteria
- Do this efficiently, reliably and repeatedly.



**Figure4 : Customer Needs**

## **5. VALUE MANAGEMENT**

Value Management/Value Engineering is a Decision-Making Methodology. A dynamic process focusing the collective wisdom of multi disciplinary groups, Value Management / Value Engineering systematically defines common objectives, functionally prioritizes what needs to be done and then creatively identifies how best to achieve the targeted results. Applications of Value Management / Value Engineering are many and varied, and include; Strategic Decision Making – Cost Improvement – Project Management – Project Risk analysis – Product /Process design and Improvement – Customer/Supplier Interacts – Industry Forums – Team Building (with strategic focus/alignment)

Value Management may be described as a structured, analytical process for developing innovative, holistic solutions to complex problems.

Value Management has the following key characteristics:

- A specific methodology
- Based upon a creative problem solving approach
- Involves key stakeholders in a managed team approach
- Focuses on function ie. what it must do, not what it is
- Focuses on achieving value-added solutions
- Based upon on integration
- Focuses on project learning

The greatest gains of Value Management have been shown when it is directed towards obtaining maximum value from a total system. The examination of function remains fundamental, however this occurs within the system wide context. It is the systematic analysis of functions, which sets Value Management apart from other approaches to improving value.

Value Management studies should be scheduled at optimal points in the project lifecycle and structured to meet the objectives relevant to the particular stage of the project.

Applications of Value Management to government projects include but are not restricted to:

- Establishing and verifying project objective analysing project briefs
- Optimising design solutions
- Resolving conflicts and improving communication and
- Creating and analysing a range of options for executive consideration.

## 6. VALUE MANAGEMENT ANALYSIS

Value Management is a structured, systematic and analytical process that seeks to achieve all the necessary functions at the lowest total cost consistent with required levels of quality and performance.

Underlying the Value Management theory is the principle that there is always more than one way to achieve project objectives and that examination of the alternatives will produce the most acceptable conclusion.

At the core of the Value Management process is the analysis of functions from the point of view of the system as a whole (including the relationship or cost impact of design decisions on the project and/or scheme operation). This aspect distinguishes Value Management from other methods of improving value.

Function analysis involves identifying what things actually do or perhaps more importantly, what they must do to achieve the objectives.

Through the analysis of functions, wastage, duplication and unnecessary expenditure can be identified giving opportunity for value to be improved.

The functional analysis perspective not only enables Value Management to explore the project and/or program brief but also to test the assumptions and needs perceived by the author(s) of the brief.

Taking a system wide view has particular relevance to the construction industry which generally has a compartmentalised approach to the design of facilities.

As a result each specialist group within the industry is responsible for issuing, reviewing and updating the criteria and requirements of its own field. This emphasises the performance and costs of the part without due consideration of performance and costs of the whole.

The concept of value as used in Value Management distinguishes this method from conventional methods of cost review. It achieves this by considering the relationship between function, cost, and worth.

Value Management is not a review process, but a means to assist in the better management of the procurement process.

Value Management essentially aims to produce solutions creatively and economically by:

- Identifying unnecessary expenditure
- Challenging assumptions
- Generating alternative ideas
- Promoting innovation
- Optimising resources
- Saving time, money and energy
- Simplifying methods and procedures
- Eliminating redundant items
- Updating standards, criteria and objectives.

### 6.1 APPLICATION OF VALUE MANAGEMENT IN TO PROJECT LEVEL

At the project level it can be used to:

- Resolve a problem
- Clarify needs versus wants and set priorities
- Challenge the robustness of the business case for the project
- Generate stakeholder commitment
- Share information and clarify expectations

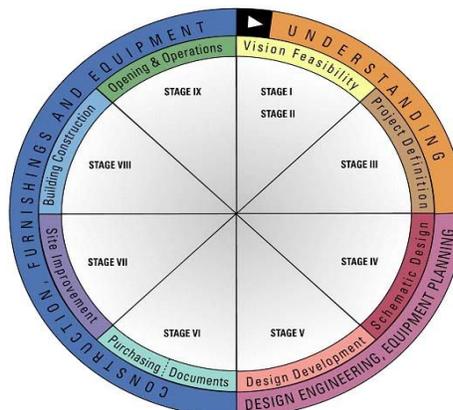


Figure5 : Stages In Value Management

- Review/establish performance requirements
- Review design solutions
- Set/agree project objectives
- Review scope/functions to be provided
- Create/confirm options for detailed analysis
- Create/select alternatives to achieve agreed functions
- Select a preferred option for detailed planning or development
- Clarify whole of life cycle costs
- Clarify stakeholder values that must be addressed
- Review/develop the project brief
- Align the project functions to resources, and
- Create/review action plan to progress the project

At the project level Value Management should be planned on an integrated basis. For most projects best Value Management results are achieved by scheduling a Value Study for both the concept and early documentation (say 35%) stages.

## 6.2 WHY VALUE MANAGEMENT

- To enhance cost effective decision making.
- Reduce delays in project.
- Reduce cost without sacrificing requirement.

## 6.3 BASIC PRINCIPLES OF VALUE MANAGEMENT

Value as used in Value Management / Value Engineering can be defined as: The lowest cost to reliably provide the required functions or service at the desired time and place and with the essential quality.”

VALUE = FUNCTION / COST

The lower the cost for optimum function, the better the value.

## 6.4 VALUE MANAGEMENT PROCESS

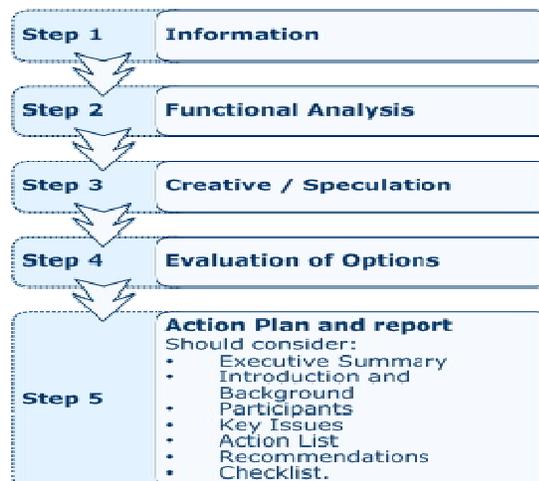


Figure6 : Value Management Process

### 6.4.1 INFORMATION

Identification and testing of program or project rationale from the perspective of stakeholders' positions eg. alignment with Corporate Objectives and/or Service Strategies.

### 6.4.2 FUNCTION ANALYSIS

Identification and ranking of primary and secondary functions and their associated cost and worth relationship.

#### **6.4.3 IDEAS GENERATION**

Generation of value improvement options through innovation and alternate means of achieving the required function.

#### **6.4.4 EVALUATION**

Sorting and prioritizing value improvement options to identify viable alternatives. Evaluation of Options may continue beyond the Value Management Study.

#### **6.4.5 ACTION PLAN**

Identification of actions/strategy required to achieve Value Study outcomes and to provide ongoing management framework for project progression.

#### **6.4.2 ANALYSIS AND REPORTING**

Final reporting includes a description of outcomes and documentation of rationale to ensure appropriate focus is maintained through the project development stages.

Although the core of the traditional approach is maintained the NSW Public Sector Model for Value Management differs in terms of timing, workshop duration, structure, and Study Group composition.

### **6.5 BENEFITS OF VALUE MANAGEMENT**

Benefits of a Value Management Study are:

- Cost Optimization: Value Management (VM) or Value Engineering (VE) is measuring its results by measuring Value being the end result of doing something functionally correct for the least cost.
- A better understanding of needs and the functions necessary to meet those needs
- A better definition of program or project objectives
- A better definition of quality and performance standards
- Clearer briefs
- Reduced wastage of resources
- Capital funds savings
- Improved operational efficiencies
- Team building and strategies which
- Create a climate of shared understanding
- Reduce conflict and risks
- Foster joint ownership of problems and solutions
- Create new ideas for improved outcomes
- Enhance the skills of the participants
- Save on project development time and ultimate service delivery to the community

As a direct result of involvement in the structured workshop process, participants generally achieve a better overall understanding of the project. In many cases there can be a major transformation of perceptions.

Communication and networking can be enhanced through the workshop process. This, in turn, can have a significant impact throughout the program planning and project development processes.

### **6.6 OUTPUTS OF VALUE MANAGEMENT**

1. We get Correct and Cost Effective Solutions to the problems we encounter, as we ensure Functional Correctness before deciding on the solution to be implemented.
2. Through participation in a VM / VE study / workshop we obtain Buy-in and achieve Alignment of the people who have to implement and run with the solution.

## **7 CONCLUSION**

- Value engineering/value analysis creates cost and quality consciousness among the employees.
- It helps employees in better understanding of their jobs.
- Value engineering reduces cost of the product, it is because of special attention which is paid for simplification, standardization and improved method of production.
- Provides information to management regarding function wise expenditure on the product under investigation.
- Quality is maintained at desired level because there is no question to reduce cost at the expense of quality.
- Value analysis helps to blast away such road blocks as "It won't work", "it is impracticable", "why change it, when it works?", etc.
- Dilutes resistance to change and accelerates the process of implementation.

- The functionality of the project is often improved as well as producing tremendous savings, both initial and Life-Cycle Cost.

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