

2.1 Introduction:

The goal of value engineering is to reduce the cost and improving the functionality.

Value Engineering (VE) is an intensive, interdisciplinary problem solving activity that focuses on improving the value of the functions that are required to accomplish the goal, or objective of any product, process, service, or organization.

Value Engineering have a major role to resolve problems, the rezones of that because Value Engineering is identify potential cost necessary and improve quality and performance.

Value Engineering can be used for anything, like, products, work procedures, manufacturing method and construction projects etc.

Value Engineering approach help to get the biggest return material and at the same time achieving the objectives and tasks required.

Value Engineering should be employed as soon as possible in the project design or process so valid recommendation could be implemented without delaying the progress of the project or causing rework of completed designs.

Value Engineering is a structured and systematic problem solving methodology, process designed to find creative alternative solutions and applied in a workshop environment by a multidisciplinary team.

Value Engineering is not just good engineering and not a suggestion program, not just a routine project or plan review and not a cost reduction exercise.

Value engineering as applied in the construction industry is a systematic process for evaluating a project's proposed design and construction methods to identify ways to achieve the lowest possible life cycle cost without impairing the project's functional requirements. For example, a value engineering study could conclude that a building material different from the one originally proposed would be more serviceable and require less maintenance. It is important to note that value engineering, properly applied, focuses on life cycle costs not initial construction costs alone. Consequently, a value engineering study could result in recommendations which would increase construction costs, but reduce costs over the life of the project.

Value engineering as applied in the construction industry, is a combination of heuristic and scientific techniques used to analyze either a building system, building material, or a construction method. Using systematic investigative techniques, a project proposed design and construction methods are evaluated to identify any methods or features that could possibly be eliminated or modified to achieve the lowest possible life cycle cost.

Value engineering can be applied at any stage of the construction projects and to any parts of a project. However, the earlier it is applied in a project life cycle, the greater the savings that will be made.

Value engineering have been applied in many countries, regardless whether the countries are developed or developing with different degree of success.

VE focuses on value rather than cost and seeks to achieve an optimal balance between time, cost and quality. [Del L,2003,Value Engineering Analysis and Methodology, USA]

2.2 Value Engineering Definition:

Value engineering (VE) is a systematic method and organized approach to improve the "value" of goods products or services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. Value Engineering promotes the substitution of materials and methods with less expensive alternatives, without sacrificing functionality.[Fadi ELayache,2010, Value Engineering Methodology in Construction,Dubai]

Value engineering (VE) is an organized way of thinking or looking at an item or process through a functional approach. It involves an objective appraisal of functions performed by parts, components, product, equipment, procedures , services and so on anything that costs money.

Value Methodology is commonly applied under the names Value Analysis (VA), Value Engineering (VE) and Value Management (VM). These terms can be used interchangeably with value methodology throughout the places according to the need of the situation.[Jay Mandelbaum,2000, Value Engineering].

In his book, Value Engineering for the Practitioner, Jerry Kaufman defines value engineering as, "an organized effort directed at achieving the functions of goods and services to achieve those necessary functions and essential characteristics in the most profitable manner.

SAVE International broadened the definition in one of its informational brochures to state "Value Engineering (synonymous with the terms Value Management and Value Analysis) is a professionally applied, function,

Oriented, systematic team approach used to analyze , facility design,

system, or service. It is a powerful methodology for solving problems and/or reducing costs while improving performance and quality requirements”.

2.3Value Engineering History:

A young engineer, Lawrence Miles, at the General Electric Company in U.S.A, developed Value Analysis methodology in 1947. Due to the shortage in materials, which had happened because of the Second World War, he was assigned to design parts from the available raw materials. Instead of focusing on the actual part he was responsible for designing, he focused attention on the function that it had to perform. He found that the result was invariably simpler, economic and performed better.

The emphasis on function remains the driving force in Value engineering (VE) today (George and Palmer 1995).

Palmer et al. (1996) stated that in 1954 this technique was adopted by the American Navy where it was called (VE) in order to reflect the nature of their engineering work in the application of this technique at the stage of design prior to the commencement of production. In 1956, the Army Ordnance Corps established a Value Engineering program In 1961, the Air Force became interested to apply this new methodology. It is worth mentioning that the Department of Defense in U.S.A. adopted value engineering mainly to the procurement of materials, systems and equipment.

However, the Corps of Engineers had a saving of almost 200\$ million in the first ten years of conducting value engineering.

Until 1972, the interest of the construction industry firms in this technique was very limited. In the same year, the 12th annual conference of the Society Of American Value Engineering (SAVE) encouraged the application of Value Engineering in the construction industry (O'Brien 1976).

Grosvenor (1997) stated that (VE) techniques spread throughout North American and by the early 1970; it had been introduced in Japan, Europe and Australia. Today Japan, flowed by Germany and the U.S.A. (in this order) are the biggest users of the system. Other countries that are using this methodology formally include Canada, France, China, Hong Kong, Hungary, India, Korea, New Zealand, Saudi Arabia, Taiwan, the United Kingdom and the United Arab Emirates. In Australia, Europe and Hong Kong particularly, the application of Value methodology is known as Value Management (VM). There is now European standard on Value Management, BS EN 12973:2000 and an explanatory document, PD 6663: Guideline to BS EN 12973, Value Management-Practical Guideline to its use and intent. The original and predominant value society is SAVE International (formerly the society of American Value Engineering).

As the program, project, product or service is begin developed, Value methodology is applied as a continuous improvement mechanism to ensure maximum cost effectiveness, functionality and appropriate quality. Early application of Value methodology as an integral component of the strategic procurement process leads to significant saving relating to schedule, staff time, capital costs and life-cycle costs (Plamer et al. 1996).

Phillips (2002) wrote, —Value methodology objective challenges assumptions, identifies alternative options, prioritize according to agreed criteria and then developed and tests the action plan for practicality of implementation. It is a very powerful consensus development tool. It has a tremendously synergistic effect, which overcomes otherwise adversarial relationships to develop a team approach and produce ownership of, and commitment to the end project.|| Differences of opinion on both philosophy and application exist with the definition of value engineering to distinguish between it and other cost-reduction techniques and disciplines. Although many emphasize the benefit of Value Engineering study in terms of reducing costs, it is essential to stress that the success of any Value Engineering study not be only measured by how much money is saved or the percentage of the cost saving. The true success should also be measured by how many recommendation are actually incorporated into the design and implemented, the level of satisfaction of the clients and project participants, and whether the project objectives can be achieved or not (Grosvenor 1997).

2.4 Value Engineering Process:

The process of VE consists of:

- An organized review to improve value by using multi-disciplined teams of specialists knowing various aspects of the problem being studied.
- A function-oriented approach to identify the system, product, or service being studied, and the associated cost.

- Creative thinking using recognized techniques to explore alternative ways of performing the functions at a lower cost or to otherwise improve the design.

2.5 The Value Methodology:

Value Methodology (VM) is an organized system of investigation using trained multi-disciplined teams to analyze the requirements of a project for the purpose of achieving its essential functions at the lowest total cost (capital, operation, and maintenance) over the life of the project.

The application of Value Methodology has grown to include virtually every aspect of human industry, including design and construction as well a wide range of processes and services. Of particular interest the application of Value Methodology to the design and construction of public facilities, specifically transportation projects.

2.6 Curriculum of Value Engineering:

Components and various parts of value engineering are its curriculum the aim of which is to improve the value indicator in the project considered. Based on a definition by SAVE (international society of value engineering) VE curriculum is "an organized approach to study value". The curriculum has a specified beginning and end, and is performed in three stages: preliminary study (pre-study), study of value and a complementary study (post- study). An effective attempt of VE must include all stages and phases of the curriculum. Omission of only one phase hampers the process of achieving goals. The precision and attention allocated to each phase is different in various projects.

2.7 Value Engineering Achievements:

VE can provide clients with comfort by its highly-value added products or services, and it can also contribute to the society for making good use of natural and industrial resources. Enterprises may enjoy and insure an adequate profit, smooth communication among people concerned, activation of organizations and creative corporate climates. People participated in a VE study will learn how to get along with other team members giving respect to each one's ideas, will gain creative thinking, achievement to a goal by systematic team approach and especially a target-oriented thinking method. These experiences are extremely valuable as they can practically be applied in any other social, official and private situations.[Moradi. 2005, The Need to Apply Value Engineering in Urban Services].

2.8 The Reasons for Poor Value:

- i. Lack of information, usually caused by a shortage of time. Too many decisions are based on feelings rather than facts.
- ii. Wrong beliefs, insensitivity to public needs or unfortunate experience with products or processes used in unrelated prior applications.
- iii. Habitual thinking, rigid application of standards, customs and tradition without consideration of changing function, technology and value.

- iv. Risk of personal loss, the ease and safety experienced in adherence to established procedures and policy.
- v. Reluctance to seek advice, failure to admit ignorance of certain specialized aspects of project development.
- vi. Negative attitudes, failure to recognize creativity or innovativeness.
- vii. Over specifying, costs increase as close tolerances and finer finishes are specified. Many of these are unnecessary.

Poor human relations, lack of good communication, misunderstanding, jealousy, and normal friction between people are usually a source of unnecessary cost. In complex projects, requiring the talents of many people, costs may sometimes be duplicated and redundant functions may be provided.[David Wilson ,2005,Value Engineering Application in Transportation].

2.9 Improved Value:

Virtually all projects have opportunities for improved value, and the VE process has the objective of identifying those opportunities. Value is proportional to the ratio of function over cost, where a project's function is defined as what it is expected to do.

$$\boxed{Value = Function/Cost}$$

Alternatively, the term “performance” can be used instead of the term “function.”

Value is achieved by improving function and maintaining cost; by maintaining function while reducing cost; or by improving function while reducing cost. VE can be defined as an analysis of a project's functions

directed at improving performance, reliability, quality, safety, and life-cycle cost.

2.10 Limits of Value Engineering Application:

VE is so widely applied ranging over a variety of fields such as the cost reduction on purchasing, cost cutting of products overall, and also at product development stages. It is now applied not only in the products but also in assembling and machinery processes, manufacturing processes such as packing, transportation, distribution, etc.

VE can also be utilized not only in manufacturing industry but also in services and construction industries. In other words, anything that can produce cost is the subject of VE study.

2.11 How Value Engineering Is Necessary:

In these days management environment is kaleidoscopically changing. Not only the efficiency but also the continued innovations are essential for corporate management. It is not possible to meet today's highly-advanced customers' demands by just quantitatively producing low-priced merchandises.

Corporate efforts must be focused on the innovation doing away with conventionality rather than the betterment of actuality, always keeping in mind what should we do, which functions should be achieved to enhance the value of products, services, etc.[SAVE International,2006,Value Methodology Standard, United States].

VE is the technique which is exactly for value improvement and is also a critical management technique for the leading companies of New Century.

2.12 Applicability of Value Engineering:

Owners who derive benefit from a VE evaluation of their projects include both public (county, city, state, and federal, including the military) and private sector entities. Project types can include any facility or structure type, such as bridges, highways, buildings, hospitals, schools, court facilities, mass transit facilities, water treatment plants, and marine facilities. VE is currently used by the U.S. Military and by many agencies at all levels of government, including federal, state, and local.[David Wilson,2005,Value Engineering Applications].

2.13 Why Use Value Engineering:

We use value engineering for these reasons:-

1. To provide the best design alternatives for projects.
2. To reduce costs of projects.
3. To improve quality.
4. To improve organizational performance.
5. To improve schedule.
6. To reduce risk.
7. To identify problems.
8. To provide optimized solutions.
9. High Profitability.

2.14 The Technical Aspects of Value Engineering Problem:

The technical aspects of the value problem involve the problems associated with identifying and removing unnecessary product costs. It could be said that if there were no unnecessary costs in product we would have the greatest value product. While everyone would be in offhand agreement with this statement, the variations in understanding of the meaning of the word 'unnecessary' would create innumerable differences of opinion regarding at what point in cost we had arrived at this asymptote of value perfection. Consequently, we should attempt to define "unnecessary" costs to clarify the situation. At this point some statement that 'unnecessary costs are those not essential for the reliable achievement of function' might have little significance.

2.15 The Different Between Value Engineering and Value Analysis:

Value analysis is "A Systematic and objective evaluation of the value of a goods or service, focusing on analysis of function relative to the cost of manufacturing or providing the items or service".

Value analysis provides insight into the inherent worth of final goods or service, possibly altering specifications and quality requirements that could reduce costs without impairing functional suitability.

Value engineering is "Value analysis conducted at the design engineering stage of the product development process." [B.S Dhillon,2002,Engineering and Technology Management Tools and Applications].

In summary value analysis refers to the analysis of an existing product, service or administrative process while Value engineering refers to the

same analysis applied to the product ,services or administrative processes that are under design and have not been finalized.

Value analysis is as improvement and value engineering is a cost reduction.

2.16 Performance and Value :

Value is determined not solely by the producer or promoter, but in concert with the customer / user. Nor is value related solely to money, as value criteria may include, for example, aesthetics, functionality, ease of operation & maintenance, fastest time to market and sustainability. Clients are really seeking to buy overall performance improvement, not just a sequence of traditionally practiced, project development activities. Good project performance includes satisfying a range of stakeholders who may have differing views, values and thresholds of tolerance for perceived risk. All too often, capital projects have been planned and implemented with too little consideration for how they would be operated and maintained efficiently, or interface with other programs. Similarly, operational improvements may not fit with strategic aims.[David Wilson,2005,Value Engineering Applications].

Some requirements for the success of projects and value programs are listed below:-

- Provision of strategic direction.
- Clear definition of stakeholders' expectations and needs.
- Ensuring key objectives are achieved.
- Ensuring risks are managed appropriately.
- Verifying that the organization's resources are used responsibly.

- Delivery of the promised results — predicted performance gains achieved on time and within the forecast return on investment, over the long term.

2.17 The Relationship Between Value and Cost:

A common misconception in the construction industry is that value is synonymous with cost. This maybe brought about by sloppy use of language rather than a fundamental misunderstanding of the meaning of the terms. Frequently, refer to the value of a project as being the capital cost.

They may then go on to describe how the project team through skilful use of various management techniques (including value engineering) succeeded in making large reductions in value! Clearly such references are to cost not to value. Few clients wouldn't be pleased if the value of their project had, in fact, reduced. .[SAVE international, under revision 2006, Value Methodology Standard, United States].

2.18 Reasons for Unnecessary Costs:

Some reasons for unnecessary costs:-

1. Lack of enough time.
2. Lack of full knowledge.
3. Lack of value measurement.
4. Lack of costs identification.
5. Honest but wrong beliefs.
6. Lack of communications.
7. Weak human relationships.
8. Fear of shame.

9. Current approaches and habits.
10. Current traditions.
11. Having haste to finish the project.

2.19 How Does Value Engineering Remove Unnecessary Costs:

Value Engineering consists of a branch of knowledge which is directed at solving this problem by helping people to achieve value products through strengthened proficiency in techniques which overcome the reasons for unnecessary product costs by:

1. Improved information technology.
2. Strengthened creative behavior.
3. Established value objectives.
4. Reduced time factors.
5. Corrected misconceptions.
6. Changed habits and attitudes.

2.20 The Contactor's Value Engineering Plan:

The contractor's proposed Value Engineering Plan shall include but not be limited to the following:

- Areas of potential Value Engineering cost reductions including specifications which the contractor considers it profitable to challenge.
- A schedule of planned Value Engineering tasks correlated with the Master Schedule.

- The project's Value Engineering organization and Value Teams to be assigned to the Value Engineering Tasks.
- The Value Engineering documents, formats and data which the contractor plans to provide for scheduled design reviews.

2.21 Value Engineering Team Selections:

The benefit of the project team including:

- Reduces contracting cycles.
- Helps teams stay within budget, while eliminating unnecessary change orders.
- Assures the best value.
- Develops strong project teams.
- Builds consensus among team members.
- Provides a non-adversarial approach to fee negotiations.
- Improves relations with affected agencies, customers and stakeholders.
- Provides a higher value consulting service.
- Ensures a better understanding of the Scope of Work.

Proper composition of the VE Team is vital for a successful VE Analysis.

The VE Team is multidisciplinary group of experienced professionals chosen for their expertise and experience with similar projects. Important factors need to be considered in the formation of the VE Team. The VE Team must be independent of the project, multidisciplinary, and specifically suited for the project with considerable experience within their discipline.

The PM will select the VE Team Leader and the VE Team in consultation with the Project Management Office (PMO) Manager to ensure project-specific disciplines are represented. The PM is encouraged to evaluate all suggestions regarding disciplines or individuals to include. A VE Team can be assembled in a number of ways. The VE Team can consist of MCDOT personnel, personnel from consultants or outside agencies, or some combination of these sources. After selection, appropriate materials, documents, and training will be provided by MCDOT to the VE Team members.

2.21.1 VE Team Leader:

The VE Team Leader should be a seasoned VE practitioner experienced in transportation project delivery. The VE Team Leader should be trained and knowledgeable in VE techniques and able to serve as the coordinator and facilitator of the team. The VE Team Leader is recommended to be certified by SAVE as a Certified Value Specialist (CVS) or be an experienced project manager and a registered engineer. All contacts prior to and after the analysis will be between the PM and the VE Team Leader.

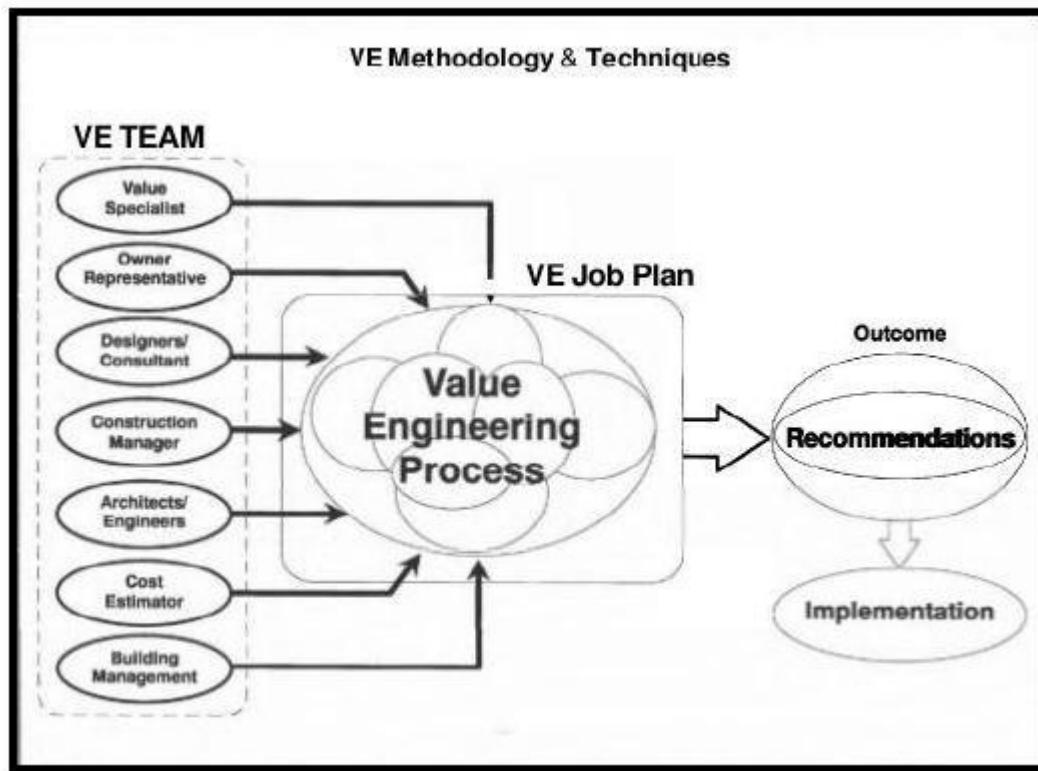
Since VE Team members are mainly active during the VE Analysis phase, their focus should be on performing the VE Analysis. The PM serves as a liaison between the Design Manager and the VE Team Leader. No formal relationship between the Design Manager and the VE Team Leader will be needed. The VE Team Leader will not contact the Design Manager directly unless approved by the PM.[SAVE international, under revision 2006, Value Methodology Standard, United States].

2.21.2 VE Team Member:

The PM will select the VE Team members; the VE Team Leader may assist in selecting the VE team members, if requested. There are no set rules regarding the number of participants in a VE Team; however, it is beneficial to have a sufficient number of members to ensure different viewpoints but also not have too many members that the VE Team discussions become stalled due to internal differences of opinion. The VE process provides flexibility to best meet the objectives of each project being analyzed. These considerations should be carefully evaluated during the planning and coordinating activities for the VE Analyses. Generally, a team of 5 to 8 persons with diverse backgrounds suited to the scope and complexity of the project works best. A VE Team should consist of a VE Team Leader and individuals from different specialty areas, such as design, construction, environmental, planning, maintenance, R/W, and other areas depending upon the type of project being reviewed. The VE Team will consist of persons not directly involved with the development of the project. Individuals from the public and other agencies may also be included on the VE Team when their inclusion is determined to be in the public interest. Technical discipline experts can provide a host of benefits as key members of the VE Team. Use of technical discipline experts can also help round out a VE Team by providing experienced personnel from disciplines not included in the Design Team. The Design Team shall cooperate fully with the VE Team, providing necessary background information for analysis. At the discretion of the PM, the Design Team may be requested to assign one of its representatives to the VE Team.

2.22Value Engineering Activities Studies:

- Understanding project criteria.
- Identifying appropriate project scope.
- Validating project initial cost and budget.
- Ascertaining best value alternatives.
- Evaluating life cycle costs.
- Identifying and evaluating risk.
- Assessing the schedule.
- Reviewing constructability.
- Evaluating contract/procurement options.



Dig. (1) Team Selection

2.23 When Value Engineering Is Used:

- Value Engineering is used to determine the best design alternatives for Projects.
- Value Engineering is used to reduce cost on existing Projects.
- Value Engineering is used to improve quality, increase reliability and availability, and customer satisfaction.
- Value Engineering is also used to improve organizational performance.
- Value Engineering is used to improve schedule.
- Value Engineering is used to reduce risk.
- Value Engineering is a powerful tool used to identify problems and develop recommended solutions.

2.24 Area of Use Value Engineering:

2.24.1 Value Engineering In Canada:

One of the earliest formal recognitions to Value Engineering, in Canada, was a Value Engineering course in the mechanical engineering department at McGill University. This course was initiated in 1973 as a means to bridge the gap between students and industry. Robert Sproule and Hank Wade, both from General Electric taught the course. David Pfeiffer was the professor that introduced the course into his curriculum at that time. Vince Thomson replaced David Pfeiffer in 1996 and has continued this course with six studies being conducted each year. In the 33 continuous years, over 500 students have been trained and more than 160 VA/VE studies have been conducted for industries in the greater Montreal area.

In 1985, there was a rapid upgrade and expansion to the wastewater facilities in Quebec. The deputy minister championed this program and instituted Value Engineering as the methodology of choice. He instructed the Director of Purchasing, to obtain training in VE and fast track a program to approve new sites. This resulted in 10 VE wastewater treatment facilities to be studied in a 1 year period.

In the mid 1980's and early 1990's, Quebec Hydro was undergoing rapid expansion with the James Bay Hydro power project including transmission line planning. This methodology was used on many projects including the addition of functional performance specifications as a complementary tool. An internal VE manual was issued in 1995.

Pratt & Whitney, Canada introduced VM/VE into their corporate structure, in 1996. PWC have conducted over 300 workshops and have trained numerous personnel in this methodology to complement their overall client focused management system.

Ontario Ministry of Transportation completed its first value engineering study in 1995. The VE program was then developed following success stories on road projects. MTO now applies VE to road standards, business processes and road projects. The savings generated by the VE program since 1998 are over \$160 million. Here are more benefits:

- Business process improvements.
- Innovative ideas.
- Collaboration between stakeholders.
- Better return for projects.
- Increased security.
- Increased value for taxpayers.

2.24.2 Value Engineering in India:

The Indian Value Engineering Society established in October 1977, serves Indian Industry by dissemination of specialized Knowledge to professionals, who in turn help industries to improve their profitability through the technique of Value Engineering.

2.24.3 Value Engineering in USA:

In 1954, US Navy Bureau of Ships applied the technique to cost avoidance during design, calling it Value Engineering (VE) (Younker, 2003). This is the first government organization use the techniques. As good result of using this technique, US Government endorses VE to their organization such as US Postal Service, US Army Corps of Engineers, US Department of Health, Education, and Welfare, and many construction projects.

The focus of Value Engineering in construction in the U.S.A is in the public sector. The society of American Value Engineering, renamed SAVE International, has lobbied continuously for legislation requiring Value Engineering to become a mandated part of public sector project development. (Palmer et al. 1996).

Table demonstrates the growth of Value Engineering within U.S.A government agencies (Male et al. 1998).

Table (1): the Growth of Value Engineering in the U.S.A Public sector:

Year	Development
1954	In production into U.S.A Department of Defense, Bureau of ships
1963	Introduction into Navy facilities Eng. Command
1965	Introduction into Army Corps of Engineers
1968	Used by Facilities Division of National Aeronautics
1973	U.S.A General Services Adm,Public Service
1974	U.S.A General Accounting Office

SAVE International (2000) stated that although Value Engineering has been around for almost 50 years but it is still not widely spread in U.S.A and around the world though practitioners in this technique have great confidence in its outcome. This might be due to fear of change, profit concerns, no credibility in the method and the capitalistic system in U.S.A, which is a part of the culture, and Value Engineering needs to rely on teamwork for its success with job plan.

Due to great effort exerted by members of SAVE, including lobbying of American Congress members, a law was issued for the application of Value Engineering by government agencies in 1996.

SAVE International (2000) also revealed that U.S.A highway and transportation department saved taxpayers a record amount in 1998 by implementing the Value Methodology on federally funded highway projects. State and federal transportation agencies completed 421 value management studies in 1998. The studies produced more than 750\$ million in cost savings- the largest in the program's history and 47 % increase over

the saving in 1997. Highway and transportation department saved U.S.A taxpayers 1\$ billion in 2000.

2.24.4 Value Engineering in U.K. :

Male et al. (1998) stated that Value Engineering (VE) came to the U.K. in the early to middle 1960.it is reputed through the activities of multinational companies. Similarly, to Australian events, it was recognized that the activity was more management than engineering in orientation. Value management (VM) in manufacturing went largely underground as those companies, which maintained activity drew their Value Management teams within their organization and concentrated upon identifying a competitive edge. Kelly and Males (1986) reported that:-

- The term Value Engineering is adopted in U.S.A manufacturing, while Value Management is a more acceptable term for U.K construction.
- In practical terms, if a decision is taken now to add Value Engineering to the surveyor's portfolio of services it is unlikely to have a major impact on the U.K construction industry.
- Any further discussion on Value Engineering should concentrate not on whether it should be introduced but in what form, by whom and when it should be institutionalized
- Value Engineering provides a method of integration in the building process that no other management structure in construction can provide.
- Value Engineering is term oriented and therefore the Value Engineering team coordinator is not expected to be an expert in all technical areas.

- Value Engineering complements project management.
- Male et al. (1998) revealed that Value Engineering (VE) in construction was slow to take root in U.K Government agencies in the main didn't take on board the ideas nor recognized any benefits.
- In 1986 the U.K construction industry provides a tenth of the U.K.'s gross domestic products, and employ 1.4 million people, designers, civil engineering, contractors and product manufactures have a worldwide reputation for working overseas.
- The U.K construction industry is one of the strongest in the world, with output ranked in the global top ten.

2.24.5 Value Engineering in Australia:

Value Engineering (VE) came to Australia in the middle to late 1960 through the activities of multinational companies. Those activities were recognized as more management than engineering in orientation.

Value Engineering in Australia manufacturing and in the defense sector is still maintaining activity. Main contractors and project management organizations employed Value Engineering consultants specialized in construction industry but clients used to choose individual facilitators suitable for certain projects. This led to what is called cottage industry of one or two Value Engineering (VE) practitioners who worked from a low cost office at home or elsewhere on a full-time basis (Male et al.1998).

In the mid-1980, Roy Barton, a construction academic at the University of Canberra, undertook a study tour of Value Engineering PR actioners in the U.S.A he returned to Australia with message that while some changes to the U.S.A system were necessary to reflect cultural differences, the basic service was applicable to Australian construction.

In 1992 it was the government's wish that the industry's productivity in New South Wales be lifted by 20% within five years (Kelly and Males 1986).

2.24.6 Value Engineering in Hungary:

Aprad and Valeria reported that Value Engineering was applied in Hungary in the 1960. There are slight difference between the American and the Hungarian process of Value Engineering in the steps, organizational background and the usage. In 1996, the government arranged training courses in this new technique to make it widely known; also it was applied in the government procurement process as an option not as mandatory. The main characteristics of Value Engineering in Hungary as follows:

- The original constructors form the study team.
- More information is gathered during project construction.
- Value Engineering starts after the information phase with a list of requirements.
- Function analysis is done at one level.
- Criticism is not allowed in the creative phase.
- Usually 300-850 ideas are generated by the study team.
- Value Engineering study time extends to several week or a month; generally 8-12 team sessions are required for the important topics while the creative phase is conducted intensively.
- Value Engineering projects are carried out by external Value Engineering consultants.

2.24.7 Value Engineering in Japan:

Nakagami (2000) stated that Value Engineering was introduced to Japan in the 1950 in the manufacturing sector and later applied to the actual phases of the site construction projects. The private sector has adopted successfully this methodology in products, components and site construction projects, while the government corporations have recognized its importance recently.

Japanese Value practitioners and professionals at international conferences in Value Engineering usually present many scientific papers. The numbers of these papers are very high compared to the papers presented by their American counterparts.

Beaton (1990) reported that Japanese are leading the world in industry because they do their engineering and make their design changes before they start construction.

In Japan, standard job plan is composed of the following phases :-

Function Definition phase: this phase includes collection of information on the selected project, definition of the specific functions of all elements of the project and preparation of functional diagram.

Function Evaluation Phase: it includes analysis of the related cost data by functions and establishing their worth in order to evaluate the specific value levels.

Alternative Development Phase: it consists of the steps of creating ideas, evaluating them and refining them to come up with alternative proposals for implementation.

Japanese contractors performed significantly better than their U.K and U.S.A counterparts in all four aspects considered, i.e. construction time, time certainty, extent of delay and client satisfaction. Japanese contractors achieved shorter construction times by using more human resources on site. Planning in more detail and work more closely with their subcontractors.

2.24.8 Value Engineering in China:

Shen and Liu (2004) stated that Value Engineering (VE) was introduced in China during 1978, when the reform and open door policy started. Although it has been developing for more than 20 years, but it has not been widely accepted and applied by the construction professionals. This situation is even worsened by the recent decline of overall Value Engineering development in China, which is induced by the radical economic transition from the socialist system to the market system.

Shen and Liu (2004) reported that the job plan follows the national Chinese Standard (GB 8223-87) which includes four phases while the international job plan established by Miles (1989) has seven phases. The Value Engineering (VE) teams members, sometimes including client representatives invited external experts and others are required, meet irregularly to explore, create and develop alternative solution without suspending their normal duties.

Shen and Song (1998) revealed that a lack of practical guidance for implementing Value Engineering in China's construction industry is another key factor blocking the wide application of Value Engineering in the industry.

2.24.9 Value Engineering in Malaysia:

According to (Che Mat M. M., Value Management-The Way Forward, 1999), Malaysia started the technique in 1986 when Roy Barton from Canberra University, Australia introduced Value Management (VM). Even the terms are different, but the concept is similar to value engineering. In 1990, Barton made another subsequent visit and together with Mohd MazlanChe Mat introduced Value Management Methodology to PETRONAS and Ministry of Defense. Later, many of industries and government use the value engineering.

2.24.10 Value Engineering In Saudi Arabia:

Al – Yousefi et al (1999) reported that Value Engineering started in 1975 at Military Works of the Ministry of defense and Aviation. In the beginning, Value Engineering was not accepted as a new approach, but once people touched its success. The main reason for the lack of adoption being unfamiliarity with the concept among public sector organizations, as well as local architectural/engineering firms in the Kingdom.

Al – Yousefi (2005) stated that the Ministry of Finance in K.S.A. issued the declaration No. 10/2/35269 on 20th of Ragab, 1442 about the application of Value Engineering studies on new construction projects. The declaration including the following points:

- Value engineering studies should be conducted on the new projects in order to be approved in the budget. The studies should include design, construction, operation and maintenance stage.
- The Government department must provide sufficient information about the purpose.

- A flexible and effective management between the different parties that participate in design, construction, operation and maintenance stages of the projects.
- A continuous training of Value Engineering techniques is very important so that they can apply this methodology effectively.
- The Value Engineering study team must be selected carefully to fulfill the target requirements of the projects.

2.24.11 Value Engineering in Sudan:

Value engineering may not be well known among engineers working on the construction industry in the Sudan, and there is lack of knowledge in Sudanese companies about Value Engineering concept.

2.25 The Value Engineering Six Steps:

○ Step one (Information Phase):-

This is the first step in the formal Value Method value study. The individuals have been selected and an expected scope of operations established. Before the first meeting, we identify, collect, and disseminate to the value study participants, all possible information operational features within the scope of the study activity. To minimize resource losses, we make a Value Method preliminary analysis.

Time for the value study, the value study participants examine and analyze the components making up the features and their costs, identify the criteria and limits affecting the activity, and if prudent, ranked and/or assigned

values. Now that the activity pieces are in manageable chunks, they examine these components are examined in terms of their function and generate a functional logic diagram (referred to as a Function Analysis System Technique or FAST diagram). This FAST shows the relationship of the performed "why" and "how" and "supporting" functions. The value study categories and assigns costs to functions of note. Finally, they identify the future concentration of value study effort. This make sure the client gets the most worth out of the value study for its cost. They use two procedures: identify items that have high potential for added value and items that are present now and have less than optimal value.

To get a real benefit from the technique, it is very much necessary that the problem is rightly understood and selected . Normally, any problem that comes ones way is taken up and a quick study is carried out as regards the functional analysis and alternatives are suggested. This is followed because of the urge for showing glaring results in terms of high percentage savings; but in fact it might be a very meager sum as far as the absolute money VALUE is concerned. What need to be done is to select those problem areas where a potential for net higher savings is expected, although the percentage scope may be very low, because it is the Rupees saved that matter and not the percentage figures. For ensuring this the easiest and surest way is to use the Pareto 's Analysis, more commonly and universally known as ABC analysis and used in any problem selection. But ironically the only potential use of this analysis made is in the area of Materials Management. Here, it is taken for granted again, that the reader is aware of the methodology of ABC Analysis.[Dallas,M.F,2006, Value and Risk,UK].

- **Step two (Functional Analysis):-**

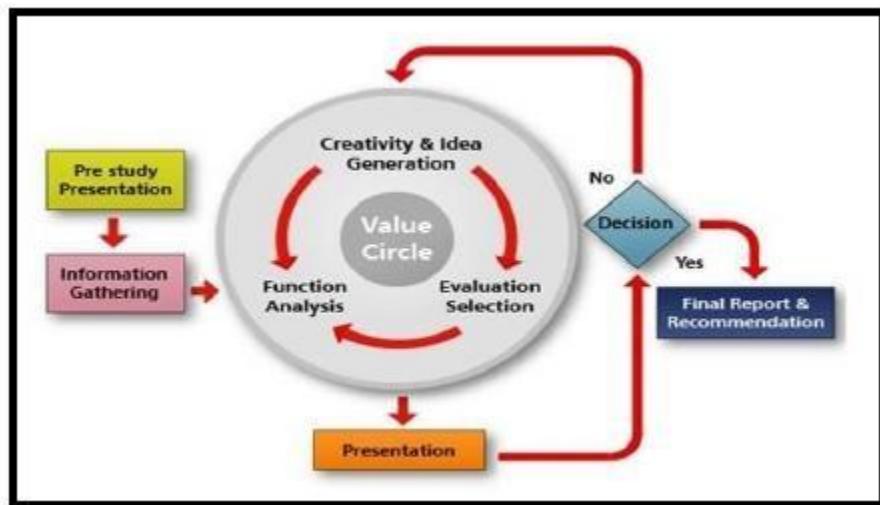
Functional analysis has similarities to value engineering in that it is applied during the development stage of a new product , but it uses the functions of product (or service) as the basis for cost management.

“Functional analysis is concerned with improving profits by attempting to reduce costs and/or by improving products by adding new features in a cost effective way that are so attractive to customers that profits actually increase”.

“Functional analysis is an analysis of the relationship between product functions, their perceived value to the customer and their cost provision”.

The Function Analysis activity will use the FAST (Function Analysis System Technique) methodology. The FAST diagram, documents the study team’s understanding of the required and desired functions and will be used as one tool to identify potential study targets. [Dallas,M.F,2006, Value and Risk,UK].

What must the project do? What are the functions and how are they Related?



Dig(2).Value Circle

- **Step three(Creativity phase):-**

Brainstorm ideas on how to improve the high cost, broken, or inadequately performed key functions, creativity it is the art of bringing something new into existence. It has the art of making, inventing, or producing something new and different.

All attendees will fully participate in the interactive Creativity session to generate ideas related to the identified targets. Brainstorming techniques and additive/ subtractive strategies will generally be used during this session. We will screen the ideas by consensus using a method which best suits the program approach. This may include a Nominal Group Technique or Value Index system.

Ideas will usually be referenced for easy identification. We generally use the selected target functions or the key target areas/elements a project. In a transportation project this might include alignment, and typical section, in a rail project this might include, operations and ridership. In a water or wastewater treatment facility this might include operational strategies. In almost all construction projects staging/phasing strategies, construction methods, material selection, risk management/schedule, etc. will be included as a basis for categorization. The team will reach consensus on each idea in terms of implementation probability (i.e. Does the idea work? Can it be modified to work? Can it be implemented when needed?). This discussion is extremely important to test the —sale - ability of each idea to senior staff later in the assignment. [Dallas,M.F,2006, Value and Risk,UK].



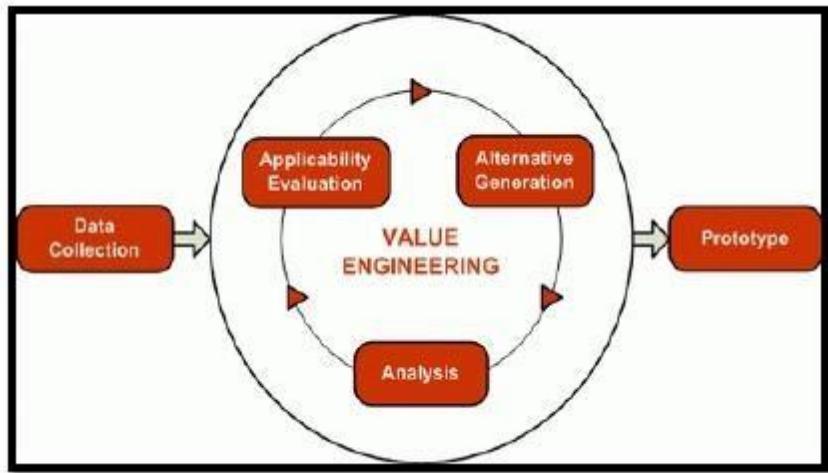
Dig. (3) Reduce Unnecessary Costs

○ **Step four(Evaluation phase):-**

Development of the short listed ideas will follow the Creativity Phase. Every effort will be made to match workshop attendees with topics of interest (people will generally be more enthusiastic with this approach) to ensure that —topic champions| emerge.

Performance measures will be developed for the baseline and for subsequent concepts to compare the differences in overall effectiveness. Performance indices will be used in the analysis to document the advantage and/or disadvantage of each performance attribute.

Screen ideas for acceptance, score remaining ideas on a scale and group ideas into categories. Develop design scenarios, and selection criteria. Rate and rank ideas.



Dig(4).Evaluation Phase

○ **Step five (Development phase):-**

What happens during this phase is that the value study participants use a high-product producing activity to evaluate the best ideas surviving the analysis phase. As a part of the process, they make a specialized benefits, disadvantages, and risks. Only the highest-potential concepts are taken further. The Value Method process we use makes sure, as much as possible, that the value study produces the most product for the least cost. Value study participants then develop the concepts that survive into viable, efficient, and cost-effective alternative proposals. Each developed alternative proposal, which is carried to completion, has a high expectation of increasing the value (it's worth versus its cost) for the product or process customer, owner, or both. [Dallas,M.F,2006, Value and Risk,UK].

Plan how to sell ideas to management, identify key recommendations, and plan management presentation.

Each VE proposal will include the following elements:

- Brief discussion of the existing concept.
- Brief discussion of the proposed alternative.
- Advantages.
- Disadvantages.
- Discussion.
- Summary.
- Sketches (original, proposed) if appropriate.
- Calculations, if appropriate.
- Cost worksheets (capital, maintenance), if appropriate.

A key component of the Development Phase is the preparation of a compelling argument supporting the implementation of each VE proposal. This is a critical step in the VE process and its importance in the success of the VE study, and ultimately a measure of the VE program itself and should not be understated. Our experience, gained through other similar challenging VE studies, is that most successful VE proposals are focused on performance improvement rather than the traditional (and often mandated) focus on cost avoidance. As such, we often realize a greater than average acceptance rate of VE using this approach because it avoids the cost cutting label often associated with VA/VE studies.

○ **Step six(Reporting phase):-**

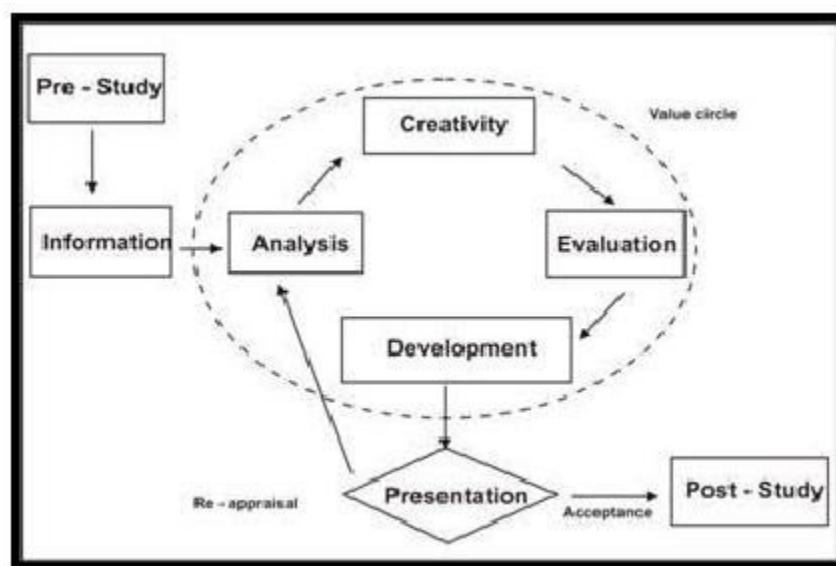
The final phase of the workshop focuses on the presentation of the developed ideas by each Team “champion”.

The best results must be made known or no one will be able to use them. Also, the people that make the decisions rarely can take out the time to

fully participate in the value study. Further, that is not their function; the good decision is their task. [Dallas,M.F,2006, Value and Risk,UK].

The concepts which make through the development are, by definition, displaying "added value." This may be by monetary or non-monetary means. First your value study group place the value study results in a written report. This is so you have a document to refer to and use to make your decision. Next a presentation of the value study results is made of the "alternative proposals." These are the concepts that have sufficient projected benefits, such as: usefulness, reduced cost, increased income, more timely results, and so on; such that they outweigh the proposal's potential disadvantages and risks.

- Give oral presentation to management.
- Support it with written executive brief.
- Be clear, concise, and positive.
- Anticipate roadblocks.
- Use good human relations.



Dig.(5) Value Engineer Methodology

2.26 The Benefits of Value Engineering:

The benefits are many. We encourage a team approach to projects, improve project performance, identify project functions, and focus the team on the project at hand. Benefits can be defined as follows:

- Lowering costs.
- Improving quality management
- Improving resource efficiency.
- Simplifying procedures.
- Minimizing paperwork.
- Lowering staff costs.
- Increasing procedural efficiency.
- Optimizing construction expenditures.
- Developing value attitudes in staff.
- Competing more successfully in marketplace.
- Customer Satisfaction.
- Performance Improvement.
- Time Saving.
- Functions Achieved.

2.27 Principal Characteristics:

In almost every case in which VE is applied, the money saved will be many times the cost of a VE study. Generally the expected savings ten times exceed the expected study and implementation costs.[Michael's book ,January 2006, Value and Risk Management].

Value Engineering is functionally oriented to include:

- Identifying the function.

- Placing a price tag on that function.
- Developing alternative means to accomplish the function without any sacrifice of quality.
- Base judgments on a total life cycle cost with strong emphasis on maintainability. Lack of VE during location, design, and construction results in higher than necessary maintenance costs.
- The two main differences that distinguish VE from other cost reduction programs are:
- Functional approach analysis
- Systematic approach job plan.

2.28 Effect of Value Engineering:

- The VE goal is not to make item costs cheaper but to determine the worth of the basic function without regard to its application and set a target cost.
- VE finds design alternatives that meet all needs at a lower overall cost.
- A VE study can generate recommendations to eliminate ten to thirty percent of the project's construction costs.
- The designer usually accepts about half of these recommendations, providing saving of at least five percent.
- The cost of the VE effort including any redesign is usually less than ten percent of the implemented savings.

2.29 Advantages of Value Engineering:

The following are the advantages of value engineering:

- Value engineering helps achieve an improved product design and quality.
- Value engineering suggests eliminating the unnecessary functions in the organization that increase costs and have complex ties.
- Value engineering enhances the customers' satisfaction and sales by determining the exact need and expectation of customers.
- Value engineering emphasizes on seeking the alternatives for achieving the function and on applying the best alternative among the various courses of actions available.
- Value engineering provides competitive advantages to the firm in the areas of product quality, costs and customer's satisfaction.
- Value engineering focuses on standardization of the parts and components by identifying the possibility of using the same component or function in different products of the company. This brings economy in the cost of manufacturing the parts and components.
- Improve your career skills.
- Separate "Symptoms" from "problems".
- Solve "root cause" problems and capture opportunities.
- Become more competitive by improving "benchmarking" process.
- Take command of a powerful problem solving methodology to use in any situation.

