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Value Engineering (VE) Application in Infrastructure Projects by Public-Private Partnerships (PPPs)

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Abstract

Infrastructure projects are considered one of the pillars for achieving urban sustainable development, as they reflect the progress of countries. Due to the high cost of this type of projects and as a result of the weakness of the ability of governments to finance this type of projects, especially the governments of developing countries, therefore the world's governments implement this kind of projects through partnership with the private sector (PPP). This paper discusses Value Engineering (VE) as a systematic process of review and analysis of (PPP) projects, during its various phases, to provide the lowest overall cost, improving the value and quality of the project and reducing the time to complete the project. Value engineering of large capital projects typically delivers cost savings of at least 10% value saving (VS), therefore it allows for maximizing the profit of this type of projects, which helps to accelerate the development through ensuring high quality service and low cost advanced technology by activating the principle of value for money (VFM) and through competition between private sector companies in a framework of transparency.

Keywords: Value Engineering - Infrastructure Projects - Public Private Partnership.

INTRODUCTION

The recommendations of the 2015 UN Summit under the title (Transforming Our World: Sustainable Development Plan 2030), which had 17 main objectives, focuses on two objectives: A- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation, B- Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development. From this point of view, the PPPs infrastructure approach becomes necessary. Thus, to improve the value of these projects value engineering can be applied for various aspects: 1- it can be used for reduction of unnecessary cost on existing project. 2- It can help in determining the possible alternatives which is best for the project. 3- The schedule of the project which was delayed due to uncertain situations can be improved. 4- Whenever there is threat for risk in project Value engineering can help in reducing risk. 5- It is imparted for better quality, reliability and satisfaction of all the needs of customer. 6- The performance of organization can also be improved to a better extent. The value engineering concept allows for a clear segmentation of opportunities into two categories: cost saving versus functionality enhancement, and therefore provides a structured framework for opportunity identification. Thus, "VE in this scenario is an organized application of both technical knowledge and common sense that aims at finding and eliminating unnecessary costs while providing the best overall value to the project owners" **[1]**.

RESEARCH OBJECTIVES AND METHODOLOGY:

Research Objectives

1- Identifying the concept and patterns of the state's partnership with the private sector in medium and long-term projects, 2- Study the principles and mechanisms of value engineering on the phases of the project, 3- applying value engineering on (PPP) infrastructure projects.

Research Methodology

There will be identification to the concept of (PPP) infrastructure projects' goals and objectives, and studying (PPP) phases within (PPP) definition, using the inductive method. Then explaining value engineering definition, benefits and implementation different steps of (VE) practice, using the analytical method. Finally, Applying value engineering on (PPP) infrastructure projects, using the conductive method.

INFRASTRUCTURE PROJECTS:

Infrastructure projects are one of the pillars of achieving sustainable socio-economic and environmental development and a key indicator to the progress of countries. According to

World Bank figures in 2015, the investment in infrastructure projects in the next five years till 2020 will reach 9 trillion dollars worldwide. The Middle East accounts for 9.2%, or about 830 billion dollars **[2]**.

Infrastructure Projects Financing:

Infrastructure Projects Financing have a special nature in terms of their size; complexity and high investment cost, therefore funding this type of projects require a huge amount of money. Sources of funding these projects are: A- Direct governmental finance, B- Governmental funding by loans from local and international sources, C- Funding from taxes, D- financing through tariff from the service, E- Funding by the private sector (PPP) **[3]**.

PUBLIC PRIVATE PARTNERSHIP (PPPS):

Public –Private Partnership (PPP) is one of the mechanisms which can be used to face the financial challenge for the infrastructure projects. PPP is "as a legally binding contract between a public sector entity and a private company-typically referred to as a concessionaire - where the partners agree to share some portion of the risks and rewards inherent in an infrastructure project" **[4]**. Infrastructure projects are considered an effective partnership between the state and the private sector in medium and long-term projects through the implementation of the BOT system with various applications.

2. The BOT concept **[5]**: UNCITRAL define the BOT system as, contractual arrangement between a public-sector agency and a private sector concerns whereby resources and risks are shared for the delivery of a public service or development of public infrastructure. Several public private partnership models are shown in **(Table 1)**.

Advantages of Partnership Systems:

The advantages of partnership systems can be defined as: A- Addressing the lack of government funding, B- Sharing project risks with the private sector, C- Increasing the efficiency of operation and maintenance, D- Stimulate and develop the financial markets through offering the company's shares on the stock exchange, E- Increase job opportunities, F- Technology transfer, G- The ownership of the assets remains in the hands of the government, H- Reducing administrative and financial corruption **[6]**.

(PPPS) Common Characteristics:

PPP projects have the following common characteristics **[8]**: 1- a private partner provides the design, construction, financing and operation of the infrastructure, in return for payments either from the users of the infrastructure or from the public client itself; 2- public and private partners share risks and jointly manage them through better utilization of resources and improved project control; and 3- PPP projects are usually based on a long-term contract to encourage innovations and low life cycle costs.

Table.1: Public-Private Partnership Models

Model	Description of Model
BOT	Build, Operate and Transfer
BOT	Build, Own and Transfer
BOO	Build, Own and Operate
BOOT	Build, Own, Operate and Transfer
BLT	Build, Lease and Transfer
BRT	Build, Rent and Transfer
BT	Build and Transfer
BTO	Build, Transfer and Operate
BOR	Build, Operate and Renewal of concession
DBO	Design, Build, Operate
DBOM	Design, Build, Operate and Maintain
DBMF	Design, Build, Manage and Finance
DBFO/M	Design, Build, Finance and Operate/Maintain
MOT	Modernize, Own or Operate and Transfer
ROO	Rehabilitate, Own and Operate
ROT	Rehabilitate, Own and Transfer
O&M	Operate and Maintain

Source: Summarized from **[7]**

VALUE ENGINEERING (VE)

VE is a systematic approach for analyzing the functional requirements of products or services to obtain the essential functions at the lowest total cost **[9]**. The VE techniques have been able to make significant changes in the integrative management of complex and large projects as an effective instrument **[10]**. In fact; it aims to reduce overall project costs through identifying and eliminating unnecessary costs. In addition, the successful implementation of a VE practice can result in update of standards and policies, and quality improvement of products **[11]**. The appropriate use of the value engineering methodology can save companies significant amounts of money, whilst also allowing for opportunities to increase revenue and/or reduce risk. Value engineering provides a highly viable and effective method for optimizing major capital projects and respond to the ever increasing pressure of driving substantial value benefits and delivering maximum efficiency **[12]**.

Benefits of Value Engineering:

Value engineering differs from standard cost reduction methodologies in a number of ways, which allows this approach to generate far bigger benefits as shown in (**Figure. 1**) due to it : 1- improve project quality, 2- insure efficient investments by mitigating the risks, 3- increase the revenue by eliminating unnecessary and costly elements.

Value Engineering across the Organization:

Three steps are required to roll out and internalize value engineering across the organization (see **Figure 2** below). The first step is to implement the results of the value engineering initiative along the implementation plan, prioritizing more urgent capital projects in the case of numerous similar projects. Following this pilot, the second step is to review how the client's current strategy, processes and organization structure and capabilities foster/hinder value engineering through undertaking gap analysis against best practice.

Fit for purpose solutions to leverage and internalize value engineering are developed from this analysis as a third step. It is crucial for governance mechanisms, roles and responsibilities to be clearly defined. A project management office could be set up in the interim to ensure successful roll-out. Corporate communication plans should be drafted and training programs for selected staff to develop in-house capabilities rolled out.

5.3 Factors Influencing Value Engineering:

There are various factors which has a great influence on the Value engineering study: 1- Customer requirements (determine actual need): to provide satisfactory performance to the customer as they are the prime importance of any business, It is necessary to keep the must needs of the product and the want needs can be taken into consideration depending on the cost and utility**[14]**, 2- Quality of product (output)/ services: It is always used to study in detail the benefit and problems associated with the alternative material. Selecting the most appropriate material along with keeping

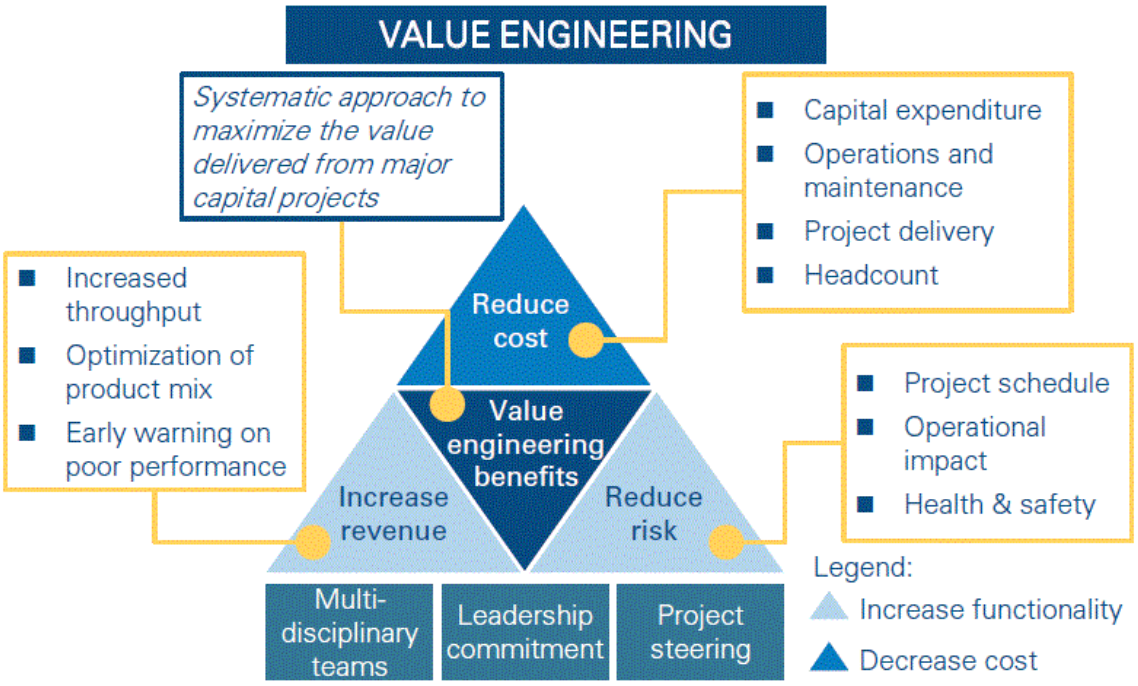

Figure 1: Benefits of Value Engineering

Source: Summarized from **[13]**

Figure 2: Value Engineering across the Organization

Source: Summarized from **[13]**

up the quality of the product/service is important**[15]** ,3- Cost of resources (material and labor): due to The cost of material is the major 50% cost of total cost of the product ,also, improving the productivity and improving overall efficiency for labour**[16]**, 4- Systematic process approach: It needs to be taken care that all the processes need to be crucially studied and identify the problems so that better function ability is achieved, 5- Continuous improvement: Continuous monitoring on periodic basis is required so that it can be analyzed where there are problems mitigation of the same can be done at earliest to ensure cost saving in the unnecessary cost**[17]**.

The steps of implementation (VE) technique:

The aim of VE is to increase the value of the project based on following equation **[18]**: value = performance / cost

To obtain the efficient results in implementation of the VE methodology, a cohesion plan including the specified steps (**Figure 3**) must be conducted as follows **[19]**:

1- Information phase: in this phase, the VE team realizes the project objectives, technical specifications, plans, and constraints of the original design, the design of the consultant before applying the VE approach.

2- Function phase: In order to identify and eliminate unnecessary cost areas, the project functions must be identified. The functions are the expected results from the construction of a project/product. In VE, functions are divided into two groups **[20]**: A- basic functions and B- secondary functions. The performance features that must be performed are named basic functions. Secondary functions answer the question, 'What else does it do?" Indeed, the basic functions are the project's aims and the secondary ones cause to increase the project value. In order to realize the relationship among all functions, they are displayed in a FAST diagram.

3- Speculation phase: explore effective alternative designs required to answer the identified functions through the brain storming session. This session involves the free flow of the ideas and the VE members are permitted to mention each idea even the most ridiculous one. (Brainstorming session, Criticism is not allowed).

4- Analysis phase: reduce the speculation list by evaluating each idea.

5- Development phase: analysis become proposals, alternative designs are made.

6- Decision phase: presentation made to those who have interested.

APPLICATION OF (VE) IN (PPPS) PROJECTS:

As PPP infrastructure projects involve a large amount of stages starting from the initiation to transfer stage as shown in (**Figure 4**) below, and due to the cost of these projects can be extremely high cost, (VE) approach is necessary to reduce the overall cost without wasting production or service quality.

So (VE) from point of view (PPP_S) projects can be defined as a systematic process of review and analysis of a project, during the project phases, by a multidiscipline team of persons not involved in the project, that is conducted to provide recommendations for: 1-providing the needed functions safely, reliably, efficiently, and at the lowest overall cost, 2-Improving the value and quality of the project, and 3-reducing the time to complete the project**[22]**, and therefore, achieving public – private win-win solution which mean it allows the private partner to make adequate returns to its capital investments and on the other hand it allows the public partner to achieve social objectives, productive and a locative efficiency, and to maintain appropriate quality, environmental, and health standards**[23]**.

Thus, The chosen (Project Company) must focus on 1-performance improvement, 2- customer satisfaction, 3-reducing the cost and increasing the efficiency, by acquiring the newest techniques and methods which can solve the problems, decrease costs and improve function and quality.

The best time for doing the VE practice:

The probable cost savings differ in various phases of a project **[24]**. While the VE method can be used in each phase of a project, the highest benefits are obtained when it is used in conceptual and design phases **[19]**. (**Figure 5**) shows the potential of cost reduction during the project life cycle. As it can be observed, the earlier VE can enhance chances of better cost reduction. Therefore, the VE technique is more effective when it is conducted at an appropriate time. In this regard, reviewing various experiences related to VE workshops for construction projects indicates that evaluating different alternative solutions in the design stage results in considerable cost savings **[25]**.

(VE) Applications in (PPPS) According to its Models:

Indeed, the government, in the public – private partnership projects normally prepares the feasibility study, the initial design and the tender documents by a professional consultants (technically, financially and legally) appointed by the government. The project is then announced and submitted to the private sector institutions, whether local or international, to choose the project company that will execute, maintain, operate, then transfer the project to the government at the end of the concession period, which is known as the traditional partnership system (BOT).

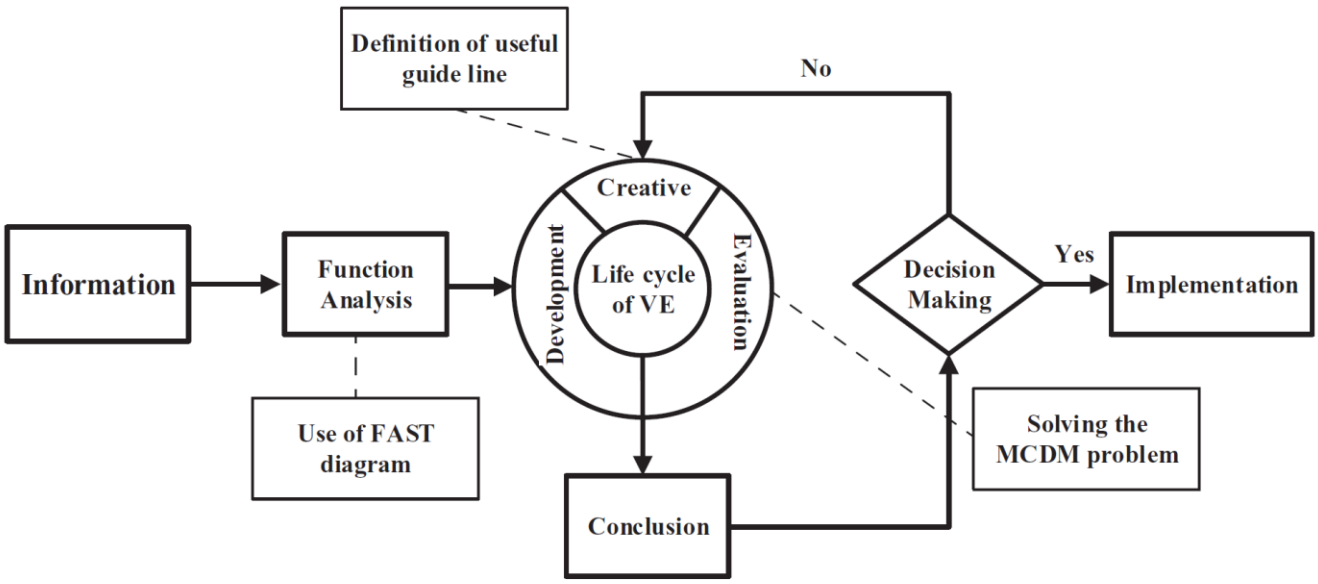

Figure 3: Different steps of VE practice

Source: **[21]**

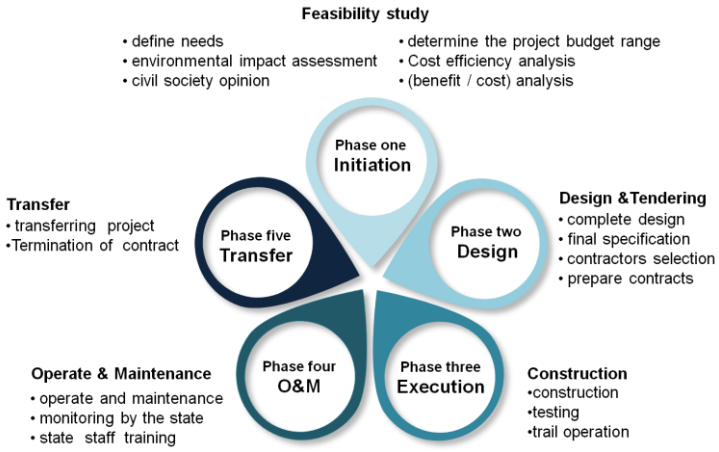

Figure 4: PPP Infrastructure Projects life cycle

Source: by Author

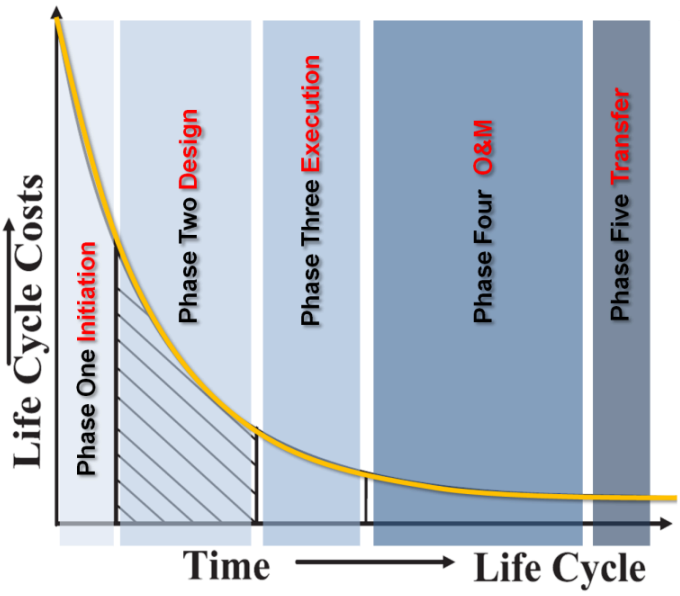

Figure 5: Influence of VE Practice on Costs

Source: by Author& **[21]**

According to Table.1 (Public-Private Partnership Models) and Figure .4 (PPP Infrastructure Projects life cycle) which illustrate that, there are many models for concession; the private sector has the responsibility of preparing design process, for instance (DBO, DBOM, DBMF), therefore, (VE) process will be applied by the private sector starting from design phase which will achieve a great benefits as :

- Increase the competitiveness and reduce corruption.
- Activate Science, Technology, and Innovation (STI) approach.
- Decrease the overall cost and increasing the efficiency.
- Preventing monopoly.
- Using the suitable technology in accordance with social and economic conditions for the community and the conditions of the site.

Whatever, the model of the concession, the (VE) process can be divided according to (PPP) Infrastructure Projects life cycle as:

1- Initiation phase: The State (public sector) prepares the economic, social and environmental feasibility study for the project by its consultants and to apply VE on this stage as shown in (**Table 2**), these steps must be done as; determine the actual needs of the target group of the project, Study the available resources in project site to be used, determine how the project will effect and affect in the surrounding areas

whether positive or negative, identify the expected risks of the project and study the mechanism to prevent or mitigate them, determine the accepted quality level (AQL) for the project and expect the completion time for the construction then starting operation.

2- Design phase: design phase is considered the best practice for (VE), either the state (public sector) or private sector prepare the project's design and specification according to PPP model as shown in (**Table 3**), these steps must be done as; explore effective alternative designs, prepare specifications for each design, link the specifications with the available resources in the suggested site and explore cost, time, quality for each deign.

3- Execution phase: this phase is done by the private sector through the (project company), actually the (VE) processes is not finished, and therefore, to ensure the successful implementation of the proposed design and to continue the application of value engineering, the project manager must:

- Monitor material and equipment cost.
- Minimize the project defects to achieve (AQL).
- Improve productivity for labors by providing **[28]**: Leadership: team leader, Team Formation: team must truly cross functional problems, and reduce organization changes.
- Improve communication between stakeholders.
- Assess the risks and mitigate them according to the risk plan.
- Transfer the function problems immediately for (VE) team to evaluate and solve them.

4- O&M phase: this phase start after the completion date for construction, operation and maintenance is consider the critical and the longest phase in (PPP) projects, consequently application of (VE) in this phase is too important, because it ensures the success and safe transfer for the project to the government (public sector), the Project Company and (VE) team must concentrate on:

- Customer satisfaction for the product/service.
- Improve the performance of the operation (performance/cost).
- Improve the operation and maintenance technology
- Follow the maintenance schedule for equipment according to the manufacturing instruction.
- Achieve safety procedures.
- Assess the risks and mitigate it according to the risk plan.
- Training the government team.

5- Transfer phase: this phase is the last phase in (PPP) projects, and if (VE) applied in correct way through the different project phases, that will eliminate unnecessary costs, thus, achieve public–private (win-win) solution.

Table 2: VE for initiation phase

Responsible Authority	**Steps**	**(VE) process**	
The State (public sector)	1- Determine actual need 2- Available resources 3- Excepted project risks 4- (AQL) for the project 5-Starting operation time 6- prepare initial design	**Information phase**	**Organization process**
			1- Prioritize projects
			2- Agree (VE) program
			3- Assign multidiscipline team
			Project process [26,27]
			1- What is it? (basic function)
			2- What does it do? (secondary function)
			3- How much value is it? (function cost)

Source: by Author

Table 3: (VE) for design phase

Responsible Authority	Steps	(VE) process	
The State (public sector) Or Private sector	1- determine constrains 2- alternative designs 3- cost for each design 4- time for each design 5- performance for each design	**Organization process**	
		Function phase	1- Review strategic, process
			2- Brain storming session
			3- Identify gaps
			4- Develop solutions address
			Project process [26, 27]
			1- What other cases can do it?(related to design product/service)
			2- How much does it cost? (related to design product/service)
		Speculation, analysis, Development And Decision phase	**Project process [26, 27]**
			1- Carry out VE in critical elements which will not effect in overall quality and safety
			2- Combination of the elements which can have the maximum cost reduction
			3- Compare the selected results with quality of the project
			4- presentation made to choose the final design

Source: by Author

CONCLUSION:

(VE) is too important in infrastructure (PPP) projects to achieve better services at reasonable cost by eliminating unnecessary costs in the different projects phases, (VE) is not only decreasing the overall cost of the project but also improving the value, quality of the project, and reducing the time to complete the project. Determine the actual need of the target group of the project is the success key for implementation of (VE) because that identifies the basic function of the project. Application of (VE) in O&M phase is too important, because it ensures the success and safe transfer for the project to the government (public sector). Finally (VE) can achieve public–private (win-win) solution.

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