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The Process of Value Engineering in Construction Projects in Nairobi, Kenya

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Abstract

Value Engineering is an exercise whose goal is to achieve value at the lowest cost possible. This paper reports on the findings of a study that established the process of executing value engineering in construction projects in Nairobi County. The study population comprised of Construction Project Managers, Architects, Quantity Surveyors and Engineers registered in Nairobi County. With a sample of 288 respondents. Data was collected through administration of questionnaires and structured and unstructured interviews. The findings established that there are features of Value Engineering incorporated in construction projects but a lot improvement in its execution is required. 60% of the respondents reported that VE is facilitated by Architects instead of Construction Project Managers who may be more objective, while 96% reported that VE is extended to construction stage contrary to the expert's recommendation. In 70% of the construction projects the tool adopted is cost cutting measure rather than to create value and in 75% of the construction projects the exercise lacks teamwork and is carried out in informally hence limiting it effectiveness. These weaknesses in the implementation of VE may be explained by the finding that 86% of the practitioners had learnt the features of VE through their work experience hence the recommendation of its introduction in academic curricula and training and sensitization through continuous professional developments workshops and seminars. This will enhance the achievement of VE's goal among Nairobi projects.

Keywords: Value engineering (VE), functions, value, quality and cost

INTRODUCTION

Construction industry plays an indispensable role in socio-economic development of both developed and developing countries. Study by Renz and Solas (2016) postulates that the industry globally generates USD10 trillion with an added value of USD 3.6 trillion and it is expected to grow to USD15 trillion by the year 2025. It accounts for about 6% of global Gross Domestic Product (GDP) and employs more than 100 million people worldwide. Further, the industry is often referred to as a 'horizontal industry with vertical linkages' due to its connection to many other sectors among them finance and manufacturing (Khan, 2008).

In Kenya, the construction industry has been identified as one of the enablers towards achievement of the vision 2030. Several projects towards the vision are ongoing while others are complete, among them: the Single-track Standard Gauge Railway (SGR) from Mombasa to Nairobi, the second Phase of SGR running 120 kilometres from Nairobi to Naivasha, expansion and modernization of the Outer Ring Road, Expansion of Ngong Road, Construction of Kenya Western Bypass, Dongo Kundu bypass and Nuno-Modogashe Road (KRB, 2018). Three medium plans were devised to drive achievement of the vision, in the third medium plan, provision of affordable housing was made a priority and KES. 7.0 billion shillings set aside for its realization. The plan looks into provision of one million homes and in return contribute 14% to the GDP in the year 2022. One way of achieving Vision 2030 goals e.g. affordable housing, is through standardization of design elements without compromising their value. Value is the ratio of the benefits delivered to the cost used to realize the product; Value = (Function + Quality)/Cost (Dalla, 2006) hence "best value" is represented by an item or process that consistently performs the required basic function at the lowest cost.

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Value Engineering (VE) is a globally known and utilized concept. Its main objective is to minimize or rationalize cost while maintaining or improving the project value, quality and functionality (Tohidi, 2011). Other benefits include project risk reduction and eventual customer satisfaction (Haskins, 2010). Poor VE application, or lack of it, leads to poor communication in development of project scope, conflict amongst the project team members, omissions and additions during execution phase and incorrect assumptions based on poor information (Rane, 2016).

To achieve maximum benefits, VE has to be executed during the pre-construction stage, specifically design stage as compared to the project execution stage. This is because the design process critically influences activities in the subsequent phases and ultimately overall project performance. Kelly et al (2008) explains that the highest cost minimization is only possible at the planning and design phase of a project before the actual commitment of construction funds. Suhaimi (2014) explains that 10-30% saving can be realized when VE is applied before the construction phase. Achrya et al. (1995) postulates that a saving of 5-30% can be realized, while Dell Isola (1982) indicates a cost saving of 5-20%.

The major construction contract procurement system adopted in Kenya is the traditional system where the design and the construction stages are completely separate. Ong'ondo (2016) investigated the performance of pre-construction planning process in Kenya and established that the process is quite inadequate, the designs done are not sufficiently detailed and usually, they are fluid, leading to a lot of variations (omissions and addition of elements) at the construction stage. From the definition of Value Engineering, it is an exercise that close the gaps identified by Ong'ondo (2016). The objective of the study was hence to find out the process of Value Engineering applied in Construction projects in Nairobi, Kenya and in addition give recommendations on the gaps identified. This entailed finding out the practitioners involved in VE exercise, the project stage they implement it, the procedure adopted, as well as finding out how the practitioners leant about Value Engineering. Conventionally, for VE to be effective, it should be implemented at the design stage and all project teams should be involved.

THEORIES

Value Engineering Defined

SAVE (2012), The Federal Highway Administration (2012) and Mandelbaum and Reed (2006) all define Value Engineering as a structured use of well-known methods and techniques to establish and identify elemental functions of a product or service, determine their elemental worth, come up with alternatives to the functions at the lowest cost possible through creative thinking and ensuring that the end product achieves the reliability expected. It is critical to note that value engineering is not applied because designs have been poorly done, rather it refers to evaluation of the project concept design, specifications and the proposed construction methods with an aim of achieving the client's functional requirements at the lowest cost possible. Additionally, it is not a cost cutting procedure; cost cutting involves making trade off in the product scope without a keen consideration of value and quality preservation while VE is the process of eliminating unnecessary costs and replacing of functions while preserving the value, quality and meeting the anticipations of the clients (Fischer, 2009). This can be summarized as Value = (Function + Quality)/ Cost (Perera, Karunasena and Selvaduari, 2003).

VE has its roots in the manufacturing sector. During and after the World War II, there was a shortage of raw materials for production which led to some entities either closing down or consideration of alternative raw materials. General Electric Company resulted to identification of alternative raw materials which they later realized provided equivalent performance as the replaced ones. This led to a launch of an effort for improving product efficiency through systematic development of less costly alternatives in 1947 (Mandelbaum and Reed, 2006). This process was driven by Engineer Lawrence D. Miles. Miles (1989) described the process as a well-organized procedure, accustomed to achieving the functions that the client requires, at the lowest price possible. In 1957, The US Navy Bureau of ships sought the assistance of Lawrence Miles and his colleague Raymond Fountain in minimizing of the cost of ship building which had doubled since the end of World War II.

In the construction industry, Value Engineering was adopted in the 1960s (Dell'Isola, 1982). In

1993, two bills were introduced in the United States senate which made application of Value Engineering mandatory in all government programmes (Fong and Shen, 2000). This has since spread to other countries like Japan, United Kingdom, Australia and Canada. In America, VE is widely practiced in the construction industry and the role is driven by the Engineers while in the United Kingdom the technique is led by the cost experts (Quantity Surveyors).

Value Engineering Execution Approaches

Though the procedure of carrying out VE in general is similar, there are several approaches that can be adopted and are distinguished by the time expended, the stage of application and the team involved. These approaches include Charette, 40-Hour Workshop, Value Management Audit and Value Management Change Proposal (VMCP) and the notable observation is that they are all implemented before project construction stage though the teams involved vary. Some of the approaches involve independent teams for VE.

In Charette approach, VE is conducted after development of the project brief in the initiation project stage. Its purpose is identification of the actual functions of the project through analysis and review of the client's wish list and then separation of the needs from the wants. It helps reconciliation of the client needs and wants with the budget (Kelly and Male, 1993). The approach is not expensive and takes a very short duration, usually less than two days (Kelly and Male, 1993).

According to Pickles (2000), 40-Hour Workshop VE approach involves outsourcing of an independent team when the project design is 35% done. This helps in creation of room for a fresh outlook and input of more ideas. However, this can bring adversity amongst the design team since it appears as a way of critiquing their design. The 40 -hour is an indication of the time that should be spent in the process (Kelly and Male, 2003). It is an expensive approach since it requires procurement of an external/independent team.

Value Management Audit VE approach is carried out by an independent team after compilation of the project proposal before production of the required designs. Its aim is to offer more input to the proposal and ensure that the key functions have been captured (Kelly and Male, 2008). It is equally costly due to procurement of an independent team and can be perceived with adversity by the project design team.

Lastly, in Value Management Change Proposal (VMCP), VE is carried out post tender by the construction contractor. Its purpose is to allow the contractor introduce changes or modification to the project design for reduction of cost without altering the functionality of the product (Kelly and Male, 2008).

Value Engineering Methodology

Whichever of the four discussed approaches is adopted, VE is carried out in a structured process to achieve desired results. They all have similar methodology but distinguished by:

a. The time expended
b. The party that facilitates and executes the process
c. The project life-cycle stage it is executed

The process has been given various terminologies by different authors; Dell'Isola (1982) and Kelly and Male (2008) refer to it as Job Plan, SAVE International (1998) refer to it as Value Methodology while in Australia it is referred to as a Work Plan. The term applied really doesn't matter since the essence and the objective remains the same. Below is the process as explained by Kelly, Male and Graham (2004).

Pre-workshop/ Orientation stage

It is the preparation stage of VE. One representative from every project design discipline is selected to form VE team. Client needs, wants and objectives are analysed through division of the project into constituent elements and the respective costs of these elements detailed and verified. Depending on the project size, nature, and complexity the team decides on the approach to be adopted. Finally, all documents which include designs are collated and disseminated to the whole team.

Workshop stage - Information Phase

The purpose of this stage is to discuss the scope to be addressed and build more solidarity among the participants. Any queries about the project, designs and its functions are cleared at this stage (Norton & McElligott, 1995).

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Workshop Stage – Function Analysis Phase

This stage involves development of a logical relationship amongst the elemental functions of a project (Canadian Society of Value Analysis, 2013). Functions are determined using a process referred to as Word Abridgement in terms of verbs and nouns (Mandelbaum and Reed, 2006). The verb answers the query "what does it do?" While the noun answers "What does it do this to?" For example for a fire alarm system the verb would be detect while the noun is Fire thus the function is detect fire. This is then followed by categorization of the functions into primary and secondary; primary is what the function must do and secondary is definition of what else it can do, for instance provision of aesthetics is a secondary function. The costs for the primary function are then segregated from those of the secondary functions to disregard as many non-value-adding secondary functions as possible and at the same time advance the worth of the remaining ones (Mandelbaum and Reed, 2006).

Workshop Stage Creative or Speculative Phase

This is the brainstorming stage where suggestions on alternative technologies and materials that can be used for the functions identified in the previous stage are brought out. It is a qualitative method that directs the way of searching for solutions to issues within the project limitations (Fong and Shen, 2000)

Workshop stage - Evaluation Phase

This phase also referred to as Judgment phase or Analytical Phase (Dell'Isola, 1982). It involves reviewing and evaluation of the suggestions made at the speculative stage with a purpose of reducing them or short-listing them to those that have maximum potential of achieving the required value of the project (SAVE International, 2007). The suggestions are polished and finalized into a feasible solutions (Dell'Isola, 1982).

Workshop Stage - Implementation Phase

This phase is also referred to as "Recommendation Phase" (Che'Mat, 2010) or 'Proposal Phase' (Dell'Isola, 1982). The list produced in the evaluation stage is compiled into a workable report and an action plan handed over to the client. The report should include the refined drawings/ designs, specifications, the refined cost estimates and Cost-Benefit analysis (Dell'Isola, 1982).

Post-workshop Stage

This is a decision-making stage where commitment and approval from the client is provided.

Conceptual Framework

The goal of Value Engineering is achievement of the intended project value within the least cost possible. From the theoretical discussion, the project final detailed construction drawings, project final standardized cost and the value of the final product are dependent on the implementation of VE. Effectiveness of VE exercise on the other hand is dependent on the stage of its application, the team involved, and the techniques adopted, for instance as seen earlier it is not effective to use a cost cutting technique. The idea is to have a final product that meets the value expected by the client for their satisfaction at the lowest cost possible. The framework summarizes this in **Figure 1.**

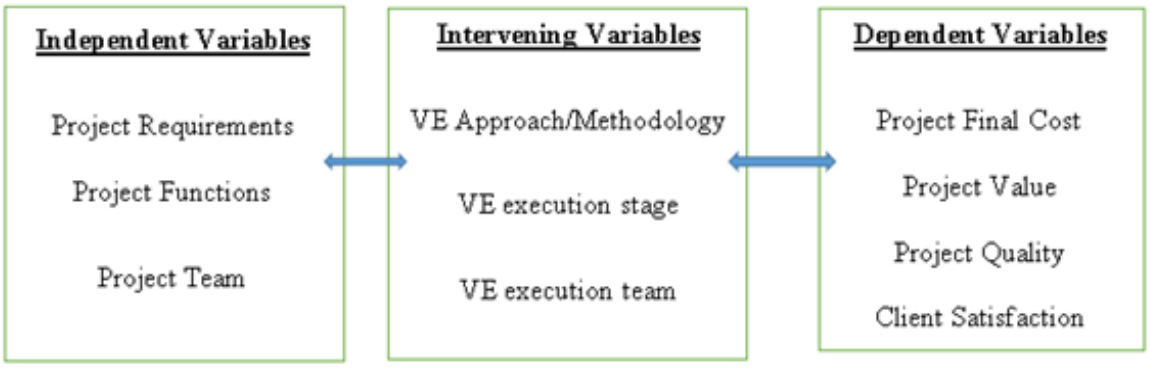

FIGURE 1
Conceptual Framework,
Source: Authors, 2022

RESEARCH METHODS

The study adopted descriptive survey research design and was based in Nairobi County, Kenya. The population was constituted of 370 architects, 236 Quantity Surveyors, 242 Engineers and 290 Construction Project Managers. With the population size of 1138, confidence level of 95% and a margin error of 5%, the calculated sample size was 288. From each stratum 72 respondents were sampled randomly. The study data was then collected through administration of questionnaires and conducting of structured and unstructured interviews through online platforms and face to face meetings. The study did not have a focus on specific construction projects rather the focus was on the mentioned practitioners, to determine how they have exercised VE in their respective projects.

RESULTS AND DISCUSSION

The response rate was 85% which was comprised of 62 Architects, 68 Quantity Surveyors, 54 Engineers and 60 Construction Project Managers.

Value Engineering Application Process

Construction Stage

62% architects, 75% quantity surveyors, 61% Engineers and 58% Construction Project Managers, an average of 64% respondents indicated that they usually carry out Value Engineering exercise across both the design and construction stages while apart from 4% of the respondents who were not sure about the process, the rest were specific that they execute it during the construction stage. This is an indication that approximately all construction projects in Nairobi County have an aspect of being Value Engineered at the construction stage. Characteristically, value engineering should be carried out during the design stage, and extending the process to construction stage explains the fluidity of drawings established by Ong'ondo (2016), in his investigation of pre-construction planning process in Kenya, which often lead to variations (omissions and addition of elements). Variation orders lead to time and cost overruns and subsequently client dissatisfaction. Chonge, Kivaa and Gwaya (2016) established that performance of contractors in terms of achievement of baseline time and cost in Kenya, is largely influenced by the design changes introduced into the project by the client and consultants at the construction stage. Variations at the construction stage, based on the definition if VE is an indication that VE is usually not effectively done during the design stage to capture all the necessary changes. This supports the findings that VE is usually extended into the construction stage.

Value Engineering Procedure

The study having established that value engineering is usually executed both in the design and construction stages, interrogated the procedure applied. This was achieved through interviewing the respondents. Interviews are effective for descriptive research since they help in understanding the views and opinions of the respondents

Facilitation

An average of 60% respondents indicated that the Architect usually play both the roles of architect and project manager in the construction projects and hence takes up the role of VE facilitator while 40% reported that the construction project manager is usually the facilitator leaving the architect to play the role of the designing only. This finding may explain the shortcomings in the application of VE in construction projects in Nairobi given that the Architect's training does not equip them with VE facilitator skills. This lack of facilitator skills is exacerbated by the lack of objectivity in the process propagated by the fact that the Architect as the principal designer is unlikely to critique his own designs. Unfortunately, the construction project managers, who have the requisite skills are largely sidelined. The prevalent use of Architects as VE facilitators stems from pre-project management era where architects were the main project administrators for building projects despite being involved in the design. This supports the findings by Gitau (2000) that there is a need to increase the role of project managers in the construction industry in Kenya and Ronoh (2020) who established that project management practices in Nairobi still require improvement.

Information phase

The 60% respondents further indicated that once the architect is brought on board by the client, together with the Quantity Surveyor they prepare preliminary designs and preliminary costs respectively which are then discussed with the client. This can be equated to commencement of value engineering. The client gives their opinion

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on the drawings and changes are made accordingly. In relation to the formal value engineering process, this can be compared to the information phase. The only shortfall is that the engineers are not involved yet all design disciplines ought to be available. This may be part of the reasons that construction projects in Kenya have fluid drawings as established by Ong'ondo (2016).

Evaluation and implementation phases

The 60% respondents reported that after approval of the preliminary designs and costs by the client, they are then sent to the engineers, both civil/ structural and services engineers to prepare their respective designs. The detailed designs are then prepared by the design team. The whole team then holds a design meeting for final design discussions. 70% respondents intimated that this stage is usually guided by the project budget and changes made at this point mainly focus on fitting into the client budget which can be equated to cost cutting as discussed by Fischer (2009) while 30% indicated that usually in the design meetings, elemental functions are considered. Cost cutting and value engineering are two distinct exercises. Cost cutting is the process of omitting some functions without necessary replacing just to fit into the client cost ceiling (Fischer, 2009) while in value engineering, omitted functions are substituted with consideration of the project value. 75% of the respondents reported that in most cases, once the designs are discussed, the individual discipline designers retreat to their offices to implement the changes then circulate the final drawings to the whole team. This is an indication of disjointed evaluation of drawings. Value Engineering as mentioned earlier should be a team exercise, fragmentation may lead to uncoordinated drawings leading to omission of some functions. In relation to the formal value engineering process, this stage can be equated to a combination of evaluation and implementation phases, shortfalls being cost cutting and lack of teamwork.

96% of the respondents further indicated that during execution stage of the project, design meetings are held where evaluation of design drawings continue in relation to financial appraisals prepared by the Quantity Surveyor. The respondents indicated that the process includes omission and addition of functions and elements to fulfil the client needs and still fit into the client cost ceiling. This is as an indication of continued cost cutting and as explained earlier, it leads to variations which in turn lead to cost and time overruns.

Independent teams

The 40-Hour Workshop and Value Management Audit VE methods involve procurement of independent teams to value engineer drawings while in Value Management Change Proposal the Main Contractor is involved since it is carried out post-tender. 92% of the respondents reported that no independent teams are procured to evaluate drawings while 10% indicated that contractors are only involved in the cases of Design and Build construction projects. It is noted that while early involvement of contractor may attract an extra cost it helps in consideration of project constructibility during design stage and reduction of errors and design changes in latter phase of the project (Sodahl et. al., 2015). The research recommended that this option be considered for adoption in construction projects in Nairobi County as a measure of reduction of construction drawings fluidity.

VE Training and Sensitization

The study sought to establish how the practitioners learnt about the VE tool. 86% indicated through work experience and the others through academic learning curricula particularly the Construction Managers. The respondents explained that value engineering is rarely incorporated in academic learning curricula, and it is rarely sensitized through continuous professional development workshops. This lack of proper training of the VE tool explains the informal implementation structure and inconsistencies in its application in the industry. It additionally highlights the dire need of VE training.

CONCLUSION AND RECOMMENDATIONS

From the findings the study concluded that although there are features of Value Engineering incorporated in construction projects in Nairobi County, a lot improvement in its execution is required to realize its full benefits. First, the study established that in 60% of the construction projects in Nairobi County, VE is facilitated by the architect who lack facilitator skills and objectivity instead of a construction project manager who would be more suitable since a designer may not

be in any position to evaluate or critique their own drawings. Secondly, the study established that in 96% of construction projects the exercise is carried out in the execution stage and in 70% of the projects, cost cutting measure is adopted as a technique of VE which leads to fluidity of construction drawings. In 75% of construction projects, the study established that VE is carried out in a fragmented manner, an indication of lack of teamwork which explains the omission and additions of elements in the design drawings. As much as the study established that several features of VE are incorporated in the construction projects, critical steps are missed out, they include functional analysis of elements, creative or speculative process of selecting functions substitution and the process of reviewing and evaluation of the selected elemental substitutes.
The study established that the few features practiced by the 86% practitioners were learnt through work experience hence recommended introduction of value engineering in academic curricula in institutions of higher learning and its training and sensitization through continuous professional developments workshops and seminars.

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