Application of Value Engineering Techniques in Appraisal Stage of Construction Projects in Rwanda

Eric Uwurukundo, Gwaya Abednego, Kivaa Titus

***Abstract*: *The construction industry faces problems that are classed as: demand issues, supply issues, and some common issues such as poor management and an adversarial culture. This results to production of low and unreliable returns because of low performance in terms of cost and time overrun and poor durability* [1]. *The present research presents the benefits of applying value engineering techniques at the appraisal stage of construction projects, by relating the functions, the quality and the costs of the project to determination of optimum solutions for construction projects. Literature related to construction industry was briefly reviewed, on why the application of value engineering techniques is necessary, the benefits that led to it being indispensable how , VE could help to improve the effectiveness of a significant number of decisions taken when managing construction projects, which are most of the time made under risk and uncertain conditions*[1]. *A survey research design was adopted with the use of questionnaires. A sample size of 65 project managers working on Rugarama Park Estate was issued the questionnaires. The analysis of findings indicated a necessity of value engineering techniques application (planning, effective decision-making, and ability to identify opportunities and cost reduction without sacrificing requirements). It was therefore recommended that Value engineering be applied at early stages for all construction projects in Rwanda*.

Index*: *Planning, Effective, Value Engineering Techniques.

I. INTRODUCTION

The construction industry involves different kinds of work, it encompasses a range of different activities, covering the whole construction supply chain. It includes the mining, quarrying, production and sale of materials and products. It also covers construction contracting, be it house building, large-scale civil engineering, or repair and maintenance. Furthermore, it is a whole range of professional services, including architectural, civil, structural, mechanical and electrical design, and project management, as well as allied services such as finance, IT and insurance [2]. Bower states that the construction industry faces problems that are classed as: demand issues, supply issues, and some common issues such as poor management and an adversarial culture. This results to production of low and unreliable returns because of low performance in terms of cost and time overrun and poor durability [1]. Rane states that engineers have always tried to reduce the cost of construction without affecting the quality and the functional utility, however their approach was based mainly on the past experience. Keeping the costs low with traditional cost management has been a commonly applied measure to improve competitiveness. However, keeping cost down alone is not enough, there is an increasing need for improve in schedule as well as efficiency and effectiveness. Saving money at the same time, providing better value is a concept that everyone emphasizes [2]. Value engineering is therefore is a methodology that is known, accepted and has an impressive history of improving value through customizing Quality and optimizing Life Cycle Cost of a construction project. The success of its application 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. Value Engineering can also improve decision-making that leads to optimal expenditure of owner funds while meeting required function and quality level, as it a methodology that is comprised of many useful tools and techniques that create change on purpose rather than letting change happen accidentally[3].

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II. BACKGROUND

In Rwanda, the construction industry comprises the building, transport and civil engineering sub-sectors thereby providing the physical infrastructure, which is central to the development of the economy. The sector also facilitates peoples' life and ways of doing business. Its activities create business for suppliers and manufacturers and provide employment to professionals, semi-skilled and unskilled labor. More than 50% of the employment so created in the construction industry is in the unskilled labor market. According to [4], the Rwandan construction industry grew from RWF billion 105 in 2006 to RWF billion 244 in 2010, which means that the sector contributed 6.1%, 6.5%, 7.5%, 7.3% and 7.4% of the total GDP in 2006, 2007, 2008, 2009 and 2010 respectively [4]. In 2011, the Rwanda Ministry of Trade and Industry Government of Rwanda reported a strong growth in the services and industry sectors. The vibrant services sector growth was mainly pushed by transport and telecommunication that grew by 34.6%, finance 20.4% and wholesale and retail trade with 10.5%. On the side of the industry sector, construction continued to show a strong growth with 15.9% of the real GDP growth rate.

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In addition, the industrial sector contributed 15% of the total GDP in 2010, among which the construction sector was the largest industrial sub sector, whereby the construction was the largest industrial sub-sector, with 7% of total GDP or 52% of industrial output in 2010, up from 41 % in 2002 [5] . The Rwandan construction industry has been underdeveloped and plagued with a number of problems which included insufficient project continuity due to inadequate affirmative public policies; insufficient access to finance and credit; inadequate relevant human resources in the public and private sector; unfavorable conditions for accessing donor credit; and lack of a database for performance indicators in the industry[4]. Even though a rapid advancement of the industry is remarkable in Rwanda, construction projects still need better performance and value for money improvement, because of ineffective decision-making associated with management of risks, uncertainties, and changes which are inherent in projects, particularly at the appraisal stage and the investment decisions, which can be seen as an inability to balance cost, time and quality. This is mainly because there is a strong link between improving investment decisions in the appraisal stage and good business performance. Moreover, in order to deliver the right project at the right time within budget, there is a need to improve decision making, particularly at the appraisal stage [6].

The study objectives were to investigate the application of value engineering techniques in appraisal stage of construction projects in Rwanda, by analyzing the impact of planning, effective decision-making, ability to identify opportunities, and analyzing the effect of cost reduction without sacrificing requirements to success of a construction project. The study would be significant to the housing and construction project developers, to project managers whose task was primarily overseeing the overall success of the project, to the client and all other project stakeholders through realization of the overall objectives of the project and to the entire population through economic growth cognate to a stable construction industry, and it will be an advantage for future researchers to use this research as a second source of data. The study focused on the Rwandan construction projects.

III. LITERATURE REVIEW

A. Value Engineering

VE (value engineering) was developed at General Electric Corp. during World War II and is widely used in industry and government, particularly in areas such as defense, transportation, construction and healthcare [3].VE has been recognized as one of the most effective methodologies for achieving “best value-for-money” for clients since its introduction into the construction industry in the early 1960’s[7]. VM evolved from the manufacturing industry, which initiated Value Analysis (VA) in 1940’s, and was first applied in the construction industry in 1963[8] and is now attracting interest from many sectors of the construction industry across the world [4]. The UK has already seen a substantial growth in the development and practice of VM, mainly in the construction industry, since the introduction of VE to the UK in the 1980s. As reported by [9] and proposed the benefits and potential of using VM in the UK, particularly to the quantity surveying (QS) profession, the publication marked the beginning of the serious development of VM as a tool to be used in the construction industry to achieve better value for money.VM in the UK construction industry has evolved to become an established service with commonly understood tools, techniques, and styles [10]. Ever since this time, the VM initiative has been benchmarked by several countries such as Australia, France, Germany and Hong Kong and this has helped to further the development and implementation of country-specific VE initiatives [4].

VE is a structured, organized team approach to identifying the functions of a projects, product or service with recognized techniques and providing the necessary functions to meet the required performance at the lowest overall cost [5]. In a paper prepared by[11], Value engineering (VE) is a structured and analytical process that seeks to achieve value for money by providing all necessary functions at the lowest cost consistent with required levels of quality and performance. VE, which has been widely used in many developed countries for several decades, is a useful tool that can help the industry to meet these challenges. On one hand, the major reasons for choosing VE, are to achieve cost saving, establish a clear project objective and provide creative thinking for design improvement. This target cannot be met unless there is a clear cut picture of actual situation of the projects in terms of time; cost and quality which are crucial cause of concern in Value engineering process also, so that in order to assess the process of value engineering, it is necessary to implement the feedback system during execution of the project [6]. On the other hand, as a matter of fact, construction projects are subjected to changes so that there is a requirement of this issue to have the updated feedback throughout the whole process of construction project. Timely and targeted feedback can able the project management to identify problems early and make adjustment that can keep the project on time and budget.

This research covered the definition and description of value engineering, how early stages of construction projects can benefit the most from its techniques in a proper management session.

B. Impact of Planning on Success of Construction Projects

Project planning has been defined as ‘‘the process of choosing the one method and order of work to be adopted for a project from all the various ways and sequences in which it could be done’’[12]. The [1] defined the planning process as ‘‘those processes performed to establish the total scope of the effort, define and refine the objectives, and develop the course of action required to attain those objectives’’. Project planning serves as a foundation for several related functions, such as cost estimating, scheduling, project control, quality control, safety management, and others [7].

Project planning consists of project structuring with the tasks of project scheduling and resource allocation. Normally, resources are not available in unlimited amount. After all, at least the most important project resources are scarce. In construction projects,

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These resources comprise money, labor, equipment and construction materials. The timely allocation of scarce labor and equipment to construction projects is objective of construction project planning. Thereby, the selection of the appropriate project planning method for allocation of the scarce resources labor and equipment is prerequisite for efficient project planning. Efficient is thereby described as 'as accurately as possible, but as loose as necessary'. Success on a project implies that specific desires for a given member are met, whether proprietor, organizer, designer, temporary worker, or administrator. The accompanying are some different dentitions of "Project Success" in general: Project success is alluded as having results much superior to anything expected or typically saw as far as cost, calendar, quality, security, and member fulfillment [8].

A project is viewed as general success on the off chance that it meets the specialized execution specification or potentially mission to be performed, and if there is an abnormal state of fulfillment concerning the project's result among key individuals in the parent association, enter individuals in the project group and key clients or customers of the project exertion[13]. Success for a given project member as how much project objectives and desires are met. They included that these objectives and desires may incorporate specialized, financial, instructive, social, and expert angles[7]. Numerous exact reviews demonstrate the positive effect of project planning anticipate project success. The process of planning through what's more, making unequivocal the targets, objectives, and procedures important to bring the project through its lifecycle to a fruitful end when the project's item, management, or process assumes its legitimate position in the execution of project proprietor methodologies. Various specialists have explored extend possibilities that impact of anticipating project success. Planning and determination of the ideal project lifecycle for the project being embraced can significantly affect the success of that project. [14].

Extend planning viability can be conceptualized as the degree to which a project accomplishes its arranged targets[14]. Choices taken amid the planning procedure have been found to affect the plausible result of a project. Project Planning can be utilized to devise new items, administrations, inside operations, or hierarchical strategies. Most creators concur that a project is an interesting attempt, an extraordinary undertaking that has not been done some time recently. Subsequently, it is extremely troublesome or even difficult to know exactly at the underlying planning stage that what is every one of the exercises that should be done to finish the project and what are their cost and length parameters [14].[15] found that an increase in pre-project planning for construction projects increased the likelihood of a project meeting financial goals. The top third of projects from a planning completeness perspective had an 82% chance of meeting those goals while only 66% of projects in the lower third did (a difference of 16%). Similar results are seen for schedule and design goals. In a study of programme management in the construction industry, effective planning had the highest criticality index of .870 of all the Critical Success Factors (CSF) studied [9].

[16] noted that research results show that effective pre-project planning leads to improved performance in terms of cost, schedule, and operational characteristics.

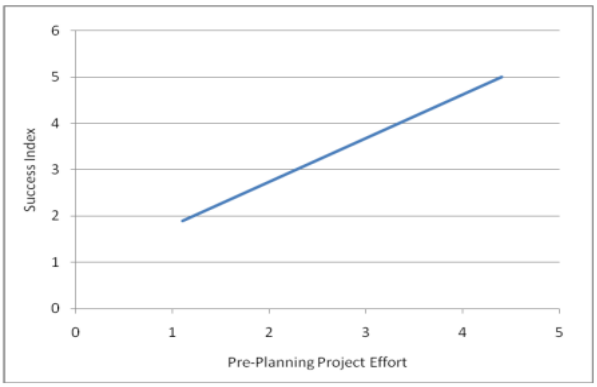

Figure 1. Success Index vs Pre-project planning effort

The index is established with a score ranging from one (the lowest level of pre-project planning effort) to five (the highest level). Note that the relationship is linear. In the construction industry, project success is closely linked to project efficiency so this can apply to efficiency and success. The index does not measure work effort just completeness. The PDRI, a method to measure project scope definition for completeness, developed by the Construction Industry Institute (CII) in 1996, this tool has been widely adopted by various owners and designers in the building industry[16]. It has gained acceptance in the facilities and construction industry as a measure of the quality of pre-project planning. The PDRI offers a comprehensive checklist of 64 scope definition elements in a score sheet format. Undertaking no planning correlates to a PDRI score of 1000 where a score of 200 or less is good planning. The following results show a marked difference in empirical measurements of project success based on the project PDRI score[16].

Table 1 - Comparison of Projects with PDRI-Building Projects Score Above and Below 200, after Gibson and Pappas (2003)

	PDRI score	
Performance	<200	>200
Cost	3% below budget	13% above budget
Schedule	3% ahead of schedule	21% behind schedule
Change orders	7% of budget (*N*=17)	14% of budget (*N*=61)

This study found that "the PDRI score and project success were statistically related; that is, a low PDRI score (representing a better-defined project scope definition package just prior to detailed design) correlates to an increased probability for project success."

The following diagram summarizes the result of this survey and shows a clear relationship between the PDRI score and project success [17].

Table 2 - Comparison of Projects with PDRI-Industrial Projects Score Above and Below 200, after Gibson and Pappas (2003)

	PDRI score	
Performance	<200	>200
Cost	3% below budget	9% above budget
Schedule	1% ahead of schedule	8% behind schedule
Change orders	6% of budget (*N*=35)	8% of budget (*N*=27)

Further, they note "Indeed, due to the iterative and often chaotic nature of facilities planning, many owners face such uncertainty that they skip the entire planning process and move to project execution, or decide to delegate the pre-project planning process entirely to contractors, often with disastrous results." [16] found that pre-project planning is identified as having direct impact on the project success (cost and schedule performance). The following diagram summarizes the result of this survey and shows a clear relationship between the PDRI score and project success.

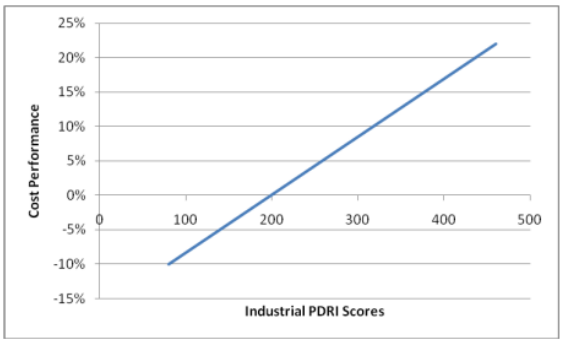

Figure 2. Cost Performance vs. Industrial PDRI Score

Source: Wang and Gibson (2008)

This graph clearly shows a linear relationship between the quality of planning and the cost aspect of project success. Thus, upon the above-mentioned literature, Project planning is the process of deciding ideal strategies, arrangement and timing of project exercises, and obliged assets to boost the possibility for a Successful Projects. In the construction field, we can note that the level of planning completeness is positively correlated with project success in the construction industry.

C. Effective Decision-Making Impacts on Success of Construction Projects

A decision is the agreement to adopt an alternative (s) to resolve that issue. The processes of making decisions facing two difficult situations: **Dynamic situations**: where decisions may be affected later if additional alternatives are generated, or if criteria and preferences are changed, and **complicated situations**: where decisions are made under influence of multi-objectives. For this situation objectives are generally conflicting and preventing simultaneous optimization of each objective [10]. Decision making in the complex global business environment is increasingly challenging and vulnerable to unforeseen circumstances. Yet it is also vitally important to every aspect of business, especially project management, which involves making a multitude of decisions every day about priorities, approaches, resources, and timelines [11].

As with all important business decisions, project outcomes can be traced to decisions that were made at an earlier point in time—and there's no doubt that poor decisions have negative consequences to both outcomes and an organization's bottom line. There are many reasons projects fall short of their original goals. (Langley, 2015) following is a number of contributing factors and the percentage of projects they impact: ineffective communications (56 percent), poor requirements management (47 percent), poorly engaged executive sponsors (34 percent), and untimely/inaccurate knowledge transfer (34 percent).The most effective decision making—the kind that helps improve project outcomes—results from a formal, methodical approach, such as the five-step process highlighted in A Guide to the Project Management Body of Knowledge [12]:

1. **Problem Definition:** Fully explore, clarify, and define the problem.
2. **Problem Solution Generation:** Prolong the new idea-generating process by brainstorming multiple solutions and discouraging premature decisions.
3. **Ideas to Action:** Define evaluation criteria, rate pros and cons of alternatives, and select the best solution.
4. **Solutions Evaluation Planning:** Perform post implementation analysis, evaluation, and lessons learned. Evaluation of the Outcome and Process: Evaluate how well the problem was solved or project goals were achieved (extension of previous phase).

Different project types, including construction ones, are made up of a group of interrelated work activities constrained by a specific scope, budget, and schedule to deliver capital assets needed to achieve its objectives [13]. These constraints, sometimes called knowledge areas, include integration, scope, time, cost, quality, human resource, communication, risks and procurement [14]. For construction projects there are four unique constraints; Safety, environment impacts, finance and claims [15].

The decision-making process is critical to the success of any construction project. Construction personnel have to make decisions on a daily basis and must be able to justify these decisions. Wrong decisions can be costly in terms of time, quality, cost and relationships. Effective time-management requires decisions to be assessed in terms of urgency and importance, and dealt with accordingly [16]. Previous research findings indicated that the client's strategic decisions, especially at the early stages of the construction process e.g. regarding the procurement route, have a significant impact on satisfaction levels [18]. This is significant, as most strategic decisions have to be made during the early stages of the construction project at a time when there is much uncertainty [18]. It was revealed that a client's strategic decisions such as development scale and revenue targets for projects with a limited life should take into account the costs of closure,

decommissioning and, where appropriate, eventual sale. Some lessons have been learned from previous project failures such as the Millennium Dome, which has lost millions of pounds due to the failure to achieve its strategic targets. Findings revealed how clients divided the decision-making process among managerial roles as decision-approvers (e.g. main board members), decision-takers (e.g. senior managers), decision-shapers (e.g. expert focus group with construction-related expertise) and decision-influencers (e.g. other internal or external people who influence). In order to gain approval, the decision-shapers had to work the proposal so that it fit positively with the expectations from internal and external forces such as corporate finance, the economy, local authority planning permission and so on [17].Unnecessary costs do exist in the construction industry because of many factors such as lack of information, lack of ideas, temporary circumstance, honest but wrong beliefs, habits and attitudes, changes in owner requirements, lack of communication and coordination, and out dated standards a specification. These factors are roadblocks to good value. The best way to overcome these roadblocks is by using the VE/TQM team approach. Individual efforts can be costly and inefficient. Management has learned that by involving more of their organization in the decision-making process and committing the organization to a goal, significant improvements can be realized. The quality revolution has demonstrated that waste and inefficiency are unacceptable anywhere in the organization. Therefore, managing value and change is necessary to meet this difficult challenge. Many characteristics of unacceptable qualities can be traced to the approach taken during the design and management process. Application of Value Engineering with the TQM approach will more closely achieve the desire concept as a totally integrated effort toward improving performance of every process at every level. Value Engineering seeks optimizing and improving decision making to realize the optimal expenditure of owner funds while meeting required function at the lowest cycle cost [18].

To improve the efficiency and effectiveness of managing construction projects all these constraints, should be considered. In the construction project decision-making stage, to implement value engineering is of great significance: it can make the function of the building products more reasonable.

D. Value Engineering Ability to Identify Opportunities to Success of Construction Projects

Companies in the construction sector have a better chance of getting jobs when they use the resources of the country in which they work reasonably, keep their costs at the lowest level and decrease their offer price in comparison with their rivals [19]. But the low offer price is not the only factor for a specific company to get the job. Project must have a high "value". Value has different meanings for the producing company, owner, user or the designer. The builder company tries to finish the construction with the lowest cost to obtain high profit. Owner wants to get the biggest income from the building. User wants to be able to perform his works easily, while the designer gives more importance to his creation's aesthetics or functions.

Purpose, time, quality and cost of every activity that will be realized during the construction process must be determined or estimated beforehand. Owner or user wants to know which feature they will have after the building is completed and with what cost they will have it. Because construction process has many components such as concept, design and drawing details of the project, construction etc., and it is a long-term production, the risk of completion of construction in time, based on the estimated costs (first investment + usage cost) by providing features such as quality, durability, usefulness, continuity, feasibility, compliance, image and management convenience, increases.

Suitable precautions are taken by predetermination of problematic areas via various project planning and scheduling techniques. But none of these methods includes an examination in terms of the "value". After a building is completed or during the construction stage, comparing the building value with the costs that occur during its construction is not thought about. Although many buildings were built with high costs, desired functions were not provided. There is absolutely no direct proportion between a building's costs and provided benefits. In value engineering rationalist evaluation techniques are used considering the target features, and unnecessary costs are determined to be eliminated from the project, so that a building's value is increased and resources (money, material and workforce) are not wasted [3].

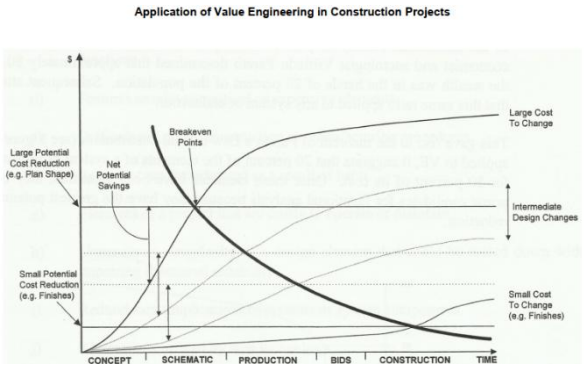

Figure 3. Application of Value Engineering in Construction Projects

Source: Bechtel Corporation, 2000

Value engineering can be applied during any stage of a project cycle. VE may be applied more than once during life cycle of construction project, its early application helps in more organized implementation of project activities, thus reducing overall cost by avoiding any major changes right in the beginning. If the application of VE is done in later stages it may result in higher project cost [20].VE is applied in an organized process known as VE job plan. The purpose of 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 Applications. The VE job plan consists of five phases as below [20]:

a. Information Phase: In this phase maximum information is collected from various aspects of project regarding identification of problems to be solved and gathering of information on background, function and requirements of the project.

b. Creative Phase: This phase involves generation of creative ideas and listing of them project viewpoint.

c. Evaluation Phase: In this phase of project, VE team together with client defines the criteria for evaluation.

d. Development Phase: During this phase many of ideas are expanded into workable solutions.

e. Presentation Phase: In this phase presentation of recommendation is prepared in the form of a report

In [19] Value Engineering is an effective technique for reducing costs, increasing productivity and improving quality. It can be applied to hardware and software; development, production and manufacturing; specifications, standards, contract requirements and other acquisition program documentation; and facilities design and construction. VE is defined as "an analysis of the functions of a program, project, system, product, item of equipment, building, facility, service or supply of an executive agency, performed by qualified agency or contractor personnel, directed at improving performance, reliability, quality, safety and life cycle costs". It may be successfully introduced at any point in the life-cycle of products, systems, or procedures. In construction, VE application facilities can yield a better value when construction is approached in a manner that incorporates environmentally-sound and energy-efficient practices and materials. Because "costs" are measurable, "cost reduction" is often thought of as the sole criterion for a VE application and indeed it is primarily addressed. However, the real objective of VE is "value improvement" and that may not result in an immediate cost reduction [3].VE is a systematic, low-cost approach to assessing the "value" of a project. Typically, VE on projects can be used to gain the following benefits [21]:

- cost reductions;
- time savings (schedule savings)
- quality improvements;
- isolation of design deficiencies

VE should be performed as early as possible-before commitment of funds approval of systems, services, or design-to maximize results [22]. Contribution of potential savings from VE applications is much greater at earlier stages of a project, as illustrated in Fig. 3. When VE is applied later, two things increase: the investment required to implement any changes and resistance to changes.

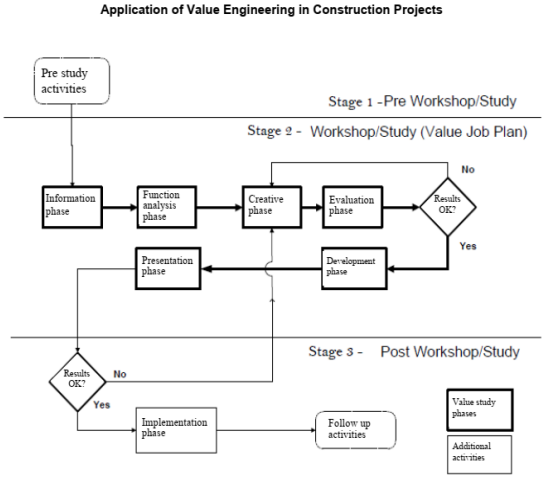

Figure 4. Job plan
Source: Senay et al., 2013

VE is neither just good engineering, nor a suggestion program, nor a routine project or plan review; it is carried out in independent analysis of the project. It must be recognized that VE entails a certain amount of additional expense that must be justified by potential cost saving. Accordingly, the need for a change in criteria, concepts, or plans must be recognized. A distinct opportunity for financial rewards in terms of life-cycle cost savings must warrant the added project engineering cost of a VE effort.

E. Effect of Cost Reduction Without Sacrificing Requirements to Success of Construction Projects

In constructions, especially in functions with high production costs, the costs can be reduced without sacrificing construction's quality or disregarding customer's requests, by using different materials and/or different methods. Materials, equipment and stipulated production methods in the specification and projects may become old according to current day or be out of date. In case the suggestion of the contractor for making changes is accepted by the employer, a much more economical solution will be provided for both sides. Carrying out production with better quality by using the suggested methods, in other words improving the quality may be a more economical solution [23].VE is a formal procedure and approach that can be used to ensure that hazardous waste remedial actions are accomplished in a cost-effective manner. VE has been demonstrated to be successful in reducing costs and improving value in major construction projects. It is a methodology that is known, accepted and has an impressive history of improving value through customizing Quality and optimizing Life Cycle Cost [24].

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. VE is a systematic, low-cost approach to assessing the "value" of a project by using an examination of function. Value as defined, is a ratio of function to cost. Value can, therefore, be increased by either improving the function or reducing the cost [25].

$$\text{Value} = \frac{\text{Function (desired performance)}}{\text{Overall costs}} \quad \text{(Equation 1)}$$

Typically, VE on projects can be used to gain the following benefits:

- Cost reduction;
- Time saving (schedule savings);
- Quality improvement;

- And Isolation of design deficiencies.

Reasons for poor value can be that: lack of information, decisions based on wrong beliefs, habitual thinking, negative attitudes, reluctance to seek advice, shortage of time, changing technology, lack of a yardstick for measuring value, old specifications and poor human relations.

Value engineering gets closer to cost control because it looks at ways to reduce costs on specific items or activities. However, it does not look at the total project picture or check the daily performance, it focuses only on specific items in the design, procurement or construction area.

In a paper prepared by [26], VE can be used as a tool for achieving sustainable construction but must be applied during early stages of a project. As sustainable construction brings additional value to projects, VE can be used to ensure that these values are maximized. The main issue for construction regarding sustainability are what to build, where to build, how to build and whether to build, and this is related to planning, design and construction. But VE plays important role in sustainability for generating significant funds in initial installation and operating cost. It is not only a management approach for construction industry but also is the best technique for producing best results in achieving value for money for client. The sustainable decision uses professional judgment and vision to distinguish between capital expenditure and operational expenditure. VE job plan is a systematic approach for identifying problems and finding out solutions of them. It can raise sustainable construction principles and can give the techniques to help decision makers to take appropriate decisions and actions in order to realize value of project. Functional analysis enables the team members to apply sustainability issues in assigning components of a project. In creative phase of VE suitable alternatives for sustainability are generated and unsuitable alternatives are discarded.

To apply sustainability principles following steps are considered during project: For VE study experienced VE professional should be appointed, Consumption of non-renewable energy resources should be minimized, Protection and conservation friendly material should be adopted, and Appropriate design and construction solutions are developed.

IV. RESEARCH METHODOLOGY

This research used a mixed method strategy where both qualitative and quantitative approaches complemented each other. It employed the survey research design with data collected through self-administered questionnaires that aimed at investigating the application level of value engineering techniques in appraisal stages of construction projects in Rwanda.

Due to limitations in terms of time and financial resources, the research site and study population for the proposed study were from Rugarama Park estate, established in December, 2013 by the City of Kigali, Shelter Afrique and the Banque Rwandaise de Development. The Census data collection method was adopted to collect data from 65 project managers working on the very mentioned project.

Both Qualitative and Quantitative data were used. Quantification of data was achieved by the use of a five-points Likert scale. Qualitative data was obtained by use of an open question at the end of the questionnaire aiming at getting the opinion of respondents on the value engineering techniques application to meet successfulness of construction of construction project in Rwanda. A pilot study was first conducted to establish the clarity and effectiveness of the questions in relation to the study objectives. Its findings were used to restructure the final questionnaire.

Data analysis employed both qualitative and quantitative methods. Quantitative analysis was achieved through Pearson's correlation analyses. The qualitative analysis strategy used for this research was thematic analysis that emphasizes on pinpointing, examining and recording patterns (themes) within data. It was in line with the one unstructured question. The analyzed data was presented by use of both statistical and graphical techniques.

V. RESEARCH FINDINGS

To assess the significance to apply value engineering techniques at early stages stage of construction projects in Rwanda, it was necessary to find out if the success of the appraisal Rugarama Park estate project depended on VE techniques adoption. It was also important to investigate how the respondents view those techniques and their level of impact towards the successfulness of the project. The following tables show how the respondent highlighted how values of Engineering Techniques and their effect on success of Rugarama park were based on planning, effective decision making, ability to identify opportunity and reduce cost without sacrificing requirement.

Table I: Correlation between planning and success of Rugarama Park Estate

			Planning	Success of RUGARAMA Park Estate
Spearman's rho	Planning	Correlation Coefficient	1	.855**
		Sig. (2-tailed)	.	.000
		N	65	65
	Success of RUGARAMA Park Estate	Correlation Coefficient	.855**	1
		Sig. (2-tailed)	.000	.
		N	65	65

**. Correlation is significant at the 0.01 level (2-tailed).

The evidences from the table above indicate that planning has a high positive correlation to Success of Rugarama Park Estate, that is equal to .855*and the sig. is .000 which is less than 0.01.

Table II. Correlation between effective decision-making and success of Rugarama Park Estate

			Effective decision-making	Success of RUGARAMA Park Estate
Spearman's rho	Effective decision-making	Correlation Coefficient	1	.812**
		Sig. (2-tailed)	.	.000
		N	65	65
	Success of RUGARAMA Park Estate	Correlation Coefficient	.812**	1
		Sig. (2-tailed)	.000	.
		N	65	65

**. Correlation is significant at the 0.01 level (2-tailed).

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The evidences from table 4.12 indicate that effective decision-making has a high positive correlation to the Success of Rugarama Park Estate, that is equal to .812*and the sig. is .000 which is less than 0.01.

Table III. Correlation between cost reduction without sacrificing requirements and success of Rugarama Park Estate

			Cost reduction without sacrificing requirements	Success of RUGARAMA Park Estate
Spearman's rho	Cost reduction without sacrificing requirements	Correlation Coefficient	1	.873**
		Sig. (2-tailed)	.	.000
		N	65	65
	Success of RUGARAMA Park Estate	Correlation Coefficient	.873**	1
		Sig. (2-tailed)	.000	.
		N	65	65

**. Correlation is significant at the 0.01 level (2-tailed).

The evidences from this table indicates that cost reduction without sacrificing requirements has a high positive correlation to the Success of Rugarama Park Estate, that is equal to .873 *and the sig. is .000 which is less than 0.01.

Table IV. Correlation between ability to identify opportunities and success of RUGARAMA Park Estate

			Ability to identify opportunities	Success of RUGARAMA Park Estate
Spearman's rho	Ability to identify opportunities	Correlation Coefficient	1	.801**
		Sig. (2-tailed)	.	.000
		N	65	65
	Success of RUGARAMA Park Estate	Correlation Coefficient	.801**	1
		Sig. (2-tailed)	.000	.
		N	65	65

. Correlation is significant at the 0.01 level (2-tailed), **Source: Primary data, 2019

The evidences from table above indicate that ability to identify opportunities has a high positive correlation to the Success of Rugarama Park Estate equal to .801 *and the sig. is .000 which is less than 0.01.

VI. CONCLUSION

Value engineering application in construction project appraisal is a consistent process that help to review a given project and evaluating its content to approve or reject this project, through analyzing the problem or need to be addressed by the project, generating solution options (alternatives) for solving the problem, selecting the most feasible option, conducting a feasibility analysis of that option, creating the solution statement, and identifying all people and organizations concerned with or affected by the project and its expected outcomes. It attempts to justify the project through analysis, which is a way to determine project feasibility and cost-effectiveness.

Success of a project, deciding on where and how a project will be built, completion of the structure according to desired design and building quality, within determined time and cost limits, have been identified to be possible with application of value engineering techniques at project early stages, therefore the techniques are completely in direct proportion to success.

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