APPLICATION OF VALUE ENGINEERING APPROACH: CASE OF HAWASSA CITY PUBLIC BUILDING PROJECTS

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This is to certify that the MSc. Thesis entitled ‘*’Application of Value Engineering Approach: Case of Hawassa City Public Building Projects*’’ was prepared by Abraham Dereje Tilahun, Id. No. PGCoTM 003/10 has met the required standard for submission in partial fulfillment of the requirement for the Degree of Master of Science in Construction Technology and Management at the Department of Construction Technology and Management, Faculty of Civil Engineering and Built Environment, Institute of Technology, Hawassa University.

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DECLARATION

I declare that this thesis entitled **"Application of Value Engineering Approach: Case of Hawassa City Public Building Project"** is my original work. This thesis has not been presented for any other university and is not concurrently submitted in candidature of any other degree, and that all sources of material used for the thesis have been properly acknowledged.

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List of Abbreviations

DoD	Department of Defense
DoT	Department of Transportation
EEA	Ethiopian Economic Association
FAST	Function Analysis System Technique
FHWA	Federal Highway Administration
FIDIC	Fédération Internationale Des Ingénieurs-Conseils
GC	General Condition
GDP	Gross Domestic Product
GSA	General Service Administration
HEW	Health, Education and Welfare
hr.	hour
IDA	Institute for Defense Analysis
IVM	Institute of Value Management
LCC	Life Cycle Costing
MDB	Multilateral Development Bank
OMB	Office of Management and Budget
PMBOK	Project Management Body of Knowledge
SAVE	Society of American Value Engineers
SNNP	Southern Nations Nationalities and Peoples
SPRINT	Strategic Program for Innovation & Technology Transfer
UK	United Kingdom
USA	United States of America
VA	Value Analysis
VE	Value Engineering
VECP	Value Engineering Change Proposal
VESA	Value Engineering Systematic Approach

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ABSTRACT

Value Engineering (VE) is one of the advanced project management technique having a solution for unnecessary costs, time delay and less quality achievements occurring currently in the public building construction sector. The purpose of VE is not reducing costs but increasing the value standards, making project easier and saving time. This thesis examines the application of VE in Hawassa City and is restricted to public building projects. The objective of the study is to examine the application and awareness of Value Engineering approach in the public building construction sector. There is also an identification of critical activities which are 20% of the total project activities but consuming the 80% of the total project cost. Two approaches were employed with data collection using questionnaire and case studies. Descriptive method was employed to narrate the study. The data collected was analyzed and critically assessed based on the responses of 38 experienced clients, contractors and consultants by using Statistical Package for Social Science (SPSS) tool. The result obtained indicate that there is an awareness on the approach of VE by 71.9% of the population in expert, knowledgeable and familiar level but the application at zero level, 0%. The major factors affecting VE applicability in the industry are habitual thinking & negative attitude on VE, believing it interrupts the normal schedule, outdated standards & specification, need of systematic approach and lack of culture to accept changes. There have been identified seven critical activities that incur the highest percentage of the total public building project cost. The top three trade of works are finishing work, concrete works for super structure and concrete work for sub-structure of buildings. In the future there is a willingness to apply VE by 49% and different requirements have been identified which measures the readiness to apply it like availability of professionals, organizational structure, client's requirement and government influence. This study is helpful in knowing the level of awareness, status the willingness of the stakeholders in applying the advanced technique and their factors for not applying.

Key words: Value Engineering, Unnecessary cost, Value standards, Critical activities

CHAPTER ONE

INTRODUCTION

1.1 Background

Construction industry's aim of project control is to ensure the projects finish on time within budget. Cost, time and quality are the main constraints in construction project. Out these, cost is the main concern which increase importance in value enhancement. Project controlling is managing and controlling factors that change or affect the project scope and budget. There are different project management techniques in construction sector for effectively monitoring the cost of a project, the delivery system, the quality of product & services having their own impact.

Cost is one of the primary measures of project success (Nega, 2008). One way of reducing or controlling construction cost is to implement Value Engineering (VE). Sherif (2015) explains VE differs from other conventional cost reduction activities because it is function oriented as it involves a searching analysis of the function of a product as opposed to just seeking lower costs.

Value Engineering is a systematic approach aimed to achieve the designed functions of product, process, system or service at a minimum overall cost and having maximum performance with consistency without in any way affecting quality, reliability, performance & safety (Lakshmana et al., 2018). When applied to construction, VE has many benefits for stakeholders of the industry, (Dell'Isola, 1997). Similarly, VE is a structured technique commonly used in project management. Some methods incorporated in VE include reducing production time, reducing expenses, increasing earnings, expanding market share, using existing resources more efficiently and improving quality.

Construction has its own budgeted project cost but, the industry is facing cost overrun as a major problem (Nega, 2008). Cost optimization has become a critical need for every industry to survive in this competitive environment. VE can be used to solve those problems also identify and eliminate unnecessary costs, while improving poor value, function and quality. VE can be applied at any stage of the construction project, however Scott (2016) said that the earlier it is applied, the higher return on time and effort invested. Even during construction is possible although some scholars argue that this stage can sometimes create the biggest risk.

The aim of VE is to increase the value of products (buildings), satisfying the building's performance requirement at lowest possible cost. Also, it has a purpose of providing each

individual with a means of systematically analyzing and controlling the total cost of the building. This helps the user able to define & segregate the necessary from the unnecessary and thereby to develop alternative ways of accomplishing the necessary at a proper cost. Controlling costs lead to monitor the cost overrun, variation order and quality of final product.

Cost control of construction projects by stakeholders at the level of project operations has remained ineffective largely due to inability of existing control systems to accurately predict. Then, VE helps to analyze the functions of the research objects which can identify and eliminate unreasonable and surplus function through functional analysis, then it will reduce cost and raise revenues.

There are various critical works which are gaining excess cost in projects. These need to be addressed by VE in order to achieve the requirements of the project constraints following Pareto's Law. Chougale (2014), states that VE is performed to eliminate any element or work that significantly contributes to the overall cost without adding value to overall function.

1.2 Problem Statement

In the context of Ethiopia, the construction sector is facing many problems like cost overrun, delay, poor quality, poor engagement and low satisfaction of stakeholders (Garomsa et al., 2019). As well Nega (2008) mentioned cost overrun is a major problem encountered by many contractors in Ethiopia. Also, in the sector it is usual that the actual cost of project work is more than estimated cost. In order to resolve these problems proper management, planning and controlling technique is needed in advanced way. Ethiopian construction industry is still dependent on conventional approach rather than using improved and modern construction management system (Garomsa et al., 2019). Good cost control technique would be essential to solve those problems and consequently, it is important to identify good cost controlling technique in order to make sure that a project gets its proper value and can maximize profit. Value Engineering is one those advanced techniques. So, Value Engineering is a low cost approach to assess the value of a project (Senay, 2013).

In Ethiopian experience a study on impacts of VE related practices on federal road projects and concept of VE & current project management practice in Ethiopia were done in Addis Ababa University by Daniel (2018) and Garomsa et al. (2019) respectively. However, total VE application level in construction sector particularly in public building is not seen. This research helps to fill the gap shown on status of application and awareness of VE. Also, figure to out the willingness level by the sector to apply VE. In construction almost all clients want to obtain

fully functional building completed in the agreed range of time, cost, quality and scope. The industry has to be amended by following the updated and advanced way of project management tools which VE is one of them. VE has the potential to fill this gap and satisfy Client's need as per the proper design & construction life cycle cost. In this research an effort has been made to fill the research gaps, determining the awareness & application level about VE, essentiality and willingness for adopting VE, factors affecting the applicability in the construction sector and to contribute knowledge on effectiveness on cost controlling by VE approaches.

1.3 Objectives of the Research

1.3.1 General Objective

The general objective of this research is to examine the application of Value Engineering approach in the construction industry on public buildings.

1.3.2 Specific Objectives

The specific objectives of the research are:

- To investigate the application of Value Engineering in Public Building Construction,
- To identify critical works incurring huge costs in Public Building projects and
- To determine the factors affecting VE application in Public Building construction.

1.4 Research Questions

To address the above objectives, the study will have the following specific questions:

- Is the Public Building construction sector applying Value Engineering?
- What are the critical works consuming higher cost in public building projects?
- What are the factors affecting the application of VE approaches in the sector?

1.5 Significance of the Study

According to the study conducted by Garomsa et al. (2019), the parties in the construction industry of Ethiopia has no know how about the concept of VE and has no willingness to practice such type of practices. Also as per the researcher's observation application and implementation of Value Engineering is rare in practice & invisible. So, this study tries to increase the importance of this approach (VE) in order to accomplish the necessary requirements of projects. By conducting this study, it allows to have an idea on VE prevention of poor value & qualifying customer's expectations & also gives a better understanding on how

VE eliminates unnecessary costs. The study aims to propose a framework for construction parties to effectively use VE application after exposing the critical factors affecting the application of VE.

This study tries to fill the gap of knowing the level of awareness by local contractors and clients and their future interest on applying this advanced technique. Basically, the critical trade of works which are incurring higher costs of the project will be identified by this study for recommending future taking care of budget allocations for those activities in order to target VE study. In this research work an attempt has been done to increase knowledge and information about VE application and for individuals who are interested to study further on VE. Besides this, it also provides the better suggestion in which type of approach is effective in Ethiopian Construction.

1.6 Scope of the Study

To address the research objectives stated above a review on VE approaches has been done using literature review, questionnaire and case study. This study is intended to show the relationship between VE application approach and value improvement of project by controlling unnecessary costs for successful completion of projects. Cost control is commonly used in every project, but the study focused on the assessment of awareness & application level. This study ascertains the willingness level of applying VE in local construction firms. The scope of the study has focused on Public building projects which are found in Hawassa City founded on construction in 2019. because government is investing higher budget on public projects in the city. So, those projects need to achieve the proper value with optimum cost by using VE. The main concern given for the public building is a less concern given by given than private sectors.

The research area Hawassa is a fastest growing city by construction in Ethiopia, then the study is impactful because the sources of the fund are from four different establishments like Federal Government, SNNPR, Hawassa City Administration and Sidama Zone Administration. This study tried to ascertain the level of awareness and application by reviewing the factors affecting the application level by local firms. Also, examining the level of readiness for using VE application is a main concern of this research referring other countries experience.

1.7 Research Organization

The research has five parts. The first part is concerned mainly on the introduction and general purpose of the study. The second chapter gives an overview of impacts of construction in a specific VE aspects on cost controlling approaches based on literature review. The third chapter deals with providing the outlines of the framework of the research goes through with the necessary data gained through the instruments. The fourth chapter focuses on analysis and discussion of the survey results and case studies to identify critical activities discussed in the second chapter by identifying the activities by Pareto's analysis. The last chapter includes the conclusion part of summarizing all the results, essential factors to be considered in VE applications also indicate the recommendations.

CHAPTER TWO

LITERATURE REVIEW

This chapter consists of the review of literatures that are related to this research objective. First, an overview of the different definitions and labels attached to the VE concept is presented, followed by a review on the history and developments of this application since its conception. Next, this chapter offers a hint on the functioning mechanism of this technique and mentions some of the various aspects commonly used with it. This is a quick description of the principles of VE that merely seeks to familiarize the reader with the technique. A wide array of literature is available on describing the VE methodology and its approaches. Thirdly, this chapter dives into the trace of VE within the construction industry, in order to start a closer connection between the theory and the practical objective of this research. Finally, this chapter concludes with the presentation of Ethiopian Construction industry experience relating with global countries.

2.1 Overview of Value Engineering

Application of new advanced techniques and technologies in the field of construction are essential. In a study prepared by Saganti et al. (2016), the construction sector need to be developed by using updated technologies. On the other hand, as Abraham & Abhijit (2016) explained construction projects are nowadays getting bigger in size day by day and it is becoming necessary to complete the project in planned cost and time. As Abraham & Abhijit (2016) said, it is very necessary to meet all the needs of customer through organized and creative approach and thinking to impart value by Value Engineering.

Value Engineering is an intensive, interdisciplinary problem solving activity that focuses on improving the value of the functions that are required to accomplish the goal or objective of any product, process, service or organization. It stands to a reason that is useful for development of building construction product (Saganti et al.,2016). According to Nayana & Gowrisankar (2015) and Saganti et al. (2016), ‘’Best Value’’ is represented by an item or process that performs the required basic function and has the lowest life cycle cost. Aminzadeha et al (2011) described, Value Engineering is a formal procedure and approach that can be used to ensure that hazardous waste remedial actions are accomplished in cost-effective manner.

2.1.1. History of Value Engineering

In 1947, a Design Engineer of General Electrical Company in USA known as a father of Value Analysis ‘’Lawrence D. Miles’’ organized the technique of Value Analysis while attempting to reduce the manufacturing cost of some products. His attempt was to search for unnecessary manufacturing cost and indicate the ways to reduce it without lowering down the performance or product during World War II (Annappa & Panditrao, 2012). Also Dell’ Isola (1987) said that the first use of Value Engineering in construction occurred in 1963 by Navy Facilities Engineering Command in USA. VE techniques originated in the United States, development and growth has taken place in United Kingdom and Europe during the past decades.

2.1.2 Fundamentals of Value Engineering

Prior to discussing VE meaning and aspects, it is important to understand the fundamentals of VE for better understanding.

2.1.2.1 Value

A paper of Dell’ Isola (1997) explained that Value is the most cost effective way to reliably accomplish a function that will meet the user’s needs and expectations. Also, in the study of Institute for Defense Analysis (IDA) (2006) there is a definition of value as a relationship between the worth or utility of an item (expressed in monetary terms) and the actual monetary cost of the item. The highest value is represented by an item with the essential quality available at the lowest possible overall cost that will reliably perform the required function at the desired time and place.

Value as defined by Society of American Value Engineers (SAVE), (1998), is the fair return or an equivalent in goods, services or sometimes even money for something exchanged. However, Dell'Isola (1997), indicated that three basic elements providing a measure of value to the user: function, quality and cost. These elements can be interpreted by the relationship indicated in the formula below.

$$Value = \frac{Function + Quality}{Cost}$$

Where:

‘’Function - the specific works that a design/item must perform.

Quality - the owner’s or user’s needs, desires, and expectations.

Cost - the life cycle cost of the product.''

2.1.2.2 Function

Ning (2015) stated that the definition as operating function of the country or the users about the project. IDA (2006) also described function as the purpose or use of an item or process, the consideration of function is the fundamental basis of the VE method. Department of Defense (DoD) (1994) also defined that Function is used to mean the action for which a thing is specially fitted, or used, or for which it exists.

DoD (1994) classified function into two:

i. Basic functions - are those performance features that need to be attained in the application under consideration. Also, known as primary functions and cannot be changed.
ii. Secondary functions - are an item's performance features that need to exist for the item to perform its basic function(s). they are supporting functions which can be modified or eliminated.

2.1.2.3 Cost

Ning (2015) put Cost refers to the construction cost and maintenance cost after use in the entire project or some part of it. In a study of Chitkara (2011), Cost is the budgeted expenditure which the client has agreed to commit for creating or acquiring the desired construction facility.

2.1.3 Definitions of Value Engineering

Various important definitions of VE have been proclaimed by different scholars and professional institutions as mentioned below. The definitions, like others, merely repeat almost important points but slight difference of insight into the concept. VE is a powerful problem solving tool that can reduce costs while maintaining or improving performance and quality improvements (Illayaraja & Eqayabal, 2015). Here are the definitions depending on their year of being recent and unique description:

SAVE (1998) also defined ''*Value Engineering is a professional team approach in its application-oriented functions and carried out systematically used to analyze and improve the value products design, facility, system or service*.''

Singh (2010) explained the definition of VE like ''*Value Engineering is an approach attempting to find the lowest cost way to perform the desired function rather that the lowest*

cost way of producing the product. Therefore, VE challenges; the very specification, design requirement and the design itself.''

Annapa & Panditrao (2012) defined ''Value Engineering *is the systematic application of recognized techniques which identify the function of the product or service, establish a monetary value for that function and provide the necessary function reliability at the lowest overall cost*.''

Urmila & Anil (2015) stated ''*Value Engineering is creative, systematic efforts described at analyzing functional requirements of a project for the purpose of achieving essential functions at lowest total cost over life span of a project*.''

Khaled & Pandey (2016) demonstrated that ''*Value Engineering is considered as a tool of construction management that can help companies to improve their procedures, services and final products readings the need of client's as an end user with respect to time, cost and quality*.''

Ramani & Pitroda (2017) defined ''*Value Engineering is a proven management technique that can make valuable contributions to value enhancement and cost reduction in construction industry*.''

There is no unique definition of VE but different authors have defined VE in their own perspectives as mentioned above. The researcher gave an attention on VE definition of SAVE international which guides the study because many countries are experiencing the methodology by following some regulations described by the professional institute.

2.2 Value Engineering Principles

The study of Farhani (2014) tried to illustrate some of the principles of VE, such as: systematic method for evaluating product performance & value, the use of multi-functional teams and focus on a simplified product. Again the paper also dictated that there are 3 goals of VE that we are looking for.

- Identify additional functions that are not attractive to customers.
- Add attractive functions for customers.
- Saving because of the elimination of redundant functions.

VE study is normally conducted by a team of members if multi-disciplinary experience and expertise (Xiaoyong, 2012). Also, the study includes three sessions; Pre-workshop, Workshop and Post workshop. Each session in turn has some phases. For instance; the workshop session

has three phases; Information & Functional Analysis, Creativity and Evaluation phases. It is generally recognized that Creative phase of the workshop is the most critical phase that determines the success or failure of a VE study because creativity techniques are applied to generate innovative ideas. There are many tools and techniques being applied in a VE to improve value. These tools include the FAST Diagram, Creative thinking technique, LCC (Life Cycle Costing), weighted scoring techniques and others (Ramani & Pitroda, 2017).

The purpose of VE systematic approach is to provide each individual with a means of skillfully, deliberately and systematically analyzing and controlling the total cost of product. This purpose of VESA is well serviced when the user is able to define and segregate the necessary from the unnecessary and develop alternate means of accomplishing the necessary at a lowest cost (Annappa & Panditrao, 2012).

2.2.1 Factors affecting Value Engineering

According to Ali et al. (2013) study, it has been studied different factors which have their own result in affecting the application or implementation of VE in the construction of Iran. Those factors are:

- Change in owners' requirements & Conflict of objectives by different project stakeholders
- Outdated standards and specifications & Habitual thinking and negative attitude
- Lack of local guidelines and information & Lack of knowledge and practices
- Interruption to normal work schedule & Over-design and overestimating
- Lack of culture to accept the change and
- Lack of communication and poor human relation

On the other hand Senay & Niyazi (2013) illustrated in their study that Value Engineering Applicability barriers are *Lack of local guidelines and Information, Lack of knowledge and practices, Interruption to normal work schedule, Change in owners' requirements, Conflict of objectives by different, project stakeholders, Outdated standards and specifications, Habitual thinking and negative Attitude, Lack of culture to accept the change, Over-design and overestimating, Lack of communication and poor human relations* and *Lack of inventive ideas*.

Additionally, in the study by Abraham & Abhijit (2016), there are various factors which have a great influence on VE study:

A. *Customer requirements* - The basic function of any product is to provide satisfactory performance to the customer as they are the prime importance of any business. While doing VE it is necessary to keep the basic function of the product or service same and also the functionality of the product should not change.
B. *Brand value* - This is also considered to be one of the important aspects as VE shouldn't hamper the quality of the product and thus affecting the brand value. Selecting the most appropriate material along with keeping up the quality of the product or service is important.
C. *Cost of material and labor* - The cost of material is the major 50% cost of total cost of the product. Hence, it is very important to consider reducing the cost of material by way of reducing wastages, substitution with alternatives without affecting quality and even adding some changes to the existing material.
D. *Systematic process approach* - The major problem for effective functioning of VE ideas needs a systematic process approach in the organization. If the methods in which the activities are done are not controlled and not systematic then the VE is of no use.
E. *Continuous Improvement* - The continuous improvement will ensure the stability of the organization and also much cost savings in the unnecessary cost.

2.2.2 Requirements for Applying Value Engineering

According to recent study by Aya (2017) Value Engineering applicability needs different requirements like; basically if the client need to study the documents by VE, knowing the importance of adding Value Engineering Change Proposals (VECP) clause in the Contract Document, Necessity of the presence of a Value Engineering Certified Personnel in design team or professionals availability, the necessity of providing Value Engineering training opportunities for experts and students, the necessity of improving the communication and social skills of engineering students during their study, the criticality to provide the emergence of a diversity of procurement routes for projects and the necessity of making clients more demanding and knowledgeable of the Value Engineering and Essentiality of updating standards and criteria in construction industry in the participants' countries.

Dell'Isola (1997) asserted that improving project value is the main objective of VE. Additionally, he stated that the project team should utilize VE to overcome poor project value and quality, including:

i. Lack of shared project information - like insufficient data on the function of stakeholders' requirements, which may include building materials and processes.
ii. Lack of ideas or failure to develop alternate solutions and then making choices based on economics and performance.
iii. Temporary circumstances - like urgent delivery, design or schedule circumstances which may force decisions that, while quick, are often incomplete with regard to value.
iv. Honest but wrong beliefs - Often decisions are based on what is believed to be correct rather than facts.
v. Habits and attitudes developed as a response to doing the same thing, the same way, under the same circumstances.
vi. Changes in stakeholders' requirements - which may cause costs to increase without awareness.
vii. Lack of communication and coordination - which become oftentimes reasons for unnecessary costs, and
viii. Outdated standards and specifications.

In this regard, VE helps isolate and focus new technologies and standards in areas where high costs with poor value may incur based on wrong or legacy information. Thus, VE can provide a framework for a rigorous review of project specifications and the requirements must be fulfilled before applying.

2.3 Value Engineering Approaches

As a principle of VE, the study of Aminzadeha et al. (2011) explained that VE focuses on function analysis of research objects and strives to achieve the required function reliable at a lowest life cycle cost to gain the best integrated benefits. Illayaraja & Eqayabal (2015) discussed about correct information and relevancy is the core for VE studies which are available from several sources including: Project documentation (studies, charts, specifications etc.), Owner/Designer, Field visits, Data costs & market quotations and the parties related to the project- project coordinator. The manual of DoD (1994), has an idea of the application of VE requires the analysis of function, the assessment of their relative need and the comparison of their worth to the cost of their achievement.

According to the research study by Ratnam (2013) and Kelly & Male (1993), there are four clearly identifiable and commonly employed approaches to Value Engineering. Briefly the four approaches are: -

1. The ‘Charette’

A process of putting concerted effort for utilizing the experience of professionals form diverse discipline with an objective of achieving a perfect design is known as Charette among design teams. Charette is conducted before start of actual design i.e. after development of a project brief and appointment of the design team. In this approach both customer and the design team sit together and try to generate ideas to address customer’s expectations with in 4 or 5 days.

2. The ‘40 hours’ study’

40 Hour Workshop is said to be the most commonly adopted approaches to VE. This approach is conducted for 5 days focusing on review of the design prepared by the client’s design team by the other independent team. This approach to VE is considered as quick and effective & usually conducted at the 35% of the product design phase. This workshop can also be conducted into the construction phase to exploit the experience of the constructor to seek VE solutions.

3. The ‘Value Management Audit’

A study of the proposals made by a subsidiary company, of a large holding company of the capital to fund a project. This study will be undertaken by a Value Management Team in order to ensure that the parent company is receiving value for money.

4. The ‘Contractor’s change proposal’

In this solution a clause in the construction contract allows the contractor to suggest changes to the proposed design in order to reduce the construction costs. The contractor receives a bonus in exchange for any accepted proposal.

Depending on the types of the approaches, different countries have their own experience on each approaches. But. Indonesian construction sector is more of concentrating on VM Audit. The 40hrs workshop is experienced in USA. Other developed countries also use the charrette approach like Japan. The contractor change proposal is appreciated by FIDIC for giving flexibility to the contractor to forward his best.

2.4 Procedure of Value Engineering

After identifying the high cost areas, its essential to form multi-disciplinary teams for more and better ideas generation, greater consideration to be given to the total impact of decisions on both facility and costs. All members of the team have to have no previous association with the design being studied. Also, each team should have one member from each of the major disciplines. One appropriate team has been selected, the VE job plan can be applied (Dell’ Isola, 1974). Also, Singh (2010) said that VE methodology is an excellent tool for aligning

stakeholders in a way that allows to make decision and get clarity on what is important and what is not.

Institute for Defense Analysis (2006) has discussed that there is a mechanism for guiding a study from inception to conclusion which can be applied to any subject, the so called VE Job Plan. By adhering to certain formalities, the VE job plan ensures that consideration is given to all necessary facets of the problem. It leads to establishment of an effective program aimed at the selection of best value alternatives. The job plan is normally organized by a value team leader.

Value Engineering study will be proceeded following different phases according to SAVE international guidance on VE Job plan. VE job plan defines the VE study procedure. The plan will go through six phases as figure 2.1 demonstrates.

1) *Information* – after random selection of the public buildings sites collecting all the available necessary documents needed in the project
2) *Function* – the function of every activity in the project has to be described to develop detailed understanding of what the project is supposed to accomplish.
3) *Creativity* – developing alternatives phase Using recommended well organized techniques such as Brainstorming and function-cost-worth analysis technique.
4) *Evaluation* – a phase of evaluating obtained ideas and reduce their quantity to short list of ideas to improve the project. Such as filtering non-beneficial ideas of works.
5) *Development phase* – critical one in providing information such as Sketches, narratives and discussions are prepared based on feasible alternatives to improve the value of the project.
6) *Presentation or recommendations*
    a. Identify the suggested different modifications

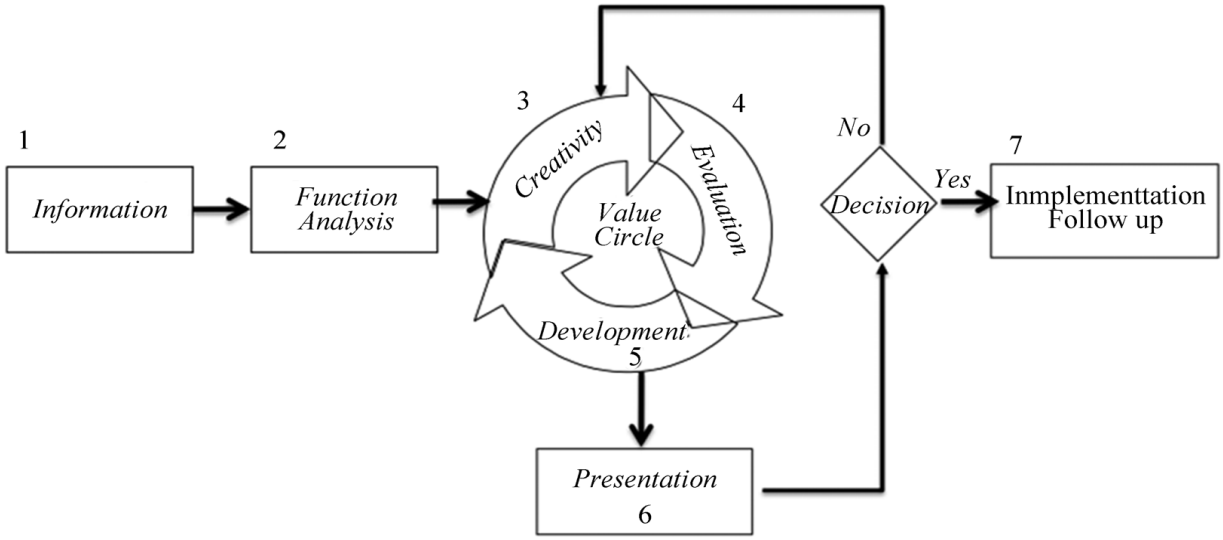

*Figure 2.1: Value Engineering Methodology, (*Abdulaziz (2007) & Arabiyyat (2016*))*

2.5 When to Apply Value Engineering?

Felipe (2011) study revealed that VE studies' effectiveness is closely affected by the timing of the study within the project life cycle. Accordingly, it was found that the earlier the timing of the VE study, the higher its potential for improving the value of the project. According to Davis (2004) study there are two factors controlling the correct time to apply a VE study: the **first** being the objective of obtaining maximum return from the VE effort and the **second** being a consideration of the ease or difficulty with which the study may be applied. Urmila & Anil (2015), explained that VE can be applied more than once during life cycle of construction project. Ning (2015) said that using VE methods to control costs in the most productive phase of VE – design phase bears great significance.

The study of Rane & Attrade (2016), said that the VE is applied in three stages. The *first* stage is Pre-study of VE having the purpose of planning & organizing the value study. The *second* stage is the Value study which is the core of Value Engineering study which need to be performed sequentially. The *third* stage is the Post study having an objective of assuring the implementation of the approved value study change recommendations.

Value Engineering should be performed as early as possible before commitment of funds approval of systems, services or design to maximize results, Dell'Isola (1997). On the other side Senay & Niyazi (2013), said that when VE is applied later, two things will increase; the investment required to implement any changes and resistance to changes. Also, Urmila & Anil (2015) explained that if the application of VE is done in later stages it may result in higher

project cost. Thus, the greatest benefit and resource saving is achieved in planning and conceptual stage.

Also, Potts (2008) said that since VE is generally undertaken at approximately the 30% stage, there is still a good opportunity to adjust the design before it proceeds to the definitive and detailed design stage.

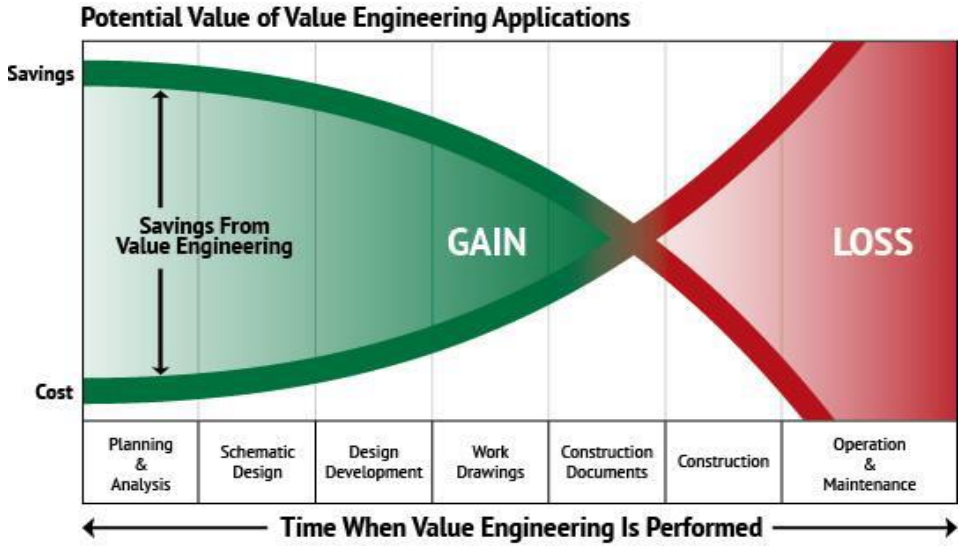

*Figure 2.2: When to Apply VE (*Source: https://architizer.com/blog/for-manufacturers/get-specified-value-engineering)

2.6 Why Need to Apply Value Engineering?

Project must have a high ‘’Value’’, purpose, time, quality and cost of every activity that will be realized during the construction process must be determined beforehand, (Senay & Niyazi, 2013). A study of Tohidi (2011), The fourteenth meeting of "Value Engineering Society" which was introduced in 1973 suggested that for every one dollar invested in management, Value Engineering projects obtained about $4.53 savings in administrative costs. These figures show the savings rate of 1.8 billion dollars at the end of 1973. According to Ramani & Pitroda (2017) study, about 5% to 10% reduction in construction cost can be achieved using VE in building construction.VE is an efficient tool for fostering the construction quality with an aim of low cost and high services (Nayana & Gowrisankar, 2015).

Approximately $43 million (6% financial saving) and 12 months of time (which is 17% of work time reduction) were saved in total by VE works (Senay & Niyazi, 2013). A research by Janani (2018) also identified that by applying VE concepts in the project, it can be used to reduce money, solve problems, make profit in the project, routine review on site, attain project

objectives, select best alternatives, reduce Life Cycle Costing, planning at tender stage and align resource efficient & effective.

Value Engineering can be applied for various aspects: few uses are explained by Abraham & Abhijit (2016) study like;

- It can be used for reduction of unnecessary costs on existing project.
- It can help in determining the possible alternatives which are best for the project.
- The schedule of the project which was delayed due to uncertain situations can be improved.
- Whenever there is threat for risk in project VE can help in reducing risk.
- It is imparted for better quality, reliability and satisfaction of all the needs of customer.
- The performance of organization can also be improved to a better extent

The main focal point in VE is reduction of material cost (Abraham & Abhijit, 2016). Also, Sharma (2017) stated that improvements of quality and reliability of the product focusing on functions are the main significance of VE. Urmila & Anil (2015) explained the advantages of VE: to determine best design alternative, to reduce cost, to identify problems & develop solutions for them, to improve quality, to increase reliability, availability and to save time. Illayaraja & Eqayabal (2015) stated that VE can improve decision making that leads to optimal expenditure of owner funds while meeting the required function and quality level. Also, Ramani & Pitroda (2017) explained that VE application deliver better quality, faster completion, environmentally friendly practices and less waste generation.

Summary of VE Benefits for Project Participants

According to Abraham & Abhijit (2016), it is necessary to have a better value for stakeholders to their project. The value in this case can be different for all concerned parties. Bad VE will be noticed but the good VE, end user shouldn't know even its existing (Sammer, 2018). According to Senay & Niyazi (2013), using VE helps the sector because construction process has many components such as concept, design and drawing details of the project and it is a long term production, the risk of completion on time based on estimated cost by providing features such as quality, durability, usefulness, continuity, feasibility, compliance, image and management convenience increases.

When it comes to Client's side; profit maximization, qualitative improvement of futures & resources, increasing customer satisfaction and to reduce the cost are impacts of VE (Singh,

2010). Also, owners want to know which feature they will have after the building is completed and with what cost they will have it, Senay & Niyazi (2013). Abraham & Abhijit (2016) also stated that client needs to get maximum gains as possible. From contractor side also, he would always try to complete his work in the lowest possible cost.

According to Ahmed & Pandey (2013), Value Engineering has different importance like:

a) Simplification of methods and procedures resulting in less recurrent costs and a more efficient process.
b) Better communication and understanding of the project's objects - responsiveness to client's priorities.
c) An opportunity for client to formally participate in the design process.
d) Improved communication between parties.

As well as Sharma & Kumar (2017), illustrated the benefits of VE: lowering operation & maintenance costs, improving quality management, improving resource efficiency, simplifying procedure & minimizing paperwork, increasing procedural efficiency, lowering staff costs, optimizing construction expenditures and developing value attitudes in staff.

2.7 Application of Value Engineering

As Sherif et al. (2015) study shown the top significant factors affecting the performance of construction projects are Change order, Change in the design and Errors in the design, Current economic situation deterioration, Delay projects and rising prices of materials. Dell'Isola (1997) said that VE gets closer to cost control because it looks at ways to reduce costs on specific items or activities. Both Nayana & Gowrisankar (2015) and Saganti et al. (2016) studies have shown that the application of VE yield a better value when construction is approached in a manner that incorporates environmentally sound and energy efficient practices and materials. The optimization of resources is demand increasingly needed day after day because value becomes application engineering approach to projects for development under severe global competition, especially if knew that the application of VE in results to reduce costs and development & improvement of ranged between 5% to 15% (Illayaraja & Eqayabal, 2015).

Scott (2016) reported that there are three stages of a project and VE's application which are described below.

1) Planning – at this stage there are additional benefits to be gained from VE workshop. An independent team can: review the program, perform a functional analysis of the facility, obtain the owner definition of value, define the key criterial and objectives for the project, verify or validate proposed program, offer alternative solutions and verify if budget is adequate for the developed program.
2) Design – this the stage that most VE participants are used to becoming involved, when the design has at least made it to the schematic stage. The primary tool available to the VE team is the workshop – typically a 40 hr. session.
3) Construction – during this phase VE is still possible through the use Value Engineering Change Proposals (VECP). Contractors can be provided monetary incentives to propose solutions that offer enhanced value to the owner.

   Architect or Engineer must be brought in to the decision making process to agree to the proposed change as not having any negative impact on the overall design and building function.

2.7.1 Value Engineering Misconceptions

Chougule et al. (2014), stated that the practice of this technique (VE) requires a certain amount of expense which may get justified by potential cost savings. According Illayaraja & Eqayabal (2015), VE is confused with cost cutting exercises in construction industry. The essential difference between conventional cost cutting and VE is that it involves reducing cost by improving the functionality through lesser consumption of manpower, materials and machines (equipment).

The study of Singh (2010) says that if you lose the designer intent in adding or removing features, it is not VE, it is redesigning. So, take care. Again this study illustrates the difference between VE and Cost cutting. Here it is tabulated below in Table 2.3.

Table 2.1: VE vs Cost cutting difference

	Value Engineering	Cost Cutting
It is	Function based	Equipment based
Focus	Poor value functions	Big cost items
Results	Increased value	Scope reduction
Optimizes	Overall design	Local design
Clarifies	Client requirements	Nothing

Mukti et al. (2018) explained that the concept of VE is the reduced cost of product or services involve engineering principles. These technique attempt to achieve at least the same quality as planned at minimum cost. Therefore, VE is not:

i. Cost cutting process – lowering cost by sacrificing quality & appearance
ii. Design review – correcting the results of an existing design
iii. Correct errors made by the planning error
iv. Reduce costs by lowering the unit price, quality

2.8 Value Engineering in Building Construction

2.8.1 Aspects of VE in Construction

Value Engineering's first application to construction process was in the 1960's but it became widespread in the 1970's especially by the public sector bodies (Olawuyi, 2017). Nayana & Gowrisankar (2015), also said Value engineering has its origin in the manufacturing industry, its methodology has been well developed for use in the construction industry. Milladi & Yamini (2016) stated the main cause of using VE concepts in construction projects are high project implementation cost, high distance between design and implementation, difficult implementation of construction projects, high complexity of construction projects, lack of primary information in construction projects, advancement of employed technologies & improvement of standards in construction projects, creativity, honest but wrong primary beliefs, changing rules & regulations, changing Client's need, changing technical characteristics of design, changing the employed resources.

Public buildings are any type of building that is accessible to the Public and is funded from public sources. All types of governmental offices are considered public buildings (bizfluent. com). Many of these public buildings services are free to residents. For example; Public schools, Libraries, Courthouses, Post offices. In the design phase of Federal building development, properly applied VE considers alternative design solutions to optimize the expected cost or worth ratio of projects at completion (Dell'Isola, 1997).

Construction companies are pressured to deliver projects at a lower cost while maintaining performance on design functions. Keeping costs low with traditional methods has been a common practice to improve competitiveness. Saving money at the same time, providing better value was everyone's emphasis. VE is such a systematic application of recognized techniques

which identify the function of a product, establish monetary value for the function with lowest overall cost (Rane & Attrade, 2016).

The realization of whole-life value for a building project involves finding optimum combinations of initial project costs, maintenance cost, and cost associated with the time for completion of the project. Value engineering is technique directed towards analyzing the functions of an item or process to determine "best value" or the best relation between the cost and value (Nayana & Gowrisankar, 2015).

Dell'Isola (1997) described that in large agencies, expect program (VE) costs of 0.1 – 0.3% of total project costs for an effective program. These funds should result in a minimum of 5 -10% saving in initial costs and 5 – 10% follow-on cost savings in annual maintenance and operation costs. Also, Abraham & Abhijit (2016) explained that there is much unnecessary cost which comes throughout the lifecycle of the construction. To solve this problem, Xiaoyong, et al (2012) said that application of VE to the cost control in construction sector can get the target of reduction of costs. Nayana & Gowrisankar (2015) helped this idea by stating, the function analysis is carried out with the help of FAST tool and the projects study deals with a step by step process in order to reach out better quality.

The rate of utilizing value by using VE in construction field had savings equivalent to one billion dollars in 2000 in projects of buildings, highways in USA (Tohidi, 2011). The objective of VE in construction is to achieve the necessary functions with the lowest project life cycle cost. This may be done through the use of new material, creative design, simplified construction process, innovative construction method, reduced construction cost and time, improved construction quality & safety and minimal environmental impacts (Xiaoyong, et al, 2012).

2.8.2 Implementations of VE in Construction

According to Felipe (2011) study a number of key factors must be considered when applying the Value concept to the construction industry. First, it is essential to identify the parties who affect the costs of construction projects. Secondly, experience shows that the determination of points during the life cycle of a construction project where VE is used is closely related with the kind of payoff it may offer. The construction industry has not been exempted from VE's proliferation. In fact, several public works organizations around the world currently utilize VE for the inception and development of infrastructure projects and the benefits drawn from it have been so significant that governments have even enacted laws to make it mandatory among their executive agencies.

In addition to performing VE studies during the development and design phases of a project, VE principles can also be applied during the construction of the project through Value Engineering Change Proposals (VECPs). Provisions for VECPs encourage contractors to develop VE proposals, so that the State would eventually benefit from a contractor's design and construction ingenuity, experience and ability to work with new techniques (Felipe, 2011).

Ashworth & Hogg (2007), explained in their study, the popularization and application of VE in construction industry completely destroy or eradicate the problems of long construction period, poor quality and high cost. The focus of cost control must be balanced with the importance of value in terms of what is being provided for a client. If the cost control is to be effective, then any changes might affect the contract should cost prior to instructions being issued to the contractor. The cost control of construction project mainly lies in the investment decision-making stage, design stage and the implementation stage during construction (Ning, 2015). SAVE (2007) pointed out Excess cost control requires to be maintained throughout the project life of building.

2.9 Cost Control and Value Engineering

2.9.1 Cost Controlling Principles

Cost is one of the primary measures of project success (Nega, 2008). Saving money at the same time providing a better value is a concept that everyone emphasizes (Nayana & Gowrisankar, 2015). They mentioned also, project control includes both progress control and cost control. The Malkanti et al. (2017) study has discussed that in order to achieve success in a project, it would be essential to plan that project well and have a proper monitoring mechanism in place. Cost overrun is a major problem encountered by many contractors in addition to causing many other problems to all the parties involved. Good Cost Control technique would be essential to solve those problems.

According to Dhawadler (1985), cost control can be achieved by selecting the right man for the right job, the right equipment and tools for the right work and the right quality of materials, in the right quantity from the right source at the right price and deliver at the right time. Abraham & Abhijit (2016) also stated that the production cost is always a major concern and it has to be reduced for achieving a better reduction in the overall cost of project, either in material or equipment cost etc. Cost types need to be managed in construction are material,

inventory, production and procurement (Sammer, 2018). So, Wong (2015) study said that cost control has different aims like:

a) Best use of resources to gain the good value for money during the design and construction process
b) Controlling measures exercising in the design and construction processes to ensure the total construction cost or final sum doesn't exceed the client's approved budget
c) Cost as an element of design during the design and construction processes to achieve a suitably balanced costs throughout all parts of the building.

The control of the project cost is not an easy task as it requires knowledge on the application of cost controlling techniques (Malkanthi et al, 2017). Although, Ramani & Pitroda (2017) solved this by explaining that VE is one of the most effective techniques to identify and eliminate unnecessary costs in building design, construction, operations and maintenance. Dell' Isola (1974) research also supported the above idea as VE uses an organized approach to isolate the elements having the greatest bulk of unnecessary costs with the objective of developing lower cost alternates. Reducing costs without requiring a cut in high - priority amenities or affecting integrity of the end product is crucial in any construction project and VE is a key way to accomplish this (Ruig, 2017).

The basic premise of VE is that a certain amount of unnecessary cost is inherent in every design (Potts, 2008). A study of Nayana & Gowrisankar (2015) states VE gets closer to cost control because it looks at ways to reduce cost on specific items or activities. However, it doesn't look at the total project picture, it focuses only on specific items in the designs, procurements or construction area.

2.9.2 Poor Value

Dell'Isola (1997) study said that each reason for poor value provides an opportunity for improved decision making and an area where a VE effort is appropriate. Abraham & Abhijit (2016) study identified that there are many aspects which can impart poor value to the project.

1. Proper information is not considered as there is time shortage.
2. Whenever there is a problem some adjustments are done and the problems are tried to be solved which lacks the quality.
3. Sometimes the requirements and needs of the customer are not taken in to consideration and after the completion of the projects it lacks its function for which was meant to be.
4. No proper communication has been done and few aspects are misunderstood.

Poor value leads to extra cost without maintaining the necessary function. According to Annappa & Panditro (2012), the following are some of the more common reasons for poor value:

i. Wrong beliefs, insensitivity to public needs or unfortunate experience with products or processes used in unrelated prior applications.
ii. Lack of information, usually caused by a shortage of time. Too many decisions are based on feelings rather than facts.
iii. Habitual thinking, rigid application of standards, customs, and tradition without consideration of changing function, technology, and value.
iv. Reluctance to seek advice, failure to admit ignorance of certain specialized aspects of project development.
v. Risk of personal loss, the ease and safety experienced in adherence to established procedures and policy.

2.9.3 Critical Trade of Works

The cost control of construction project mainly lies in the investment decision making stage, design stage and implementation stage during construction. It aims to control the project investment with in the approved cost quota and correct deviation at any time to ensure implementation of project investment objectives (Ning, 2015). Therefore, choosing VE scheme is in essence to pick out a design scheme that is qualified, reliable, with low cost in whole life cycle and can well realize the function of the engineering. Potts (2008) says ideally, every design decision should be subject to VE, but 80% of cost is often contained in 20% of the design decisions. On building projects, services in particular account for a very large percentage of the overall cost (28 – 40%).

The VE team comprises of a cross-functional team and it is necessary for all the key expertise to be in the team for the best outcome of the VE study. The method of selecting critical areas will result in the success of VE. it is necessary to select the critical high cost area so that we can have better outcomes. Also, before selecting the areas it is essential to categorize into prominent categories so that it will give us better idea to select from the most appropriate categories (Abraham & Abhijit, 2016). Dell'Isola (1974) said that an initial step to identify the unnecessary costs is an understanding of Pareto's Law.

Vilfredo Pareto, an Italian economist created a curve known as Pareto's Law of Distribution in 19th century. The law shows that for any area, a small number of elements (20%) account for a

great percentage of the costs (80%). In this case, it can be determined that a small number of elements will account for a great percentage of the unnecessary costs, (Dell'Isola, 1974). The application of Pareto Law 20/80 states that around 20% of the functions constitute around 80% of the cost. These functions are the subject of Value Engineering (Attrade & Rane, 2016).

2.9.3.1 Pareto Analysis in Construction

Pareto analysis is a tactical decision making technique that identifies a limited number of input factors as having a greater impact on outcomes; positive or negative. Pareto analysis can also be used as a project management tool. A Pareto diagram or chart can be used to present the analysis, helping the project team on the inputs with the greatest impact (Dell'Isola, 1974).

2.9.3.2 Pareto's Law Analysis

In a study by Mukti et al. (2018) there is an explanation of identifying budget plan of the total jobs in the building will look for the value of the largest costs in VE will be whether it can provide cost efficiency by using the method of execution or new materials. Identification of cost values that will be of VE use Pareto's Law analysis in its determination. Here are the test steps of Pareto's Law:

1. Collecting data from financial documents
2. Sort the cost of the work from the largest to smallest
3. Sum total cumulative cost of work
4. Calculating the percentage of the cost of each job
5. Calculating the cumulative percentage
6. Plot cumulative percentage.
7. Form Pareto diagram

Singh (2010) illustrated that the time to use Pareto Analysis for the purpose of prioritizing potential causes of a problem and identifying improvement opportunities.

2.10 Global Experience

Sesmiwati et al. (2016) journal explains that in the current globalization era, substantial improvement in both technical and management aspects constitute an inevitability in all kind of industry, including Construction. Felipe (2011) mentioned in his study, VE is not a new invention. It has a long and successful history that spans more than 50 years, back until the days of World War II. Sesmiwati et al. (2016) also added an idea that a number of countries

have witnessed the successful applications of VE in the construction industry. Dell'Isola (1997) said that an initial study was conducted in 1965 by the USA, DoD to determine the sources of opportunity for VE. The global development of VE began in the 1960's with the spread of VE techniques by North American subsidiary companies to principally Europe and Australia (Felipe, 2011).

IDA (2006) described in its book, since its inception the VE concept has proved to be so successful that today it is practiced throughout the world, with many organizations dedicated to its use and promotion. According to Dell'Isola (1997), approximately twenty-one (21) countries have active VE. SAVE International Chapters are also located in Korea, India, France, Germany, Hungary, Saudi Arabia, and Australia. In addition, there are currently programs throughout Europe, Canada, South America, Taiwan, and South Africa (Dell'Isola, 1997).

Both public and private sectors have benefited from its implementation. In fact, several public works organizations around the world currently utilize VE for the inception and development of infrastructure projects and the benefits drawn from it have been so significant that governments have even enacted laws to make it mandatory among their executive agencies (Felipe, 2011).

Therefore, for pointing out the international experiences this literature review part will be done separately for developed and developing countries. Felipe (2011) study said that the long history of VE and the innumerable examples that support its enhancing attributes for managing projects have led to the emergence of several standards, guidelines and laws, which regulate its use throughout the world. Due to its VE origin, USA has been selected, England created Value Management, China has the most top ten contractors in the world and Saudi Arabia is growing fast on using advanced technologies.

2.10.1 Developed Countries experience

2.10.1.2 United States of America (USA)

Laurence Miles went on to form SAVE (Society of American Value Engineers) with a number of other individuals in 1959. Miles early VE was based on his 1961 Job Plan. Stage four of Miles Job Plan was later enhanced with the development of the Functional Analysis System Technique (FAST) diagram developed by Charles in 1964. By the 1970's Miles early work had been developed into a three pronged process carried out in the confines of the Miles Job Plan

with the FAST diagram (Felipe, 2011). The Americans maintain a comprehensive record of the savings achieved by VE in every project. In the USA, the classic VE exercise is a 40-hour workshop attended by the value manager and an independent design team. The findings are reported to the client and project manager for further action/implementation (Potts, 2008).

VE in the USA is basically a design audit. It consists of a 40-hr workshop structured loosely around a job plan. It is carried out at 35% design by an external team. It involves the selection of high cost areas and the generation of alternatives to them. The selection of high cost areas is a fairly loose procedure. The technique of function analysis bears little or no relationship to the output of the study. Almost all VE activity in the USA is government work (Construction Management New Directions book). Elias (1998) explained in his study that the use of VE in the United States expanded widely in 1993 with the introduction of two bills making the process mandatory on all government programs. In 1996 President Clinton signed into law an act obliging all executive agencies to establish Value Engineering procedures – the estimated savings for 1996 alone were forecast at $2.19Billion.

The FHWA's *Fiscal Year 2008 Value Engineering Accomplishment Report* identified successful practices States across the country (USA) are using to enhance and improve their VE programs. In addition to highlighting the more than $2 billion in savings on transportation projects obtained in 2008, this report asserts that the VE process can also shorten project times, encourage innovation, lower life-cycle costs, and improve quality. In terms of the timing for VE studies, an increasing number of States are opting to conduct the study prior to the completion of preliminary designs (less than 30% of design completion) for design-bid-build projects. For major projects costing more than $500 million, a few States described their process for conducting multiple studies. For example, Pennsylvania would conduct three VE studies, timed at the 30%, 60%, and 90% design stages. For the 2008 report, States were also asked to share information regarding successful practices that encourage implementation of VE proposals after the award of construction contracts (Felipe, 2011).

2.10.1.2 United Kingdom (UK)

A research of Felipe (2011) stated that in the UK, VE in construction evolved in the late 1980's. VE activity in UK construction led the publication of a European Standard for VM (Value Management) authored by a Consortium of the various value associations throughout Europe. Within UK, the Institute of Value Management (IVM) is currently developing systems and procedures, ethics and standards. Kelly & Male (1993) said that VM is more prevalent in

European context and is considered to encapsulate a broader scope, commence deeper and be more strategically focused within the client organization.

The climate of the 1990s in UK construction was therefore right for the development of innovative systems such as Value Management. A training and qualification system entitled Value for Europe has been configured with its own European Governing Board. The quality surveying system provided all the accountability that was needed. The North American Value Engineering process was adopted in the UK on a modified basis rather than on franchise basis. This adoption resulted in a number of modifications to the Value Engineering process. Kelly and Male (1993) were one of the first researchers and authors on a UK Value Engineering process suggested four stages of Value Engineering process.

The European standard EN 12973:2000 "Value Management" was approved by CEN (Comité Européen de Normalisation – European Committee for Standardization) on October 7th 1999. Even though its application is not meant to be compulsory, it endorses the use of good practices in management at all levels, be it strategic, organizational and/or operational (Felipe, 2011).

2.10.1.3 China

VM was introduced in China in 1978 as per Hongping & Xuwei (2013) study. The use of Value Engineering in China has grown significantly in the last twenty years (Xiaoyong Li et al., 2012). According to Ning (2015), there is certain difference in both the theoretical research and practical application of VE in construction industry compared with other countries. VM has been identified in government surveys as being their second most famous management methodology. Its use has now however has declined sharply in the absence of support from the formally state owned companies in the recent transaction to the market economy.

Application of VE in the construction industry in China is still in the initial launch stage concepts and applications of value engineering do not seem to be well embraced by China construction industry. One possible reason was a lack of knowledge transfer when local subcontractors might have been excluded from the VE programs. Although generally there is a strong belief that future prospects of VE in Chinese construction industry are positive, a number of impediments still stand in the way (Li and Ma, 2015).

2.10.1.4 Saudi Arabia

Value Management (VM) was adopted by the Saudi Public Sector (SPS) during the 1980s. Saudi Arabia has adopted the traditional USA VM approach and utilized it without

contextualization. VM is conducted once during the project lifecycle at the schematic design stage or later.

The Saudi Public Sector has considerable VM experience, also VM are mandatory in all projects financed by the Saudi's government. Utilization of VM brings substantial benefits as a road map to be used for establishing sustainable construction principles. The experience and skills of people who work in the VM sector can be exploited and can be turned to accelerate the understanding and implementing of sustainable development. The principles and techniques of VM can provide the required quality at optimum whole life during the process of developing a project.

2.10.2 Developing Countries

2.10.2.1 India

According to Annappa & Panditrao (2012), in India VE is mostly associated to any alternative design with the intension of cost cutting exercise for a project. A study by Mansoor & Abuesef (2015) revealed some experiences in India by VE which is explained below in the Table 2.2.

Table 2.2: Application of Value Engineering on different construction projects in India

Project	**Findings and savings**
Seven story building of the Institute of Pathology, New Delhi by CPWD Project	• Saving of 9.2 lakhs i.e. about 8% of the total project cost. • Some changes have been increase • And many more recommendations in design and etc.
Police housing Scheme at Delhi	• Optimum use of interior space was analyzed and in turn the livable area was increased by about 4 %. • Improvement in specification has made which cost additional 12.80 lakhs, which was about 2.4% of the project cost
Higher secondary school Building in Najafgarh, Delhi	• Total cost saving of the project was Rs.11.87 lacks, which was 6.6 % of the total project cost. • Improvements in the some of the finishing items were improved.
Hiranandani Gardens projects Residential complex at Powai, Bombay.	• In this project the cost saving is about 8-10% of total project cost. • With this VE project, it became possible to deliver the project on time with the highest quality.
Large building complex on the north of the Mehrauli Badarpur road in Delhi.	• Architecture, planning has been modified at eight-storied blocks with two basements. • This decision helps in reduced cost, Optimum utilization of site adhering to the maximum permissible FAR, ground coverage regulations and parking space.

2.10.2.2 Nigeria

VE technique is totally new in Nigerian Construction industry with no much records of its practice while most clients and professionals in the industry are ignorant of the techniques and the numerous benefits to be derived from its application. The term “Value Engineering” is not very popular among professionals in Nigerian Construction Industry. Although the concept is observed to be incorporated in the cost control and reduction approaches being adopted by some of the professionals in the Industry. The most adopted approaches in practice are modified

forms of the Design and/or Construction Audit, the Package Review or a combination of the two and the Contractor's Change Proposal.

No Value Engineering Team is known to exist in practice in Nigeria, while the sampled professionals are yearning for an involvement in an organized Value Engineering Team or Workshop. There is a study observing that unlike the practice in United States of America and the United Kingdom, Value Engineering is practiced in Nigeria is engaged in only as a later thought. Mostly born out of the need to reduce the cost of construction (Olawuyi, 2017).

2.10.2.3 Indonesia

Sesmiwati et al. (2016) said that VE was introduced in Indonesia in 1986 through seminars and workshops. Also, the study of them has shown Indonesian experience in tabular form shown below.

Table 2.3: Indonesian Experience

Year	Major historical development
1986	VE was introduced through seminars and workshops.
1990s	Informed that several government projects have implemented VE methodology and VE Contractor Change Proposal during this period but there has been no authentic evidences published or official document stated the activities
2006	Association of Indonesian Value Engineering Expert (*Himpunan Ahli Value Engineering Indonesia* – HAVEI) was established.
2007	Ministry of Public Work issue a regulation No. 45/PRT/M/2007 stating a mandatory for VE study for specific public building projects at design stage and a VE Change Proposal can be proposed by contractor at tendering process.
2008	Ministry of Public Work issue a regulation No. 06/PRT/M/2008 stating that VE methodology can be applied for any indication of inefficiency in construction and working method.
2015	Ministry of Employment issue a decree for National standard of Competency for Value Engineering expertise (*Keputusan Menteri Ketenagakerjaan No. 159 Tahun 2015*)

As mentioned in the study VE application in Indonesia is very limited. This may be caused the number of VE study applied in project are little as well. In Jakarta (Indonesia) there are regulations on value engineering (VE), but the implementation in construction project somehow still grows slowly.

2.10.2.4 Ghana

The concept of VM is in the route of finding a niche in the construction industry in Ghana. Currently, the state of VM adoption in Ghana is not satisfactory. As this was evident in the preliminary survey of the Antwi (2015) study, 10% of the 80 respondents indicated that their companies undertake internal VM studies within the construction project and 8% also indicated that their firms do provide VM services. These inadequate figures call for concern.

The Kruskal-Wallis test confirmed that, the awareness of VM and its application in the Ghanaian construction industry is low. In descending order of ranking, the significant strategies as indicated by all the respondents are; development of a successful application model in the context of construction; clarifying clients' perceptions about VM, creation of VM workshops for construction professionals, creation local guidelines and data on VM techniques, and application of effective techniques and tools in VM (Kissi et al, 2015).

2.10.2.5 South Africa

Value management was introduced to South Africa (SA) in 1968 by *Union Carbide.* Van Heerden, an engineer who was part of this group, realized the potential of the process and, after further study in the USA, established his own value management enterprise in South Africa. *The Value Engineering Management Society of South* Africa (VEMSSA) was established in 1997. At present *VM Services (Pty) Ltd*, a South African company, uses value management as a process to facilitate decision making (Staden, 1991).

Value management is currently implemented to a very limited extent in the construction industry. Clients only currently implement value management to a very limited extent on a structured independent basis to construction projects and/or it is offered as a service by quantity surveyors to an equally limited extent. The reasons are probably as follows: clients are generally not familiar with the technique of value management and the benefits to be derived therefrom. Quantity surveyors generally have the wrong perception of the approach and techniques of value management; and quantity surveyors will have to be equipped with special skills to enable them to offer value management as a professional service (Sigle et al, 1999).

2.11 Ethiopian Construction Industry and VE

Ethiopian Construction Industry is lagging behind in meeting the project management principles. Because, the industry is still plagued with cost overrun, late completion and delay schedule (time overrun) (Garomsa et al., 2019). Nega (2008) research has explained that Public construction projects in Ethiopia are parts of the country's development initiative. It shared considerable amount of the country's scarce financial resources. In Ethiopia, the construction industry is the highest recipient of government budget in terms of government development program. Consequently, public construction projects consume an average annual rate of nearly 60%, according to MoWUD, (2006), and 58.2% according to Wubishet, (2004), of the government's capital budget.

The construction industry has important contributions to the Ethiopian economy, as demonstrated by its share in the GDP. For instance, the share of the sector in the total GDP averaged at about 5.2% in the period 2002/03- 2006/07. So, this sector has to maintain its value through advanced technologies for improvements and growth.

Since, Ethiopia is a country in transition from public sector dominance to private sector, the share of public sector in the economy has been significant in the construction industry, though gradually declining. Construction activities in Ethiopia are generally financed by government budgets and private equity capital, NGOs and banks. Government budget finances public infrastructures and other public constructions such as schools, clinics, etc. (EEA, 2008).

While Ethiopia has long history of project management and building construction experience like Axum Obelisk in 4th century & others, the industry is not growing as expected and is not adopting latest project management approaches. To overcome those problems in the sector, applying VE is necessary as it is practiced in many countries (Garomsa et al., 2019). Stakeholders are not interested to practice VE and they don't have knowhow about the principles. The study of Garomsa et al. (2019) has shown, VE principle is the cost of construction can be reduced and even the quality can be improved. However, the parties in the study (Contractor, Client & Consultant) were not focusing on the alternatives of reducing cost.

In research of Dawit (2018) described that the Value Engineering in ERA documents like; The Ethiopian Roads Authority adopts the FIDIC 4th edition general conditions in the majority of its government financed projects and the FIDIC, MDB Harmonized edition general conditions in its projects financed by different financial institutions such as the African Development Bank and the World Bank.

This also worthwhile to mention here that the FIDIC Conditions of Contract has also provisions for application of VE clauses in the contract document. Clause 13.2 of the Conditions of Contract for Construction (for Building & Engineering Works Designed by the Employer, 1999) states that "*The Contractor may, at any time, submit to the Engineer a written proposal which (in the Contractor's opinion) will, if adopted, (i) accelerate completion, (ii) reduce the cost to the Employer of executing, maintaining or operating the Works, (iii) improve the efficiency or value to the Employer of the completed Works, or (iv) otherwise be of benefit to the Employer.*

The proposal shall be prepared at the cost of the Contractor and shall include the items listed in GC Clause 13.3 (Variation Procedure).

If a proposal, which is approved by the Engineer, includes a change in the design of part of the Permanent Works, then unless otherwise agreed by both Parties:

i. *the Contractor shall design this part,*
ii. *sub-paragraphs (a) to (d) of Sub-Clause 4.1 (Contractor's General Obligations) shall apply, and*
iii. *if this change results in a reduction in the contract value of this part, the Engineer shall proceed in accordance with Sub-Clause 3.5 (Determinations) to agree or determine a fee, which shall be included in the Contract Price. This fee shall be half (50%) of the difference between the following amounts:*

    (i) such reduction in contract value, resulting from the change, excluding adjustments under Sub-Clause 13.7 (Adjustments for Changes in Legislation) and Sub-Clause 13.8 (Adjustments for Changes in Cost), and
    (ii) the reduction (if any) in the value to the Employer of the varied works, taking account of any reductions in quality, anticipated life or operational efficiencies.

However, if amount (i) is less than amount (ii), there shall not be a fee."

It is also worth mentioning that the FIDIC Conditions of Contract for EPC/Turnkey, 1st edition (1999), and Conditions of Contract for Design-build and Turnkey, 1st edition (1995), also allow for a Value Engineering under clauses 13.2 and 14.2 respectively. Clause 13.2 of the EPC/Turnkey states as "The Contractor may, at any time, submit to the Employer a written proposal which (in the Contractor's opinion) will, if adopted, (i) accelerate completion, (ii) reduce the cost to the Employer of executing, maintaining or operating the Works, (iii) improve

the efficiency or value to the Employer of the completed Works, or (iv) otherwise be of benefit to the Employer.

2.12 Summary of Literatures

VE has different perspective on different people. Understanding the priorities from the financial matrix will help to understand and identify the scope and long cost for successful project for all stakeholders. A project cost can be reduced with the advancement of new material, new technology, invention of new methodology. A good design will have quality, appearance, useful life and functional performance. If any of these have been decreased or increased in order to achieve different things or to save cost a technique must be applied, this process is what we call Value Engineering.

Value Engineering is an organized, creative, cost search technique for analyzing the function of a product with the purpose of value enhancement without compromising its quality, performance and efficiency. VE was first philosophical but L.D. Miles brought to systematic approach in 1950's. Value is the relationship between the client need and the resources that we need to accomplish it, client's need is function. VE helps to identify the areas which are not customer satisfaction features, neither quality nor use, nor appearance. VE and Cost cutting has difference in a way that VE; optimizes the overall design so the complete design may be changed and Cost Cutting; only on fixed design to do minimal cost. Also, VE uses different tools to improve value like; FAST, LCC, Creative thinking technique etc.

VE can be applied in Planning, Design and construction stages but maximum benefits can be derived if we use VE at the design stage. There are different factors affecting its applicability like customer requirement, habitual thinking, lack of culture to accept changes are helpful for this research which balances the Ethiopian experience with Iran. We need to apply it from the beginning and it is continual process from Scope setting, design management, construction and aside management. VE is conducted by a team of members following the methodology procedures called Job Plan having different six phases. The VE cycle to put it into practice is; Pre-study presentation, information gathering phase, creativity & idea generation, evaluation & selection of ideas, functional analysis and lastly decision & final recommendation with report.

VE has goals of adding features without adding cost, deducting features that are not critical in achieving ''design intent'' and determine best design alternative. Pareto analysis (20/80 rule;

what 20% works are leading 80% of the project cost) helps to prioritize potential causes of cost consuming activities for better result in VE study.

Value Engineering occurred in Construction in 1963 by Navy Facilities Engineering Command, USA. Different factors affect the application of VE like customer requirements, cost of material & labor and so on. VE has four (4) approaches helping systematic analysis and control of the total project cost. They are; Charette, 40-hour workshop, the VE Audit and the Contractors Change Proposal approaches.

VE has been applied worldwide and there are so many stories of experiences in different countries like developed (USA, UK, Saudi Arabia, & China) also developing (India, Nigeria, Indonesia, South Africa). It has been learnt form the literature review that in USA and Saudi Arabia, there is an obliging law to establish VE procedures which is on contrary in UK, its application is not meant to be compulsory but believed that it's a good practice. In China, VE is identified the 2nd most famous management methodology by government surveys but their construction industry didn't embrace the application well because of lack of knowledge as a reason. But, VE has a bright future prospects in China.

In Nigeria, VE is not popular, no records of its practice and stakeholders are ignorant of the technique but uses the adopted approaches. On contrary in Indonesia VE study is mandatory by issuing regulation for Public building projects by using VECP. But, the implementation is low. On contrary with USA & UK, in India, VE is considered as alternative design. They formed an association as South Africa. South African implement VE to a very limited extent because of stakeholders' wrong perceptions of the approach. In Ghana, the adoption is not satisfactory along with the awareness is very low.

When compared Ethiopian experience with the developing countries on VE application, there is much difference in forming associations, accepting the approach as a management technique and making a law to enforce using VE in contractual documents. with The reasons for not applying the VE approach in developing countries lower than developed ones are probably as follows: clients are generally not familiar with the technique of value engineering, not knowing critical benefits VE generating, giving less concern.

2.13 Research Gaps identified

Value Engineering has been practiced for a half century in the construction industry with an aim to produce innovative ideas and solutions for enhanced project value. Surprisingly, limited

researches have been done on how to reutilize the ideas and techniques generated in previous VE studies for future projects and share the VE knowledge in the industry.

The research of Nega (2008) described referring MoWUD, 2006 that in Ethiopia, the present state of the construction industry falls short of meeting domestic and international quality standards and the performance demand expected from the sector. At present Public Sector Clients are increasingly dissatisfied with the service they receive from contractors and design professionals due to unforeseen & intangible reasons. This is leading the government to lose much cost over a single project and the project is facing cost overrun & time overrun.

The motivation for this research arose from personal observation of the fact that the necessity of modern construction technology techniques in the sector to improve the visible defects of construction project management for completion on time with budgeted cost satisfying the required quality. The industry has to be amended by following the updated and advanced way of project management tools which VE is one of them. VE has the potential to fill this gap and satisfy Client's need as per the proper design & construction life cycle cost.

In this research an effort has been made to fill the research gaps, determining the awareness & application level about VE, essentiality and willingness for adopting VE, factors affecting the applicability in the construction sector and to contribute knowledge on effectiveness on cost controlling by VE approaches. Also, research evidences support my idea that VE exercise can achieve 15-20% savings in cost of goods and services, when it is employed in the concept and design stage (SAVE, 1997).

Researches show that VE principles are widely used throughout the world; developing and developed countries. However, in Ethiopia, according to the researcher's view, there is no available published information on the extent & application effectiveness. In Ethiopia, MSc study and one journal have been done on ''Impact of VE on Federal Road projects'' and ''Concept of VE & Current project management practice in Ethiopia'' by Dawit (2018) and Garomsa et al. (2019) respectively. Both the literatures don't cover and provide the application level and applicability approach. So, this research will fill the gap identified.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter includes the research methodology of the study. In more details the researcher outlined the research design or strategy, the research method, the research approach, the methods of data collection, the selection of the sample, the research process and the type of data analysis. Three approaches were utilized to conduct this study: a comprehensive literature review, questionnaire survey and case study.

3.2 Study Area

The study has been conducted in Hawassa City. Hawassa city is a located in southern part of Ethiopia in Sidama Zone on the shores of Lake Awasa in the Great Rift Valley. It is located 271km south of Addis Ababa. The town serves as a capital of SNNPR. Figure 3.1 demonstrates Hawassa City map.

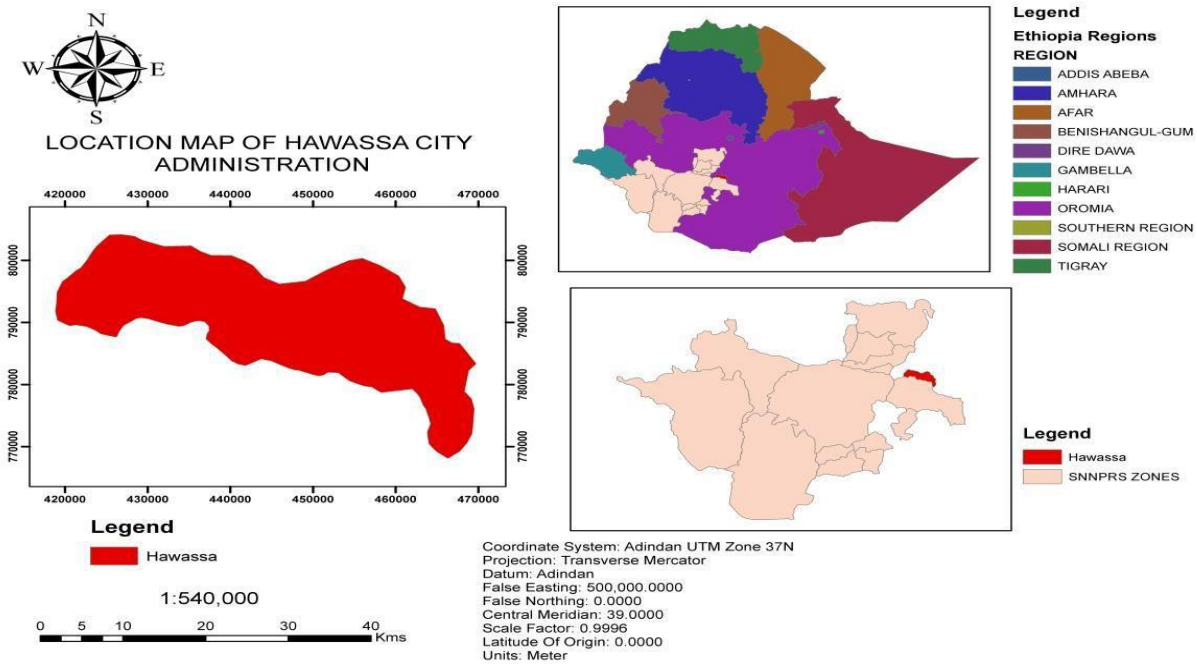

Figure 3.1: Diagrammatic representation of Hawassa City

3.3 Research Design

It is making a research efficient for getting maximum information with minimal expenditure of effort, time & budget. It is very crucial that selecting the ways of analyzing the research questions & finding ways how Value Engineering plays a major role in building construction. The research is about assessing the application status of VE approach in building construction

sector and evaluating the factors affecting its application previously. Also, if it is not used to know the interest of applying it. Further, the development and success of the research mainly depends on the methodology selected. This study tries to increase the knowledge about VE and its aspects in eliminating unnecessary costs and poor value. It has a visible impact on knowing the industry status on advanced techniques of project management.

This part describes the research methodology adopted for determining the effective application of Value Engineering approach in Public Building Projects located in Hawassa City. The main aim of this research is to improve the building construction process by applying VE principles and create awareness to adopt it. The framework planned targets to address the research objectives.

The research approach is descriptive research design deploying both qualitative and quantitative approach. The qualitative approach seeks an answer from the questions and explain them, as well helps to clarify concepts through reviewing literatures & documents. The quantitative approach also be an assessment of previous payment survey through document analysis and gathering factual data. Being descriptive helps to know critical trade of works through Case study and information through survey.

3.4 Methods of Data Collection

This design has referred to a set of methods and procedures describing variables. The study has been conducted by finding the primary data and secondary data. The stage of finding secondary data from Literature review which is conceptual framework & theoretical perspective approach is done. It developed from a detailed review of literatures relating to the subject of Value Engineering and the existing problem of applying it causing poor value & unnecessary costs in Public buildings.

As a primary data, a set of questions prepared & put as a Questionnaires. The questions were based on the literature review and awareness that the building projects possess on VE, how VE can be applied in the industry, the willingness to adopt the technique, the importance of the application, etc. The questionnaire included both closed and open-minded questions giving opinion based comments. The responses for the structured parts of the questionnaire based on Likert's Scale of five ordinal measures (from 1 to 5) for reasons of providing simplicity for the respondents to answer and to make an evaluation of the data easier.

Additionally, for getting primary data, there is Case study discussion on purposely selected public building projects located at Hawassa City and necessary data was collected from the organizations for this desk study. It is done by having full financial records or Bill of Quantities of three public building projects either completed or on-going under construction projects found in the city which are funded by each Clients i.e. SNNP Region, Hawassa City administration and Sidama Zone Construction office. This enabled the researcher to assess and identify the critical trade of works and giving an idea for future management before applying VE study & to give special concern on those areas for minimizing time of study and efforts. Whilst the number of case studies are limited, most public projects founded in the city are homogenous, it can provide an in-depth insight to VE approaches using Pareto's analysis and most projects have the same ways of cost estimation.

The critical step is Data Analysis & Discussion. It is a stage of writing up the content of the research and information obtained and compare with the theoretical information. There is a final draft corporate analysis and discussions. Finally, conclusion has been done depending on the research outcomes and respondent's opinions on the subject of VE. And recommendations have been given on the application and adoption possessions.

To address the research objectives, it is critically important to develop a research guideline process like Identify the factors, methods and strategies through literature review, Collect data through case study (review of data) and Develop results and recommendations. the Statistical Package for Social Science (SPSS) and Microsoft Excel were the tools used for organizing the data and performing data analysis.

3.5 Sources of Data

The sources of the data are desk study, questionnaires and case study. The research has used the data sources to produce the following basic documents: respondents' documents and archival documents. The respondents' documents were collected using questionnaires from Clients, Contractors and Consultants. The survey questions were closed ended Likert's scale and contingency formats.

The literature review provided a good basis for preparing the questionnaire. The questionnaire has five (5) sections. The first part consisted of questions about the general profile of respondents. The second one was compromised of questions to test the level of awareness of the parties about VE approach. In the third section questions were developed to examine the application level of VE techniques. The fourth & final parts of the survey investigated the

factors affecting its application and requirements for future applying on public building projects.

3.6 Population and Sampling Technique

The population of this research are local Hawassa City Public building projects which are currently on construction, current contractors, private or public consultants and clients which are purposively selected. Purposive sampling is a useful sampling method which allows a researcher to get information from a sample of the population that one knows most about the subject matter. This sampling technique helps the study to choose the population, the project price range and for distributing the questionnaire equally. In this research it is decided to study the whole population of public building projects which are on currently under construction, therefore the sample size for the study is equal to the population size. From the population the questionnaire was distributed to all the projects selecting participants from each and participants from the clients' side.

The proposed study area is Hawassa City which can help to face different project types. The population of the Contractors will be Grade 1 up to 4 General Contractors because their experience level of adopting new technologies and ability of constructing highly budgeted projects. In the selected population, the standards vary from grade to grade then the sample included under the study will be those who are able to show their data of previous payment.

The research samples are taken from stakeholders in the building construction sectors which are selected based depending on their direct exposure to public building construction activities. The selected public owners are Regional agency of SNNP construction office, Sidama Zone constriction office and Hawassa City Administration construction department which are employed in Hawassa City. Building projects with contract amount greater than 25Million birr were a criterion for selecting the projects for case study. The major reason for selecting these amount of contracts is in order to limit the population in to an affordable size for the study. Therefore, this study was conducted on twenty-two Public building construction projects that are being constructed by construction firms and the population includes Hospital buildings, Apartment blocks, Educational buildings, Police offices, Low cost housings, SNNP prison and Cultural center.

3.7 Methods of Data Analysis

The researcher examined all completed questionnaires. The information gathered through this survey has been processed and reported as a descriptive narration. The results can be presented in charts, graphs and tables. Both qualitative and quantitative analysis technique was applied. In the analysis the ‘’Frequencies’’ and ‘’Mean Score’’ method is adopted to establish the relative benefits of VE, factors affecting its application and requirements to apply VE for public building construction projects in Hawassa City. The Likert’s scale is used to calculate the mean score for each input that is used to determine the relative ranking.

The mean score for each variable of VE is computed by using the following formula;

$$MS = \sum(f*s)/N \quad \text{(3.1)}$$

Where, MS – mean score

F – frequency of responses for each score

S- scores given to each factor (from 1 to 5)

N – total number of responses concerning each variable

The case study:

This part of case study approach is dependent on scrutinizing the financial document of public building projects in order to identify the critical 20% activities incurring higher costs which mainly consumes the 80% of the total project cost. This has been done based on Pareto’s Law and can be explained in tabular form and with graphs.

Descriptive statics method was used to analyze the responses in quantitative manner. Frequencies were used to figure out how many times something occurred and the finding were presented in a table. Percentages were easier to interpret in the analysis. The findings were presented in the form of pie chart or bar charts to help understanding easily.

Finally, a conclusion and recommendations will be discussed about the total application of VE and its aspects for future building sector improvement in adopting a better project planning process and management.

CHAPTER FOUR

ANALYSIS AND DISCUSSION

This chapter presents the results obtained from survey study and desk study in Hawassa City Public building construction project on application of Value Engineering approach. The objectives of the research revealed in first chapter to determine the application level of VE, factors affecting its application, its benefits when applied, critical trade of works incurring higher costs or budgets and readiness to apply the technique.

The results obtained from the questionnaire were analyzed using Statistical Package for Social Science (SPSS). It is a windows based program that can be used as an analytics resource. It allows to gain fast and accurate insights into their data for improved decision making and simplify analysis. A summary of analyzed results is presented in the form of frequencies, percentages, mean index and range. The researcher adopted list wise deletion to deal with missing data to allow for a sound or good data analysis, as proper holding of missing data is critical. Because, the missing data were not functions of the outcome variable which has no effect on the result obtained from the survey.

4.1 Questionnaire Findings and Discussion

4.1.1 General Profiles of Respondents

Detailed questionnaires were designed and a self-administered 51 questionnaires were distributed to organizations to achieve the described objectives of the research in Hawassa City stakeholders which are Client, Consultant, and Contractor. The organizations were selected purposively based on the data gathered from the particular clients who are currently participating in on-going public building projects. Among those 38 questionnaires were properly answered and returned by respondents.

The overall response rate for the survey was 38 respondents out of 51 which is 74.5% and this rate is accepted as adequate because it can be seen as a true representation of the total population which is only 22 projects are going on under construction in public building now. The respondent participation rate 18 (47.4%) was Contractors, 14 (36.85%) for consultants and 6 (15.8%) for clients. Therefore, most of the respondents were contractors.

4.1.2 Experience of Respondents

Experience is one of the most important factor that might affect the person's perception and way of looking and understanding any project phenomena. Hence, the variable experience was investigated by the researcher with respect to the job title of each organizations and the data is presented in the Table 4.1.

A cross tabulation of results was done for organization job titles and experience aspects of the respondents which is shown below in Table 4.1. It defines the six targeted groups plus an additional item for those outside these groupings. It enables respondent's responses to be classified in to six professional groups so as to establish if different targeted groups differ in respect to awareness, expectation and application of VE.

*Table 4.1: Job title * Experience Cross Tabulation*

Job Title			*Experience*			*Total*
			1-5 years	6-10 years	11-15 years	
Job title	Project Manager	Count	0	1	4	5
		% within Experience	0.0%	20.0%	40.0%	13.5%
	Site Engineer	Count	2	0	2	4
		% within Experience	9.1%	0.0%	20.0%	10.8%
	Architect/designer	Count	0	2	0	2
		% within Experience	0.0%	40.0%	0.0%	5.4%
	Office Engineer	Count	18	0	4	22
		% within Experience	81.8%	0.0%	40.0%	59.5%
	Construction supervisor	Count	2	0	0	2
		% within Experience	9.1%	0.0%	0.0%	5.4%
	Resident engineer	Count	0	2	0	2
		% within Experience	0.0%	40.0%	0.0%	5.4%

Total	Count	22	5	10	37
	% within Experience	100.0%	100.0%	100.0%	100.0%

In order to ensure that the respondents are able to provide the research with a good ability to give response, respondents position and experience was also inquired. The results in the above table indicated the majority of professionals from each stakeholder especially from the contractors and consultants are Office engineer respondents. Their involvement has the frequency of 18 (81.8% of experience count) by 1-5 years of experience and 4 (40%) by 11-15 years of experience. This had almost 60% of respondents and it is also the most prominent profession in the industry. This helps the study that VE is done mostly in office manner, the respondents will be able to know easily about it. Projects managers follow this with frequency with 5 (13.5%). Also, the results have shown the higher amount of professionals' experience fall in to 1-5 years. This reflects the industry is engaging more less experienced personnel compared with the age of the building construction era. Person's profession or job title do have a bearing on his/her personality on giving responses and so ways of looking at the problem. In other words, the person's response to a given question is possible determined by the type of job he/she is engaged.

4.1.3 Satisfaction of Clients

The aim of this section is to check whether clients are completely satisfied with the service they are receiving from the building construction industry or to know their level of satisfaction before discussing about VE. All respondents were asked to give opinion based response for the clients' satisfaction level because all of public building construction sector participants first aim is satisfying client's requirements. As it is known that VE is an advanced construction management technique and having different benefits for successful completion of projects based on client's requirement basically for satisfaction of him. Customer satisfaction has become one of the key issues for companies in their efforts to improve value and quality in this competitive environment. The respondents have given their response by rating from Highly satisfied, Satisfied, Average satisfied, Less satisfied and Not satisfied which is demonstrated in the Table 4.2 below.

Table 4.2: Satisfaction Level of Clients

	Frequency	*Percent*	*Valid Percent*	*Cumulative Percent*
Highly satisfied	2	5.3	5.6	5.6
Satisfied	9	23.7	25.0	30.6
Average satisfied	21	55.3	58.3	88.9
Less satisfied	4	10.5	11.1	100.0
Not satisfied	0	0	0	
Total	36	94.7	100.0	
Missing	2	5.3		
Total	38	100.0		

Public sector clients' satisfaction will be affected by the service they receive from contractors and consultants, due to unforeseen and intangible reasons. It can be concluded from the above Table 4.3 that most participants replied that clients are average satisfied by the service they are getting from the building construction industry with 55.3%. Then in the second place satisfied with the services is 23.7% followed by less satisfied with 10.5%. This shows clients are satisfied with the services they receive but the main aim of project management is to enhance the satisfaction level and reach at highly satisfaction level. This is an indicator that needs a new technique of project management.

4.1.4 Awareness on Value Engineering

4.1.4.1 Familiarity with Value Engineering

The aim of asking respondents their familiarity with the term of Value Engineering is to know the level of awareness. The Figure below (fig.4.1) shows the frequency on their perception of the term.

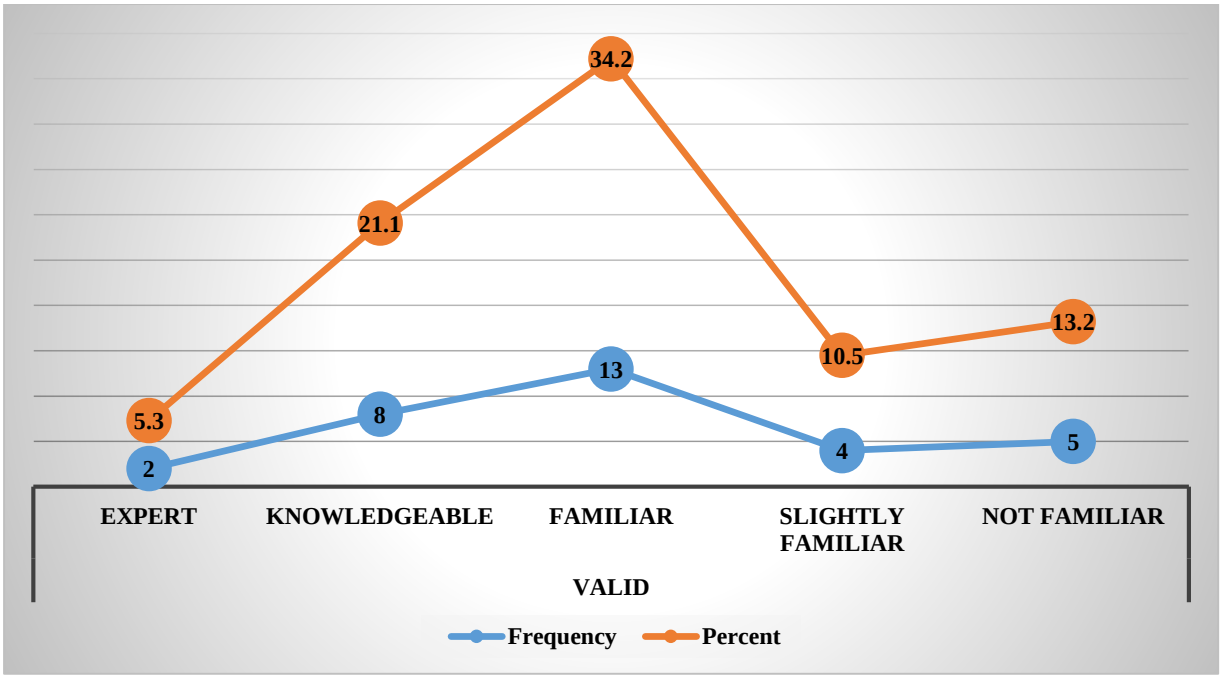

Figure 4.1: Familiarity with Value Engineering

The above Figure 4.1 shows the majority of the respondents are familiar with the Value Engineering approach with 34.2% of the total population. Also, the 21.1% of the respondents are knowledgeable and only 5.3% of them are an expert level familiarity. In addition to this, 10.5% and 13.2% of the population revealed that they are slightly familiar and not familiar of the term respectively. This shows majority of the population are familiar which also indicates the respondent's ability to give important responses. Here the response rate contradicts with the literature review of Garomsa et al (2019) that most construction activity participants in Hawassa city have knowhow about VE with 60.6%. Garomsa et al (2019)'s study concentrated on Ethiopian level and said that there is no awareness totally on VE but this research revealed that VE is familiar with the public building sector participants in Hawassa City. Even though it is a good rate that most stakeholders know about Value Engineering, the quarter percentage of the population don't know much about it. This indicates a special attention must be given to the approach to be known by all public building construction sectors. Also, this study tried to investigate more about VE awareness by asking different survey questions which are indicated below.

4.1.4.2 Value Engineering Contribution

In the survey a question was asked to know the respondents point of view on the contribution of Value Engineering in minimizing the growing of cost overrun, delay on completion time of

projects and elimination of unnecessary cost in building project. This question targeted to show the industry's perception on the technique if its applied or implemented by stakeholders.

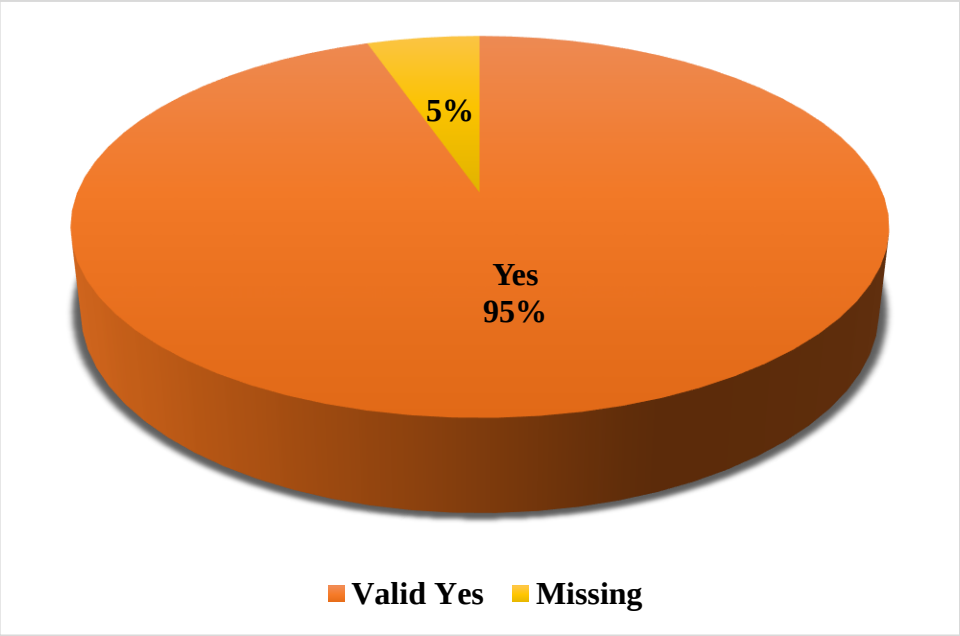

Figure 4.2: Value Engineering Contribution

It is resulted that almost all participants believe the great contribution of Value Engineering approach in minimizing the current construction problems with 94.7% and 100% with valid percentage which relates with the study of Illayaraja & Eqayabal (2015) that Value Engineering is a problem solving tool. Even there was no a response which shows VE can't contribute. This is a basic outcome that needs a special concern on VE application in every projects.

Also, this research has founded additional contributions of Value Engineering mentioned by some respondents from their opinion on the survey question ''if Yes, how?''. They provided their comments like:

- ✓ Value Engineering focuses on iron triangle (Cost, Quality & Time) & as it is a systematic technique helps to calculate the iron triangles,
- ✓ It reduces the cost & increases the value or the function of a project,
- ✓ When we apply Value Engineering we focus on subjectivity matter of the project so we can select different alternative materials with low cost & can make the building functional,
- ✓ Eliminate the unnecessary cost without causing any effect on the work procedure,

- ✓ Its engineering profession helping to minimize project cost by using construction project schedules, engineering design standards & monitoring or evaluating the project on contract administration process,
- ✓ Activities unnecessary incorporated during design & document preparation which inevitably causes extra cost could be eliminated,
- ✓ Saves time and
- ✓ It optimizes project cost which is the critical aspect of a project.

Also, one respondent recommended to give a special concern on its contribution and then apply it. The above responses are also one indication that the respondents have awareness about VE.

4.1.4.3 Value Engineering Training

As Value Engineering is an advanced technique and needs some program on training professionals or hiring Value Engineer in the construction firms. This research aimed to know the status of respondents on getting training about VE. The Figure 4.3 below demonstrates that the survey result.

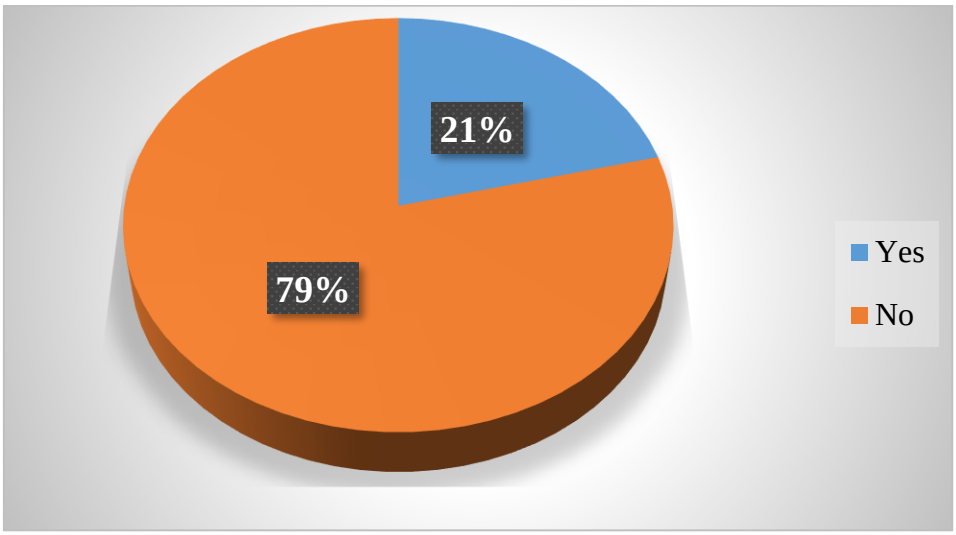

Figure 4.3: Value Engineering Training

The above Figure 4.3 reveals that the majority of the respondents have not participated in VE training. Also, it indicates the necessity for giving intensity efforts on creating awareness on the approach, benefits and outcomes of VE. Out of the population who participated in the training 21%, gave some explanations on their duration of training time like: half semester, around 3 months. This research found out the possible reasons for not participating in the trainings could be as a result of not getting the chance or opportunities to trainings and

workshops on VE concepts in the construction industry and nobody prepared training on such issues.

4.1.4.4 Necessity of Value Engineering Application

In this part of the survey, a question was given to participants for gathering information about VE necessity as a new technique for controlling cost in project management. The question targeted to know their level of agreement by Likert's scale by Strongly agree, Agree, Neutral, Disagree and Strongly disagree. The respondent gave their response and tabulated below in Figure 4.4.

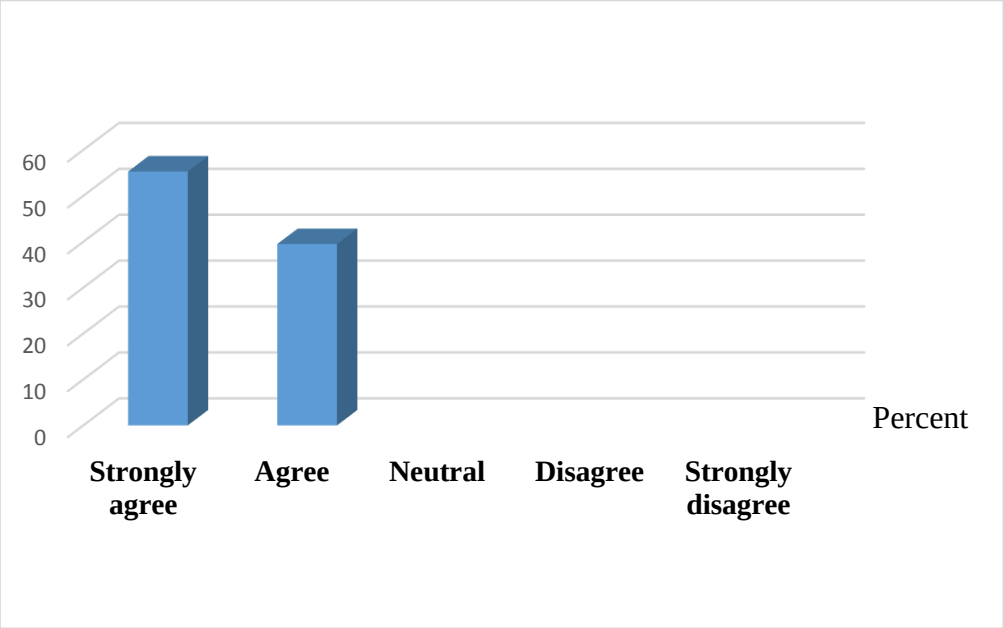

Figure 4.4: Necessity of Value Engineering

Value Engineering has the potential to fill the gap of the building project problems and satisfy client's need. As Sanganti et al. (2016) said, the sector needs using an advanced technology. From the given options in the question the majority of respondents gave their response as strongly agree by 55.3% and 39.5% by only agree. As all respondents gave their opinion on VE contribution, it is similar here that all respondents agree cumulatively on the need for utilization or application. The other options are not even picked. This shows how VE is in a need by the industry. The responsible parties must see this. The study of Nayana & Gowrinsakar (2015) and Sanganti et al. (2016) agree with this research result in application of VE yield better result. Again on the same manner, Ashworth & Hogg (2007) mentioned the popularization and application of VE can completely destroy the problem of construction.

4.1.4.5 Benefits of Value Engineering

Participants of the survey were asked a question on benefits of VE in Likert's scale rating format by ticking each inputs given in the table based on their importance level by saying '*'not important, less important, fairly important, important and very important*'' from 1 to 5. This question was asked to determine benefits generated by applying VE approach as a project management tool and advanced technique. It helps to determine the prominent benefits which VE results based on respondents' perception and experience.

The respondents indicated their perception on the benefits of VE. The mean scores for each of these were calculated and presented below in Table 4.3. This shows that the perceptions or responses lean towards a certain input.

Table 4.3: Benefits of Value Engineering

Inputs	*N*	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Eliminate unnecessary costs	35	4	5	4.71	.458
Save time	35	3	5	4.37	.690
Improve project quality	35	2	5	4.31	.900
Align resource efficient & effective	32	3	5	4.31	.592
Increase customer satisfaction	34	3	5	4.29	.760
Reduce operation & production costs	34	2	5	4.06	1.013
Simplify methods & procedures	35	3	5	3.97	.822
Identify problems & develop solutions	34	3	5	3.94	.814
Mitigate risks & reduce satisfaction	34	2	5	3.71	.906
An opportunity for client to change in design	34	2	5	3.59	.988
Better communication for responding client's requirement	34	2	5	3.59	.988
Valid N	32				

The general consensus among respondents' response illustrates that there is the benefit of using VE as a considerable use of project management tool. Based on the above results, there is a confirmation on eliminating unnecessary costs is the major benefit of VE application with 4.71 mean score. Unnecessary costs can be experienced in different ways which is described in the

literature review like failure to obtain the value of the project leads to extracting cost overruns and unnecessary costs. Construction projects require the elimination of these costs on prior level. This research survey also got the outcome overcoming those unnecessary costs is an important aspect by using VE to improve the value of the project.

As we can see from the above Table 4.3, the major benefits of applying VE are saving time, improving project quality, aligning resources effectively & efficiently, increasing customer satisfaction and reducing operation & production costs which matches with the research of Urmila & Anil (2015) and Abraham & Abhijit (2016). So, the survey result matched with the literature reviews. On the other hand, this research founded the following extra benefits which are collected from respondents of the questionnaire survey. So, it can be concluded that there is a good awareness level about VE in Hawassa City than Ghana. Kissi et al (2015) said that the awareness level of Ghana construction sector about VE is very low.

- For project scheduling – for better achievement on finishing on time and decrease delay,
- Minimizes cost overrun,
- Achieve an improved product design and quality and
- Eliminates unnecessary functions that increase costs highly.

4.1.5 Application of Value Engineering in Public Buildings

The first objective of this research is assessing whether the public building construction sector is using VE as a project management tool. So as to provide the stakeholders utilization level a question was asked and responses were gathered through the survey. The respondents gave their response and it is discussed below.

The outcome of the survey shows the rate of applying Value Engineering in respondents' organization. The data shows the companies who are not using Value Engineering takes the majority with total valid percentage of 100%. The response illustrated that no construction firm is using VE as a tool which matches with the literature review of Garomsa et al. (2019). It is an indication that all respondents believe the greater impact of VE and its benefits over improving a project but none of them are applying it.

When compared with experienced countries, in United Kingdom, it is believed that VE is a good technique and also applied (Felipe, 2011). According to the study by Li & Ma (2015) that in China, the government believes that VE is the second most popular type of project management technique but they are not applying because of lack of knowledge which in lines

with this research. It's obvious that VE has many benefits which are explained in the literature review although the rare or totally not applying it, has many reasons behind. Respondents also gave some reasons for not using VE based on the options given on the survey question. Those are listed in the Table 4.4 below.

Table 4.4: Comments Given by Respondents

Comments given	Number of respondents
It is not requested by stakeholders	5
There are no trainings before applying VE	6
There is no schedule for applying it	2
No budget	2
It is too complex	3
Not sure	3

The above Table 4.4 reasons can be issues for applying Value Engineering. Because Value Engineering is a systematic method which needs team members from different profession that mainly needs a training. The main aim of this advanced technique is to satisfy client's requirement, so then if stakeholders are not requesting it, there must be some factors behind this. Training need for it could also be a barrier for applying new technologies. It is clear that initially to study VE needs budget & consumes its own cost which is seen as a potential saving to the project that finally saves 5-15% of the total project cost and compensate it. The complexity is dependent on the project type and the stage of the construction. Complexity is one of the main barrier that hurts technology advancement. The time needed to learn and apply the technique would also feed in to complexity. From the different approaches of VE, the stakeholders can use one of them suiting the project.

4.1.5.1 Contractual Party Benefited Much by Applying Value Engineering?

Again the questionnaire survey asked respondents to find out the degree of benefit on who will be benefited much if VE is applied in public building projects. The main stakeholders involved in the Public building projects are Designers (Consultants), Client, Contractor and End users. The frequency analysis using mean score is shown in the Table 4.5 below.

Table 4.5: Beneficial Parties by Using VE

	N	*Range*	*Mean*	*Std. Deviation*	*Variance*
Contractor benefit by VE	30	2	4.13	.507	.257
Client benefit by VE	30	3	4.00	.910	.828
Public benefit by VE	26	2	3.85	.675	.455
Designers benefit by VE	30	3	3.33	.884	.782
Valid N (list wise)	26				

According to the survey 100% of respondents believe that they can directly get benefit from applying VE in projects. The above Table 4.5 results say that Contractors are much beneficial from all stakeholders by mean index of 4.13. Clients follow the response rate by 4.0 mean index by getting benefit from VE application, Public or End users got 3.85 and finally Designers with 3.33 mean index. These results show that all stakeholders get benefit from applying VE but Contractors and Clients will be much more benefited. On contrary, the client is more beneficial on the other research result of Singh (2010). The study of Abraham & Abhijit (2016) said that the client gets maximum benefit. This outcome is also represented graphically below. From the researcher's point of view, clients are more beneficial by using VE because the first initiation for applying the study is coming from client and the last person who is getting the service is client or end user. If any enhanced function and quality is achieved by VE, client will be more beneficial in optimizing financial loss.

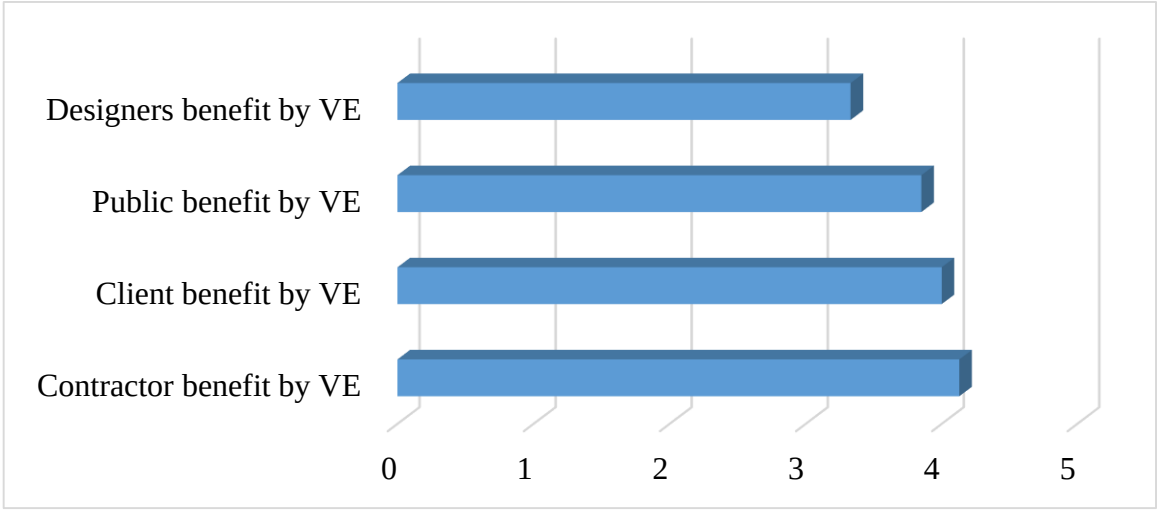

Figure 4.6: Beneficial Parties by Using VE

The above result might be influenced by the respondents' rate. Because most of the respondents were contractors constituting 47.4% out of the population.

4.1.5.2 Factors affecting Value Engineering Application

In the desk study there have been shown different factors affecting VE application either positively or negatively impacting as a management technique in construction. This section deals with the analysis of the information gathered from the questionnaire survey including identification of the rate of occurrences of factors causing the application at rare level. List of factors impacting VE application were presented to respondents to score them according their agreement level to the rate of occurrence on the scale of 1-5 (i.e., 1 to strongly disagree, 2 to disagree, 3 to neutral, 4 to agree and 5 to strongly agree). Those factors were a major causes and in this survey respondents revealed the top sensitive factors depending on their agreement level which is illustrated in below Figure 4.7.

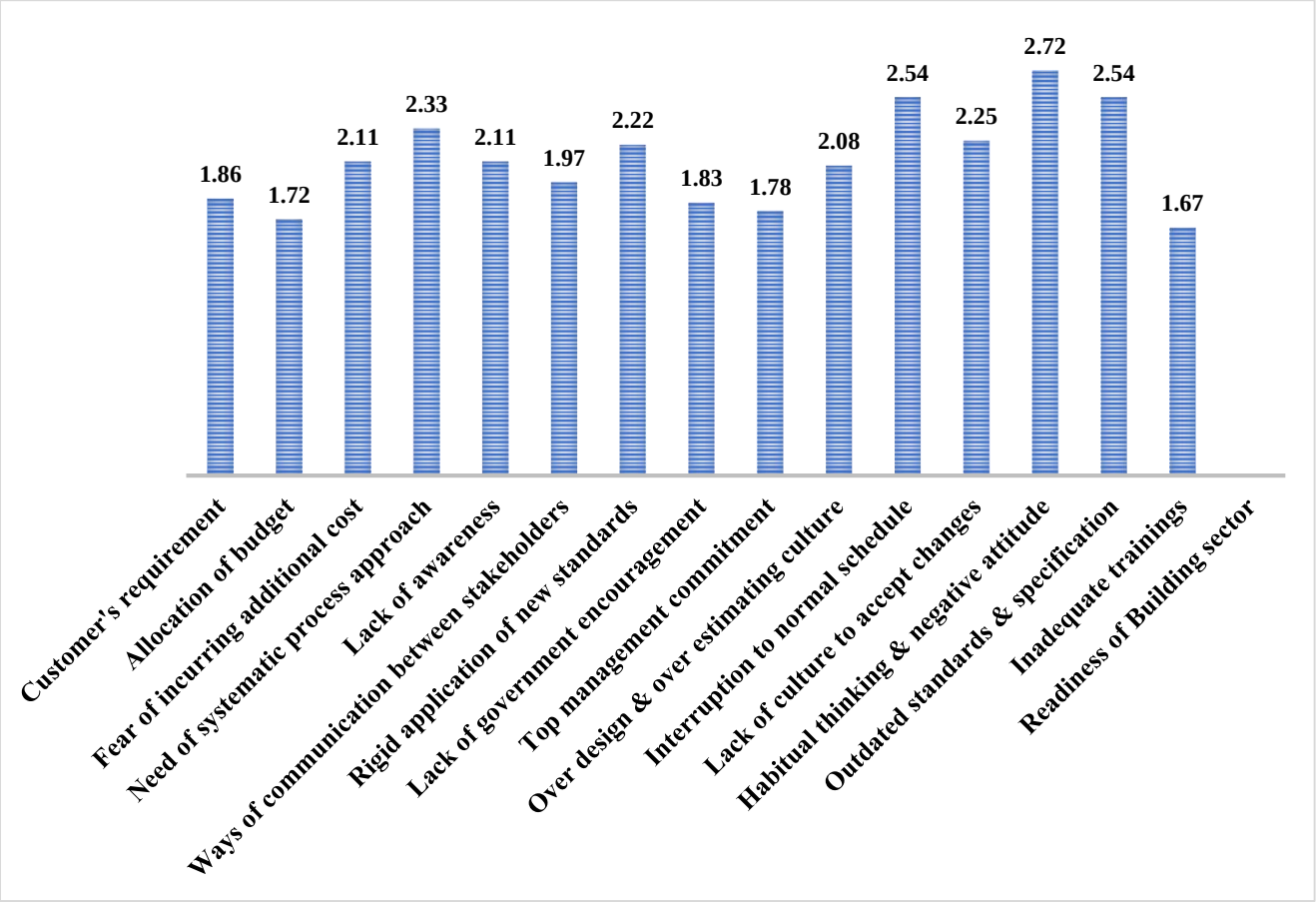

Figure 4.7: Factors Affecting VE Application

As it seems clear from the above Figure 4.7, fifteen different factors affecting regarding VE application in the context of Hawassa City Public building construction sector have been

surveyed among the respondents of the survey. According to the obtained data and based on the mean index of the scores the highest mean scores are highly the top factors having impacts. The objective of this research is to assess and point out the major factors affecting Value Engineering application in the sector. So, the survey results help this objective by demonstrating the top factors in the study area.

The result from the analysis in the Figure 4.7 above indicated that are the top five factors affecting the application Value Engineering Scoring highest mean scores with some discussions. Those are;

- Habitual thinking & negative attitude – the participants of the public building construction sector are using more conventional method of project management which is not updated and follows different advanced technique. This affects the application of new technology.
- Interruption to normal schedule – most of the stakeholders believe that the study of VE interrupts the schedule of the project but instead it enhances the proper completion time of projects with undertaking VE study simultaneously with the design or construction stage of projects.
- Outdated standards & specification – rigid application of standards, customs and tradition without consideration of changing technology and value. The standards that government enforcing to be used by the public building construction sector is not advanced and going with the current new techniques of specification preparation. Even the specifications are prepared homogeneously for projects but the specification prepared for the public buildings' must oblige to follow a special advanced technique including VECP as Indonesian practice (Sesmiwati et al., 2016).
- Need of systematic process approach – this factor affects the application; the sector project management approach is conventional but the problem occurring in the sector must be eliminated by following the systematic approach which is advanced.
- Lack of culture to accept changes – the sector is not appreciating to introduce new technique by sharing experiences from other benefited countries from VE.

When the researcher compares the factors of this study with developing country, Nigeria's there is a factor of being ignorant to apply the technique (Olawi, 2017). Again from the research result of Sigle et al (1999), wrong perceptions on the approach is a factor making the application of VE very limited.

The result of this study is similar with research outcome of Senay & Niyazi (2013) study. So, it seems very essential to consider and give attentions to those factors in order to eliminate some impacts for enabling to improve the application of VE in building construction sector. The other factors scoring less mean scores below like inadequate trainings, allocation of budget, top management commitment, lack of government encouragement and customer satisfaction are not less considerable factors but they need a special concern to obtain much benefit from VE study.

4.1.5.3 Parties Willingness for Applying Value Engineering

Under the second objective this research tried to identify the willingness of the public building industry to apply VE in the future. The survey result has shown in the section of application of Value Engineering, there is no any organization applying VE in their projects. Then knowing the willingness level of stakeholders to apply VE after knowing its major benefits and identifying factors affecting for preparation for applying was a prominent concern of this study. The Table 4.7 below show the result obtained from the survey.

Table 4.7: Willingness Level by Stakeholders to Apply VE

		Frequency	*Percent*	*Valid Percent*	*Cumulative Percent*
Valid	Yes	18	47.4	48.6	48.6
	No	2	5.3	5.4	54.1
	Don't know	17	44.7	45.9	100.0
	Total	37	97.4	100.0	
Missing		1	2.6		
Total		38	100.0		

All respondents were asked a question that whether their company has a plan to apply Value Engineering in Public building project to future or not. As the result demonstrates the higher response rate is ‘’Yes’’ with 48.6% which is good and showing their interest in the application of VE & its outcome of benefits. This reveals a construction professionals are in the way of updating their perception on advanced techniques and companies are showing such a good improvement in project planning. The respondents who said ‘’No’’ are 5% of the total population which is less in amount. But, almost equally with the interests shown to apply, respondents who don’t know about their company plan about VE implementation is 45.9%. This shows personnel who are engaged in construction projects are not aware of the future plan

on adopting new techniques of project management. On contrary with the literature of Garomsa et al. (2019), most of participants have willingness to apply. This shows if the circumstances are going to be fulfilled, most stakeholders are ready. But, the level of willingness is on half-half base.

4.1.5.4 Requirements for Applying Value Engineering

Based on the responses in the above question (plan to apply), it is fair to establish that there is a good point of view understanding the willingness level of companies to apply VE for the future. Based on the literature review there are different requirements needed before applying VE. Then respondents were asked a question to get their opinion on the influence of the building sector ready to apply Value Engineering. Their responses have been given by ranking priorities form not a requirement up to highly a requirement. The Figure 4.8 below shows the results.

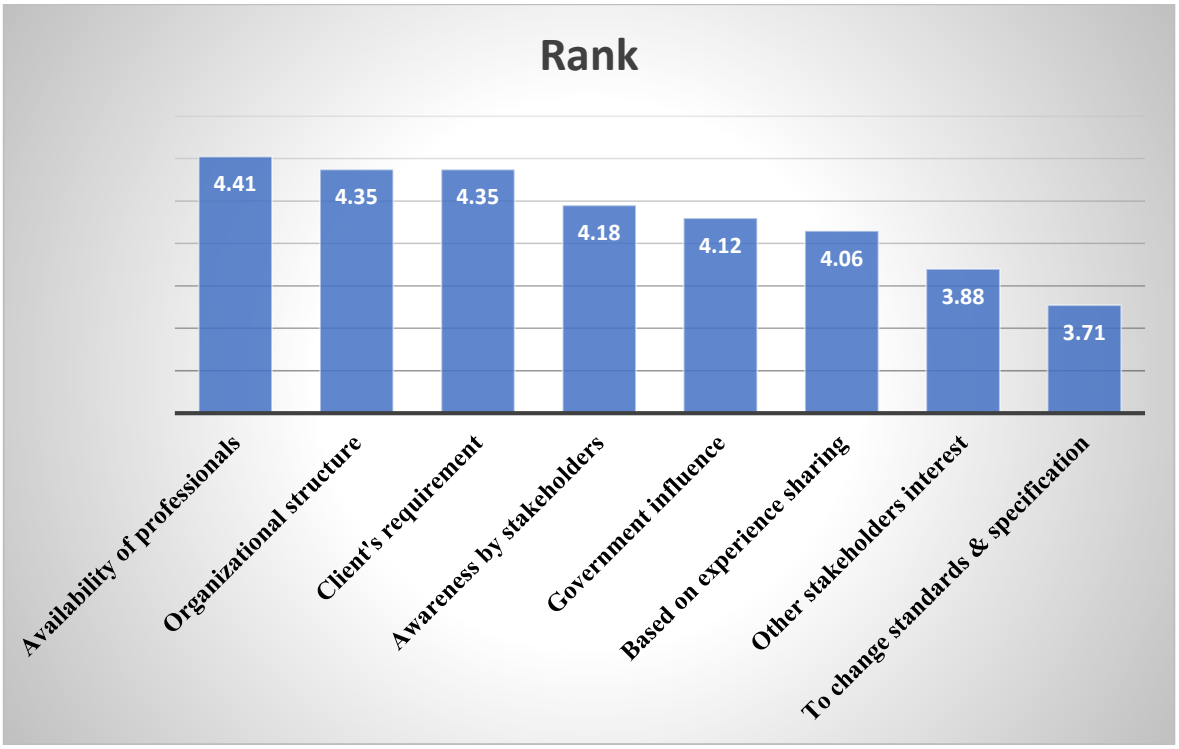

Figure 4.8: Requirements to Apply VE

It is resulted that availability of professionals is the major requirement before applying VE in the construction sector with 4.41 mean score. Organizational structure full filling each VE study team members and professionals who understand the implementation of VE is required mainly equally with client's requirement. As its known the very first criteria of any project is satisfying client's requirement and also here the survey shown again it's a basic requirement

for VE application with 4.35 mean score for both. Awareness by stakeholders also is not a slight thing but a major impact for applying VE.

In the desk study its shown that government influence in developed like USA and Saudi Arabia and developing countries like Indonesia for applying VE in their projects is a prior thing for approval of the project. Here in Hawassa city construction stakeholders is given the fifth rank as a requirement. The other requirement scoring mean below 4.06 are requirements but with less concern. So, the study has shown that the participants have willingness to apply but their readiness has to be assessed.

4.2 Case Study

The cases of purposively selected projects have been scrutinized and discussed in this section to answer the research question of what are the critical trade of works incurring high costs in projects. As Abraham (2016), said when we plan to do Value Engineering to particular project it is necessary to properly follow all steps related to VE in a proper manner to get better results. Firstly, its necessary to identify the critical elements or activities which are imparting higher cost in a project. Building projects with contract amount greater than 25Million birr were a criterion for selecting the projects for case study.

It is done by having full financial records or Bill of Quantities of three public building projects either completed or on-going under construction projects found in the city which are funded by each Clients i.e. SNNP Region, Hawassa City administration and Sidama Zone Construction office. This enabled the researcher to assess and identify the critical trade of works and giving an idea for future management by applying of VE study & to give special concern on those areas for minimizing time of study and efforts. Whilst the number of case studies are limited, it can provide an in-depth insight to VE approaches using Pareto's analysis and most projects have the same ways of cost estimation.

The case study has been done by using Pareto analysis as a statistical by referring as 80/20 rule as described in the literature review as 20% of tasks takes 80% of whole project cost. The analysis has been done by using several steps;

1. Collecting data which is financial or Bill of Quantities from completed or on progress construction projects
2. Determining each activities or works amount
3. Sort the cost of works from largest to the smallest
4. Determining the percentage share of each activity
5. Determining the cumulative percentage of each activity
6. Forming the Pareto diagram
7. Analysis of diagrams and proposing some discussions

4.6.1 Case Study 1 – Sidama Cultural Center

Project data is required to obtain basic information about a project. Here is an over view of the project which will be analyzed from Sidama Zone construction office funded project.

Project type: Cultural Center on progress project

Project name: Sidama Cultural Center (Affini Hall) B+G+10

Contract amount: 256,259,694.48Birr with VAT

Project location: Hawassa city, Gudumale park

Here is the table summary of project costs at the building.

Table 4.8: Summary of Project Costs – Case Study 1

No.	*Work Item*	*Cost*
1	Excavation and earthwork	6,746,719.06
2	Concrete work (Sub-structure)	28,188,315.23
3	Stone Masonry work	305,000.00
4	Concrete work (Super-structure)	28,017,503.66
5	Walling	2,246,740.50
6	Roofing work	2,672,246.60
7	Steel Structure	2,589,473.80
8	Carpentry and Joinery	2,249,400.00
9	Metal work	1,112,840.00
10	Finishing work	46,490,346.70
11	Glazing work	587,000.00
12	Painting work	635,850.00
13	Plaque/ Signage	267,500.00

Pareto Analysis: Identifying the total activities in the building with respect to cost they are incurring will look the value of the largest costs in Value Engineering. On the second stage sorting form largest to smallest is next.

Table 4.9: Pareto Testing Results – Case Study 1

Work Item	*Cost*	*Percentage of costs*	*Cumulative percentage*
Finishing work	46,490,346.70	38.07%	38.07%
Concrete work (Sub-structure)	28,188,315.23	23.08%	61.15%
Concrete work (Super-structure)	28,017,503.66	22.94%	84.10%
Excavation and earthwork	6,746,719.06	5.53%	89.62%
Roofing work	2,672,246.60	2.19%	91.81%
Steel Structure	2,589,473.80	2.12%	93.93%
Carpentry and Joinery	2,249,400.00	1.84%	95.77%
Walling	2,246,740.50	1.84%	97.61%
Metal work	1,112,840.00	0.91%	98.53%
Painting work	635,850.00	0.52%	99.05%
Glazing work	587,000.00	0.48%	99.53%
Stone Masonry work	305,000.00	0.25%	99.78%
Plaque/ Signage	267,500.00	0.22%	100.00%

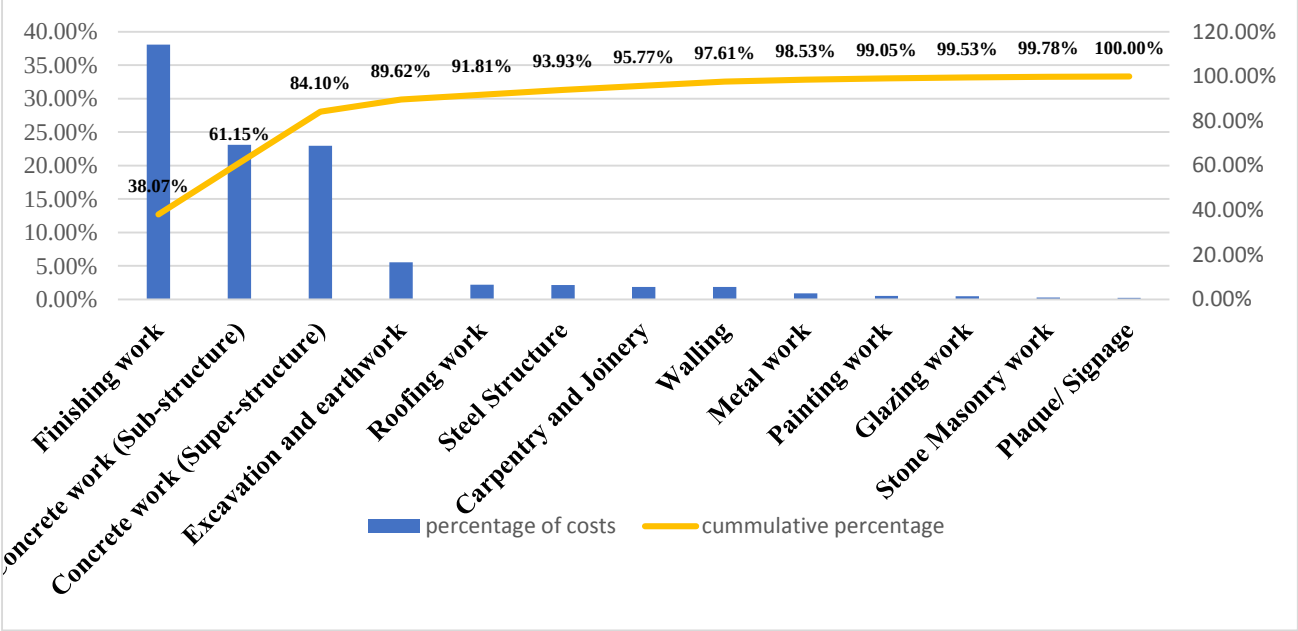

Figure 4.9: Pareto Chart for Case Study 1

From the above Figure 4.9, the critical activities here which are incurring the 80% costs of the total project are;

- ❖ Finishing work,
- ❖ Reinforced Concrete work for sub-structure &
- ❖ Reinforced Concrete work super-structure.

4.6.2 Case Study 2 – SNNP State Housing

Project data is required to obtain basic information about the second case study project. Here is an over view of the project which will be analyzed from Southern Nations Nationalities & Peoples Regional Construction Bureau.

Project type: Apartment Block project

Project name: SNNPR State Housing Development Enterprise G+6 3 Bed Room Type

Contract amount: 48,961,990.73Birr

Project location: Hawassa city

Here is the table summary of project costs at the building.

Table 4.10: Summary of Project Costs- Case Study 2

No.	*Activity Description*	*Costs*
1	Excavation & Earth work	1,672,695.42
2	Concrete works (Sub-structure)	4,792,149.57
3	Masonry works	347,404.76
4	Concrete works (Super-structure)	15,702,785.18
5	Block work	3,226,957.67
6	Roofing work	296,418.85
7	Carpentry & Joinery work	2,648,100.71
8	PVC work	1,613,114.99
9	Finishing work	10,030,029.64
10	Painting work	1,640,095.10
11	Glazing work	541,738.15
12	Electrical Installation work	3,118,558.36
13	Sanitary Installation work	3,331,942.33

Table 4.11: Pareto Testing Results – Case Study 2

Activity Description	*Costs*	*Percentage*	*Cumulative %*
Concrete works (Super-structure)	15,702,785.18	32%	32%
Finishing work	10,030,029.64	20%	53%
Concrete works (Sub-structure)	4,792,149.57	10%	62%
Sanitary Installation work	3,331,942.33	7%	69%
Block work	3,226,957.67	7%	76%
Electrical Installation work	3,118,558.36	6%	82%
Carpentry & Joinery work	2,648,100.71	5%	88%
Excavation & Earth work	1,672,695.42	3%	91%
Painting work	1,640,095.10	3%	94%
PVC work	1,613,114.99	3%	98%
Glazing work	541,738.15	1%	99%
Masonry works	347,404.76	1%	99%
Roofing work	296,418.85	1%	100%

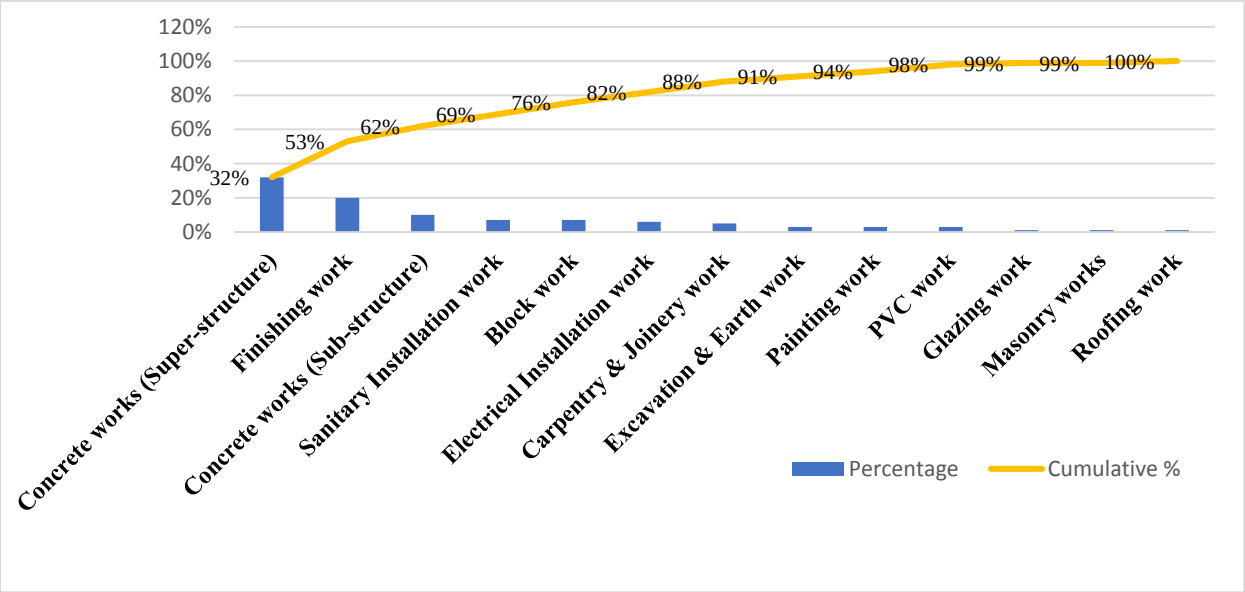

Figure 4.10: Pareto Chart for Case Study 2

It demonstrated that again in this case study there are some activities which consumed the higher 80% of cost of the project. Those activities are:

- ❖ Reinforced Concrete works (Super-structure),
- ❖ Finishing work,

- ❖ Reinforced Concrete works (Sub-structure),
- ❖ Sanitary Installation work and
- ❖ Block work.

4.6.3 Case Study 3 – Adare Hospital

As its mentioned in the introduction part of this section, the first procedure to follow in analyzing Pareto is gathering data. The data must be described in order to obtain basic information about a project. Here is an over view of the project which will be analyzed from Hawassa City Administration, Construction Department.

Project type: Hospital

Project name: Adare Hospital B+G+8 Building – on progress project

Contract amount: 219,292,654.70Birr with 15% VAT

Project location: Hawassa city, Piassa

Here is the table summary of project costs at the building.

Table 4.12: Summary of Project Costs – Case Study 3

No.	*Activities*	*Costs*
1	Excavation & Earth works	1753751.15
2	Concrete works (Sub-structure)	16784994.58
3	Masonry works	76100.00
4	Concrete works (Super-structure)	33788585.24
5	Block works	4520415.00
6	Roofing	2299958.00
7	Carpentry & Joinery	7043784.00
8	Metal works	10745476.47
9	Finishing works	31441432.5
10	Painting	703510.5
11	Glazing	2293800.00
12	Electrical Installation	26360176.00
13	Mechanical Installation	45516766.52
14	Sanitary Installation	7360515.00

Table 4.13: Pareto Test Study Results – Case Study 3

Activities	Costs	percentage	cumulative %
Mechanical Installation	45,516,766.52	23.87%	24%
Concrete works (Super-structure)	33,788,585.24	17.72%	42%
Finishing works	31,441,432.50	16.49%	58%
Electrical Installation	26,360,176.00	13.82%	72%
Concrete works (Sub-structure)	16,784,994.58	8.80%	81%
Metal works	10,745,476.47	5.64%	86%
Sanitary Installation	7,360,515.00	3.86%	90%
Carpentry & Joinery	7,043,784.00	3.69%	94%
Block works	4,520,415.00	2.37%	96%
Roofing	2,299,958.00	1.21%	97%
Glazing	2,293,800.00	1.20%	99%
Excavation & Earth works	1,753,751.15	0.92%	100%
Painting	703,510.50	0.37%	100%
Masonry works	76,100.00	0.04%	100%

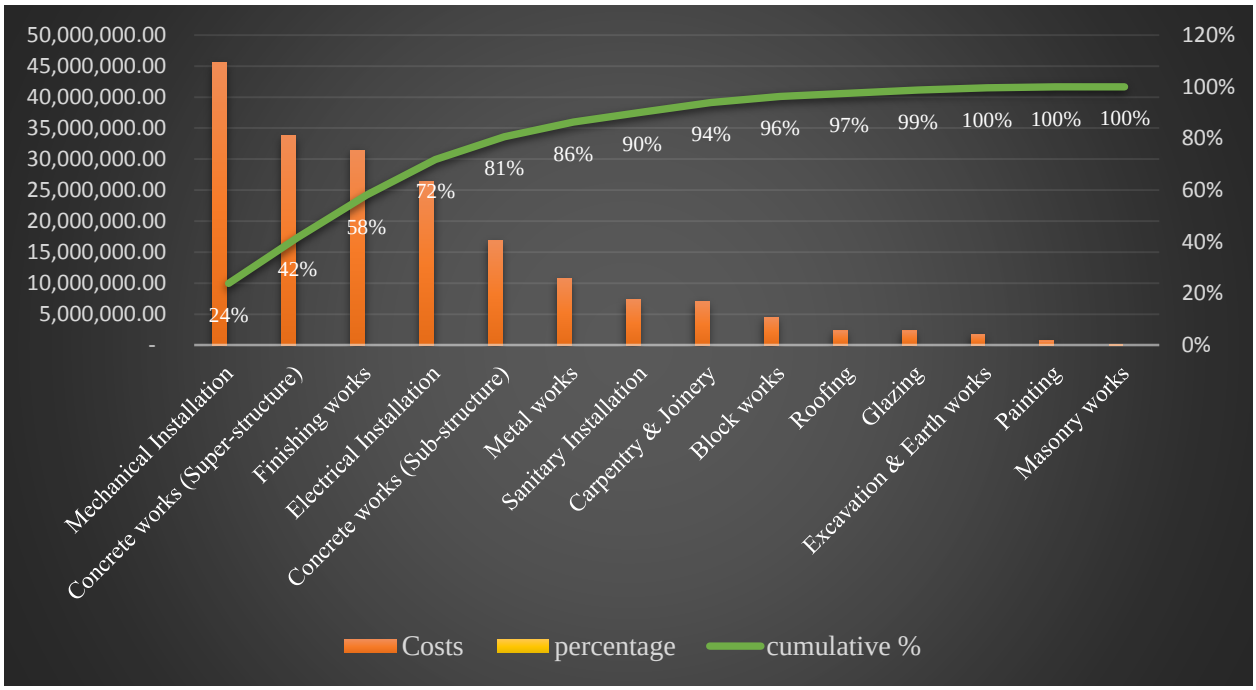

Figure 4.11: Pareto Chart – Case Study 3

The above Figure 4.11 illustrates that the major activities which are constituting the higher 80% costs of the total project of Adare General Hospital Building;

- Mechanical installation
- Reinforced Concrete works for Super structure
- Finishing works and
- Electrical works.

Finally, for concluding the case studies, it has been identified different critical activities on each project depending on their costs by Pareto Analysis. The above three case studies were taken as a sample because most of the public building projects are homogenous. Those 20% activities or works were consuming the higher percentage of the total project cost which is 80%. There has been shown similarities in every project that takes the top ranks. It has been founded that seven (7) critical trade of works which are incurring higher costs in projects depending on the study results. The activities are shown below depending on their percentage share and repetitions.

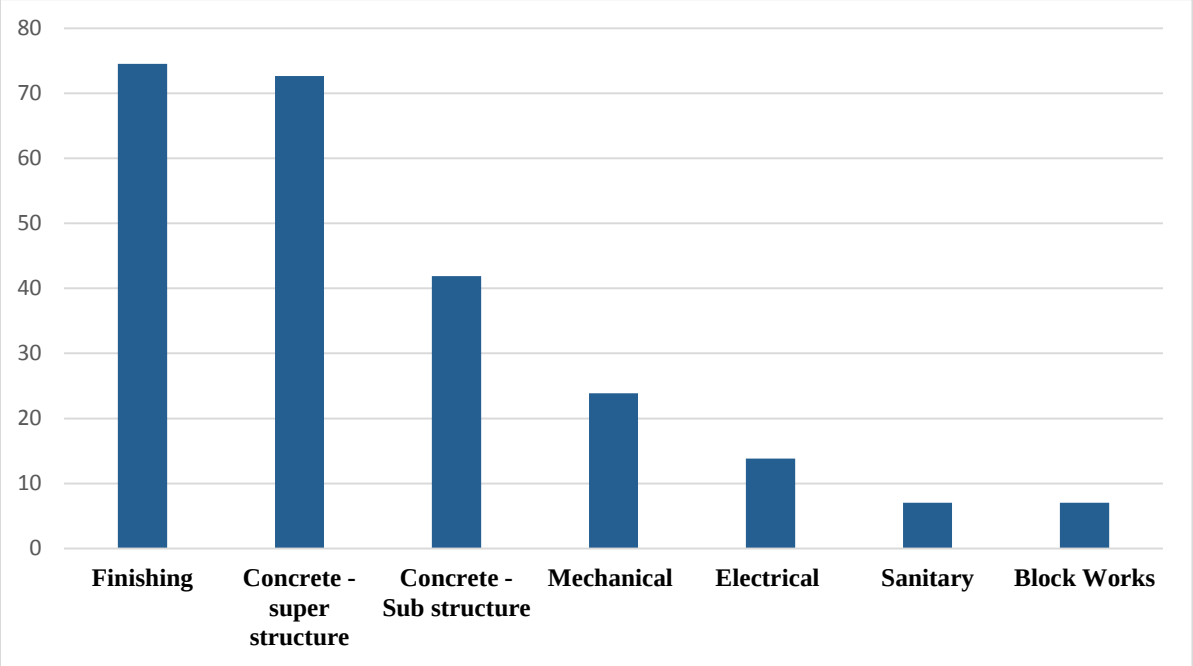

Figure 4.12: The critical activities incurring higher costs

Before applying Value Engineering identifying the critical trade of works which helps prioritizing the causes of cost consuming activities for better result in VE study. According to the study by Dell'Isola (1974), VE is done after identifying high cost areas only before forming a team. So, if any stakeholder is going to give an attention on those activities, they would be

very beneficial in optimizing costs by using Value Engineering study. It doesn't mean the other activities have no impact on the total project cost if they go through the VE study but for optimum result and better achievement the seven activities must be prioritized as per their much cost consumptions.

4.3 Summary of Findings

This part illustrates on the findings of the research based on the objectives that are the level of awareness on VE, the factors affecting its applicability, the future readiness of applying VE and critical activities incurring higher costs. There is an awareness about Value Engineering in the public building industry in Hawassa city but the problem is in the application. The respondents agree on VE necessity in the sector for benefiting projects. But, the application level is at zero level. Contractors will be much benefited from VE approach depending on the survey result. There are different benefits of VE as eliminating unnecessary costs, saves time, improve project quality, align resources efficient & effective and increases customer satisfaction.

Also, major factors affecting application of VE pointed out in the study as; habitual thinking & negative attitude, interruption to normal schedule, outdated standards & specification, need of systematic process approach and lack of culture to accept changes. The willingness level is on half-half base. For applying Value Engineering, the availability of professionals, organizational structure, client's requirement, awareness by stakeholders and government influence are the major aspects. Form the case studies, different critical activities pointed out for better result in future VE study preparation. Those activities are helpful for forming team members prior to the study. This is an indicator for initiation for studying Value Engineering.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

This chapter summarizes the research main findings and provides conclusions & recommendations for the application of Value Engineering approach in Hawassa city in case of public building projects. Also, this chapter includes the research contributions of the study to knowledge. By reconsidering the research objectives and findings, an overview has been discussed to assess the extent to which the research objectives were met. In achieving the aim of the research, four main objectives have been outlined and achieved through the findings of the analyzed questionnaires and the conducted case study.

5.1 CONCLUSION

The research has founded that customer satisfaction is on average level in the study area by the services clients are receiving from the public building construction sector. So, Value Engineering is one of the problem solving project management technique to enhance the satisfaction level. The study indicated the familiarity of the building construction stakeholders with the Value Engineering approach is on familiar level which is an indicator for the assessing the awareness level. It is believed that Value Engineering has a great contribution in eliminating the possible problems faced by the building project. It is shown by the study that VE is necessary for the public building projects.

For the first objective achievement, the study founded the level of application of Value Engineering in Hawassa City is near to be poor by the population whom considered samples in the scope of the research have good awareness level but none of the respondents never applied the VE approach. The study founded unlike the developing countries experience; in Hawassa City, VE is not totally applied and but all organizations are approving the benefits of Value Engineering application. There are different reasons for not applying the approach founded by the study. Those are; it is not requested by stakeholders, there are no trainings before applying it, there is no schedule for applying and it is too complex to use. As a major problem, there are no trainings given for professionals in the sector though only few respondents of the population have been participated in training for a short period of time.

The study objective has been met by illustrating the willingness level for applying VE in the future public building projects. The research result says that less than half of the population have a plan to apply. The result shows half-half willingness to the future on applying VE. Much

of them even do not have any idea what their company will do in the future on the technique application. But, less amount percentage from the population is in a having no plan. This study hereby offers that the VE approach if it is properly applied to building projects, it will ensure effective project management benefits and removal of unnecessary cost.

To meet the second objective, the study found out the following factors are the main factors that are influencing VE application in public building projects: habitual thinking & negative attitude on VE, having feelings that it has an interruption to normal schedule, the available standards & specifications are outdated, there is no need of systematic process approach and lack of culture to accept changes. These show if the stated factors are going to be handled there are possible ways of applying Value Engineering according to their priorities.

The research has shown that contractors will be more benefited from applying the VE technique in projects. This means there are different benefits gained from VE. The benefits of Value Engineering are eliminating unnecessary costs, saving time, improving project quality, aligning resource efficient & effective, it increases the customer satisfaction, reduces operation & production costs and simplifying methods & procedures. To answer the last objective bearing in mind those benefits the critical activities which are consuming the higher budget of public building projects were identified. They are concrete work for super structure, finishing works, concrete work for sub structure, mechanical works, electrical works, sanitary and block works. These are activities listed on their prior share on incurring the 80% of the total project cost. It doesn't mean the other left activities are not critical but they only consume the rest 20% of the total project cost. If a great concern is given on those basic trade of works, there will a better achievement in implementing VE approach for better result in short time.

5.2 RECOMMENDATIONS

Construction industry need to be developed in a better way by satisfying project scope of work in reducing unnecessary cost without imparting the required functional requirements of project components. There are positive attitudes towards the VE in Hawassa city public building project stakeholders, which needs some good decision makers to apply it. As the customer satisfaction is on average level, the public building sector has to be supported by an advanced technique to get a maximum output.

Based on the findings and conclusion, the following recommendations put forward for stakeholders:

For Clients

1. Supporting the agent roles or consultants by financial base for studying Value Engineering
2. Performing some Value Engineering studies on a very low cost base for initiation
3. The management team must fully understand the implications of the application of VE in to their business. This means that it should seek explanation of the technique and its potential, together with some specialist advice on the way in which it may best be introduced and developed. It should then be possible for them to determine the long term objectives, the areas of initial application and to produce an outline policy and program.

For Contractors:

1. Such organization must amend their organizational structure and techniques of preparing specification for better achievement like introducing the VECP (Value Engineering Change Proposal)
2. Conducting trainings for the public building sector participants
3. There are different four approaches of VE, but as example for companies having subsidiary or sister company who are participating in the public projects can involve in VE study by applying the ‘’The Value Management Audit’’ approach. They might bring honest and true result for benefiting the client.
4. Involving professionals capable of conducting the VE study for forming a good team

For Government:

1. Implement some governmental regulations especially in public building construction sector which obliges to use Value Engineering,
2. Enforcing new management strategy for organizations to adopt advanced technologies from some standards for better result of the country's building sector output, founding accredited certifying body on VE like USA,
4. Improving the awareness level of Value Engineering in the public building sector by promoting the benefits of it,
5. Follow up and get knowledge from other experienced countries by using VE as to how they are successful in applying it,
6. Improve the capacity of public building sector so as to ensure efficient, transparent and effective implementation of modern and advanced construction management tools.

For Future Research:

1. Study on the identification of challenges facing in adopting advanced practices in Ethiopian Construction industry and their remedies,
2. Study on Value Engineering application related with sustainability construcion and
3. Further study should also be conducted on modernizing the Ethiopian construction industry.

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APPENDICES

Appendix 1- Questionnaire

Hawassa University

Institute of Technology

Faculty of Civil Engineering & Built Environment

Department of Civil Engineering

MSc in Construction Technology and Management

Questionnaire

Dear Respondent,

I am currently undertaking a MSc degree in Construction Technology & Management at Hawassa University. By responding this questionnaire, you will help to finish my research work on the subject of ‘’*Application of Value Engineering Approach: Case of Hawassa City Public Building Projects*’’.

Value Engineering is an advanced, systematic multidisciplinary technique by which we get to know how the cost of the project can be optimized without affecting the quality requirements, function of the particular project and enhancing value.

The survey objective is understanding the application level of Value Engineering approach or knowing the readiness level to apply and factors against its application by stakeholders in Hawassa City building sector.

This questionnaire has 5 parts and it takes on average 10 minutes of your time. Please read each question carefully and try to answer all questions honestly and to your best knowledge. Your feedbacks will be treated confidentially and only for academic purpose. I greatly appreciate your cooperation & contribution to the success of this study by participating in this questionnaire.

Thank you!!

Abraham Dereje

PG student (CoTM)

Instruction: The questions utilize a Likert, ranking & contingency formats. Give your answers by ticking ☐ in the box. Some questions permit the inclusion of additional opinion based comments.

Part I: - General profile & Awareness on Value Engineering

1.1. Which of the following is your organization?

Company name (optional): _____

☐ Client ☐ Consultant ☐ Contractor ☐ Architect

Others _____

1.2. Your job title in the organization.

☐ Company Manager ☐ Site Engineer

☐ Project Manager ☐ Architect / designer

☐ Quantity Surveyor ☐ Office Engineer

Others, please specify, _____

1.3. Regarding experience, how long have you been working in the construction industry?

☐ 1-5 years ☐ 6-10 years ☐ 11- 15 years ☐ over 15 years

Part II: - Awareness on Value Engineering

2.1 Are Clients completely satisfied with the service they receive form the construction industry?

☐ Highly satisfied ☐ Average satisfied ☐ Satisfied

☐ Less satisfied ☐ Not satisfied

Reason for your level of satisfaction: _____

_____

2.2 How familiar you are with Value Engineering?

☐ Expert ☐ Knowledgeable

☐ Familiar ☐ Slightly familiar

☐ Not familiar

2.3 Do you think Value Engineering can contribute to minimize the growing cost overrun, delay and eliminate unnecessary costs in building projects?

☐ Yes ☐ No

If Yes, how? _____

If No, your reasons: _____

2.4 Have you ever participated in Value Engineering training?

☐ Yes ☐ No

If Yes, how long? _____

If No, why? _____

Part III: - Value Engineering application

3.1. How much do you agree that value of VE, as a new technique of cost controlling is necessary in project management?

☐ Strongly agree ☐ Agree

☐ Neutral ☐ Disagree

☐ Strongly disagree

3.2 Does your company utilize Value Engineering in building projects?

☐ Yes ☐ No

If your answer is "Yes'' in question 3.2, could you mention the benefit it generates.

_____

_____

_____

_____

If your answer is ''No'' for question 3.2, could you identify one or more reasons for not using VE? (choose one or more answers)

☐ not requested by stakeholders ☐ not successful

☐ no trainings ☐ too complex

☐ no budget ☐ no schedule

☐ not sure

3.3. If your answer is ''Yes'' for question 3.2, Who do you think can be benefited much by applying value engineering in building projects??

Party	***No benefit***	***Less benefit***	***Average benefit***	***High benefit***	***Extreme benefit***
Client					
Contractor					
Designers					
End users (Public)					

3.4 What benefits do you think your company will get form applying VE in building projects?

Note: These factors were assessed by literatures and give on a scale from 1 to 5, where;

‘’**1= not important, 2= less important, 3= fairly important, 4= important and 5 = very important.’’** Indicate your assessment in the table below.

No.	***Benefits of VE***	***Please tick in the box***				
		5	***4***	***3***	***2***	***1***
A	Improve project quality					
B	Reduce production and operating costs					
C	Save time					
D	Mitigate risks & reduce mistakes					
E	Increase customer satisfaction					
F	Eliminate unnecessary costs					
G	Simplify methods and procedures					
H	Identify problems and develop solutions					
I	Align resource efficient and effective					
J	Better communication for responding client’s requirements					
K	An opportunity for client to engage in design					
If Others (please specify):						

Part IV: - Factors affecting for application

4.1. What are the factors affecting the application of Value Engineering as a management technique? (Using 1 to 5 showing agreement level.)

	Factors	***Strongly Agree***	***Agree***	***Neutral***	***Disagree***	***Strongly disagree***
1	Customer's requirement					
2	Allocation of budget					
3	Fear of incurring additional cost due to Value Engineering					
4	Need of systematic process approach					
5	Lack of awareness or knowledge					
6	Ways of communication between stakeholders					
7	Rigid application of new standards or technique					
8	Lack of government encouragement					
9	Top management commitment					
10	Over design and over estimating culture					
11	Interruption to normal schedule					
12	Lack of culture to accept changes					
13	Habitual thinking & negative attitude					
14	Outdated standards and specification					
15	Inadequate trainings					
Others (please specify)						

Part V: - Requirements of building sector before applying VE

5.1. Does your company have a plan to apply VE in projects?

☐Yes ☐No ☐ Don't know

5.2. What requirements do you think influence the building sector ready to apply Value Engineering? Give your answer by ranking priorities from the given criteria. Note: where;

''1= not a requirement, 2= less requirement, 3= fairly requirement, 4= a requirement and 5 = highly a requirement.''

Requirements	5	4	3	2	1
Client's requirement					
Government influence					
Availability of professionals					
Awareness by stakeholders about value engineering benefits					
To change standards & specification					
Other stakeholders interest to use the technique					
Based on experience sharing					
Organizational structure					
Others					

THANK YOU AGAIN FOR YOUR ASSISTANCE AND COOPERATION.

I LOOK FORWARD IN RECEIVING YOUR INPUT AT THE SOONEST POSSIBLE TIME.