The Synergy between Value Engineering and Sustainable Construction

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Biography
Abdulaziz is the founder and owner of the first Value Engineering office in the Arab World. He is a Certified Value Specialist for life (CVS-life) from SAVE International: The Value Society. He is the only Arab to get a Fellow of SAVE International.

He served in the past: as the president of The SAVE International- Arabian Gulf chapter; the General Secretary of the Saudi Council of Engineers and the Vice president of the Arabian Gulf Chapter of Project Management institute (PMI-AGC).

He is a board member SAVE International Certification Board: The international Value Engineering Certifying Body, Saudi Council of Engineers, King Abdulaziz Quality Award and Saudi National Quality Council.

He has over 25 years experience in Value Engineering (VE), Life Cycle Costing (LCC), Project Management and Design Reviews of large-scale projects. He led more than 200 VE Study Workshops in high-rise (tall) buildings, large scale Construction projects, Oil & Gas, Industry, Operation & Maintenance and management processes. He has conducted more than 150 training courses in VE, High-rise and Tall buildings conceptual designs, Project Management, Quality Management, and LCC.

He has done these VE Services with many distinguished clients, such as: Saudi Aramco, Royal Commission of Jubail & Yanbu, SABIC, Saudi Electric Company, Dubai Municipality, Saudi Ministry of Defense, Saudi Ministry of Municipality, UAE Ministry of Public Work, Bahrain Engineering Society, UAE Engineering Society, Kuwait engineering Society, Saudi Council of Engineers, Qatar Society of Engineers, and other private companies in Saudi Arabia and the Gulf countries.

He is the founder of the newly acclaimed quality improvement methodology that is called “Total Value Management (TVMT™)”. He presented many papers at the PMI, ASCE, SAVE, SJVE and IEEE conferences. He has specialized in computer applications in Value Engineering and Project Management.

He wrote the first VE book ever written in Arabic titled Value Management: Concept and Techniques in 1991. The fourth edition was published in 2006. He Holds BSEE (Arizona State University, 1982) and MS (State University on New York at Albany, 1987) degrees in Electrical Engineering and Project Management.

Abdulaziz is a member of SAVE, IEEE, PMI, ASHRM, ASQ, Saudi Quality Counsel, Saudi Council of Engineers and Saudi Computer Society.
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Abstract
Traditionally, construction projects have been developed by generating a program of needs and requirements, using in-house staff, or hiring consultants to develop necessary documents, and subsequently award projects. However, there is little programmed input to implement some kind of Value Engineering and Sustainability Analysis. In the past two decades, there has been a growing awareness of the importance of both Value Engineering (VE) and Sustainable Development (SD) within the construction industry. Both subjects play crucial roles in realizing quality, reliability and durability as well as enhancing performance throughout the life of a project. They also help to: improve service related outcomes within budget constraints: achieve a more efficient use of resources; and accomplish an optimum combination of Life Cycle Costing (LCC) and quality to satisfy the user requirements.

This paper proposes a conceptual synergy between VE and Sustainable Construction (SC) that leads to achieving best value over the life span of a project. It demonstrates the linkage within the SAVE International Standard VE Job Plan tools and techniques for better planning for Sustainable Construction (SC) during early stages of a project.

Keywords: value, sustainable, development, quality, VE, VM

1. Introduction
The construction industry has vital impact on the environment and people. On a global scale, the construction industry and its products contribute to environmental problems through resources depletion; energy consumption; air pollution and waste creation. The construction industry’s fragmentation creates many difficulties for its clients who must procure individual project elements from different sources (Egan 1998).

2. Sustainable Development (SD)
SD can be defined as "Development that meets the needs of the present without compromising the ability of the future generations to meet their own needs"(WCED 1987). Sustainable development integrates a variety of subjects: environmental quality, economic constraints in addition to social equity and cultural issues (Hajek 2002).

SD implies changes and should lead to an improvement in the quality of life for humanity. Development encompasses not only growth, but also general services and welfare. SD involves the transformation of natural resources into productive output and the balance between economic progress and environmental conservation, given that both are imperative to our future survival. Sustainable development thus implies using renewable natural resources in a way which does not degrade them or otherwise decrease their usefulness to future generations. It also implies using non-renewable natural resources at a rate slow enough as to ensure a high probability of an orderly societal transition to new alternatives (Langston and Mackley 1998).

3. Sustainable Construction (SC)
SC is generally used to describe the application of sustainable development in the construction industry. This may mean that for the construction industry to continue its business and growth under the premise of sustainable construction it will need to slow down its growth in some areas, or grow in different ways (Plessis 2002). Sustainable construction could be defined as ‘the creation and responsible management of a health built environment based on resources efficient and ecological principles’ (Hill and Bowen 1997).

4. Value engineering (VE)
VE is a methodology that is know, accepted and has an impressive history of improving value through customizing Quality and optimizing Life Cycle Cost (LCC). VE is an organized process that has been effectively used by a wide range of companies and establishments to achieve their continuous goals. The success of the VE process is due to its ability to identify opportunities to remove unnecessary costs while assuring quality, reliability, performance, and other critical factors that meet or exceed customers’ expectation. The improvements are the result of recommendations made
by multi-disciplined teams from all concerned parties.

Value Engineering can improve decision-making that leads to optimal expenditure of owner funds while meeting required function and quality level. VE is a methodology that is comprised of many useful tools and techniques that create change on purpose rather than letting change happen accidentally.

5. VE History

The value analysis concept was conceived by Mr. Lawrence D. Miles during the 1940s. He worked for General Electric, a major defense contractor, which faced the scarcity of strategic materials needed to produce their products during World War II. Miles realized that if value and related innovation improvements could be systematically “managed,” then General Electric would have a competitive advantage in the marketplace. With that ambition in mind, Miles took the challenge and devised the function analysis concept, and integrated it into an innovative process that became known as Value Analysis. Miles understood that products are purchased for what they can do. These products can either do work or provide pleasing aesthetic qualities. (SAVE International 2006)

The success that Miles unleashed was quickly recognized by other companies and the U.S. Navy. The result was that value analysis began to gain in popularity, eventually leading a group of practitioners to form a learning society to share insights and advance their innovative capabilities. Thus in 1959, the “Society of American Value Engineers” was officially formed. Soon VE was used to improve value in government projects, the private sector, manufacturing, and the construction industry. VE spread out from the USA to North and South America, Europe, Australia, Asia, the Middle East, and parts of Africa. The international growth caused the membership of SAVE to reconsider the society’s name and was changed to “SAVE International” in 1996.

6. Value Concept

The traditional approach to the design process begins with the architect's assets, core competencies, and desire to create a product that ideally matches the client's priorities. The new VE decision making approach takes the reverse view: defining the client's priorities, then acquiring or improving the skill sets, talent, and knowledge needed to create products that meet the client's needs. This more formalized decision making approach allows a more holistic understanding of the project by all stakeholders.

The new approach involves using a multidisciplinary team that includes representatives of the owner, user, facility manager, and constructor. It would be helpful to have some participants new to the project in order to maintain independence and to ensure that all viable ideas are explored. If all stakeholders are not represented, it is a good idea to role-play those who are missing. The owner is involved from the beginning to help define the owner's value expectations for the project and to set priorities. Real-time decisions are reached using value-based methods in a team workshop setting.

Value engineering concentrates on the effectiveness through stating functions, goals, objectives, needs, requirement and desires. Then define the quality features that make the product more acceptable. Finally, generate VE Proposals that meet the requirements at the least possible Life Cycle Cost. VE is a balance between Function, Quality and Cost as shown in figure 1

Function: The specific work that a project must do.

Quality: Customer requirements, desires and expectation, or Fit for Use or the Value-Added benefits

Life Cycle Cost (LCC): The initial Cost plus all the associated cost of running the facility. The running cost covers energy, maintenance, repair replacement, staffing...etc. etc.

Over all Expenses = Real Cost + Waste

Waste: any process that does not add value to the projects

Figure 1: The three main issues of Value

Therefore, VE can be defined as: An organized team effort aimed at analyzing Functions and Quality of projects in order to generate practical cost-effective alternatives that meet customer requirements. (Al-Yousefi 2004).

7. VE Applicability

VE can be applied during any stage of a project’s design development cycle. However, the greatest benefit and resource savings are typically achieved early in the development and conceptual design stages. This is a point in time where the basic information of the intended product is established, but before major design and development resources are spent.

VE may be applied more than once during the life of the project. Early application of VE helps to get the
project started in the right direction, and repeated applications help to refine the project’s direction based on new or changing information. It is important to note that the later that a VE study is conducted, the higher the cost of change will be to implement the improvements.

The ideal way is to apply VE at three deferent design stages, as shown in figure (2).

The first VE Study (VE 1) is applied during the design planning stage to define project functions, goals, objectives, requirements, design Criteria and Scope Of Work (SOW).

The second VE Study (VE2) is applied at about 15-30% of design, to generate Detailed VE proposals and alternatives to the design and to define Technical Systems and make sure that Value Engineering Proposals (VEP) of VE 1 are implemented

The third VE Study (VE 3) is a mix of VE and Design Review (DR) and its is applied at about 80-85% of design to check the conformance to codes, standards, specifications and make sure that VEP of VE 2 are implemented

The value methodology is used to identify new improvement ideas and develop these ideas into proposals that lead the enhancement of the project. Value studies, as shown in figure (3), are conducted in three stages, Pre-Study, VE workshop and Pre-Study.

A unique feature of VE is the function analysis phase. During this phase, functions of the project under study are identified and described using a verb-noun pairing. The functions that appear to show a value mismatch between “function’s cost” and “function’s worth,” or with apparent deficiencies in the function’s performance are selected for brainstorming in the creative phase. The ideas generated then are evaluated, and those with the most potential to improve value are developed into alternatives to the original concept. Implementation of these alternatives will improve the value of the project.

9. The VE Job Plan

VE is the systematic application of recognized tools and techniques by a multidisciplinary team to identify and categorize the functions of a project and to create, select, and develop alternative approaches to cost-effectively deliver the functions and improve performance. It is applied in a logical process known as the “Value Engineering Job Plan. The purpose of the job plan is to assist a study team to identify and focus on key project functions in a systematic manner, in order to create new ideas that will result in value improvements.

The VE Job Plan consists of the following seven sequential phases:
1. Information Phase
2. Function Analysis Phase
3. Creative Phase
4. Evaluation Phase
5. Development Phase
6. Presentation Phase
7. Implementation Phase

VE Synergy with Sustainable Construction (SC)

All phases of this job plan are required and are performed sequentially. The activities performed in each phase may vary in number to fit the study topic or time constraints, but it is the outcome achieved at the end of each phase that marks the reliability and quality of the VE performance. During the conduct of a study, new data and information learned may require the study team to return to earlier phases or activities.

The linkage between VE and Sustainable Construction (SC) could be realized during the information phase, the creativity phase and the evaluation phase of the SAVE International Standard VE Job Plan, as shown in figure 4.

The VE-SC linkage will be explained, here, in the following sequence.
- A brief description of each phase of the VE Job Plan.
- Outlining the VE activities in each phase
- Summarizing the Sustainable Construction issues to be discussed.
- Define the VE-SC synergy by stating the proposed outcome of each phase.

9.1 Pre-VM Workshop Study Phase
The planning for the VE Workshop

VE Activities:
- Obtain senior management concurrence and support of the job plan, roles, and responsibilities.
- Obtain project data and information.
- Obtain key documents such as scope of work definition, drawings, specifications, reports, and project estimate.
- Identify and prioritize strategic issues of concern.
- Determine the scope and objectives of the study.
- Develop the study schedule.
- Undertake competitive benchmarking analyses.
- Identify Value team members.
- Estimate the Life Cycle Cost (LCC) of the project.
- Gather appropriate customer/user information about the project.
- If possible, invite customers or stakeholders to participate in the VE study.
- Distribute information to team members for review.
- Clearly define, with senior management, the requirements for a successful VE study results.

Pre-study outcome: Clear understanding of what senior management needs to have addressed, what the strategic priorities are, and how improvement will increase organizational value. It is during this phase that a view is formed as to whether subsequent phases are likely to yield sufficient value to justify the cost of the study within the terms set. It may be appropriate to increase or decrease study parameters at this time.

9.2.1 Information Phase
At the beginning of the VE Study workshop, it is important to understand the background and decisions that have influenced the development of the project design. Because of this, the Owner and Designer present an oral overview of the design. This presentation usually includes: the history of the project; the rationale for the design; project constraints; site conditions; factors influencing decision making; and the reasons for selecting the process equipment or major materials or systems for the project. Also, project costs and schedule data are discussed. Subsequently, each team member familiarizes himself with the project documents.

The information phase also includes preparation of the cost and energy models from cost data assembled before the workshop began. These models are updated based on information received during the Designer’s presentation. The VE team then reorganizes the low quality area and the high cost area and sets target quality improvements and cost saving.

VE Activities:
- Project Team presents the original design concepts
- Identify program issues and constraints.
- Confirm the most current project concept.
- Visit site or facility.
- Confirm success parameters.

Sustainable construction issues to be discussed
- Minimization of resources consumption.
- Maximization of resource reuse.
- Use renewable or recyclable resources
- Protection the natural environment.
- Creation of a healthy and non-toxic environment.
- Pursue quality in creating the built environment.
- The re-using of existing built assets.
- Designing for minimum waste.
- Target for lean construction.
- Conserving water resources;
- Considering people and their local environment.
- Offer flexibility and the potential to cater for user changes in the future.

Information phase Outcome: Brings all team members to a common, basic level of understanding of the project. That includes tactical, operational, and specifics of the subject.

9.2.2 Function Analysis Phase
The procedures used in this Phase are vital to the VE team because it forces the team to think in terms of functions and the costs related to each of the functions. Preparing the function analysis helps to generate many of the ideas that eventually result in recommendations for project improvement and/or cost savings. The higher the cost/worth ratio, the greater the potential for discovering and developing cost savings. Worth is applied based on the premise of finding the least cost to provide the required functions. This forces the VE team to come up with alternative solutions to the proposed design. The functional understanding establishes the base case to identify and benchmark alternatives and mismatches, and set the agenda for innovation.

VE Activities:
- Identify functions of the project systems and components.
- Identify high potential SC issues to be discussed
- Classify the functions.
- Develop function models.
- Select functions to focus the creativity phase.
Sustainable construction issues to be discussed
- Defining the functions of the SC issues defined in the information phase.
- Dimension the function model with cost drivers and SC performance attributes
- Select function related to SC in order to focus on them during the creativity phase.

Function Phase Outcome: Validation that the project satisfies the need and purpose of the project. Provide a more comprehensive understanding of the project. Identify the function(s) on which to focus in order to improve the project.

9.2.3 Creative Phase
This phase of the VE process involves the generation and listing of creative ideas. During this time, the VE team thinks of as many ways as possible to provide the necessary functions within the project. The creative idea listing for the team(s) and notes from discussions among the VE team members and coordinator/leader are included in the VE workshop report. Separate teams typically have separate creative phase report sections. During the creative phase, judgment of the ideas being developed is restricted, and ideally is not present at all. The VE team is looking for the greatest quantity of ideas, which will subsequently be screened, in the next phase of the study. This issue is one of the most challenging for VE team members and participants. Many of the ideas brought forth in the creative phase are a result of work done in the function analysis and pre-study efforts.

VE Activities:
✓ Creative warm-up exercises.
✓ Explanations that establish rules that protect the creative environment being developed.
✓ Generate alternate ideas that may improve value.

Sustainable construction issues to be discussed
- Minimizing energy in use.
- Avoiding pollution.
- Preserving and enhancing bio-diversity.
- Conserving water resources.
- Setting SC targets.
- Enhance the quality of life and offer customer satisfaction.
- Provide and support desirable natural and social environments.
- Maximize the efficient use of resources
- Decrease the use of raw materials and energy.
- Optimize the consumption of renewable resources.
- Decrease the amount of harmful emissions and waste.
- Enhancing indoor environmental quality.

Creative Phase Outcome: A wide choice of ideas that provide a wide variety of possible alternative ways to perform the function(s).

9.2.4 Evaluation Phase
In this phase of the workshop, the VE team evaluates the ideas developed during the creative phase. The VE team ranks the ideas. Ideas found to be irrelevant or not worthy of additional study are disregarded; those ideas that represent the greatest potential for cost savings and improvements are selected for development. A weighted evaluation is applied in some cases to account for project impacts other than costs (both capital and life cycle).

Ideally, the VE team would like to evaluate all attractive ideas but time constraints often limit the number of ideas that can be developed during the workshop. As a result, the team focuses on the higher ranked ideas. This phase is designed so that the most significant ideas are isolated and prioritized.

Common Activities:
✓ Build shared understanding of all ideas.
✓ Discuss how ideas affect project, cost, and SC performance parameters.
✓ Establish evaluation criteria.
✓ Rank, select, and prioritize ideas for further development
✓ Explain how ideas are to be written up as standalone risk-reward investment proposals

Sustainable construction issues to be discussed
- Offer flexibility and the potential to cater for user changes in the future.
- Maximize the efficient use of resources
- Increase serviceability, durability and reliability over all the entire life of the project.
- Minimizing non-renewable energy consumption.
- Using environmentally preferable products.
- Protecting and conserving water.
- Enhancing indoor environmental quality.
- Optimizing operational and maintenance practices

Typical Outcome: A focused list of ideas that contributes to the enhancement of quality, sustainability, functionality and performance.

9.2.5 Development Phase
During the development phase of the VE study each designated idea is expanded into a workable solution. The development consists of the recommended design, capital and life cycle cost comparisons and a descriptive evaluation of the advantages and disadvantages of the proposed recommendations.

The selected ideas are developed into proposals that are clearly written so that the owner and other project stakeholders understand the intent of the proposal and how it benefits the project, and also to identify any potential negative factors associated with the proposal.
The proposal should include text, sketches, diagrams, supporting calculations, cost comparison, and other information which may be necessary to convey the intent of the proposal. Issues addressed include sustainability, reliability, customer convenience, quality control, initial cost, running cost, life cycle cost, schedule, risk, availability, political ramifications, and perception.

VE Activities:
- Prepare a written proposal of ideas selected for further development.
- Assess and refine SC issues.
- Conduct benefits analysis.
- Generate sketches and information needed to convey the concept.
- Confirm that a proposal should be further developed.
- Estimate the cost difference of each VE Proposal.

Development Phase Outcome: Low-risk, medium-risk, and high-risk scenarios are created and are the minimum basis upon which senior management will be offered options that address the pre-Study strategic objectives.

9.2.6 Presentation Phase
The sixth phase of the VE study is the presentation. The VE proposals are typically screened by all VE members before presentation to the workshop personnel. That audience typically consists of the owner, end user, designer, consultants and stakeholders representatives. Final VE proposals are presented orally during the workshop and in the written report.

The VE team leader and/or team members describe the recommendations and the rationale that went into the development of each proposal. Value engineering worksheets and a summary of the VE results are given to the Owner or Designer at this time in draft format. This begins the evaluation by the Owner and the Designer of the VE report recommendations.

VE Activities:
- Prepare presentation and supporting documentation.
- Exchange information with the project team.
- Ensure management has full and objective information upon which they can make good decisions.
- Outline an anticipated implementation schedule.

Presentation phase Outcome: Ensure management and other key stakeholders understand the rationale of the VE Proposals. Also present a preliminary VE Proposal implementation action plan.

9.2.7 Implementation Phase
Following delivery of the VE preliminary report, management and the project team must digest and agree upon the VE proposals to be implemented, and then how and by when the implementation will occur. In some instances, additional study and information may be required. Implementation of alternatives is the responsibility of management with assistance from the project and VE teams.

VE Activities:
- Review the preliminary report.
- Conduct implementation meetings to determine the disposition of each VE Proposals.
- Establish action plans for those alternatives accepted and document the rationale for the rejected alternatives.
- Obtain commitments for implementation.
- Assign a timeframe for review and implementation of each VE Proposal.
- Track value achievement resulting from implemented alternatives.
- Validate benefits of implemented change.
- Ensure that new practices become embedded by establishing and managing an implementation plan.

Implementation phase Outcome: What is changed in the project as a result of a VE Study? These are usually alternatives to the original concept or base case of a study that the project development will incorporate as changes in future design or product development activities.

9.3 Post-VM Study Phase
The post-study portion of a VE study includes the finalization of the VE Report in order to incorporate the VE proposals developed during the workshop. The Designer then responds by accepting and incorporating the proposals into the project design, rejecting the proposals, or recommending further study. Usually the Designer puts these decisions in writing to the Owner as a VE Report addendum with justification for proposal responses. A summary of the cost savings and/or additions resulting from the study and the required redesign costs are also included in the Designer’s response.

VE 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.
- Reflect on the value study and consider how the experience has developed new capabilities.

Post-Study 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, is a key step in learning that will help the organization become better
at managing the way it manages innovation.

**10. Conclusion**

VE could be applied as a “quick response” type of study or as a deeply integrated part of an overall organizational desire to stimulate innovation and improve quality. VE Methodology and tools could be considered as an integral part of sustainability analyses. Furthermore, VE lies under the umbrella of Total Quality Management (TQM), quality assurance and quality control programs. VE enables the management of the team’s thinking so that the best use of the knowledge and experience they have can generate new ideas to perform functions and propose alternatives.

The VE Methodology employs various tools and techniques that help us to plan for better Sustainable Construction (SC); such as Life Cycle Costing (LCC), function modeling, strategic problem solving, Pareto analysis, paired comparison, Quality Base Selection (QBS), evaluation criteria, quality function deployment, design for Six Sigma, target costing, “Lean” concepts, idea management and action planning.

This proposed integration between VE and SC may encourage others to explore this relatively untapped subject due to a lack of research and development of both concepts.

**References**


