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The Role of Value Engineering in Government Housing Projects in Developing Countries to Improve Value

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Abstract

Government housing projects are among the complex issues facing developing countries' governments. There have been many attempts to solve problems related to this issue and a lot of effort has been made in this direction. The main problem is lowering the cost of lodging, without sacrificing its quality and the effectiveness by which it fulfills the needs of its occupants. This became possible upon the use of the value engineering technique. Value engineering is an effective tool used to solve problems related to housing, by lowering cost on one hand and sustaining or even ameliorating quality and performance.

The purpose of this study is to try to identify a series of proposed solutions and value indicators and to describe their role in improving value in government housing projects. This process may assist the designer in choosing and managing, value indicators during the creative phase, using references from the literature and the analysis of case studies.

The literature review identified the reasons for high costs and poor performance, which are often a result of misunderstanding of the fundamental principles of design criteria and value indicators, followed in government housing projects. The review also pinpointed the most important considerations that improve value.

Results obtained in this study feature the positive effects of methods under the umbrella of value engineering, applied in government housing projects. It was found that savings of 15% to 40% can be achieved in the total cost of a certain project, using this technique. Generating ideas in the creative phase is one of the most important stages in value engineering studies. A set of value indicators and proposed solutions in the form of a checklist were derived and can be used in the future, during the creative phase of value engineering studies in the initial design stage of government housing projects.

Keywords

Value Engineering; Government Housing; Value; Cost ;

1. Introduction

The value engineering (VE) theory and its application are currently among the most popular and rapidly spreading methods, in most developing and less developed countries around the globe. This has taken place as designers and

other players in the construction field are currently under pressure to find methods to fulfill their customers' expectations in terms of quality and function, while maintaining costs under tight control. Strategies related to VE have been able to produce this effect, obtaining value for money (Othman et al., 2020).

Project managers and contractors face a lot of problems while managing their projects. These problems include, but are not limited to, issues related to materials used, such as poor quality, high cost, waste, and loss. Other problems include poor planning, management, control, and communication; as well as over-budgeting, delayed deliveries, unexpected changes in weather, and shortages in various fields, including labor (Ravish et al., 2016). These problems lead to conflicts within the project and can cause delays in its timeline, as well as increased cost. As a result, there is a great need to find methods to reduce and control costs, so as to achieve effective control in such projects. Contractors can suffer greatly from cost reduction; however, current cost reduction techniques can lead to lesser costs without losses to contractors, during the performance of their various duties. VE has not been fully integrated into the processes of the Government Housing Projects in developing countries Value engineering (VE) has achieved prominence in projects in the housing field. Since construction can bear some negative impact, along with its positive ones, on both the environment, as well as the people it serves, VE has a role in achieving the latter by improving the quality of housing projects, along with their durability, reliability, and work performance (Zimmerman, 1982).

The purpose of this study is to identify a series of value indicators and suggested solutions that may assist the VE team in choosing proposed solutions and managing value indicators during the development phase.

The paper makes use of literature review dealing with the subject of the application of VE, a method with specific steps and stages, which serves the purpose of improving value. It explores value standards for government housing projects, analysis of examples, and VE reports to understand the pattern of proposed ideas in government housing projects, major value criteria, and suggestions of value engineering and classifies them. Figure 1 explains the method applied in this paper.

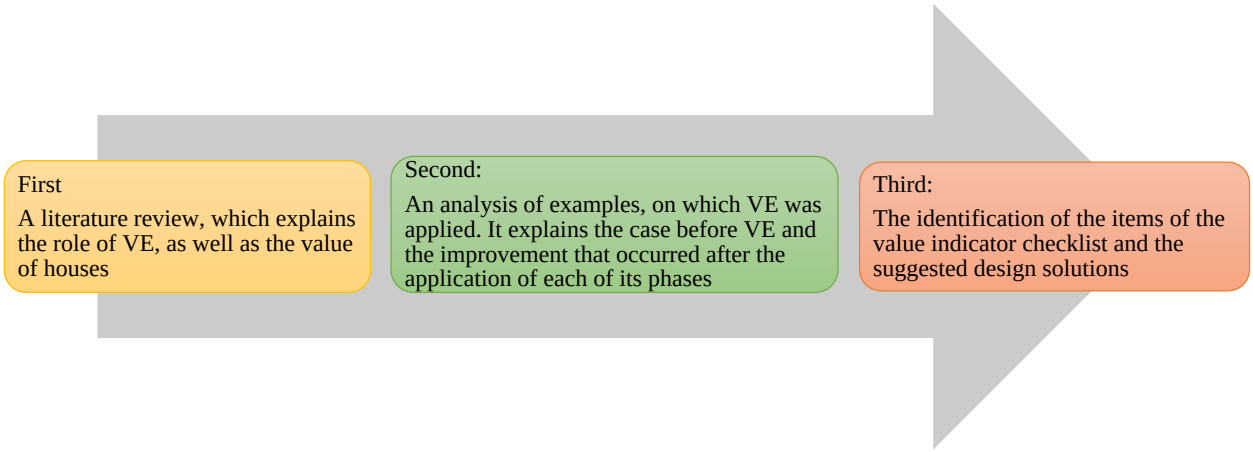

Figure 1. The structure of the paper and the methodology applied. Source: Authors.

2. Literature review

Several studies dealing with projects that applied value engineering were discussed. Value engineering is a robust approach, which uses continuous improvement to ameliorate performance within a project, through the application of a systematic analysis of its various aspects. As for value, it is defined as the ratio between function and cost. (Tom and Gowrisankar, 2015). To achieve this purpose, VE analyzes function and applies creativity along with teamwork (Sharma and Belokar, 2012). Value engineering is a creative step-by-step approach that attempts to raise the value of a certain system. The most important step of this process is idea generation. Members of a value engineering team depend on their knowledge and expertise for idea generation. They also employ them to evaluate the different scenarios obtained from ideas generated to replace original ideas (Moon et al., 2012). To improve value, VE works on reducing costs and enhancing quality by working on features within the design of residential buildings, for increased customer satisfaction. The availability of information facilitates idea generation (Ravish and Vinoth, 2016). Among the principles of the value methodology, the generation of ideas and the evaluation of a selection of construction systems come first to achieve low-cost and good-quality housing in the extended Egyptian urban

landscape (Agrama et al., 2014). The literature review indicates that generating ideas in the creative phase is one of the most important phase in value engineering studies, so it is necessary to find a checklist that classifies value indicators and proposed solutions.

2.1. Value in project manzagement

In his research, (Al-Yousefi, 2007) defined value as a relation between cost and function or performance. According to (Hiley and Gopsill, 2000), when these items are added together and are optimized, the greatest value is achieved, i.e., function and quality are raised to the highest point, while cost is reduced to the lowest point. Value identifies users' desires, needs, and requirements, along with the project's goals, functions, and objectives and focuses on achieving effectiveness, by using the stated definitions of each of the previously mentioned factors. Following this step, the quality characteristics that make the project appealing are identified. In conclusion, value proposals are generated. They would usually achieve the requirements at minimum cost (over the life cycle of the product). Figure 2 identifies the meaning of value, in terms of achieving a balance between cost, function, and quality.

Value = Function or performance/cost or price (Hiley and Gopsill, 2000).

Figure 2: The three main issues of value. Source: (Al-Yousefi, 2007).

Function is the feature in a product/service that serves the purpose for which it was created (i.e., meeting the needs and wants of users). In studies on VE, function is expressed by two words. The first is a verb indicating the activity or movements and the second is a noun that is measurable, to enable estimating the product/service's cost and comparing it with other substitutes. The purpose of this analysis is to find substitutes to achieve the same function. Value studies depend on job analysis, so as to reduce cost and ameliorate value (Walk, 2012). In general, there are two types of functions:

- Basic function is determined from the point of view of the userwhere the user is a member of the value engineering team. It represents the main reason for an item to exist.
- Secondary function does not help in achieving the basic function, but only supports it; in the sense that it helps in marketing it (Younker, 2003).

Cost represents the amount of money that a buyer pays to own a product or to have a service performed. It is divided into three constituents:

1. Direct cost of materials
2. Direct cost of labor
3. Overhead cost

For the purpose of this study, cost is applied to describe the design value, meaning the amount of money paid for the function to be achieved, as per the design. Costs expressed are those related to maintenance, spaces, and their construction (El Sadawi, 2008).

Quality is known as the achievement of the desired level of performance or function, through the properties and possibilities offered by the product or service efficiently throughout its life span. This takes place if the product/service is used for the purposes, it was created for and according to operation principles (Alfraidi and Ibrahim, 2018).

2.2. VE methodology

As per SAVE International, there are six successive phases in a VE study. They are divided over three workshop stages: before the workshop, the workshop itself, and after the workshop. Figure 3 shows the methodology followed by SAVE international, with its phases and stages (Rachwan et al., 2016).

This study investigates stage 2, the workshop stage, representing the technical part, along with its phases. The phases constituting this stage include the following:

- Information
- Function analysis
- Creativity
- Evaluation
- Development
- Presentation

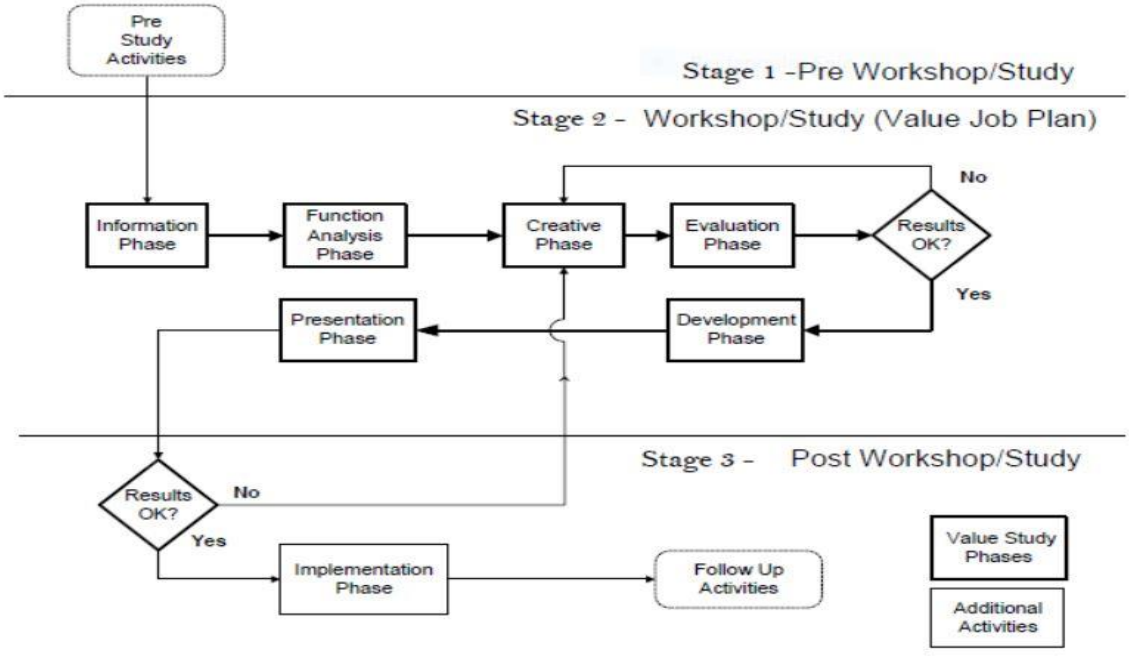

Figure 3: VE methodology. Source: (Rachwan et al., 2016).

The Information phase is the information gathering phase, where data is collected regarding the background of the project, its requirements, and its constraints, as well as the suggested design and its estimated cost. Also, during this phase, a functional analysis is performed for the purpose of identifying the parts of the project that could be high in cost. The design team has an important role during this phase, it gives out more information related to the chosen design and is present during the first meeting of the VE team (Sharma and Belokar, 2012).

In function analysis phase, the VE team provides a definition for each of the project's functions. This takes place using the previously described method, i.e., providing a two-word explanation, the first word being a verb and the second being a noun that can be measured. For each function, whether primary or secondary, and that by using

Function Analysis System Technique (FAST diagram) it is graph used to organize the relationship and specify the correlation among the different functions that have been defined by a sentence beginning with a verb composing of two words. By techniques, relationships among functions are arranged under logical relationships and being placed in particular order depending on importance of each. The relationship between its cost and its value is identified (Tang and Bittner, 2014).

During the creative phase, the VE team uses its skills of creativity to find the different methods that can be used to achieve the different functions of the project. The creative phase aims to look at functions and possible areas of high cost or low value and attempts to generate alternative solutions and methods for the project to be able to achieve these function(s). A brainstorming session is held by the value team, using the information supplied and generated from their initial studies and thoughts (SAVE, 2007).

In evaluation phase, the VE team conducts a specific type of evaluation to identify the ideas that can achieve improvement in value, while performing the required function(s), using available resources and following the requirements related to performance (Dell'Isola, 1997).

The development phase is the proposal making phase, where documentation supporting the various alternatives is thoroughly prepared, so as to allow decision-makers to choose the optimum ones for implementation. This phase seeks to perform additional analyses, in order to choose the alternative with more added value from the previous phase (Clifford, 2013).

The objective of the presentation phase is to present to decision-makers, managers, and stakeholders, the proposed value suggestions. This information is delivered through a presentation and a report with explanation about the various alternatives and the opportunities that each one presents (SAVE, 2007).

2.3. Government housing projects

The population increase is the biggest challenge faced by developing countries. One of the major issues related to this increase is housing. Thus, a lot of effort is made to solve the problem related to the construction and management of housing projects. Further, the major changes in the construction market and innovation in building methods have a strong effect on the execution of such projects (Marzouk et al., 2010). Construction systems influence the way these projects are managed, a process that requires their characteristics to be thoroughly identified (Agrama et al., 2014).

Various methodologies are available in the field of housing to assess value, however, the main issue in this context is determining the definition of value. Different meanings are available to explain the value of a house, they are all applicable at the same time and can be summarized as follows (De Jonge, 2005):

The value of a house:

- Relates to its total building costs.
- Varies as a result of a mix between maintenance and diminishing performance.
- Relates to where it is located and depends on status and quality that makes it socially acceptable, in a trade-off between the former and the two latter factors.

3. Analysis of the application of VE on government housing project examples

The coming part of this research is considered the second step towards fulfilling its aim. In this section, the authors were able to analyze two selected housing projects for which value engineering has already been applied, as well as the impact of applying VE on improving their value and to identify their value indicators. Table 1 summarizes the basic information of the two selected projects, including project names, basic data, and selection criteria.

In the information phase, it is important to understand the background and decisions that influenced the development of the design. The VE team leader prepared a cost model from the assessed costs provided by the project's team (Rachwan et al., 2016).

Table 1. Summary of the projects' basic information. Source: Updated from (Jeyakumar, 2013 & Bashir, 2015).

	Example (A)	Example (B)
Name of project	Ruwais Housing Complex Expansion – Phase III	Merowi Dam housing Project - housing type (A
Basic data	**Location:** Abu Dhabi, United Arab Emirates **Owner:** Emirati Ministry of Housing **Type of building:** - Type F4 (7 buildings) - Type F5 (10 buildings) For a total of 17 six-level buildings **Total built-up area:** 80,700 m^2 **Cost of the project:** 427.76 million UAE Dirhams **Project duration**: 24 months	**Location:** Merowi, Sudan **Owner**: Sudanese Ministry of Housing **Type of building**: - Housing type A (10 buildings) - For a total of 10 three-level buildings **Total built-up area:** 40,100 m^2 **Cost of the project:** 407,235,080 Sudanese Dinars
Criteria used for choosing the project	High construction cost (estimated) and high value indicator	High construction cost and requirements to satisfy clients' expectations
VE team	- Certified Value Specialist (CVS) - Architect - Civil engineers - End user	- Certified Value Specialist (CVS) - Three civil engineers - Two architects - Owner

In the analyzed example projects, the VE team produced a generic study of the project's elements as a whole and their cost ratio to that of the entire project. This stage also included further refinement of the cost, space, and other models, prepared before the workshop session. These models were updated based on information received from the owner/designer.

Function analysis is the single most distinguishable feature of VE, as it creates a specific view of the project. This analysis aids in garnering different ideas for the project, which eventually leads to a list of recommendations that provide improvement in quality and/or less cost (Al-Yousefi, 2007).

The architectural and structural systems were among the examples studied in the functional analysis by FAST diagram of the two previously described sample projects. Each of these projects' items and their costs were analysed. This analysis was conducted to choose the items that have the most effectiveness, in terms of cost on the totality of the project. Figure 4 shows the cost model for example (A). Example (A)'s architecture system had a significantly high percentage of cost than the project's other systems. This has been a guiding point for the VE team. As for example (B), its structural system had the highest cost effectiveness as shown in figure 5. The FAST diagram, which was prepared by the value engineering team leader just prior to the value engineering workshop, was used as a baseline for both examples for guidance and to answer why these functions are important to the owner.

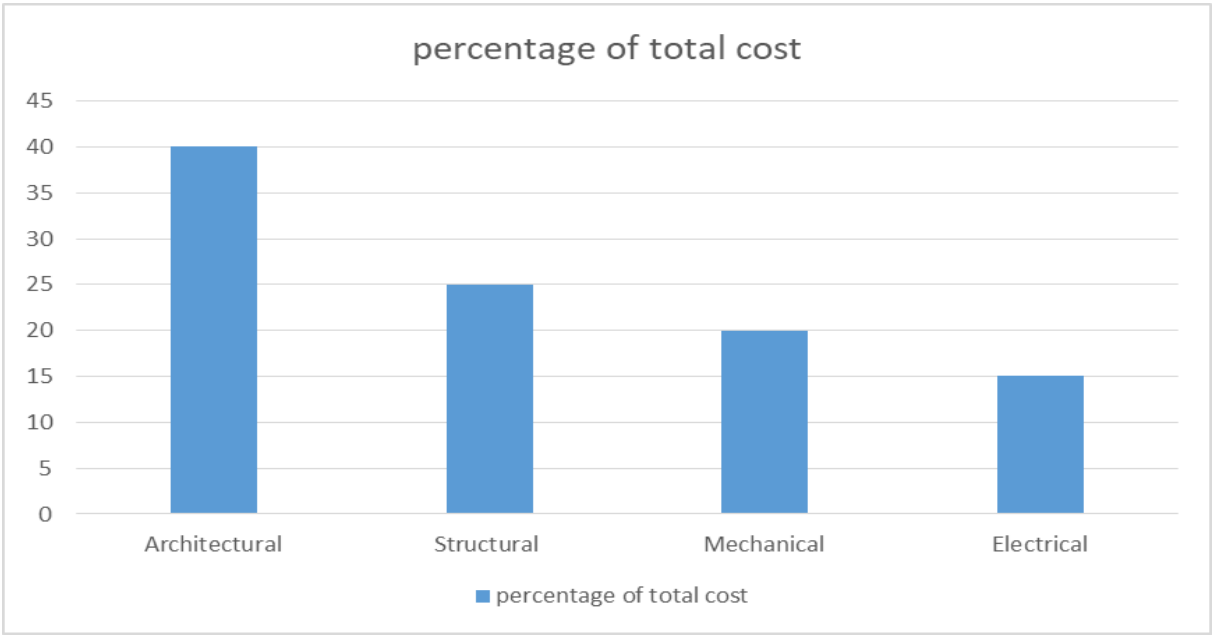

Figure 4. Cost model for example (A). Source :(Jeyakumar, 2013)

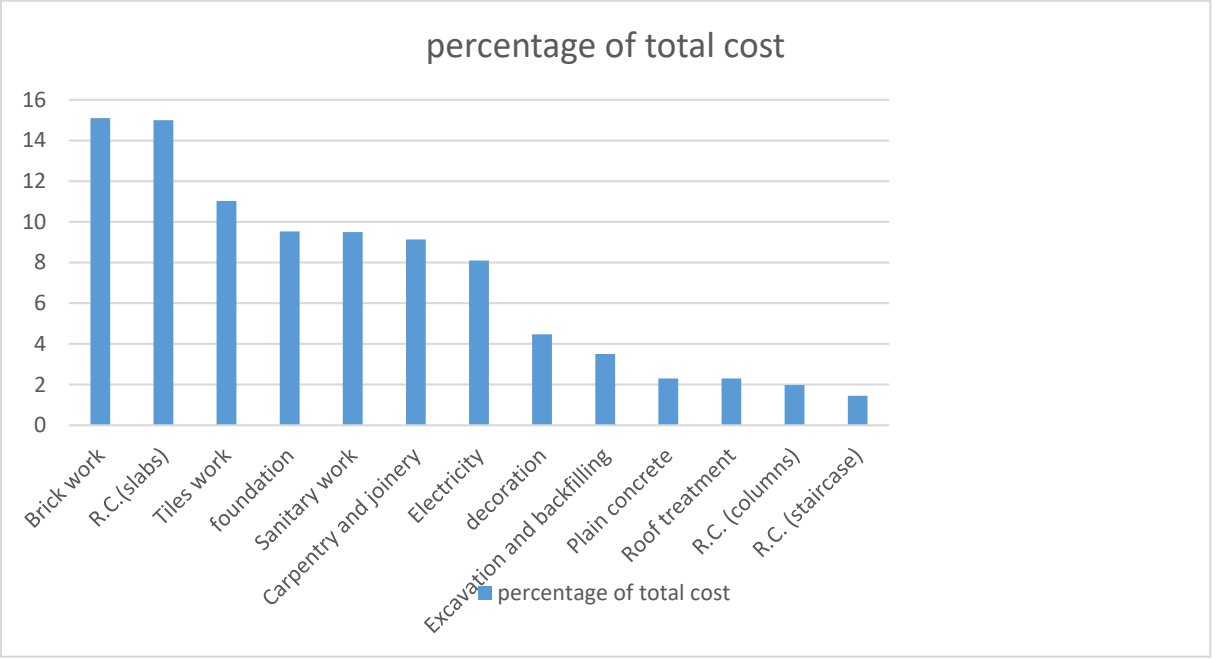

Figure 5. Cost model for example (B). Source: (Bashir, 2015).

The creative phase involves producing creative ideas to achieve the same basic functions at the lower level costs or to achieve the necessary improvements and feeding them to the evaluation phase for evaluation by the team, clients and/or users who collaborate together to accomplish this task. Table 2 shows the most important proposals and final ideas resulting from the value study in Projects A and B. In these two examples, a group of ideas were proposed, evaluated, analyzed, and divided into value indicators. The main techniques for the creative and evaluation phases were applied to both projects, however, the results were different as each has its unique characteristics.

During the development phase, each idea resulting from the VE study was developed, so as to yield a working solution. These solutions were presented in the form of written proposals, such that the owner(s) and stakeholders can understand each one and its benefits. Supporting material for each proposal should involve diagrams, calculations, sketches, cost comparisons, and text that includes the purpose of the proposal.

Table 2. Summary of proposal ideas after applying the creativity and evaluation phases on the two examples. Source: Authors as per the information in Jeyakumar, 2013 & Bashir, 2015.

Value indicators	Example (A)	Example (B)
Cost	1- Eliminating foldable or sliding doors between dining and living rooms as needed and changing the function of their spaces 2- Changing the materials of some items from imported to local to save cost and time, while maintain the level of quality 3- Changing the finishing material of façades 4- Trying to reduce the excessiveness in the safety factor, leading to a decrease in the amount of concrete and steel 5- Selecting landscaping materials that are easy to maintain 6- Changing the pavements of internal roads to interlock pavements **7-** Handling balconies in a way that guarantees privacy within the residential unit (need for privacy)	1- Changing the finishing material of floors 2- Changing the supplier of some items from international (imported) to local to save cost and time, while maintaining quality 3- Changing the specifications of the material of the corridors between residential units 4- Changing the finishing material of the exterior, while preserving its quality 5- Changing the method of implementation 6- Changing the method of finishing ceilings
Quality	1- Optimizing landscaping 2- Optimizing the number of children's playgrounds 3- Optimizing the number of service blocks 4- Modifying the shape and material of the main doors from solid to veneered and fire-rated. 5- Revisiting the external light of buildings	1- Studying the relationship between buildings, in terms of height, spacing, and orientation to provide more shade
Function	1- Optimizing or minimizing shaded areas 2- Re-arranging walkways	

3.1. Results of the analysis of the examples

The analysis described above of the application of the VE study on the two specified projects has proven that this process leads to an increase in value. In the first example, the analysis showed that applying VE has the potential of decreasing the initial costs of the project by 30.44 million UAE Dirhams, a cost saving of 7%, while savings in life cycle costs can reach 4.79 million UAE Dirhams, a cost saving of 1% (Jeyakumar, 2013). These results can be seen in Table 3. Regarding the other example, it was found that applying the ideas of the proposals can achieve improvements in the quality of elements, they were suggested to replace and reduce cost by about 18.76%, leading to savings of 76,407,000 SD (Bashir, 2015), distributed as seen in Table 4. Through the results and the suggested ideas from the analysis of the examples, a checklist was made for the development of the creative phase. This checklist is divided into indicators of value and the proposed criteria for each indicator, which can be seen in Table 5.

Table 3. Summary of the outcome of VE on example (A). Source: Jayakumar, 2013.

Description	Result	Percentage of cost saving
Total number of ideas	150	-
Potential initial cost saving – UAE Dirhams	30,441,970.00 UAE Dirhams	7%

Table 3 Continued

Life cycle costing – UAE Dirhams	4,793,694.00 UAE Dirhams	1%
Total initial and life cycle cost savings – UAE Dirhams	35,235,664.00 UAE Dirhams	8%

Table 4. Summary of the outcome of VE on example (B). Source: Bashir, 2015.

Item	Proposal	Cost in SD	Percentage of cost saving
1	Change Aluminum doors and windows to Steel doors and windows	23,303,000 S.D.	5.72%.
2	Change the Ceramic tiles to Cast in-situ terrazzo tiles	10,725,000 S.D.	2.63%.
3	Use Walls with Tri-Di panels in their finishing	42,379,000 S.D.	10.41%
Total Value Engineering Potential Savings			18.76%

Table 5. Checklist of value indicators and suggested design solutions. Source: Authors.

Value indicator	Criteria for the proposed solutions	Reason for choosing the proposed solutions
Cost	1- Canceling an item (unnecessary costs)	Cost saving
	2- Design modification	Cost saving
	3- Change in specifications	Reducing the cost of raw materials
	4- Change in the method of implementation	Reduced implementation cost
	5- Energy conservation	Cost saving
	6- Maintenance/operation	Reducing the cost of use (maintenance/operation.)
Quality	1- Environmental considerations and sustainability criteria	Improving quality
	2- Application of user's needs	The desire of the owner or user
	3- Application of security and safety standards	Improving quality
Function	1- Design modification	Increase in Performance
	2- Adding an item	
	3- Change in the location of an item	

4. Conclusion

Value engineering is considered a robust methodology for improving the value of government housing projects. It works on ameliorating the quality of a project, reducing its cost, and improving its different design features, for the benefit of clients. This takes place through the generation of creative ideas that reduce cost, while maintaining quality and functionality. This research aimed to provide a checklist for the creative phase. This list contains value indicators

and suggested solutions for the creative phase, enabling the adoption of VE in developing countries, to increase the use of the method within government housing projects. It was obvious from the projects given as an example for the application of VE and the analysis performed that idea generation is the most important part of the VE job plan. The savings achieved were the result of the proposed solutions presented by the VE team in both projects. They were presented in Table 5, which was divided into value indicators (cost, quality, and function) and the criteria for the proposed solutions in each item. The results achieved the aim of this study and suggested methods to increase the use of VE in government housing projects, to achieve better value. This list is a reference for the most important value indicators and ideas suggested by VE for government housing projects. This checklist can effectively encourage the adoption of VE in developing countries. It is the intention of this paper to provide more opportunity to promote the adoption of VE in government housing projects when these projects are carried out in a similar style and using similar methods, to achieve improved value.

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