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ABU DHABI QUALITY & CONFORMITY COUNCIL

Value Engineering Guidelines

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ABU DHABI CITY MUNICIPALITY

Value Engineering Guidelines

Version 1.0

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Table of Contents

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List of Figures

List of Forms

List of Checklists

1.0 General Information

1.1 Purpose

In 2016, the Municipal Infrastructure and Assets Sector (MIAS) of Abu Dhabi City Municipality (ADM) undertook an initiative to develop a set of guidelines for implementing Value Engineering (VE).

This document is intended as guidance in applying Value Engineering to maximize effectiveness and value of projects as well as processes throughout design, construction, operation and maintenance phases for roads, infrastructure, and public realm projects.

VE is NOT a Cost Cutting or Reduction Tool. VE is a function-oriented technique that has proven to be an effective management tool for achieving improved design, construction, and cost-effectiveness in various infrastructure elements.

The purpose of these guidelines is to update the existing VE practices, develop and establish policies as well as procedures to select, study, report and implement VE studies related to projects. The guidelines also aim to promote VE culture through consistent, uniform, and structured VE approach adopted during the various applicable phases of projects. It also aims to assist users of the these guidelines to conform to the expectations of project client/asset owner that need to be taken into consideration during project development.

1.2 Scope

During development of this guide, information was collected through a comprehensive literature review including documents from various transportation agencies in the USA, Canada, UK, Australia and other local authorities. Also, insight gained from the knowledge and personal experiences of the Value Engineering team assigned for preparing these guidelines and feedback from stakeholders, is considered, where appropriate.

The Value Engineering guidelines presented in this document are conceptually derived from SAVE International[1] approach of Value Management (VM). However, where necessary, the approach has been customized to reflect the requirements and project frameworks of relevant Abu Dhabi Emirate authorities and stakeholders.

Where required and applicable, the VE guidelines will apply to projects, as relevant, in Abu Dhabi Emirate and will be administered by the relevant client/asset owner. The procedures, processes and relevant responsibilities to be followed are described in these VE guidelines, which are intended specifically to ensure:

- VE program and policies are established, updated and followed
- Coordination with relevant Abu Dhabi Emirate authorities and stakeholders to ensure the VE process is integrated in the planning, design, construction and maintenance program processes, where warranted

- Ensure that the VE analyses are planned and conducted in accordance with the policies and procedures set in these VE guidelines, and that recommendations developed and implemented for each project are properly documented in a final report matching with project stages
- Monitoring, evaluation, and reporting to relevant Abu Dhabi Emirate authorities and stakeholders management the results of the VE analyses that are conducted and the recommendations implemented for each project.

. In case of any conflict with VE requirements specified in any other documents or manuals published by Abu Dhabi QCC, this guideline takes precedence.

During implementation of these guidelines, reference-related circulars or directives issued from time to time by relevant Abu Dhabi Emirate authorities and stakeholders will also need to be taken into consideration in the application of VE.

Note that where the consultant's scope of work and these guidelines conflict, the scope of work/ any associated circulars shall take precedence. Revisions and additions to this manual will be issued from time to time; as required, Interim Advice Notes and technical circulars will be issued accordingly.

It is expected that the user of these guidelines has the educational, working knowledge and engineering experience necessary to properly implement principles, procedures and criteria contained within.

2.0 Value Engineering

2.1 Background

Value Analysis was envisaged in the early 1940s by Lawrence D. Miles, an American engineer, where he devised the function analysis concept, which was integrated into an innovative process later termed 'Value Analysis'. He questioned whether the design could be improved or if a different material or concept could achieve the function. Soon the value methodology was used to improve the value of projects in governments and private sectors and value concepts spread worldwide. As the methodology gained popularity, a number of other value improving tools, techniques, and processes emerged, many of which were complementary to and were integrated with the value concepts. A group of practitioners formed a learning society to share insights and advance their innovative capabilities. Thus, in 1959, the "Society of American Value Engineers" was incorporated in Washington, DC. In an effort to attract the developers and practitioners of these emerging methods to their membership, the name of the society was changed to "SAVE International" in 1996[1].

Value Engineering has long been applied in Abu Dhabi. For example, soon after the formation of Save International in 1996, ADM VE requirements were included in the Consultant Procedure Manual published in 2001. Later in 2014, the VE requirements were further enhanced and included in section 2.2.3 of the Consultant Procedure Manual[2].

2.2 Concept of Value Engineering

In the context of Abu Dhabi project and processes, VE study is an organized and structured study of the function of all and/or specific components that make up the project. A VE study covers a broader area than just a life-cycle cost analysis.

The VE study process, defines a sequence of activities that are undertaken during a VE study; before, during, and following a workshop. During the VE workshop, the VE team learns about the background issues, defines and classifies the project functions, identifies creative approaches to provide the functions, and then evaluates, develops, and presents the VE proposals to key decision makers. It is the focus on the functions that the project must perform that sets VE apart from other quality-improvement or cost-reduction approaches.

VE helps achieve an optimum balance between function, performance, quality, safety, and cost. The proper balance results in the maximum value for the project.

Value is the reliable performance of functions to meet customer needs at the lowest overall cost. Value is proportional to the ratio of function over cost

$$\text{Value} \propto \text{Function/Cost}$$

Function is what the project is expected to do.

Cost is the expenditure needed to create it.

In other words, Value Engineering (VE) is the systematic application of recognized techniques by multidiscipline team(s) that identifies the function of a project, establishes a worth for that function, generates alternatives through the use of creative thinking, and provides the needed functions, reliably, at the lowest overall cost. VE may be defined in other ways, as long as the definition contains the following three basic precepts:

- An organized review to improve project value by using multi-disciplined teams of specialists knowing various aspects of the problem being studied
- A function oriented approach to identify the essential functions of the project, service, or product being studied, and the cost associated with those functions
- Creative thinking using recognized techniques to explore alternative ways of performing the functions at a lower cost, or to otherwise improve the design.

VE is not just "good engineering." It is not a suggestion program and it is not routine project or plan review. It is not typical cost reduction in that it doesn't "cheapen" the product or service, nor does it "cut corners." VE simply answers the question "what else will accomplish the purpose of the project, service, or process we are studying?" The practice of VE entails a certain amount of expense, that must be justified by potential cost savings. Accordingly there must be a recognized need for change and a distinct opportunity for financial benefit to warrant the added cost of a VE effort.

2.3 Objectives and Benefits of Value Engineering

It is recognized that there is a need for prudent use of resources and revenue while delivering quality projects. VE is a function-oriented technique that has proven to be an effective management tool for achieving improved design, construction, and cost-effectiveness in various project elements. Implementation of VE Optimization and Sustainability concepts is a major objective for Abu Dhabi. It is more than just employing the right designs and construction techniques. Considering Performance, Life Cycle Cost, Quality and Safety, Energy and raw material consumption, sustainability, stakeholders engagement, as well as minimized impacts on Natural Environment and Public Health are major considerations.

In many instances, practicing implementation of VE is one approach to help deliver projects cost-effectively and satisfy customers. Value Engineering was initially applied in view of reducing overall construction costs. However, it is recognized that greater benefits can be realized if a systematic VE process is adopted in the development of the project. Some of the key benefits realized are given below:

- Improvement of project value, performance and quality
- Reducing the time to complete the project
- Providing the needed functions safely, reliably, efficiently, and at the lowest overall cost
- Eliminating unnecessary design elements
- Fostering innovation and improving productivity
- Promoting sustainability
- Managing stakeholders expectations

2.4 Sustainability and Value Engineering

The principles of sustainability are that all natural resources are limited and, while projects development should meet the needs of the present, it should do so without compromising the ability of future generations to meet their own needs. Development of sustainable projects should integrate all relevant and applicable technical disciplines along the project life cycle to achieve sustainability needs in an effective and efficient manner that considers limited resources of the environment.

Sustainability principles are often applied in the design process. VE process should consider sustainability on each project as per client/asset owner's requirements and on a case by case basis and as may be dictated by applicable and relevant laws and regulations and Abu Dhabi Government requirements. Where projects are guided by sustainability aims and as required by the client/asset owner, sustainability can be a major objective in the VE process.

The combination of VE and sustainability encourages the use of tools that improve planning for construction during early stages. Multidisciplinary teams working together in a coordinated VE process would raise the chances of considering and implementing sustainability requirements. The process can employ Pareto’s law that states that 20% of the items make up 80% of the total cost and this can assist in selecting sustainable systems and materials based on their functions.

3.0 Project Life Cycle

Every project has a beginning and an end and passes through several phases of development known as life cycle phases. These phases are varied depending upon the type of projects but all follow the same basic steps. Typically projects are procured through several types of contracts. For example Design-Bid–Build, Design-Build, EPC, Consultancy Services, BOOT, Construction Contract etc.. Application of VE study can be undertaken through the various phases of a project life cycle[2].

3.1 Design-Bid-Build Projects

The main phases of a design-bid–build project life cycle are Planning and Study (or Pre-Concept) Phase, Design Development Phase, Construction Phase and Operation and Maintenance Phase.

Planning and Study Phase

The purpose of the Planning and Study (or Pre-Concept) phase is intended to allow a clear understanding of strategy and objectives for the project, along with an understanding of risks associated with the project. All existing information concerning the project is accumulated and information that is necessary for design that is not available or needs to be updated is identified. This phase investigates the project site and basic alternatives to meet the project objectives.

Design Development Phase

Actual design procedures vary depending on the type and complexity of a project. The objective of the design process is to develop comprehensive design and construction documents. Quality design document production is a primary objective throughout the design process. This objective is facilitated by a multi stage design process that culminates with the completion of the tender documents. A Value Engineering Report is a key deliverable for each design stage submission. The stages of the design process are Conceptual Design Stage, as applicable, Preliminary Design Stage and Final Design Stage.

Following the Pre-Concept stage, the consultant may start developing alternative design concepts, conduct in-depth analysis of the data and create design criteria at Conceptual Design stage. Major decisions related to a design will be made at the Conceptual Design stage, including selection from alternative design concepts.

Preliminary Design is the first phase of detailed design performed on a specific selected and approved alternative. The selection and approval is usually based on the consultant's recommended alternative, which is identified during the Conceptual Design stage.

The Final Design Report is a comprehensive record of the project's design history and a detailed description of the conditions and decisions that led to the Final Design. The Final Design Report should be organized like the Preliminary Design report providing a greater level of detail.

Construction Phase

Specific period, stipulated in a contract (beginning from the date stated in the notice to proceed) during which the contractor must complete construction of the project, subject to the conditions of the contract.

Operation and Maintenance Phase

The operation phase is not a separate phase in the project life cycle but referred to as the maintenance phase. The operation and maintenance phase begins after the project is constructed and starts to be used or when the project is in operation mode.

3.2 Design-Build Projects

The project life cycle elaborated above is generally also applicable for design and build projects however phases or stages may vary on a case by case basis. Refer to section 4.4 for details.

4.0 Application of Value Engineering

4.1 Potential of VE Application

VE may be applicable at any phase or stage in a project's life cycle, but greater potential savings can be achieved the earlier the VE Study is performed. VE should, therefore, be applied as early as possible in the project life cycle. Early VE tends to produce greater savings (or cost avoidance) because that is where most of the costs are committed to—there are greater opportunities for change, and the changes cost less to implement. If early opportunities are missed, VE can still be applied. Late in a project, VE is precluded only in those rare instances where the cost of the VE effort and subsequent implementation would be greater than the savings potential. While later VE normally adds implementation costs and affects smaller quantities, such deterrents can be offset by improved performance and reliability through advances in technology and by savings generated from increased project life. This Chapter describes VE opportunities early in a project life cycle[4].

4.2 Criteria of VE Applications in Projects

In general, selecting projects requiring VE study and its time frame is based on project estimated cost, project size and/or complexity of the project. In addition to the cost, other issues adding to the complexity of the project design or construction are considered in the selection process. These include projects that have critical constraints, difficult technical issues, expensive solutions, external influences, and complicated functional requirements, regardless of the estimated project cost.

VE analysis may be initiated during the design stage on any project or process when it is felt that there are sufficient potential cost savings or added value to justify the cost of VE analysis. Various international authorities have specified different threshold criteria based on project value for undertaking VE studies[8]. Table 1 addresses the criteria that shall be used to determine which projects require the performance of a VE analysis.

On a case by case basis, VE analysis may also be initiated during the planning stage using the same criteria specified in Table 1 below or other appropriate criteria approved by the relevant Abu Dhabi Emirate authorities to meet their needs and requirements.

Table 1: VE Implementation Thresholds

Project Category	Project Estimated Cost (AED)	Design Stage for VE Study Selection	VE Reviewer			Criteria to be Adopted
			Design Team of Project Consultant	Independent Design Team of Project* or other Consultant	Independent VE Certified Consultant	
1	Less than 10 million	Concept	✓	-	-	General VE Principles
2	More than 10 Less than 120 Millions	Concept Preliminary	-	✓	-	Formal VE Study Process
3	120 millions or more	Concept Preliminary Final	-	-	✓	Formal VE Study Process

**refers to a different team of the same consultant who was not involved in the design.*

In some projects, subject to relevant Abu Dhabi Emirate authorities and stakeholders approval, application of above criteria may vary based on the potential for cost savings in comparison to the cost of the VE analysis , or the potential to improve the projects' performance or quality, as per their needs and requirements.

Projects involving complex technical issues, challenging project constraints, unique requirements, and competing community and stakeholder objectives offer opportunities for improved value by conducting VE analyses.

The client/asset owner shall initiate approval of the VE study selections and the VE study timing. All projects meeting the VE study requirements will be approved in writing by the client/asset owner. An example of a typical VE Schedule is shown in Appendix C.

4.3 Application of VE Study

4.3.1 During Planning Phase

During project planning, VE can make a major impact on the life-cycle cost (LCC) of a project. LCC includes the cost of planning, design, construction and ownership of a project over a specified service life. The time period used is the projected effective useful life of the project and its determination includes consideration of functional uselessness of major components or systems. LCC is used to compare and evaluate the total costs of competing solutions. In addition, adjustments to the program at this point have very little, if any, disruptive impact on schedule and redesign costs. Consequently, the project should proceed with fewer changes and with a greater understanding by all parties of what the final function and space allocations will be.

4.3.2 During Design Phase

Most effective application of a VE study is realized early in the design phase. Changes or redirection in the design can be accommodated without extensive redesign at this point, thereby saving the owner/user/stakeholder's time and money.

At the concept design stage, performing a VE study, to develop design alternatives, defines the project's functions and achieves consensus on the project's direction and approach. By conducting a VE study exercise at this stage of the design, the project needs are identified in the common language of functions and miscommunication as well as redesign, which are costly in both labor expenditures and schedule delays, are minimized.

At the preliminary and final design stages, performing a VE study analyzes the potential alternatives of the selected option, drawings and specifications as well as concentrates on economics and technical feasibility. It also considers selection of equipment and materials, methods of construction, phasing of construction, and procurement. The goals at this stage of design are to minimize construction costs and reduce the potential for construction claims, satisfy stakeholder needs, and review the design, equipment, and materials used[5].

4.3.3 During Construction Phase

During project construction phase, VE improvements are still possible using Value Engineering Change Proposals (VECP). A VECP is submitted by the construction or design-build contractor to propose a change or substitution in the requirements, materials and/or methods prescribed in the contract documents. The change is intended to reduce cost (initial and/or life-cycle) but still meet or exceed all necessary functions including performance, safety, aesthetics, operations, quality and time. Quite often a contractor can provide a fresh approach to construction that can reduce the cost of a project and at the same time improve the construction sequences and reduce time.

The objective of the VECP is to encourage contractors to investigate improved construction methods and materials, submit VECPs. Clearly, the user of this guideline must consider VECP very carefully, from a life-cycle and a liability perspective.

In all cases, Value Engineering during construction phase shall be in accordance with the relevant clause of the construction contract unless otherwise defined in the modified particular conditions of contract.

4.3.4 During Operation & Maintenance Phase

For maintenance projects, applicability of VE study depends on the type of contracts and assessed on a case by case basis.

In cases where a VE study is applicable, it may not be necessary to follow a formal VE study process (specified in chapter 5); rather, general VE principles can be adopted. This may include considering cost benefit analysis of project elements, application of new technology, alternative materials, equipments, repair methodology etc.

4.4 Design-Build Projects

Design-build is a project delivery method in which either design and construction are provided from a single source or the concept design is developed by a different source prior tendering the design – build project. Since VE study optimizes design and promotes project value, construction through the design-build project delivery method is compatible with the goals of VE. Furthermore, VE will augment the benefits of design-build, since its focus extends beyond cost-cutting and creativity in construction. Implementing VE within the design-build process provides the following benefits:

- Generate cost shared savings for both the owner and the design-builder.
- Spurs innovation in construction, since the terms of the owner's RFP may be re-evaluated or modified.
- Minimize risk to both the owner and the design-builder due to the consensus approach to the project.
- Increase likelihood that the resulting project will satisfy owner and user needs.

Value Engineering is required on Design-Build projects in accordance with criteria and thresholds in Table 1.

5.0 Value Study Process

Value Study Process is a systematic and structured action plan for conducting, documenting of results and implementation of the VE study. The VE Job Plan includes the following three major stages:

- Pre – Workshop Stage (Preparation for the VE Study)
- Workshop Stage or Value Job Plan (The Six – Phase Work Plan)
- Post Workshop Stage

The Value Study process flow chart is presented in Figure 1 below:

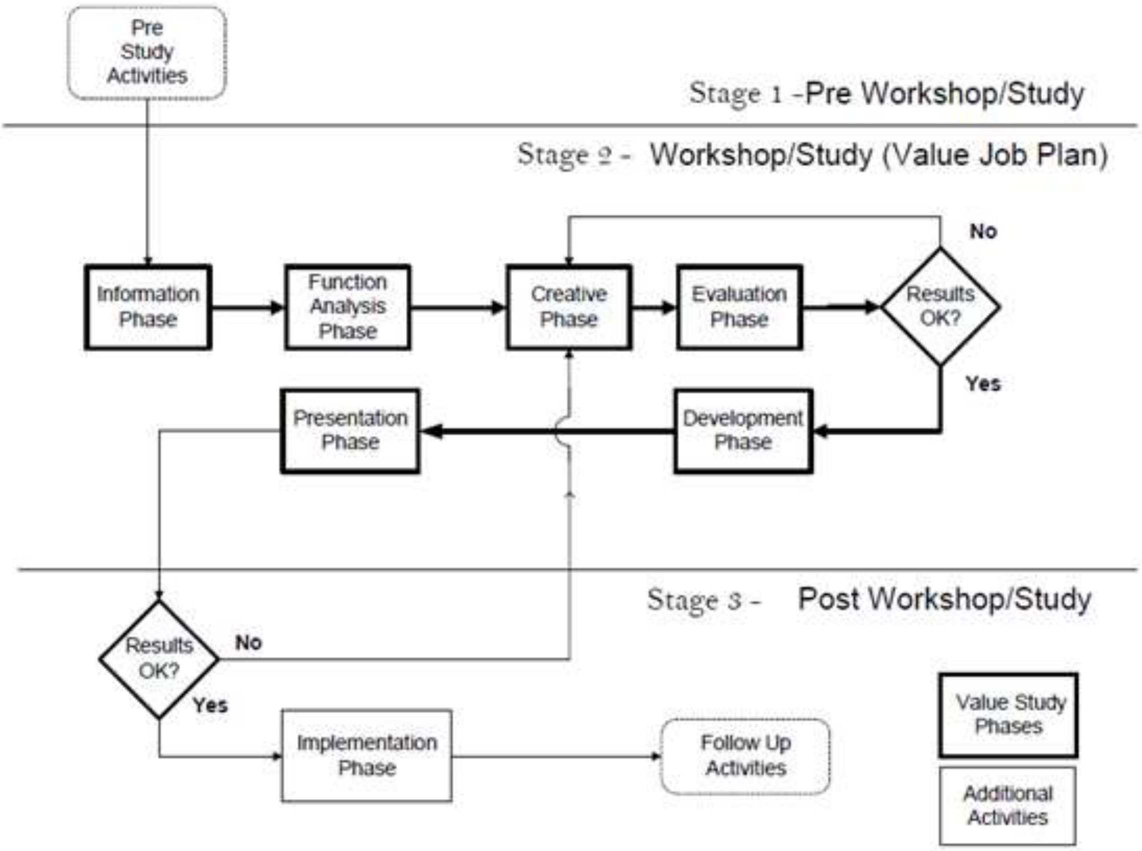

Figure 1: Value Study Process Flow Diagram
Reference: SAVE International – Value Methodology Standard, March 2015[19]

Additional information related to VE methodology and Job Plan are included in Appendix B1.

5.1 Pre – Workshop Stage

SAVE International has defined the main purpose of this stage as to prepare for the value study. The purpose of this phase is to refine the problem and prepare for the value study. Although a problem area may have been identified, the value study has a far greater likelihood of success if ample preparation time has been provided to[1, 18]:

- Determine what aspects of the problem will be addressed in detail
- Prepare everything needed for the analysis itself

- Workshop study design
- Prepare work books (or information packages)
- A site visit could be included pre-workshop as needed

Through these preparatory activities, a close working relationship between the VE team and the sponsor of the project also contributes significantly to a successful outcome.The fundamental question that needs to be answered during the pre-workshop stage is “What should be done to prepare for the Value Study?” To answer this question, following tasks need to be performed in this stage:

a. Formation of VE Team
b. Coordination with Stakeholders
c. Data Collection
d. Information Modeling

5.1.1 Formation of VE team

A. VE Team Composition

The initial criteria for selection of VE team depends on the project threshold specified in table 1 (e.g. third party consultant, extennal team of consultant or internal team). Then based on the type of project, the VE Team shall be formed by the assigned consultant/contractor (or as specified by the project client/asset owner).
Essential team member characteristics should be considered to include technical and functional expertise, problem-solving and decision-making abilities, and interpersonal skills. Participants should be team players who are willing to share responsibilities and accountability while working together toward a common objective. The team should also be multidisciplinary to ensure that relevant stakeholders and experts are included[4,11]. The Value Engineering team details should be recorded as per Form 1 include in Appendix-C

For Abu Dhabi projects and depending on the project scope, the VE team may include members from relevant technical disciplines such as, but not limited to, the following:

- Traffic and Road Safety
- Road Geometry
- Structures
- Pavement
- Geotechnical
- Lighting
- Storm water
- Wastewater
- Irrigation
- Public Realm and Landscape
- Materials
- Environmental
- QS and cost engineer
- Others as applicable

B.VE Team Qualifications

For Abu Dhabi projects, given that application of Value Engineering / Analysis is in the early stages of formalization, VE team qualifications shall temporarily (for five years from issuing this guideline) be as follows:

- VE Team Leader, is required to be SAVE International-certified AVS (Associate Value Specialist) or VMA (Value Methodology Associate) and have completed a minimum of three VE studies
- VE team members should be specialized in their technical disciplines and, at least, should attend a one–day Awareness Workshop for application of Value Studies

Generally, the VE Team Leader and members should be approved by the client before starting of the VE study.

C.Team Roles and Responsibilities

(i) Team Leader

The VE team leader should be knowledgeable and proficient in design and construction as well as VE analysis process for projects. The VE team leader’s main responsibilities are as follows:

- Plans, leads, and facilitates the VE study
- Ensures proper application of Value Methodology
- Follows the Job Plan
- Guides the team through all stages of VE study
- Prepares the agenda and outline action plan for the VE study
- Schedules a pre-workshop meeting with the project team.

In cases where the VE team leaders are from the Client/asset owner side, the team leaders are encouraged, but not required, to be certified by SAVE (or equivalent). However, consultant’s team leaders shall be certified as AVS, VMA, VPM or CVS (or equivalent).

(ii) Team Members

The VE team is typically composed of five to ten members with diverse expertise relevant to the specific study. Consultant staff proposed to be part of the VE team shall not have been directly involved in the design process of the project. Necessary client approval shall be obtained in order to ensure full time commitment of the proposed VE team members for the assigned task.

5.1.2 Coordination with Stakeholders

In this activity, it is important for the VE team to communicate with client/asset owner and the project team involved in planning and design of the project in order to:

- Obtain the project stakeholders list from the consultant including their names and contact details
- Clearly define client needs within the context of project scope

- Conduct coordination meetings with the project team, involved in planning, design (or construction) of the project, to have full information about project scope, design documents, specifications, cost estimates, design schedule, construction plan.
- Specify VE study location, timing and all required logistic preparation
- Prepare the scope, work plan activities, time schedule for the VE study
- Obtain client' approval and support on VE job plan, roles and responsibilities of all VE study parties
- Obtain commitment from VE study team to achieve study objectives and stick to schedule
- It is desirable to invite suppliers, end users or stakeholders, as applicable, for obtaining any additional data related to the VE Study.

5.1.3 Data Collection

Data collection is the key element for conducting a VE study. During this activity, the VE team shall obtain comprehensive technical and financial information as well as data from the project team such as, but not limited to, the following:

- Project objective and functions
- Design basis, public requirements, and other relevant reportsTechnical manuals, standards and guidelines, applicable codes (international and local), applicable Authorities' approvals and NOCs
- Drawings, technical specifications, quality data
- Up to date cost estimates, BOQ (if available)
- Project schedules and design status
- Project risk register
- Historical data, if any
- Calculations, if required

Use Form 2 for documents receiving, Form 3 for capturing project objectives and key functions and Form 4 for recording cost summary details respectively. These forms are available in Appendix-C.

5.1.4 Information Modeling

The main purpose of information modeling is to have better understanding of the current status of the project and different constraints influencing project decisions as well as identifying and prioritizing strategic issues of concern. The following tools may be used to perform this task [18]:

- Satisfaction – Importance Matrix
- Benchmarking analysis methods such as: Tear Down Analysis, Pareto analysis , SWOT analysis
- As applicable, developing Informational models and diagrams about the project such as: quality model, risk model, cost model, energy model, area model

5.2 Workshop Stage

The workshop stage is the major part of the value engineering study, which includes the following six phases:

1. Information Phase
2. Function Analysis Phase
3. Creative Phase
4. Evaluation Phase
5. Development Phase
6. Presentation Phase

For each of the workshop phases, the objective, purpose, common activities and expected outcome are illustrated in the following sections:

5.2.1 Information Phase

Objective	To review and define the current conditions of the project and identify the goals of the study by gathering project information, including project commitments and constraints.
Purpose	• To finalize the scope of the issues to be addressed, targets for improvement, and evaluation factors while building cohesion among VE team members. • To use the Information Phase to motivate the team to work toward a common goal. • Collection of data
Major Activities	• Obtain project data and information as well as key documents described in section 5.1.3 • Identify and prioritize strategic issues of concern. Further define the scope and objectives (client expectations) of the study **Tools:** SWOT, project charter • Project team presents the original and/or current design concepts • Perform competitive benchmarking analysis by using benchmarking, tear down analysis, Pareto analysis etc. • Determine the study schedule • Distribute project information for team member review • Understand project scope, schedule, budget, costs, risk, issues, non-monetary performance • Confirm the most current project concept • Identify high-level project functions • Conduct site visits as required • Confirm success parameters (defining performance measures for the study outcome)
Typical Outcome	This phase brings all team members to a common, basic level of understanding of the project needs. The functional understanding establishes the base case to identify and benchmark alternatives and mismatches (between the project needs and any proposed design alternatives) and set the agenda for innovation.
Checklist & Forms	Refer to Checklist 1, Form 2,Form 3 and Form 4 available in Appendix-C
References	*For further details refer to references no. 1, 6, 11 and 18*

5.2.2 Function Analysis Phase

Objective	The main objective of the function analysis is to analyze the project to understand the required functions.
Purpose	The purpose of the function analysis phase is to identify the most beneficial areas for study. The analytical efforts in this phase form the foundation of the Job Plan. The disciplined use of function analysis is the principal feature that distinguishes the value methodology from other improvement methods.
Major Activities	• Determination of functions • Function classification • Development of function relationships and priorities • Estimation of the cost of performing each function • Determination of the best opportunities for improvement • Refinement of the VE study scope • The above bullet points were elobrated in Appendix B2, Item C
Typical Outcome	This phase focuses the team on validating that the project satisfies the need and objectives of the customer. It provides a more comprehensive understanding of the project by focusing on what the project does or must do rather than what it is. The team identifies value-mismatched function(s) on which to focus in order to improve the project.
Checklist & Form	Refer to Checklist 2 and Form 5 available in Appendix C
References	Appendix B2, Item C

5.2.3 Creative Phase

Objective	The objective of Creative Phase, also called the Speculation Phase, is to generate ideas on ways to accomplish the required functions that improve project performance, enhance quality, and lower project costs.
Purpose	The main purpose is to develop large number of Ideas for alternative ways to perform each function. The Creative Phase does not necessarily identify final solutions or ideas ready for immediate implementation. It often simply provides leads that point to final solutions. The two approaches to solving a problem are analytical and creative. In the analytical approach, the problem is stated, and a direct, step-by-step approach to the solution is taken. An analytical problem frequently has only one solution that will work. The analytical approach should not be used in the Creative Phase. The creative approach is an idea-producing process specifically intended to generate a number of solutions that solve the problem at hand. In the Creative Phase, a conscious effort is made to prohibit judgmental thinking because it inhibits the creative process. All solutions could work, but one is better than the others. It is the optimum solution among those available. Once a list of potential solutions is generated, determining the best value solution is an analytical process conducted in the latter phases of the job plan. By using the expertise and experience of the study team members, new ideas will be developed. The synergistic effect of combining the expertise and experience of all team members will lead to a far greater number of possibilities.
Major Activities	• Discourage Creativity Inhibitors such as: Habitual blocks, Perceptual blocks, Cultural blocks, Emotional blocks etc. • Establish Ground Rules

	• Generate Alternative Ideas using idea-generation techniques such as: Brainstorming, Gordon Technique, Checklists, Morphological Analysis, Attribute Listing, Input-Output Technique etc. • The above bullet points were elobrated in Appendix B2, Item D
Typical Outcome	The team develops a broad array of ideas that provide a wide variety of possible alternative ways to perform the function(s) to improve the value of the project.
Checklist & Form	Refer to Checklist 3 and Form 6 available in Appendix C
References	*For further details refer to* Appendix B2, Item D

5.2.4 Evaluation Phase

Objective	The objective of Evaluation Phase is to identify the best opportunities for value improvement.
Purpose	To evaluate and select feasible ideas for development, analyze the results of the Creative Phase and select the best ideas for further expansion.
Major Activities	• List the advantages and disadvantages of each idea • Eliminate low-potential Ideas • Group similar ideas • Establish idea champions • Rank the ideas • Select ideas for further development • The above bullet points were elobrated in Appendix B2, Item E
Outcome	The team produces a focused list of concepts that warrant quality time to develop into value-based solutions that can be implemented into a project or a project feature[17]. On a case by case basis, a presentation to the asset owners/clients/end-users for the selected ideas may be undertaken in this phase.
Checklist	Refer to Checklist 4 in Appendix-C
References	*For further details refer to* Appendix B2, Item E

5.2.5 Development Phase

Objective	The objective of Development Phase is to develop the selected alternatives into fully supported recommendations.
Purpose	The Development Phase determines the “best” alternative(s) for presentation to the client. In this phase, detailed technical analyses are made for the remaining alternatives. This analysis forms the basis for eliminating weaker alternatives. The selected ideas are developed into value alternatives that are clearly written so that the owner and other project stakeholders understand the intent of the alternative and how it benefits the project. The alternative should include text, sketches, diagrams, assumptions, supporting calculations, vendor information, cost comparison work sheets, and other information etc. Issues addressed include reliability, customer convenience, quality control, capital cost, O&M cost, life cycle cost, schedule, risk, availability, political ramifications, and perception. Ideally, an action plan is developed for each alternative. The action plan should, at a minimum, include what needs to be done, who will do it, and when it will get done.
Major Activities	• Compare the study conclusions to the success parameters established during the Information and Function Analysis Phases

	• Prepare a written value alternative for each idea selected for further development • Assess and Allocate Risk Judgments and Costs, Where appropriate • Conduct Cost-Benefit Analysis and Determine the Most Beneficial Alternatives • Conduct Life – Cycle Cost Analysis • Generate sketches and information needed to convey the concept • Confirm that an alternative should be further developed • Finish initial alternative development • Develop an Implementation Plan for Each Value Alternative • Prepare Value Engineering Study Preliminary Report (Refer to Sec 5.3.3, last paragraph for report contents) • The above bullet points were elobrated in Appendix B2, Item F
Outcome	The Value Study team creates alternatives and low-, medium-, and high-risk scenarios and offers these alternatives to the client as options that address the Pre-Workshop strategic objectives.
Checklist	Refer to Checklist 5 in Appendix-C
References	*For further details on development phase refer to* Appendix B2, Item F

5.2.6 Presentation Phase

Objective	The objective of Presentation Phase is to present the VE activities and recommendation to the project stakeholders.
Purpose	The purpose is to obtain a commitment to follow a course of action for initiating an alternative. The presentation is made at the conclusion of the workshop. It is normally the first step (not the last step) in the approval process. This presentation is led by the VE Team Leader. The intent of the presentation is to communicate information regarding the VE Analysis, including all of the developed VE recommendations. After getting the client approval on proposed change, the design team is ultimately responsible for implementing these recommendations into the scoping plans and documents.
Major Activities	• Prepare presentation and supporting documentation to encourage commitment • Start the process of wining client and other stakeholders support • Exchange Information and clarification with the Project Team to ensure that the written proposals are correctly understood and proper communication exists between concerned parties • Outline an Implementation Plan • Prepare a draft report followed by a final VE Report. • The above bullet points were elobrated in Appendix B2, Item F
Outcome	The Presentation Phase Should End with a List of Actions Leading to Approval: • Preparation and submission of a final workshop report with all the necessary supporting documentation. • Ensure Briefings to other key stakeholders. • A schedule for a follow-up meeting to approve the proposal • Ensure client and other key stakeholders understand the rationale of the value alternatives. Also generate interest to sanction implementation.
Checklist	Refer to Checklist 6 in Appendix-C
References	*For further details on presentation phase refer to* Appendix B2, Item G. Refer to section 5.3.3 *of this guidelines for more details on VE study report*

5.3 Post Workshop Stage

The post workshop stage is divided into the following phases:

- Implementation Phase
- Follow up Phase

Summary of implementation phase and follow up phase are described in the following sections:

5.3.1 Implementation Phase

Objective	The objective of the Implementation Phase is to develop an implementation plan, execute the plan, and monitor the plan to completion.
Purpose	To ensure accepted value alternatives are implemented and that benefits projected by the Value Study have been realized. Additionally, to follow up on implementation of the Value Study results and improves the application of a Value Methodology for future studies.
Major Activities	• Submit and Review of final VE report and study recommendations • Conduct an Implementation Meeting with Client Project Team to Determine the Disposition of each Value Alternative. • Establish Action Plans for Accepted Alternatives and Document the Rejected Alternatives, • Obtain Commitments for Implementation, • Set a Time-Frame for Review & Implementation of Each Alternative, • Track Value Achievement, Resulting from Implemented Alternatives, • Sign Off Deliverables, • Validate Benefits of Implemented Change. • Ensure that new practices become embedded, by establishing and managing an implementation plan.
Outcome	The project stakeholders determine what will be changed in the project as a result of the Value Study. These are changes to the original concept or base case of a study, resulting from the value alternatives, that the project development will incorporate in future design or product development activities.
Checklist	Refer to Checklist 7 in Appendix-C
References	*For further details refer to References No 18*

5.3.2 Follow Up Phase

Objective	Improve the application of a value methodology for future studies.
Purpose	The main purpose of this Phase is to follow up on implementation of the Value Study results and improve the application of a value methodology for future studies.
Major Activities	• Prepare a report of the results of the study, lessons learned, or other items to be recorded and/or tracked through implementation • Identify where opportunities were missed • Identify roadblocks to innovation and understand why they existed • Debrief and record lessons learned • Integrate Value Study results into organization's lessons learned or program reporting

	• Reflect on the value study and consider how the experience has developed new capabilities
Outcome	Individuals become better value creators by reflecting on theories they held before the value study, comparing the way things turned out, and ascertaining how that knowledge affects the way they believed their own theories in the first place. This is a key step in learning what will help the organization become better at managing innovation.
Checklist	Refer to Check list no. 7 in Appendix-C
References	*For further details refer to References No 18*

5.3.3 VE Study Report

When preparing VE report, focus on the specific objectives of the study: selling the ideas and obtaining client/asset ownerapproval for them. To attain acceptance for the recommendations, the team must examine:

- Why the ideas are worth implementing?
- Emphasize the performance and delivery benefits.
- Address any concern that may exist regarding the proposals and identify what can be done to either minimize or overcome these problems.
- How these recommendations eliminate and/or reduce project risks?

Once the improvements have been detailed, the effect on cost should be documented. The cost change should also be presented on an annualized basis [17].

The VE Report will be prepared after the conclusion of the VE analysis and will summarize the findings of the VE Team. The report should highlight the proposed changes based on expected achievements of technical, financial, environmental aspects as well as Time, Cost and Quality consequences, in addition to related risks and challenges for implementation. The report should also incorporate all comments and required modifications raised in the Presentation Phase.

The initial report will be considered a Draft VE Report. The Draft VE Report will be prepared by the VE team and submitted to the client. The client/asset owner and the project team will review the report and provide comments. Once these comments have been incorporated, the report will be considered the final report and it shall be submitted for the relevant asset owner's approval

In order to maintain a standardized reporting format, the VE study report, as a minimum, should include cover page, executive summary including recommendations, introduction, project description, VE team details, VE study goals, description of VE stages including applicable phases and their outcomes, comparison of initial and final cost estimates and savings, comparison of initial and final qualities, comparison of initial and final schedule, design changes and suggestions, conclusion, recommendations, appendices etc.

5.4 VE Change Proposal

Value Engineering Change Proposal (VECP) are post-award value engineering proposals made by construction contractors during the course of construction under a value engineering clause in the contract. These proposals may improve the project performance, reduce life cycle cost, increase value and/or quality for money, lower construction cost, or shorten the construction time and enhance ease of construction, improve accessibility and maintainability, while considering their impacts on the project's overall Life Cycle and other applicable factors. VECP can include changes in drawings, design, specifications, or other contract requirements.

Although the value study process described above may still be applied in VECP's alternatively, the following basic steps can be followed to administer a VECP by the Contractor:

1. Contractor submits preliminary VECP to supervision consultant (SC) and the client.

2. SC submits their assessment of the VECP with recommendations to the client. The SC's assessment report shall contain, but not be limited to, the following:
   a. Review for compliance
   b. Impact on project objective, scope, quality, schedule and cost
   c. Evaluate math quantities, reasonable cost, accuracy of bid items, bid history etc.
   d. Estimate effort required for review and compare it to the expected savings

3. SC invites the contractor to present VECP to the project consultant and client.

4. SC determines the overall feasibility of the proposal, after execution of the Value Analysis Review jointly with Contractor, to determine if the VECP will work. The supervision team will evaluate if the proposed project, is safe, if the service life be adequate and future maintenance concerns, and is the cost reasonable.

5. Upon completion of the review, the SC makes one of three recommendations:
   a. Approve the proposal, and advise Contractor to proceed with a Formal Proposal to be submitted to client.
   b. Request revisions, if the VECP is not feasible or is not an acceptable cost to saving ratio.
   c. Reject the proposal.

6. SC prepares a final report for the client, including special conditions, restrictions, all expected schedules, cost and quality implications, etc.

7. The client notifies the SC if the VECP is approved pending construction change order.

8. In all cases, the approval of VECPs and incorporation into the construction contracts shall be subject to the prevailing procedures and requirements.

6.0 VE Education and Professional Certification

There are many possible sources of Value Engineering education and training. Some colleges and universities around the world teach the methodology in detail. One of the missions of *Lawrence D. Miles* Value Foundation is to create and promote teaching value methodology courses at the university level.

SAVE International offers its members education and training, publications, tools for promoting the value methodology, certification, networking opportunities, and recognition. SAVE also maintains a directory of "value consultants" who can lead studies or train others in VE techniques and who sponsor courses covering the value methodology and related disciplines. Private companies also provide VE training for their own employees and their customers.

Individuals may obtain certification in the practice of the Value Methodology through SAVE International. The three levels of certification are available:

- The Associate Value Specialist (AVS) (became Value Methodology Associate - VMA) is at the entry level. Requirements include training in the basics and some limited experience.
- The Value Management Practitioner(VMP), is at the mid-level. Additional requirements beyond an Associate Value Specialist are experiential. This certification level recognizes those individuals who have acquired the basic skills of value engineering/analysis but their principal career is not value engineering.
- The Certified Value Specialist(CVS), is the highest level of certification for people whose principle career is value engineering. Advanced training and leadership and managerial experience beyond the Value Management Practitioner are required.

SAVE International also conducts other training seminars. Topics have included creativity, facilitation skills, FAST, life-cycle costing, and Quality Function Deployment.

Another certification program for VE, the "Value Engineering Leader Certification Program," is registered with the All-Japan Foundation of Management Organizations conducted by the Society of Japanese Value Engineers.

For more information about SAVE International Certification system, please refer to the following link:
http://www.value-eng.org/page/Certification

The following are among the certification program's objectives:

- To create and maintain professional standards and improve the practice of the Value Methodology by identifying courses that meet the required education and training criteria
- To establish and maintain a professional recognition program encouraging practitioners in the Value Methodology field to improve professional education and training skills and competence in accordance with the standards
- To clarify methods and procedures in the application of the Value Methodology; to create a better understanding of the value profession; and to develop universal acceptance and increased application of value practices
- To establish and maintain ethical standards for workshops and seminars

- To encourage the development and application of the Value Methodology and provide examples of successful application of projects in industry and government[4].

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Appendices

Appendix A: Abbreviation and Glossary

Appendix B: Additional Information on Pre-Workshop and Workshop Stages

Appendix B1: Pre-Workshop Stage

Appendix B2: Workshop Stage

Appendix C: Forms and Checklists

Appendix A: Abbreviation and Glossary

In 1985, Lawrence D. Miles Foundation created the College of Fellows of the Society of American Value Engineers (SAVE)[1], now SAVE International, with the specific intent of developing a Glossary of Terms related to value. Over a two year period, approximately 10 Fellows worked individually and in teams to define, refine and finalize a glossary of value related terms. In 2006, the Glossary was reviewed by the Certification Board and those definitions most essential to the current application of value methodologies were identified and refined where necessary, as follows:

Associate Value Specialist (AVS): **Curretly termed as *Value Methodology Associate* (VMA), a** recognition designed for individuals who are new to the value methodology. An AVS is encouraged to progress to Value Methodology Practitioner (VMP) or Certified Value Specialists (CVS) certification.

Basic Function: Is the specific purpose(s) for which a product, facility, or service exists and conveys a sense of 'need'. In 'continuous innovation' projects the basic function must always exist, although methods or designs to achieve it may vary. In 'discontinuous innovation' projects, which seek to create new industries, the existence and persistence of the basic function is itself the focus of challenge.

Certified Value Specialist (CVS): is the highest level of certification attainable through SAVE International. Designation is reserved for Value Specialists and Value Program Managers who have demonstrated expert level experience and knowledge in the practice of the value methodology.

Classical FAST Model: A function displaying the interrelationship of functions to each other in a "how-why" logic.

Cost: The expenditure of resources needed to produce a product, service, or process.

Cost Model: A financial representation such as a spreadsheet, chart, and/or diagram used to illustrate the total cost of families of systems, components, or parts within a total complex product, system, structure or facility.

Customer-Oriented FAST (**F**unctional **A**nalysis **S**ystem **T**echnique) ***Model:*** This variation of the FAST diagram was developed to better reflect that it is the customer who determines value in the function analysis process. Customer-oriented FAST adds the supporting functions: attract and satisfy users, assure dependability, and assure convenience. The project functions that support these customer functions are determined by using the how-why logic.

FAST: Functional **A**nalysis **S**ystem **T**echnique

Function: The original intent or purpose that a product, service or process is expected to perform. It is expressed in a two-word "active verb/measurable noun" structure.

Functional Analysis: The process of defining, classifying and evaluating functions.

Function Cost: The expenditure of resources to perform the function.

Function, Sell: A function that provides a subjective expression of something that is to be achieved. In Function Analysis, sell functions are qualitative and are described using a passive verb and a non-measurable noun. Sell functions are also sometimes referred to as "aesthetic" functions.

Function, Work: A function that provides an objective expression of something that is to be accomplished. In Function Analysis, work functions are quantitative and are described using an active verb and a measurable noun. Work functions are also sometimes referred to as "use" functions.

Function Worth: The lowest overall cost to perform a function without regard to criteria or codes.

Hierarchy Function Model: A vertical "hierarchical" chart of functions. This places the basic function at the top. The function of each major system is placed beneath the basic function. The functions that support each of these functions are then placed on the next row. This process is continued until the team feels the level of detail is sufficient for the intent of the study.

***Job Pla*n**: A sequential approach for conducting a value study, consisting of steps or phases used to manage the focus of a team's thinking so that they innovate collectively rather than as uncoordinated individuals.

Life Cycle Cost (LCC): The sum of all development acquisition, production or construction, operation, maintenance, use, and disposal costs for a product or project over a specified period of time.

Low and High Order Functions: The function that is selected to initiate the project and is outside the study scope is low order function. The specific goals (needs) for which the basic function(s) exists is high order.

Performance: The capacity of a product to fulfill its intended function. Factors such as reliability, maintainability, quality and appearance are some examples.

Process: A sequence of activities that delivers a product or project.

Project: A temporary endeavor undertaken to create a unique product, service, or result. For the purpose of Value Studies, a project is the subject of the study. It may be a physical product such as a manufactured item, or a structure, system, procedure, or an organization.

Save International Certified Professional: For the purpose of a Value Study, the Job Plan shall be facilitated by a Certified Value Specialist (CVS), or a Value Methodology Practitioner (VMP) working under the supervision of a CVS. SAVE International Certification requirements are identified by the SAVE International Certification Board, which maintains a list of currently certified individuals.

Scope: The portion of the overall project that is selected for the value study. The analysis accepts everything within the defined scope in order to focus attention on the functions within those limits.

Secondary Function: A function that supports the basic function and results from the specific design approach to achieve the basic function.

Technical FAST Model: A variation to the Classical FAST that adds "all the time" functions, "one time" functions and "same time" or "caused by" functions.

Value: An expression of the relationship between function and resources where function is measured by the performance requirements of the customer and resources are measured in materials, labor, price, time, etc. required to accomplish that function.

Value Analysis (VA): The application of value methodology to an existing project, product or service to achieve value improvement.

Value Analyst: Refer to Value Professional.

Value Engineer: Refer to Value Professional.

Value Engineering (VE): The application of a value methodology to a planned or conceptual project or service to achieve value improvement.

Value Index: A ratio of function cost and function worth (Function cost/Function worth. This ratio is used to determine the opportunity for value improvement, which is usually identified in the Function Analysis Phase.

Value Management (VM): The application of value methodology by an organization to achieve strategic value improvement.

Value Methodology Associate (VMA): is the updated SAVE certification name of AVS, starting from June, 2016.

Value Methodology Alternative (or Alternatives): An alternative or alternatives prepared by the value study team and presented to management to provide financial and/or performance improvements and which is within acceptable terms and conditions of the Value Study.

Value Methodology Practitioner (VMP): VMP recognizes individuals with basic value training and some experience in the application of the methodology. Value methodology practitioners participate in or lead Value Studies.

Value Methodology: A systematic process used by a multidisciplinary team to improve the value of projects through the analysis of functions. See Value Engineering, Value Analysis and Value Management.

Value Practitioner: Refer to Value Professional.

Value Professional: One who applies the value methodology principles to study and search for value improvement. Synonymous with value analyst, value engineer, value practitioner, or value specialist.

Value Study: The application of a value methodology by SAVE International certified professionals using the Value Job Plan.

Appendix B1: Additional Information on Pre-Workshop Stage

A. Value Methodology

Value Methodology (also known as Value Engineering, Value Analysis, Value Management), based on the project stage in which the Value Study is implemented, is a Powerful Problem Solving Tool that can reduce costs while maintaining or improving performance and quality requirements. It is a function-oriented, systematic team approach to provide value in a project or service. The Value Methodology helps organizations by:-

- Decreasing Costs
- Increasing Profits
- Improving Quality
- Efficient Utilization of Resources
- Solving Problems
- Expanding Market Share

The difference between Value Analysis (VA) and Value Engineering (VE) is not in the approach taken or tools used, but in the point at which they occur in the life cycle of the project. VE is applied during the project design and development stage, while VA is applied for the construction stage and for purchased products. Value management is the application of VE and VA throughout the complete business cycle [18].

B. VE Job Plan

A Value Study is the formal application of a value methodology to a project in order to improve its value. This application is also referred to as value engineering, value analysis, value planning, or value management[19]. The VE Work Plan is a systematic and structured action plan for conducting, documenting of results and implementation of the VE study. The VE Job Plan includes the following three major sequential stages:

1. Pre – Workshop Stage (Preparation for the VE Study), including VE Team Selection, coordination with Project Stakeholders, Data Collection and VE Study Preparation, and Information Modeling.

2. Workshop Stage (The Six – Phase Work Plan), including Information Phase, Function Analysis, Creative Phase, Idea Evaluation, Development of Proposal(s), Presentation Phase (Presentation of VE Study)

3. Post Workshop Stage, including Implementation Plan and VE Study Report and Follow Up & Monitoring of Implementation and Lessons Learnt [18].

   VE Job Plan should contain the following minimal essential features:

   - Detailed Description of the Project Objectives and Scope,
   - Clear goals for the VE study,
   - Selection of VE study team members,
   - Designation of the VE Team leader,
   - VE Study activities, schedule for each phase,
   - Establishment of target data for formal presentation of VE results [18].

Appendix B2: Additional Information on Workshop Stage

The workshop stage is the major part of the value engineering study, including the Information Phase, Function Analysis, Creative Phase, Evaluation of Created Ideas, Development of selected proposals, and presentation of VE study to project stakeholders. F*or Value Engineering Workshop Venue and Logistics, please refer to Reference*[21]*.*

A. Workshop Objective

The main objective of the workshop stage is to conduct the main part of the value engineering study, including; Information phase, dealing with Gather project information, including project commitments and constraints, Function analysis phase to Analyze the project to understand the required functions, Creative Phase, to Generate ideas on ways to accomplish the required functions that improve project performance, enhance quality, and lower project costs, Evaluation Phase to Evaluate and select feasible ideas for development, Development Phase, Developing the selected alternatives into fully supported recommendations, and Presentation Phase, to Present the VE activities and recommendation to the project stakeholders [14].

In the following workshop phases, the objective, common activities, tools and expected outcome of each phase are illustrated.

B. Information Phase

Refer to Section 5.2.1 of the guidelines for details.

C. Function Analysis Phase

The purpose of the function analysis phase is to identify the most beneficial areas for study. The analytical efforts in this phase form the foundation of the job plan. The disciplined use of function analysis is the principal feature that distinguishes the value methodology from other improvement methods. The following subsections describe the activities in the Function Analysis Phase[6].

Common Activities of Function Analysis Phase

1. Determination of Function

For the project under study, this activity encompasses determining about 40 to 60 functions that are performed by the project components. Functions are defined for every element of the project that consumes resources. The functions are typically recorded on adhesive backed cards for later manipulation.

Functions are defined for every element of the project that consumes resources. A function is defined as the natural or characteristic action performed by a project or service. In VE, a function must be defined by two words: an active verb and a measurable noun.

The verb should answer the question, “What does it do?” For example, it may generate, stop, detect, emit, protect, or transports. This approach is a radical departure from traditional cost-reduction efforts because it focuses attention on the required action rather than the design. The traditional approaches ask the question, “What is it?” and then concentrates on making the same item less expensive by answering the question, “How do we reduce the cost of this design?”

The noun answers the question, “What does it do this to?” The noun tells what is acted upon, (e.g., electricity, vehicles , movement, light , facilities, or pedestrians). It must be measurable or at least understood in measurable terms, since a specific value must be assigned to it during the later evaluation process that relates cost to function.

A measurable noun together with an active verb provides a description of a work function (e.g., generate electricity, stop vehicles , detect movement, etc.). They establish quantitative statements. Functional definitions containing a verb and a non-measurable noun are classified as sell functions. They establish qualitative statements (e.g., improve appearance, decrease effect, increase convenience, etc.). It is important to provide the correct level of function definition. For example, the function of a water service line to a building could be stated as “provide service.” “Service,” not being readily measurable, is not amenable to determining alternatives. On the other hand, if the function of the line was stated as “conduct fluid,” the noun in the definition is measurable, and alternatives dependent upon the amount of fluid being transported can be readily determined. The system of defining a function in two words, a verb and a noun, is known as two-word abridgment. Advantages of this system are that it:

- Forces conciseness. If a function cannot be defined in two words, insufficient information is known about the problem or too large a segment of the problem is being attempted to be defined
- Avoids combining functions and defining more than one simple function. By using only two words, the problem is broken down into its simplest element
- Aids in achieving the broadest level of dissociation from specifics
- When only two words are used, the possibility of faulty communication or misunderstanding is reduced to a minimum
- Focuses on function rather than the item
- Encourages creativity
- Frees the mind from specific configurations
- Enables the determination of unnecessary costs
- Facilitates comparison[6]

2. Function Classification

The second major activity in the Function Analysis Phase is to group the functions into two categories, basic and secondary. The basic function is the required reason for the existence of a component of a project, and answers the question, “What must it do?” Basic functions have or use value: A basic function is the primary purpose or most important action performed by a project. The basic function must always exist, although methods or designs to achieve it may vary.
A project may possess more than one basic function. This is determined by considering the user’s needs. A non-load-bearing exterior wall might be initially defined by the function description “enclose space.” However, further function analysis determines that, for this particular wall, two basic functions more definitive than the above exist; they are “secure area” and “shield interior.” Both answer the question: “What does it do?”
Secondary functions answer the question “What else does it do?” Secondary functions are support functions and usually result from the particular design configuration. Generally, secondary functions contribute greatly to cost and may or may not be essential to the performance of the primary function: A function that supports the basic function and results from the specific design approach to achieve the basic function. As methods or design approaches to achieve the basic function are changed, secondary functions may also change.

There are four kinds of secondary functions:

1. Required—a secondary function that is essential to support the performance of the basic function under the current design.
2. Aesthetic—a secondary function describing esteems value.
3. Unwanted—a negative function caused by the method used to achieve the basic function such as the heat generated from lighting which must be cooled.
4. Sell—a function that provides primarily esteem value. For marketing studies, it may be the basic function.

Secondary functions that lend esteem value (convenience, user satisfaction, and appearance) are permissible only in so far as they are necessary to permit the design or item to work or sell. Therefore, they sometimes play an important part in the marketing or acceptance of a design or product. Value analysis separates costs required for primary function performance from those incurred for secondary functions to eliminate as many non-value-added secondary functions as possible, improve the value of the remaining ones, and still provide the appeal necessary to permit the design to sell.

3. Develop Function Relationships and Priorities

The principal technique that has been developed to create a better understanding of functional relationships is the Function Analysis System Technique (FAST)

A FAST diagram is best accomplished as a team effort. Involving different viewpoints which cause deeper thinking and a more thorough investigation about the subject. FAST Diagrams are used to prioritize the objectives or functions of the project / product. Once the objectives are prioritized the options are evaluated to determine which will return the most value based on predetermined value criteria such as:

1. Targeting true customer needs and wants.
2. Delivering requirements but still enabling cost reduction by focusing on what the function accomplishes versus what the project is eliminating unimportant requirements.
3. Adding incremental costs to achieve larger performance benefit.
4. Improving performance and reducing cost simultaneously[7].

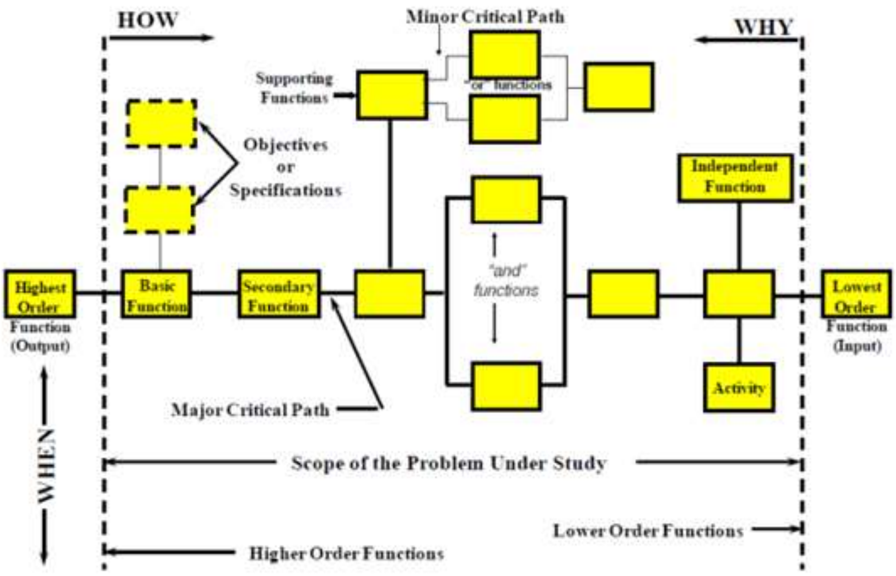


Figure 2: Sample FAST Diagram

The FAST model has a horizontal 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. Start with a function on the left and ask HOW that function is performed and continue to ask why as you move across the page to the right. This will create a specific approach to the function. Begin to ask WHY and move from right to left to develop the solution to a higher level.

A good rule to remember in constructing a FAST diagram is to build in the HOW direction and test the logic in the WHY direction. There is essential logic associated with the FAST HOW-WHY directional orientation.

1. When undertaking any task it is best to start with the goals of the task then explore methods to achieve the goals. The question HOW, is answered by the function on the right and is a method to perform that function being addressed. FAST diagram, reading from left to right, starts with the goal, and ends at the beginning of the "system" that will achieve that goal.
2. Changing a function on the HOW-WHY path affects all of the functions to the right of that function. This is a domino effect that only goes one way, from left to right. Starting with any place on the FAST diagram, if a function is changed the goals are still valid (functions to the left) but the method to accomplish that function and all other functions on the right, are affected.
3. Building the diagram in the HOW direction, or function justification, will focus attention on each function element of the diagram. Whereas, reversing the FAST diagram and building it in WHY direction (right to left) will cause individual functions to be overlooked and leaving gaps in the system.

FAST is generally used to understand a problem, issue, or opportunity. However, developing a FAST diagram can be a difficult and time consuming effort, but the decision to use a FAST diagram should be based on an understanding of the problem. The following broad considerations apply to such a decision:

- The more complicated the situation, the more useful a FAST diagram will be.
- If the situation is not well understood, a FAST diagram should be used.
- If there are more than three stakeholders that need to come to a common understanding of the situation, a FAST diagram should be used.
- If during the initial function analysis, it is discovered that there are multiple secondary functions (particularly if they are co-dependent), a FAST diagram should be used.
- A FAST diagram should not be used if no one in the group has performed a Function Analysis before.
- If the scope is narrow and constrained, a FAST diagram may not be necessary[4,7]

Components of the FAST Diagram

- The vertical orientation of the FAST diagram is described as the WHEN direction. This is not part of the intuitive logic process but it supplements intuitive thinking. WHEN is not a time orientation but indicates cause and effect.

- Scope lines represent the boundaries of the study and are shown as two vertical lines on the FAST diagram. The scope lines bound the scope of study or that aspect of the problem with which the study team is concerned. The left scope line determines the basic function of the study. The basic function will always be the first function to the immediate right of the left scope line. The right scope line identifies the end of the study and separates the input function from the scope of the study.

- The objective or goal of the study is called the "Highest Order Function", located to the left of the basic function and outside of the left scope line. Any function to the left of another function is a "higher order function". Functions to the right and outside of the right scope line represent the “Lowest Order Functions”. Any function to the right of another function is a "lower order" function and represents a method selected to carry out the function being addressed.

- Those functions to the immediate right of the left scope line represent the purpose or mission of the project or process under study and are called Basic Functions. Once determined, the basic function will not change. The project or process will lose its value if the basic function fails.

- All functions to the right of the basic function portray the conceptual approach selected to satisfy the basic function. The concept describes the method being considered or elected to achieve the basic function. The concept can represent either the current conditions as is or proposed to be approach.

- As a general rule, it is best to create a "to be" rather than an "as is" FAST diagram, even if the assignment is to improve an existing project. This approach will give the project development team members an opportunity to compare the "ideal" to the "current" and help resolve how to implement the differences.

- Working from an "as is" model will restrict the team's attention to incremental improvement opportunities. An "as is" model is useful for tracing the symptoms of a problem to its root cause and exploring ways to resolve the problem because of the dependent relationship of functions that form the FAST diagram.

- Any function on the HOW-WHY logic path is a logic path function. Functions along the WHY direction lead into the basic function and are located on the major logic path. A minor logic path does not lead directly to the basic function.

- Changing a function on the major logic path will alter or destroy the way the basic function is performed. Changing a function on a minor logic path will disturb an independent or supporting function that enhances the basic function. Supporting functions are usually secondary and exist to achieve the performance levels specified in the objectives or specifications of the basic functions or because a particular approach was chosen to implement the basic function.

- Independent functions describe an enhancement or control function on the logic path. They do not depend on another function or method selected to perform that function. Independent functions are located above the logic path functions and are considered secondary with respect to the scope, nature, level of the problem, and its logic path. An example of a FAST Diagram for a pencil is shown below

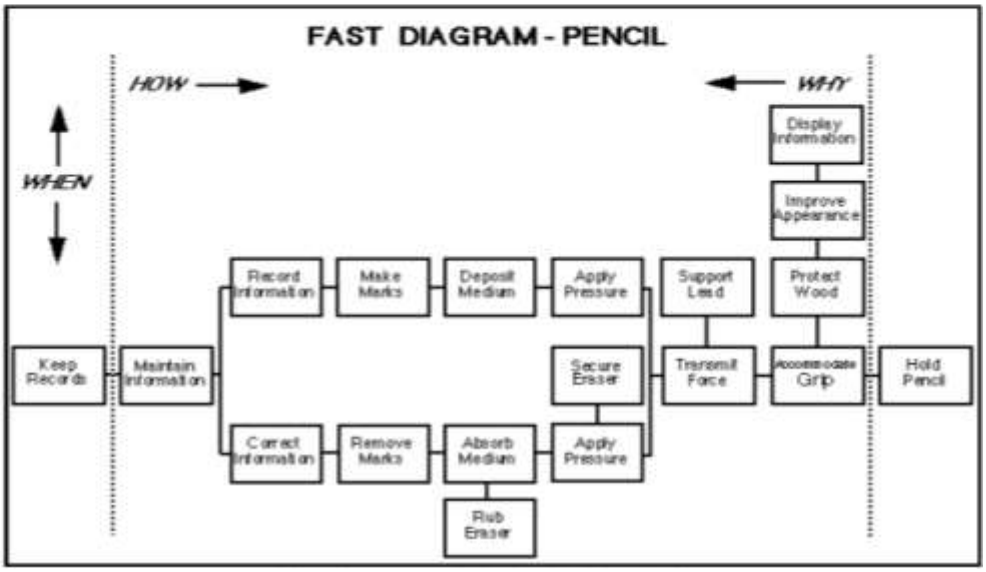


Figure 3: Example of FAST for a Pencil

- Step 1: Determine the highest order function. “The objective of the value study is called the Highest Order Function(s) and is located to the left of the basic function(s) and outside the left scope line.

- Step 2: Identify the basic functions. Select the basic functions that directly answer the question, “How does the project or process perform the highest order function?” If all direct answers are not among the existing basic functions, create a new one. All of these basic functions should be included in the first column to the right of the higher order function.

- Step 3: Expand the FAST diagram. Keep asking how the function is performed from the viewpoint of a user. Most answers will be found among the existing functions. Add second, third level, and lesser functions as needed to the right of the basic functions but do not expand a function unless the “how” question is answered by two or more functions. Repeating the “how” question in this way is sometimes called the “ladder of abstraction” method. It is a thought-forcing process. Because using more than one definition can generate more creative ideas, this approach leads to greater fluency (more ideas), greater flexibility (variety of ideas), and improved function understanding of the problem. It generates critical paths for achieving the basic functions.

- Step 4: Identify the supporting functions. Supporting functions do not depend on another function. They are placed above a critical path and usually are needed to achieve the performance levels specified for the critical path function they support. The supporting functions above the critical path and the activities below the critical path are the result of answering the “when” question for a function on the critical path. A supporting function can have its own minor critical path.

- Step 5: Verify the FAST diagram. The FAST diagram is verified by driving one’s thinking up the ladder of abstraction. Asking “why” raises the level, making the function description more general. In practice, the desired level is one that makes possible the largest number of feasible alternatives. Since the higher levels are more inclusive and afford more opportunities, the desired level is the highest level that includes applicable, achievable alternatives. A practical limit to the “why” direction is the highest level at which the practitioner is able to make changes. If the level selected is too low, alternatives can be restricted to those that resemble the existing design. If the level selected is too high, achievable alternatives can be obscured, and alternatives that are beyond the scope of effort might be suggested.

4. Estimate the Cost of Performing Each Function

All VE studies include some type of economic analysis that identifies areas of VE opportunity and provides a monetary base from which the economic impact can be determined. The prerequisite for any economic analysis is reliable and appropriate cost data. Consequently, the VE study should use the services of one or more individuals who are skilled in estimating, developing, and analyzing cost data. The cost of the original or present method of performing the function (i.e., the cost for each block of the FAST diagram) is determined as carefully and precisely as possible given the time constraints for preparing the estimate.

The accuracy of a cost estimate for a product depends on the:

- Maturity of the item,
- Availability of detailed specifications and drawings, and
- Availability of historical cost data.

Similarly, the accuracy of a cost estimate for a service depends on the:

- People involved,
- Time spent performing the service,
- Waiting time, and
- Direct, indirect, and overhead labor and material costs.

In some cases, a VE study will involve both products and processes[4].

5. Determine the Best Opportunities for Improvement

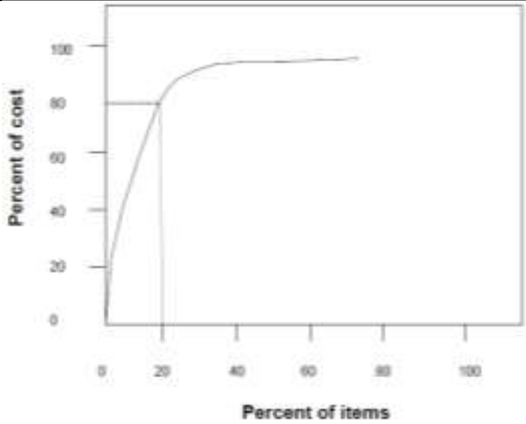
The objective of this activity is to select functions for continued analyses. It is often accomplished by comparing function worth to function cost, where value is defined by the ratio of worth to cost (or cost to worth). Thus, the use of function worth focuses the VE effort on those functions that will be most worthwhile and provides a reference point to compare alternatives. It can even be used as a psychological incentive to discourage prematurely stopping the VE effort before all of the alternatives are considered.

Function worth is defined as the lowest cost to perform the function without regard to consequences.

Determining the worth of every function is usually not necessary. Cost data aid in determining the priority of effort. Because significant savings potential in low-cost areas may not be a worthwhile pursuit and high-cost areas may be indicative of poor value, the latter are prime candidates for initial function worth determinations. Costs are usually distributed in accordance with *Pareto*'s Law of Maldistribution: a few areas, "the significant few," (generally 20 percent or less) represent most (80 percent or more) of the cost. Conversely, 80 percent of the items, "the insignificant many," represent only 20 percent of total costs.

A technique for developing the worth of functions, conceived in the early days of VE and still effective today, *Pareto*'s Law of Maldistribution compares the selected function to the simplest method or product that can be imagined to achieve the same result. One increasingly popular technique for assigning worth to functions ascertains the primary material cost associated with the function.

The value calculation can be done in many ways. For example, some workshop facilitators use a ratio of "percent relative importance" to "percent of cost." In this approach, all functions are evaluated pairwise, with different numbers assigned to reflect the relative importance of the two functions being compared (e.g., three may mean a large difference in importance, 1 may mean a small difference in importance). A relative importance is calculated for each function individually as the sum of the relative importance scores that function received when it was ranked higher than another function in the pairwise comparisons. The "percent relative importance" is calculated by converting the individual function's relative importance scores to a percentage of the total. The "percent of cost" is the cost of a function relative to the total cost of all functions.



There are other approaches. For example, Thomas Snodgrass suggests an alternative approach based on high, medium, and low scores for function acceptance, function cost, and function importance.

Whatever approach is used, the best opportunities for improvement are determined by improving functions that have excessively low ratios of worth to cost (or high ratios of cost to worth). This ratio is referred to as the value index.[4]

For more detailed way to determine function worth and cost, please refer to Ref. No. [20].

6. Refine VE Study Scope

The final activity in the Function Analysis Phase refines the study scope to reflect any changes that have taken place[4].

D. Creative Phase

Common Activities of Creative Phase

1. Discourage Creativity Inhibitors

For these activities to work well, the team must avoid mental attitudes that hinder creativity. The facilitator should point out creativity inhibitors to the team. Awareness of these inhibitors encourages people to overcome them. *Parker* identifies the following as common habitual, perceptual, cultural, and emotional blocks to creativity.

- Habitual blocks,
  - Continuing to use "tried and true" procedures even though new and better ones are available,
  - Rejecting alternative solutions that are incompatible with habitual solutions,
  - Lacking a positive outlook, lacking effort, conformity to custom, and reliance on authority

- Perceptual blocks
  - Failure to use all the senses for observation,
  - Failure to investigate the obvious,
  - Inability to define terms,
  - Difficulty in visualizing remote relationships,
  - Failure to distinguish between cause and effect,
  - Inability to define the problem clearly in terms that will lead to the solution of the real problem,

- Cultural blocks
  - Desire to conform to proper patterns, customs, or methods,
  - Overemphasis on competition or cooperation,
  - The drive to be practical above all else, thus making decisions too quickly,
  - Belief that all indulgence in fantasy is a waste of time,
  - Faith only in reason and logic,

- Emotional blocks
  - Fear of making a mistake or of appearing foolish,
  - Fear of supervisors and distrust of colleagues,
  - Too much emphasis on succeeding quickly,
  - Difficulty in rejecting a workable solution and searching for a better one,
  - Difficulty in changing set ideas (no flexibility) and depending entirely upon judicial (biased) opinion,
  - Inability to relax and let incubation take place,

The following list adapted from *Michel Thiry*'s "good idea killers" could also be used to make the team aware of attitudes to avoid:

- It is not realistic.
- It is technically impossible.
- It does not apply.
- It will never work.
- It does not correspond to standards.
- It is not part of our mandate.
- It would be too difficult to manage.
- It would change things too much.
- It will cost too much.

- Management will never agree.
- We do not have time.
- We have always done it that way.
- We already tried it.
- We have never thought of it that way.
- We are already too far into the process

The Creative Phase does not necessarily identify final solutions or ideas ready for immediate implementation. It often simply provides leads that point to final solutions [4 &18].

2. Establish Ground Rules

The ground rules for creative idea generation are summarized as follows:

- Do not attempt to generate new ideas and judge them at the same time. Reserve all judgment and evaluation until the Evaluation Phase.
- Focus on quantity, not quality. Generate a large quantity of possible solutions. As a goal, multiply the number of ideas produced in the first rush of thinking by five or even ten.
- Seek a wide variety of solutions that represent a broad spectrum of attacks on the problem. The greater the number of ideas conceived, the greater likelihood of an alternative that leads to better value.
- Freewheeling is welcome. Deliberately seek unusual ideas.
- Watch for opportunities to combine or expand ideas as they are generated. Include them as new ideas. Do not replace anything.
- Do not discard any ideas, even if they appear to be impractical.
- Do not criticize or ridicule any ideas. (Criticism could be discouraged, for example, by maintaining a criticizer list or imposing a mock penalty on criticizers)4.

3. Generate Alternative Ideas

In this phase of the VE study, generating a free flow of thoughts and ideas for alternative ways to perform the functions—not how to design a project or service—is important. While creativity tools are available for problem-solving situations, no specific combination of techniques is prescribed for all VE projects, and the degree to which they should be used is not predetermined. The selection of specific techniques and the depth to which they are used are primarily matters of judgment and vary according to the complexity of the subject under review[4].

The following list of idea-generation techniques describes some commonly used tools in the VE context:

a. Brainstorming

Brainstorming is a free-association technique that groups use to solve specific problems by recording spontaneous ideas generated by the group. It is primarily based on the premise that one idea suggests others, which suggest even more. An individual can brainstorm, but experience has shown that a group can generate more ideas collectively than the same number of persons thinking individually. *Roger B. Sperling* has suggested combining group and individual brainstorming. He found that after the group brainstorming was complete, individual brainstorming can generate additional ideas of comparable quality.

b. Gordon Technique

The Gordon technique is closely related to brainstorming. The principal difference is that no one except the group leader knows the exact nature of the problem under consideration. This difference helps avoid the pre-mature ending of the session or egocentric involvement. A participant may cease to produce additional ideas or devote energy only to defending an idea if he/she is convinced that one of the ideas already proposed is the best solution to the problem. Selecting a topic for such a session is more difficult than selecting a topic for a brainstorming session. The subject must be closely related to the problem at hand, but its exact nature must not be revealed until the discussion is concluded.

c. Checklist

The checklist technique generates ideas by comparing a logical list of categories with the problem or subject under consideration. Checklists range from the specialized to the extremely general.

d. Morphological Analysis

Morphological analysis is a structured, comprehensive system for methodically relating problem elements to develop new solutions. In this approach, the problem is defined in terms of its dimensions or parameters, and a model is developed to visualize every possible solution. Problems with too many parameters rapidly become intractable.

e. Attribute Listing

The attribute listing approach lists all of the various characteristics of a subject first and then measures the impact of changes. By so doing, new combinations of characteristics (attributes) that will better fulfill some existing need can be determined.

f. Input-Output Technique

The input-output technique establishes output, establishes input as the starting point, and varies combinations of input/output until an optimum mix is achieved.
When using any one of these techniques, the team reviews the elements of the problem several times. If possible, new viewpoints should be obtained by discussing the problem with others. Different approaches should be used if one technique proves to be ineffective. However, before rejecting any possible solutions, one effective strategy allows the team to take a break to allow time for subconscious thought on the problem while consciously performing other tasks.[4&18]

E. Evaluation Phase

The objective of the Evaluation Phase of the Value Engineering Job Plan is to analyze the results of the Creative Phase and, through review of the various alternatives, select the best ideas for further expansion.[5]. The Evaluation Phase selects and refines the best ideas to develop into specific value improvement recommendations. Ultimately, the team should present the decision-maker a small number (e.g., fewer than six) of choices. In the Creative Phase, a conscious effort was made to prohibit judgmental thinking because it inhibits the creative process. In the Evaluation Phase, all the alternatives must be critically assessed to identify the best opportunities for value improvement. This phase is not the last chance to defer ideas. A detailed cost-benefit analysis conducted in the Development Phase leads to the final set of choices presented to the decision-maker. The following subsections describe the activities during the Evaluation Phase.[4]
In Evaluation phase, there are key questions that VE Team need to ask:

- How might the idea work?
- Can it be made to work?
- What is the cost?
- Will each idea perform the basic function?

- Which is the least expensive?
- Can it be modified or combined with another?
- What are the chances for implementation?
- Will it be relatively difficult or easy to make the change?
- Will the users' needs be satisfied?
- What is the savings potential, including life cycle costs?[5]

Common Activities of Evaluation Phase

1. Eliminate Low-Potential Ideas

Ideas that are not feasible, too hard, not promising, or do not perform the basic function should be eliminated. A useful approach to this activity is to classify the ideas into three categories:

- Yes. These ideas appear to be feasible and have a relatively high probability of success.
- Maybe. These ideas have potential but appear to need additional refinement or work before they can become proposals.
- Not Now. These ideas have little or no potential at this time.

At this point, eliminate only the “not now” ideas.[4]

2. Group Similar Ideas

The remaining ideas are grouped into several (three or more) subject-related categories and examined to determine if they should be modified or combined with others. Sometimes, the strong parts of two different ideas can be developed into a winning idea. In other cases, several ideas can be so similar that they can be combined into a single all-encompassing idea. Some workshops employ a “forced relationships” technique that deliberately attempts to combine ideas from the different subject-related categories to discover new, innovative alternatives[4].

3. Establish Idea Champions

The remaining activities in this phase are designed to prioritize the ideas for further development. An idea champion is a study team member who will serve as an idea’s proponent throughout the prioritization process. If an idea has no champion, it should be eliminated at this point.[4]

4. List the Advantages and Disadvantages of Each Idea

The advantages and disadvantages of each idea are identified along with the ease of change, cost, savings potential, time to implement, degree to which all requirements are met, and likelihood of success. All of the effects, repercussions, and consequences that might occur in trying to accomplish a solution should be anticipated. Useful suggestions include how to overcome the disadvantages. No matter how many advantages an idea has, disadvantages that cannot be overcome may lead to its rejection.[4]

5. Rank the Ideas

A set of evaluation criteria should be developed to judge the ideas, using the factors considered when listing advantages and disadvantages (e.g., cost, technical feasibility, likelihood of approval, time to implement, and potential benefit). The ideas should be ranked according to the criteria that have been developed. No idea should be discarded, and all ideas should be evaluated as objectively as possible. Ratings and their weights are based on the judgment of the people performing the evaluation[4].

Idea Ranking Techniques can be summarized as follows:-

- Benefits – Implementation Matrix (A – B – C – D),
- Ranking out of 10 (5 + 5) system,
- Conceptual Ranking (High – Medium – Low),
- Voting of VE Team,
- Weighted Evaluation Matrix (WEM) 18

For more details about ranking techniques, please refer to ref. no. 18.

This initial analysis will produce a shorter list of alternatives, each of which has met the evaluation standards set by the team. For the higher-ranked ideas, the VE team should suggest ways to reduce the disadvantages and enhance the advantages. This exercise can lead to the following potential benefits:

- Ideas can be revised to improve their potential for success.
- Insight into implementation issues can be obtained from the suggested ways to reduce the disadvantages.
- Insight into the acceptability of the idea and the likelihood of management approval can be derived from suggested ways to enhance the advantages.

This approach can serve as a basis for distinguishing among the higher-ranked ideas (i.e., re-ranking the ideas) and, as a consequence, simplifying and strengthening the procedure for selecting ideas for further development[4].

6. Select Ideas for Further Development

Typically, a cutoff point is established for identifying ideas for further development. If a natural break occurs in quantitative evaluation scores, a cutoff point may be obvious. If only qualitative evaluation scores are used or if quantitative scores are close, a more refined ranking scheme may be needed to make the selection. However, if several alternatives are not decisively different at this point, they should be developed further.

Alternatives with the greatest value potential will normally be among those selected. If that is not the case, those ideas should be reexamined to determine whether they should be developed further. Retaining at least one idea from each of the subject-related categories used to group ideas at the beginning of the Evaluation Phase is also useful[4].

F. Development Phase

Development Phase Objective and Outline

The Development Phase determines the "best" alternative(s) for presentation to the client decision-maker. In this phase, detailed technical analyses are made for the remaining alternatives. These analyses form the basis for eliminating weaker alternatives[4&18].
The selected ideas are developed into value alternatives that are clearly written so that the owner and other project stakeholders understand the intent of the alternative and how it benefits the project. Write-ups also identify any potential negative factors associated with the alternative. The alternative should include text, sketches, diagrams, assumptions, supporting calculations, vendor information, cost comparison work sheets, and other information which may be necessary to convey the intent of the alternative. The text should also identify other alternatives which may be enhanced or complemented by acceptance of an alternative. Issues addressed include reliability, customer convenience, quality control, capital cost, O&M cost, life cycle cost, schedule, risk, availability, political ramifications, and perception. Ideally, an action plan is developed for each alternative. The action plan should, at a minimum, include what needs to be done, who will do it, and when it will get done[17].

This phase is an objective appraisal of the lowest cost alternative methods of reliably performing the required functions. During this phase, the most promising alternatives selected during the Evaluation Phase will be further developed into detailed alternative design ideas. The intent is to obtain and present adequate backup data regarding design changes and costs for presentation to the client .

The best ideas are completely developed, with the assistance of experts and specialists, as required. Recommended design changes, materials, procedures, new forms, changes to standards and policy, all costs, and implementation requirements are to be documented. Select about three alternatives for performing each major function based on the best value potential(s). Develop each idea until enough data has been accumulated to prove the idea, and then choose the best, developing that one fully. Develop the next best idea deeply enough to prove its potential. The idea that was initially selected as the best could get rejected by the client. It is handy to have a close-running number two idea to fall back on.

The development phase outline can be summarized in the following bullet points:

- Determine sources for additional information about the selected alternatives.
- Ascertain technical feasibility of the selected alternatives.
- Determine economic feasibility of the selected alternatives.
- Present findings in detailed change proposals.
- Develop implementation plan20.

Common Activities of Development Phase

1. Compare the study conclusions to the success requirements established during the Information and Function Analysis Phases

Consider Alternate Products, and Materials, In developing ideas one should give consideration to all possible design solutions, including different products, and materials, as applicable.

Testing, Tests required to demonstrate technical feasibility should be performed before the alternate is recommended for implementation. Often the desired tests have already been conducted by another agency. Ask for a report on those tests. If not already available, the VE team may arrange for the necessary testing and evaluation involved. Required testing should not delay approval of a proposal when:

- Risk is low;
- Consequences of less success would involve nothing more serious than less cost saving;
- The element being tested involves an intangible or subjective factor; and
- The test is normal confirmation procedure after an action is taken.

Consult Specialists, To obtain better value in design, one must obtain better answers to technical and construction problems through consultation with the most knowledgeable specialists available. If the functions have been defined correctly, using precise verbs and measurable nouns, the area of knowledge needed for value can be identified. For example, "support weight" would indicate that a material specialist or structural designer could contribute. While consultation can be done by telephone or mail, it is usually more desirable to have a personal meeting with the specialists. The Value Analyst must be able to:-

- Define the required functions and the cost problem;
- Indicate the importance and priority of the problem;
- Make the specialist a part of the project;
- Direct the specialist's efforts;
- Give credit for his contribution; and
- Ask him/her to identify other specialists or sources of assistance. Effective use of specialists can remove many potential roadblocks.

Consult Suppliers, The industry employs a unique group of suppliers, particularly in the structural field, including personnel with the latest information on structural shapes, pipe culverts, cements, chemical additives, etc. Recent advances in traffic control techniques include electronic applications that the average highway engineer has no time to review. The Value Team's job is to find and use this knowledge. Encourage your suppliers to suggest alternatives, other materials, design modifications, etc., to learn from their experience. In design, don't demand unnecessarily stringent requirements "just to be on the safe side." Over-specification may be safe and easy, but it is an expensive "shortcut." Solicit suggestions for improvement from the suppliers, and ask what there is about the design that causes high cost. In early planning, thoroughly describe the functional and technical requirements of the project, indicating those that are critical and those where some flexibility exists. Keep abreast of the services your suppliers have to offer, and maintain an up-to-date file of new services as a potential source of ideas leading to tangible cost savings in future planning and design.

2. Prepare a written value alternative for each idea selected for further development,

Develop Specific Alternatives, Those alternates that stand up under close technical scrutiny should be followed through to the development of specific designs and recommendations. Prepare drawings or sketches of alternate solutions to facilitate identifying problem areas remaining in the design and to detail a cost analysis.
Each alternate must be subjected to:

- Careful analysis to insure that the user's needs are satisfied;
- A determination of technical adequacy;
- The preparation of estimates of construction and life-cycle costs; and
- Full consideration of the costs of implementation, including redesign and schedule changes.

3. Assess and allocate risk judgments and costs, where appropriate,

4. Conduct Cost-Benefit Analysis and Determine the Most Beneficial Alternatives ,

Certain key questions should be answered as Part of this effort:

- What are the life cycle savings?
- Do the benefits outweigh the costs?

- What are the major risks?
- How can the risks be mitigated?
- Are there any outstanding technical issues?

If more than one alternative offers a significant savings potential, it is common to recommend all of them. One becomes the primary recommendation and the others are alternative recommendations, usually presented in decreasing order of saving potential. Take other nonqualified benefits into account.

The VE team should consult with personnel knowledgeable about what the item must do, the operational constraints it faces, how dependable the item must be, and what environmental conditions it must operate under. Technical problems related to design, implementation, procurement, or operation must be determined and resolved.

5. Conduct Life – Cycle Cost Analysis ,

Life-cycle cost is the economic measure of value. A life-cycle cost analysis must rank all remaining alternatives according to an estimate of their life-cycle cost-reduction potential relative to the present method. Cost estimates must be as complete, accurate, and consistent as possible to minimize the possibility of error in assessing the relative economic potential of the alternatives. Specifically, the method used to estimate the cost of the original or present method should also be used to estimate the cost of alternatives[20&17].

To Perform a Detailed Cost analysis for proposed alternatives, to be included in the final proposal, the following basic concepts of Economical Evaluation should be considered:

Economical Evaluation Concepts[17]

To Perform a Detailed Cost analysis for proposed alternatives, to be included in the final proposal, the following basic concepts of Economical Evaluation should be considered:

In order to assess the feasibility of any investment, some economical evaluation techniques should be used. This part illustrates the most common techniques and the advantages and disadvantages of each one of them.

Common Methods to generate, review, analyze, select, and implement long-term investment proposals:

- Payback Period
- Net Present Value (NPV)
- Internal rate of return (IRR)
- Accounting rate of return
- Discounted payback period
- Profitability index (PI)

Payback Period

The length of time required to recover the cost of an investment.

Net Present Value (NPV)

NPV compares the value of a dirham today to the value of the same dirham in the future, taking inflation and returns into account. If the NPV of a prospective project is positive, it should be accepted. However, if NPV is negative, the project should probably be rejected because cash flows will also be negative.

Internal Rate Of Return (IRR)

The discount rate often used in capital budgeting that makes the net present value of all cash flows from a particular project equal to zero. Generally, the higher a project's internal rate of return. The more desirable it is to undertake the project. As such, IRR can be used to rank several proposals a firm is considering. Assuming all other factors is equal among the various proposals.

The proposal with the highest IRR would probably be considered the best and undertaken first. IRR is sometimes referred to as "Economic Rate of Return (ERR)". You can think of IRR as the rate of growth a project is expected to generate. While the actual rate of return that a given project ends up generating will often differ from its estimated IRR rate, a project with a substantially higher IRR value than other available options would still provide a much better chance of strong growth.

Payback Period

The length of time required to recover the cost of an investment. The better investment is the one with the shorter payback period.

For example, if a project costs AED 1 00,000 and is expected to return AED 20,000 annually, the payback period will be AED 100,000 / AED20,000, or five years.

There are two main problems with the payback period method:

a. It ignores any benefits that occur after the payback period and, therefore, does not measure profitability.
b. It ignores the time value of money.

Because of these reasons, other methods of capital budgeting like Net Present Value, Internal Rate of Return or Discounted Cash Flow are generally preferred.

Cash Flow

- A revenue or expense stream that changes a cash account over a given period. Cash inflows usually arise from one of three activities - financing, operations or investing - although this also occurs as a result of donations or gifts in the case of personal finance. Cash outflows result from expenses or investments. This holds true for both business and personal finance.

- An accounting statement called the "statement of cash flows", which shows the amount of cash generated and used by a company in a given period. It is calculated by adding non-cash charges (such as depreciation) to net income after taxes. Cash flow can be attributed to a specific project, or to a business as a whole. Cash flow can be used as an indication of a company's financial strength.

Discounted Cash Flow (DCF)

A valuation method used to estimate the attractiveness of an investment 0pportunity. Discounted Cash Flow (DCF) analysis uses future free cash flow projections and discounts them (most often using the weighted average cost of capital) to arrive at a present value, which is used to evaluate the potential for investment. If the value arrived at through DCF analysis is higher than the current cost of the investment, the opportunity may be a good one.

There are many variations when it comes to what you can use for your cash flows and discount rate in a DCF analysis. Despite the complexity of the calculations involved, the purpose of DCF analysis is just to estimate the money you'd receive from an investment and to adjust for the time value of money.

Time Value of Money (TVM)

The idea is that money available at the present time worth more than the same amount in the future due to its potential earning capacity. This core principle of finance holds that, provided money can earn interest, any amount of money is worth more the sooner it is received. Also referred to as "present discounted value".

For example, assuming a 5% interest rate, AED 100 invested today will be worth AED105 in one year (AED100 multiplied by 1.05). Conversely, AED 100 received one year from now is only worth AED95.24 today (AED100 divided by 1.05), assuming a 5% interest rate. Compound interest may be calculated as per standard procedures.

Life Cycle Costing (LCC)

Life cycle costing (LCC) measures the economic value of decisions of a design project. Life cycle costing can be defined as "an economic assessment of competing design alternatives considering all significant costs over the economic life of each alternative, expressed in equivalent AED."

The National Institute of Standards and Technology (NIST) *J-Iandbook*-1995 edition, defines Life Cycle Cost (LCC} as "the total discounted dollar Cost of owning, operating, maintaining, and disposing of a building or a building system" over a period of time. Life Cycle Cost Analysis (LCCA) is an economic evaluation technique that determines the total cost of owning and operating a facility over period of time.

The concept of economic analysis, which is used in LCC, requires that comparisons be made between things similar in nature.

Life cycle cost analysis (LCCA) is defined as a cost-centered engineering economic analysis whose objective is to systematically determine the costs attributable to each of one or more alternative courses of action over a specified period of time. It is a method used to compare and evaluate the total costs of competing alternatives for satisfying identical functions based on the anticipated life or the facility or product to be acquired. The key elements of such an analysis are those that affect the manner in which the analysis will be conducted and, therefore, the effectiveness of its results in a particular situation.

This approach determines the least costly of several alternatives; however, the selected alternative may only represent the best of several poor value candidates. VE should be used to develop additional worthy alternatives to consider when life cycle cost studies are being performed.

LCC emphasizes cost visibility, VE seeks value optimization. The two disciplines are complementary because Lee is required to achieve VE. A decision concerning each key element must be made before the LCCA can be performed.

In particular, the definition of the LCCA suggests six questions that must be answered:

1. What analysis approach is to be used?
2. What is a realistic discount rate for use in the analysis?
3. How are the effects of inflation and increases in individual costs to be taken into account?
4. Over what specific period of time are the total costs of ownership to be determined?
5. When is that time period to begin?
6. What type of costs are to be included in the analysis and what costs (if any) may be ignored?

Life cycle cost analysis requires the knowledge of several economic concepts. One of these is the concept of equivalent costs to deal with time frame. Equating all costs to a common baseline using an interest rate to adjust for variable expenditure years typically develops equivalent costs.
One must also hold the economic conditions constant while the cost consequences of each alternative are being developed. That is, the same economic factors arc applied to each alternative using a uniform methodology.

The two most frequent methodologies used to calculate LCC are:

1. Present worth costs
2. Annualized costs.

Both methods account for the time value of money, and therefore are interchangeable as measures of life cycle cost.

Present Worth Method

The present worth method allows conversion of all present and future costs to a single point in time, usually at or around the time or the first expenditure. In the present worth approach, the equivalent cost baseline would be present day values. All ownership costs would be recalculated to present day values - discounted for the cost of money. Annual cost would be calculated at the present worth of a periodic payment over the specified life cycle.

Annualized Method

The annualized method is also used to convert costs expended over various points in time to an equivalent cost. Rather than being expressed as a one-time present worth cost, this method converts all costs to an equivalent uniform annual cost. Using this method, all costs incurred are converted to equivalent annual costs using a baseline and a specified life span. Initial costs would be amortized over the life cycle (such as home mortgage payments) and include principal and interest. Replacement costs at various points during the life cycle would also be converted to equivalent annual Cost [17].

6. Generate sketches and information needed to convey the concept,

7. Confirm that an alternative should be further developed

8. Finish initial alternative development

9. Develop an Implementation Plan for each value alternative

The implementation plan for each alternative should include a schedule of the steps required to implement the idea, who is to do it, the resources required, the approval process, the documents needed, the timing requirements, coordination required, and so on. Anticipate problems relating to implementation and propose specific solutions to each. Particularly helpful in solving such problems are conferences with specialists in relevant areas.
When needed, testing and evaluation should be planned for and scheduled in the recommended implementation process. Occasionally, a significant reduction in implementation investment is made possible by concurrent testing of two or more proposals. Also, significant reductions in test cost can often be achieved by scheduling tests into other test programs scheduled within the desirable time frame. This is particularly true when items to be tested are a part of a larger system also being tested. However, care must be exercised in instances of combined testing to prevent masking the feasibility of one concept by the failure of another[6].

10. Prepare Value Engineering Study Preliminary Report.

G. Presentation Phase

The purpose of this phase is to present the recommended value alternatives to Decision maker and stakeholders and to obtain a commitment to follow a course of action for initiating an alternative. The presentation is made at the conclusion of the workshop. It is normally the first step (not the last step) in the approval process. Typically, a decision to implement is not made at the time of the briefing.
This presentation is led by the VE Team Leader. The intent of the presentation is to communicate information regarding the VE Analysis, including all of the developed VE recommendations. After getting

the client decision maker approval on proposed change, The Design Team is ultimately responsible for implementing these recommendations into the scoping plans and documents; therefore, it is important for the VE Team to be comprehensive and informative. The VE Team should convey all pertinent information concerning the VE recommendations. It is recommended that the VE Team Presentation should be casual, allowing the Project Team to ask questions. After the presentation, the VE Team Leader will be available for questions and to provide further information as needed. The conclusion of the presentation completes this stage, which is the last stage of the VE Analysis phase. Following the Presentation Stage the Post-Analysis phase activities begin, which include review, implementation, and approval of the VE recommendations[12&16].

Common Activities of Presentation Phase

The major activities that should be conducted during this phase:

- Prepare presentation and supporting documentation to encourage commitment
- Start the process of wining client and other stakeholders support
- Exchange Information and clarification with the Project Team to ensure that the written proposals are correctly understood and proper communication exists between concerned parties
- Outline an Implementation Plan,repare a draft report followed by a final VE Report.

Presentation's Effectiveness is Enhanced When:

- The VE team is present and is introduced.
- The presentation lasts no longer than 20 minutes with time for questions at the end.
- The presentation is illustrated using models, slides, graphs, or flip charts.
- The team is prepared with sufficient backup material to answer all questions during the presentation[18].

The Presentation Should Give the Following:

- Describe the workshop objectives and scope.
- Identify the team members and recognize their contributions.
- Describe the "before" and "after" conditions for each alternative.
- Present the costs and benefits/advantages and disadvantages /impact of each alternative.
- Identify how to overcome roadblocks.
- Demonstrate the validity of the data sources.
- Suggest an action plan and implementation schedule[18]

The Presentation Should Include (But Not Limited To) The following:

- Identification of the project studied.
- Brief summary of the problem.
- Description of original design.
- Cost of original design.
- Results of the Function Analysis.
- Technical data supporting selection of the alternative(s).
- Cost data supporting the alternative(s).
- Explanation of advantages and disadvantages and reasons for accepting the alternative(s).

- Sketches of before-and-after design, clearly depicting proposed changes. (Drawings marked to show proposed changes are acceptable.)
- Problems and costs of implementation.
- Estimate net savings..
- A summary statement.
- Acknowledgment of contribution by others.

Presentation Format (about 20 Minutes):

- Introduction (3-5 Minutes)
  - Introduction of the VE Team Members
  - Define your agenda
  - Define Scope of the project
  - FAST Diagram
- Body (10-12 minutes)
  - Number & List of. Ideas
  - Total Saving (Addition)
  - Talk about only 5 Value Engineering Proposals
  - Out of the 5 VEP, Present LCC,
- Conclusion (2-3 Minutes)

Considerations to Improve Success Probability and Facilitate Acceptance of Proposals:

- **Consider the reviewer's needs**.
- **Address risk**, Decision-makers are often more interested in the risk involved in making a decision than the benefits or value that might be achieved. Do not confuse decision-making risk with technical risk. Decision-making risk encompasses the uncertainty and complexity generated from making change. Therefore, consider the organizational culture and behavior when characterizing the recommendation .
- **Relate benefits to organizational objectives**. If the proposal represents advancement toward some approved objective, it is most likely to receive favorable consideration from the client. Therefore, the presentation should exploit all the advantages a proposal may offer toward fulfilling organizational objectives and goals. When reviewing a proposal, the manager normally seeks either lower total cost of ownership or increased capability.
- **Show collateral benefits of the investment**. Often, VE proposals offer greater benefits than the cost improvement specifically identified. Some of the benefits are . collateral in nature and may be difficult to quantify. Nevertheless, collateral benefits should be included in the proposal.
- **Use terminology appropriate to the background and experience of the reviewer**.
- Each proposal is usually directed toward two audiences; First is the technical authority that requires sufficient technical details to demonstrate the engineering feasibility of the proposed change. Second are the administrative reviewers for whom the technical details can be summarized while the financial implications are emphasized (implementation's cost and likely benefits)[18].

Successful Presentation Skills

While the VE team presenting the VE study to client, and stakeholders, the following skills should be considered:-

- Practice on Presentation,
- Read his audience, and consider audience style,
- Contact Eyes & Ears,
- Convey the message through Short words, short sentences,
- Use Examples,
- Avoid boring by repetition,
- Provide Smooth Transition between presentation parts,
- Be Interactive, Answer and ask questions,
- Be Careful about Presenting Time,
- Provide Introduction to your presentation,
- Give priority to presentation Opening & Closing,
- Be Calm and free from Nervous,

Good speaker should have:

- Knowledge,
- Good Preparation,
- Linguistic,
- Deliver an important message,
- Self-confident,
- Honesty,
- Customize according to audience,
- Good listener, and
- Believe in what you say and do[18].

Appendix C: Checklists, Forms, and Example of VE Schedule

Checklist 1: Information Phase

No	Description of Information to be Collected/Verified	Y	N	NA	Remarks
General					
1	Are all documents collected? (Design Drawings, Reports, Specifications, Conditions, Cost Estimates, All Current Related Prices etc.)				
2	Are All Design – Construction – Maintenance References collected?				
3	Has the project designer been contacted?				
4	Is Direct Contact with project Client conducted and All VE output expectations Are clarified?				
5	Is Project End User approached by the VE Team?				
6	Did the VE Team visit the Project Site?				
7	Did the VE Team contact the maintenance team?				
8	-				
9	Are environmental commitments satisfied?				
10	Are other commitments met?				
11	How does it work?				
12	What does it do or accomplish?				
13	Why does it work?				
14	What must it do or accomplish?				
15	How does it relate to other systems?				
16	Why is it needed?				
Specifications					
17	Have specifications and requirements been reviewed?				
18	Are specifications realistic?				
19	Can a modification of the specifications simplify design and construction?				
20	Are the specifications required, or Are they just guidelines?				
21	Are all performance and environmental requirements necessary and sufficient?				
22	Have all of the specifications been interpreted correctly?				
23	What Are the desirable characteristics?				
24	Have Abu Dhabi policies, procedures and regulations been reviewed?				

Checklist 1 (Condt.): Information Phase

Engineering and Design					
25	Has the background information been collected?				
26	Who designed it and when?				
27	Who determined the requirements (this would be the members of the Concept Team)?				
28	Who must review and approve a change (this would normally be the Project Manager or the manager of the Responsible Design Division)?				
2	Who must approve implementation funding (the Project Client Managing Engineer)?				
30	Who must implement the change (this will probably be the Design Consultant (or Engineer))?				
31	Does the design meet or exceed those set forth in the Concept Report?				
32	What alternatives were considered during design?				
33	Why were the alternatives rejected?				
34	Are any changes to the design planned?				
35	Do the drawings reflect state-of-the art?				
36	What is the design life?				
37	What are the Life Cycle Costs?				
Methods and Processes					
38	Are any nonfunctional or appearance-only items required (these should be identified in the Document)?				
39	How is construction performed and why?				
40	Are there any high direct labor costs?				
41	Are high-cost areas or items identified?				
42	What is the schedule? (this is very important, because VE cannot be seen as a delaying process)				
Materials					
43	Are special, hard-to-get, or costly materials specified?				
44	Were alternative materials considered, and if so why were they rejected?				
45	Are the specified materials hazardous or difficult to handle?				
46	Are there new materials that may perform the same function?				
47	Is this a single source item?				
Maintenance					
48	Has the Maintenance Division, District Engineer, and the District Maintenance Engineer been consulted?				
49	What is normal maintenance?				

Checklist 2: Functional Analysis Phase					
No	**Description of Information to be Collected/Verified**	**Y**	**N**	**NA**	**Remarks**
1	Have all of the functions been identified?				
2	Have redundant function been identified?				
3	Have required functions been identified?				
4	Are functional requirements understood?				
5	Can functions be combined, simplified, or eliminated?				
6	Are costs assigned to each function?				
7	Has a worth been established for each function?				
8	Have target costs been determined for each function?				
9	Are design requirements established that do not require any function to be performed?				
10	Are functional requirements exceeded?				
11	Are unnecessary features called for?				
12	Can a function be eliminated, entirely or in part?				
13	Does it cost more than it is worth?				
14	Have all the high and unnecessary cost areas and high cost/worth ratio areas been identified?				
15	Does the potential cost reduction (net savings) appear to be sufficient to make further VE investigations worthwhile?				

Checklist 3: Creative Phase

No	Description of Information to be Collected/Verified	Y	N	NA	Remarks
1	Have creative thinking techniques been used?				
2	Has an atmosphere been provided that encourages and welcomes new ideas?				
3	Has there been cross-inspiration?				
4	Have all members of the team participated?				
5	Has an output goal been set?				
6	Have all of the ideas been recorded?				
7	Have negative responses been discouraged?				
8	Has the team reached for a large number of ideas?				
9	Have ideas been generated without all of the constraints of specifications and system requirements?				
10	Has a thorough search been conducted for other items that are similar in at least one significant characteristic to the study				
11	Have all basic functions of the project been defined?				
12	Has a speculation worksheet been filled out for each basic function?				
13	Have you dismissed from your thoughts the present way the basic function is accomplished?				
14	For group brainstorming, have techniques, method of approach, and "ground rules" been explained before				
15	Have all of the basic functions of the project team been subjected to the complete speculation Phase?				

Checklist 4: Evaluation Phase

No	Description of Information to be Collected/Verified	Y	N	NA	Remarks
1	Have all ideas been reviewed?				
2	Has each idea been refined to see how it could be made to meet all needed functional and physical attributes?				
3	Have evaluation criteria been established?				
4	Has a cost estimate been made for each feasible idea?				
5	Has the time to implement each idea been considered and estimated?				
6	Has each idea been rated according to relative merits regarding cost and other advantages or disadvantages?				
7	Can alternates be simplified to attain further performance/cost optimization?				
8	Have all the functions been reevaluated as to their need?				
9	Have at least three ideas been selected as the best ideas?				

Checklist 5: Development Phase					
No	**Description of Information to be Collected/Verified**	**Y**	**N**	**NA**	**Remarks**
1	Have all required information about the proposed alternatives have been Determined?				
2	Has each selected option been technically evaluated?				
3	Has technical feasibility of each alternative been ascertained?				
4	Has each proposed alternative been economically evaluated?				
5	Have Cost – Benefit Analysis and Life Cycle Cost Analysis been conducted for each proposed alternative?				
6	Have the Initial and subsequent changes to the scope of schedule project been assessed and documented?				
7	Have all risks and challenges relevant to each proposed alternative been listed?				
8	Have detailed calculations, sketches, cost estimates, technical – financial – environmental benefits, related risks are documented separately for each proposed alternative?				
9	Have the study conclusions been compared to the success requirements established during the Information and Function Analysis Phases?				
10	Has the implementation plan for proposed alternatives been developed?				
11	Has the VE preliminary report been prepared?				

Checklist 6: Presentation Phase					
No	**Description of Information to be Collected/Verified**	**Y**	**N**	**NA**	**Remarks**
1	Is the need for a change clearly shown?				
2	Is the problem defined?				
3	Is the proposal concise?				
4	Are all the pertinent facts included?				
5	Are cost savings included?				
6	Is your VE Proposal Summary Book complete and accurate?				
7	Have you double-checked your recommendations, costs, and savings?				
8	Is your information complete?				
9	Have you prepared back-up material for questions that may be asked?				
10	Has a plan of action been established that will assure implementation of a selected alternative?				
11	Is the change described?				
12	Are there pictures or sketches of before-and-after conditions?				
13	Has the best alternate been considered?				
14	Have all the constraints been considered?				
15	Has the implementation plan developed?				
16	Have the recommendations been extended to all areas of possible application?				
17	Has the improved Value design been considered for standard of preferred practice?				
18	Has credit been given to all participants?				

Checklist 7: Implementation & Follow Up Phase					
No	**Description of Information to be Collected/Verified**	**Y**	**N**	**NA**	**Remarks**
Implementation Checklist					
1	Are the expected results known?				
2	Has someone been designated as responsible for taking action to implement the approved alternatives?				
3	Has the contract been amended?				
4	Have the specifications or drawings been revised?				
5	Have completion dates for implementation been established?				
6	Have the resources needed to accomplish implementation been recommended and allocated?				
7	Have required test plans, allocations, and schedules been established?				
8	Have modifications to the VEP been documented?				
Follow Up Checklist					
1	Did the idea work?				
2	Was money saved?				
3	Was the design improved?				
4	Could it benefit others?				
5	Has it had proper publicity and distribution?				

Value Engineering Guidelines

Form 01: Value Engineering Team Details

No	Name	Organization	Designation	Specialty/ Study Area	Contact no	Email	Remarks

This form to be initiated by VE team Leader.

Value Engineering Guidelines

Form 02: Documents Receiving Form

No	Document Title	Document Type and Description	Document Source/Ref.	Developed by	Initials & Date	Received by (VE Team Leader)	Initials & Date	Remarks

This form to be initiated by PM to be received by the VE team.
Example of Documents are: Reports, Plans, Drawings, Calculations, BOQ, Cost Estimates, Specifications etc.

Value Engineering Guidelines

Form 03: Project Objectives and Key Functions

No	Before VE Study*		After VE Study**		Remarks
	Project Objectives	Key Functions	Project Objectives	Key Functions	

** PM to Define Main Objectives of the Project and Key Functions.*

*** After completion of VE Study, VE Team to define Project Objectives and key Functions and confirm that they are not compromised.*

Value Engineering Guidelines

Form 04: Cost Summary

Check one; Use separate sheet for each:

- Construction Cost ☐
- O & M Cost ☐
- Replacement Cost ☐
- Energy Cost ☐

Total Cost of the Project (AED) :………………………………

Source of Estimate: ………………………………………………

No	Major Items	Before VE Study		After VE Study		Remarks
		Original Estimate (AED)	% of the Project	New Estimate (AED)	% Savings	

This form is to capture the cost data to be initiated by the PM and completed by the VE team after completing the VE Study.
PM to attach Detailed BOQ along with this form.
Examples of major items for Infrastructure Projects are: Architecture, Road Pavement, Storm water, Irrigation, Landscape, Electrical & Lighting, Mechanical, Structures, Geotechnical, Detour etc.

Value Engineering Guidelines

Form 05: Function Analysis

Architecture ☐	Irrigation ☐	Lighting ☐	Geotechnical ☐	Others ☐
Road Pavement ☐	Landscape ☐	Mechanical ☐	Materials ☐	
Storm water ☐	Electrical ☐	Structures ☐	Detour ☐	

Function = Active Verb + Measurable Noun ; Types: Basic (B), Secondry (S) Required Secondry (RS), Unwanted (U)

No	Item Description	Function		Function Type	Cost	Worth	Cost/ Worth	Remarks
		Active Verb	Measurable Noun					

Value Engineering Guidelines

Form 06: Evaluation of Ideas

Architecture ☐	Irrigation ☐	Lighting ☐	Geotechnical ☐	Others ☐
Road Pavement ☐	Landscape ☐	Mechanical ☐	Materials ☐	
Storm water ☐	Electrical ☐	Structures ☐	Detour ☐	

No	Idea	Advantages	Disadvantages	Rank (1 - 10) (Least - Most Favorable)	Remarks

Idea Stimulator: A) Eliminate partly or entirely, eliminate duplication, combined. B)Standardize, modify, simplify. C) Challenge, Identity, Specialty, Justification. D) Maintenance, operation, accessibility, frequency of use. E) Requirements, Cost, Proprietary, Factor of safety, different less expansive alternatives.

Value Engineering Guidelines

Form 07: Value Engineering Information Collection & Monitoring VE Outcome

Value Engineering Information Collection and Monitoring VE Outcome

Project Information						Details of Major Items of VE Study (If required, use extra sheet to describe)	Before VE Study		After VE Study		Cost Reduction	Other Values added to the project as a result of VE Study	Remarks
S. No.	Project IDAS Ref. No & version.	Design Stage~	Project Name and Description	Technical Discipline*	VE applied to which project Cycle Stage#		Original Estimate AED	% of the Project	New Estimate AED	% Saving			

~ *Select from these Design Stages:* Concept, Preliminary, Detailed, Other (Specify)
* *Select from these Technical Disciplines, as applicable:* Architecture, Road Pavement, Storm water, Irrigation, Landscape, Electrical, Lighting, Mechanical, Structures, Geotechnical, Materials, Detour, Others (specify details)
\# *Select from these project cycle phases as applicable:* Study, Planning, Design, Construction, O & M, Others (specify details)

Example of VE Schedule for Different Design Stages