Addis Ababa University

Addis Ababa Institute of Technology

School of Civil and Environmental Engineering

Impacts of Value Engineering related practices in Ethiopian federal road projects

A Thesis submitted to School of Civil and Environmental Engineering in partial fulfillment of the requirements for the Degree of Master of Science in Civil Engineering (Construction Technology and Management Stream)

By: Dawit Belay

June 2018
Addis Ababa University
Addis Ababa, Ethiopia

Addis Ababa University (AAU)

Addis Ababa Institute of Technology (AAiT)

School of Civil and Environmental Engineering (SCEE)

Impacts of Value Engineering related practices in Ethiopian federal road projects

By: Dawit Belay

Approved by Board of Examiners

Abebe Dinku, Prof. (Dr. –Ing.) (Advisor)	Signature	19/11/2018 Date
Dr. Abraham Assefa (Internal Examiner)	Signature	2018/11/14 Date
Eng. Yibeltal Zewdu (External Examiner)	Signature	2018/11/14 Date
(Chair Person)	Signature	Date

Dr. Agizew Nigussie
Dean, School of Civil &
Environmental Engineering

Addis Ababa University
Addis Ababa Institute of Technology
Director of Postgraduate Program

Declaration

I declare that this thesis entitled "***Impacts of Value Engineering related practices in Ethiopian federal road projects***" 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 duly acknowledged.

Name: Dawit Belay

Signature:

Place: Addis Ababa, Ethiopia

Date: June 2018

Acknowledgement

I would like to express my deep gratitude to my thesis advisor Prof. (Dr.- Ing.) Abebe Dinku for his constructive advises in realizing this paper. Being his student throughout the graduate program, I have learnt so much from him and got empowered to think outside the box.

My gratitude also extends to the office engineers of all contract management directorates of the Ethiopian Road Authority for their assistance and cooperation in providing the necessary data and information.

Last but not least important, I owe more than thanks to my beloved mother, W/ro Mulu, for her unconditional love, support and encouragement throughout my life.

Dawit Belay

Table of Contents

List of Tables

List of Figures

List of Abbreviations

A/E	Architecture and Engineering
AASHTO	American Association of State Highways & Transportation Officials
AC	Asphalt Concrete
ADT	Average Daily Traffic
AfDB	African Development Bank
ASPR	Armed Services Procurement Regulation
AVS	Associate Value Specialist
CBR	California Bearing Ratio
CM	Construction Management
CVS	Certified Value Specialist
DBST	Double Bituminous Surface Treatment
DC	Design Class
DCP	Dynamic Cone Penetration
DLP	Defects Liability Period
DS	Design Standard
DTM	Digital Terrain Model
EIRR	Economic Internal Rate of Return
EoT	Extension of Time
ERA	Ethiopian Roads Authority
ESIA	Environmental and Social Impact Assessment
ETB	Ethiopian Birr
FAR	Federal Acquisition Regulations
FHWA	Federal Highway Administration
FIDIC	Fédération Internationale Des Ingénieurs-Conseils
GDMW	General Directorate of Military Works
GMD	Geometric Design Manual
GPS	Global Positioning System
HDM-4	Highway Design and Maintenance-4
ICB	International Competitive Bidding
ICE	Institution of Civil Engineers
IPC	Interim Payment Certificate
IRI	International Roughness Index
IRR	Internal Rate of Return
MDB	Multilateral Development Bank
mESA	million Equivalent Standard Axles (8.16 ton)
NCB	National Competitive Bidding
NHS	National Highway System
NPV	Net Present Value

RED	Road Economic Decision
Rs.	Rupees
RSDP	Road Sector Development Program
SAVE	Society of American Value Engineers
TOR	Terms of Reference
U.S.	United States
USA	United States of America
USDOT	United States Department of Transportation
VA	Value Analysis
VE	Value Engineering
VECP	Value Engineering Change Proposals
VM	Value Management
w.r.t.	with respect to

Abstract

In spite of the government's prior attention to development of infrastructure facilities such as roads, research indicates that the Ethiopian federal road construction sector still faces significant cost overrun, time overrun and performance problems thereby reducing the overall value of the road infrastructures. Management tools, such as value engineering, can result in the required and/or improved performance of a project at the lowest possible life-cycle cost and assure the greatest value for money being invested. Though research indicated that value engineering is not being applied in Ethiopian federal road projects, recently value engineering related practices are being observed in some projects.

This study attempts to research the impacts of value engineering related practices in design and construction phases of federal road projects administered by the Ethiopian Roads Authority. A thorough literature review has been done to apprehend the concepts and techniques of value engineering as well as the global and national experiences. Cases of randomly selected 6 design projects and 6 construction projects have been analyzed. A survey questionnaire was also distributed to randomly selected consulting and construction firms working with the Ethiopian roads authority and the responses were analyzed.

The analysis result indicates that the impact of the value engineering in the design service contracts is increasing the original design service contract amount and duration by 1% and 2% respectively. Whereas, the impact of value engineering practices on construction projects is observed to reduce time (or have no time implication) and reduce cost by 0.65% of the original contract amount or 0.51% of the final/estimated contract amount.

Finally, it is recommended that the government should formulate an appropriate policy aimed at safeguarding better value for the money being spent in road construction industry, emphasis should be given to life-cycle costs of road projects, design projects should undergo value engineering study prior to floating a tender; and professional associations should promote value engineering through training and workshops.

Key words: Value engineering, Job Plan, Function analysis, Value Analysis, Value Methodology, Road construction

Chapter – One

Introduction

1.1. Background of the Study

Value Engineering is a non-specific term applied to any exercise to find out possible savings, economies and better 'value for money' by investigating alternative designs, construction processes, ways of planning and meeting risks, etc. for a proposed project. The exercise often takes the form of arranging a special 'workshop study' in which the client, designer, and contractor and other parties involved take part, and put forward suggestions for discussion and investigation (Alan, et al., 2004). The purpose of value engineering is to optimize resources to achieve the greatest value for the money being spent (Barbara, 2004).

Value Engineering is an effective technique for reducing costs, increasing productivity and improving quality. It can be applied to hardware and software development, production and manufacturing, specifications, standards, contract requirements and other acquisition program documentation; and facilities design and construction (Atabay, et al., 2013).

The Value Engineering goal is not to make item costs cheaper but to determine the worth of the basic function without regard to its application and set a target cost. Value Engineering finds design alternatives that meet all needs at a lower overall cost. A Value Engineering study may generate recommendations to eliminate 10% to 30% of the project's construction costs. The designer usually accepts about half of these recommendations, providing savings of at least five percent. The cost of the Value Engineering effort, including any redesign, is usually less than 10% of the implemented savings. In almost every case in which Value Engineering is applied, the money saved will be many times the cost of a Value Engineering study. Generally, the expected savings ten times exceed the expected study and implementation costs (Division of Highways, 2004).

The Federal Highway Administration (FHWA), of U.S. Department of Transportation, annually collects information on Value Engineering accomplishments achieved within the Federal-aid Highway Program, including the projects administered by Federal Lands Highway. According to the FHWA Value Engineering Accomplishment Report for the Fiscal Year 2014, the total saving achieved is $ 1.783 billion by conducing 215 number of value engineering studies worth $ 0.008665 billion (Leuderalbert, 2015), which is only 0.49% of the total saving achieved.

On the other hand, in order to address constraints in the Ethiopian road sector, mainly low road coverage and poor condition of the road network, the Government of Ethiopia formulated the Road Sector Development Program (RSDP) in 1997. The 17 years performance assessment report of the RSDP indicated that the total budget for the planned works during the period amounted to ETB 160.3 billion whereas the total amount disbursed in the same period is ETB 180.9 billion. The report also indicated that the physical accomplishment on Federal Roads was 29,155 km against a plan of 29,915 km, which is 97%. However, the budget planned for the Federal Roads was ETB 115.593 billion whereas the actual disbursement was ETB 142.095 billion, which exceeds by 22.93% (ERA, 2014). This indicates that there is a cost overrun of ETB 26.502 billion which may be due to countless reasons.

The success of the VE process is due to its ability to identify opportunities to remove unnecessary costs while assuring quality, reliability, performance, and other critical factors that meet or exceed customers' expectation (Ilayaraja, et al., 2015). Hence, pertaining to the cost overrun, time overrun and durability problems being encountered, this study will address the impacts of value engineering related practices in relation to cost, time and durability of federal road projects.

1.2. Statement of the Problem

Most of the federal road projects administered under the Ethiopian Roads Authority (ERA) are observed to face numerous problems such as completion time overrun, cost overrun and durability problems. The 17 years performance assessment report of the Road Sector Development Program (RSDP) also confirms the same. Turkey Wakjira, 2011, also indicated that the perceived average cost overrun in Ethiopian federal road projects was found to be 34.18% of the contract amount.

Becker and Behailu, 2006, as cited in Getachew (2009), have also ascertained that many of the federal road projects were not completed on time, within budget, and desired quality. Further, studies invariably show that all designs have unnecessary costs regardless of how excellent the design team may be (Zimmerman, et al., 1982). This unnecessary cost incorporated in the designs, the cost overrun, the time overrun and the quality problems being encountered trigger a question of viability of the economic return with respect to the life-cycle cost of the projects.

Value Engineering is a proven management tool that can counteract the growing of highway design and construction problems by providing: cost reduction, process improvement and alternative means and materials for highway construction and maintenance in the Ethiopian Federal road projects. According to Adugna (2015), the Ethiopian Roads Authority has not applied value engineering on its completed projects up to the time of his study. However, recently Value Engineering related practices are being observed in some federal road projects. Hence, the aim of this thesis is to study the impacts of Value Engineering related practices in relation to cost, time and durability of federal road projects administered by the Ethiopian Roads Authority.

1.3. Objectives and Research Questions

1.3.1. General Objective

The objective of this thesis is to study the impacts of value engineering related practices in design and construction phases of federal road projects administered by the Ethiopian Roads Authority.

1.3.2. Specific Objective

The specific objectives of this study are:

i) To study the impacts of value engineering related practices in relation to cost, time and durability of federal road projects by conducting case studies.
ii) To explore the costs and benefits of contractors and consultants from conducting Value Engineering studies under the current scenario.
iii) To point out the possible incentives to promote value engineering practice in federal road projects.

1.3.3. Research Questions

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

i) Can value engineering contribute to minimize the growing cost overrun, delay and durability problems?

ii) What are the impacts of value engineering related practices in the Ethiopian federal road projects?

iii) Who is interested to apply Value Engineering? Contractor or Consultant?

iv) Who can benefit much from Value Engineering?

v) What are the costs and benefits of contractors and consultants from applying value engineering studies in federal road projects under the current scenarios?

Chapter - Two

Literature Review

2.1. History of Value Engineering

Most people in the construction industry believe that value engineering is a new program still in its infancy. Value engineering, as applied to the construction field, has been there since the late 1960s or early 1970s. Value engineering is not a new concept (Zimmerman, et al., 1982).

Value Engineering had its origin during World War II, at General Electric Company, when innovation was required because of material shortages (Division of Highways, 2004). All types of steels, aluminum, copper, bronze, nickel and tin were committed to the war effort (Zimmerman, et al., 1982). Some critical materials were difficult to obtain, and a great many of substitutions had to be made. Mr. Harry Erlicker, a vice president, made the observation that many times these changes resulted in lower costs and improved products. This encouraged him to seek an approach to intentionally improve a products value. He assigned Lawrence D. Miles, a staff engineer, the task of finding a more effective way to improve a product's value.

In 1947, Mr. Miles and his team developed a step-by-step system, called Value Analysis (VA), to analyze a product's cost and function to ferret out unnecessary costs. As a result of substantial investment, the new methodology, Value Analysis, was developed, tested, and proven to be highly effective (Division of Highways, 2004).

In 1954 the U.S. Navy Bureau of Ships, a division of the Department of Defense, established a value program. The Navy did not call its program value analysis as General Electric’s program had. General Electric’s program was to take an existing product that was being manufactured and analyze it for unnecessary costs. The Navy felt it would be more prudent for their needs if they analyzed the engineering drawings before anything was built. It would not make sense to analyze a ship, a gun mount, or something like that after it had already been built. They thought the program should be applied at the engineering stage so they changed the name from value analysis to value engineering.

The purpose of Value Analysis was to analyze the cost required to achieve the required function without jeopardizing the reliability of the product. To meet this need, a multidisciplinary team was organized to involve the key decision makers. The team concept was an instant success. In some cases, 60-80 percent of the cost of the project was removed. In other cases, 5-10 percent of the cost was removed. Larry Miles' program has spread to the other areas of industry and is an effective tool of management. He deserves the credit for developing the program that endures today, and will continue to grow in the future. This is the reason he is referred to as the "Father of Value Engineering" (Zimmerman, et al., 1982).

In 1963, the US Armed Services Procurement Regulation (ASPR) committee added an article which made it mandatory that value engineering incentive provisions be included in all procurements exceeding $ 100,000, and value programs be included in certain contracts over $ 1 million.

The U.S. Defense Procurement Circular Number 11 went in to effect in October of 1964 and allowed percentage sharing of contractor and supplier approved saving proposals. The change in policy was revolutionary in terms of procurement policy. With these sharing incentives in their contracts, many companies took advantage of the potential. As much as $ 20 million of extra profits as their contractual share of successful value engineering proposals were achieved by many firms. Value engineering was introduced in to the construction industry between 1963 and 1965 when the contractor sharing clauses were added to the construction contracts (Zimmerman, et al., 1982).

As the part of the U.S. Department of Transportation (USDOT) responsible for the highways in USA, FHWA produced its own value engineering regulation. This regulation covers all highway projects in the United States. As per the regulation, the "Applicable projects" are defined as "all Federal-aid highway projects on the National Highway System (NHS) with an estimated cost of $25 million or more" (Clark, 1999). Nowadays, different countries have made criteria to promote the implementation of Value Engineering.

2.2. Definition of Value Engineering

The terms Value Engineering (VE), Value Analysis (VA), and Value Management (VM) can be used interchangeably (SAVE International, 2007). The Value Engineering Program Guide for

Design and Construction of the U.S. General Services Administration, 1992, also mentioned that Value Engineering (VE) is used in lieu of all the various related terms such as Value Analysis (VA) and Value Management (VM). Further, IS 11810:2003, 2003, uses the term value engineering as being synonymous with term 'value analysis', 'value management' and 'value methodology'.

Brown, 1992, also stated that the terms Value analysis and Value Engineering are considered synonymous as far as methodology is concerned. Usually the term "Value Engineering" is used when the cost-saving techniques are applied during product design and development, whereas the term "Value Analysis" is preferred when techniques are used in manufacturing the product or purchasing parts of it.

Value Engineering has a somewhat broader scope, and is generally applied as a basic design evaluation while a product is still in the design stage. Value Analysis, on the other hand, tends to concentrate on after-the-fact and review cost-value relationships in existing products. The distinction between the two is hardly clear cut since both require the same skills and approaches (Brown, 1992).

On the contrary, Kelly, et al., 2004, stated that Value Management is the structured management of the total value equation through all stages of the project and therefore in this respect subsumes Value Engineering as a component part of the whole service. The UK Value Engineering Association, established in 1966, changed its name to the Institute of Value Management in 1972. The more recently formed Institute of Value Management in Australia and the Hong Kong Institute of Value Management also see Value Management as an activity that is wider than Value Engineering. SAVE International in the USA has opted to use Value Management as the all-inclusive term. Further to this, Kelly, et al., 2004, also declared that it is generally accepted internationally that 'value management', or 'the value methodology' in the USA, describes the entire service. Other terms, principally 'value engineering', describe specific part of the service.

In 1959, the Society of American Value Engineers (SAVE) was incorporated in Washington, D.C., to unite practitioners and promote the growth of value engineering. The Society officially defined value engineering as "the systematic application of recognized techniques which identify the function of a product or service, establish a value for that function, and provide the necessary function reliability at the least overall cost. In all instances, the required function should be achieved at the lowest possible life cycle cost consistent with requirements and/or performance, maintainability, safety, and aesthetics" (AASHTO, 1987).

It is important to recognize that increased value is the real objective of Value Engineering, which may not result in an immediate cost reduction. Typically the implementation of the Value Engineering process increases performance, reliability, quality, safety, durability, effectiveness, or other desirable characteristics (Department of Defense, 2011).

Zimmerman, et al., 1982, attempted to show a clear understanding of value engineering by the following list.

Value Engineering is:

1. System oriented – a formal job plan to identify and remove unnecessary costs.
2. Multidiscipline Team Approach – teams of experienced designers and value engineering consultants.
3. Life Cycle oriented – examines the total cost of owning and operating a facility.
4. A proven management technique.
5. Function oriented – relates function required to the value received.

Value Engineering is not:

1. Design Review – it is not intended to correct omissions made in design, nor to review calculations made by the designer.
2. A cheapening process – it does not cut cost by sacrificing needed reliability and performance.
3. A Requirement done on all designs – it is not a part of every designer's scheduled review, but a formal cost and function analysis.
4. Quality Control – it does more than review fail-safe reliability status of plant or product design. (Zimmerman, et al., 1982)
5. Constructability review – The purpose of constructability reviews during project development is to ensure that projects are biddable, buildable, cost-effective and maintainable. Constructability reviews involve the optimum use of construction knowledge and experience in the planning and development of a project (Transportation Department,

2011). The comparison between value engineering and constructability has been discussed in Table 1 below.

Table 1 Comparison of value engineering and constructability

Criteria	**Value Engineering**	**Constructability**
Focus	Overall reductioln of life-cycle cost	Optimize construction process in terms of construction cost, schedule, safety, and quality.
Implementation	A brainstorming session where life-cycle cost alternatives are considered for systems components while maintaining design fuction.	An internal part of project management and scheduling allowing construction knowledge and experience to be integrated in to project planning and design.
Timing	Usually performed during design phase. In many cases, performed as a reactive process to reduce cost after design has been completed.	On-going from conceptual planning through construction and start-up.

Source: (Russell, et al., 1994)

However, this does not mean that they are mutually exclusive. Rather, activities within the two work processes may complement each other in achieving their goals. This may result in construction optimization while, at the same time, achieving lowest life-cycle cost (Russell, et al., 1994).

Definition of Function

Function is the purpose or use of an item or process. The Value Engineering approach first concerns itself with what the item or process is supposed to do. The consideration of function is the fundamental basis of the Value Engineering methodology (Department of Defense, 2011).

Zimmerman, et al., 1982, calssified function in to basic function and secondary functions. Basic functions are the specific work of purpose the product or project must complete. Secondary functions are support functions that may be a necessary part of the project, but do not perform the actual work. Classification of the two types of functions give the analyzer some very valuable information. It identifies the costs of the project that are really doing the work necessary to accomplish the primary function. It helps to identify the costs that are associated with performing the basic function.

In the search for basic objective thinking, functions are divided in to two types. Either or both may cause the buyer or the user to buy the product. One type is the use function, and the other is the aesthetic function. Each is important. The cost that is expended to cause the product to perform a use that the buyer wants and is willing to pay for is called the use function cost. Whereas the cost that is expended for the purpose of pleasing the buyer through color or shape or feature, causing him to buy, is typed as the aesthetic function cost. Any costs other than those that provide the amount of each of these two functions that the user or buyer wants are unnecessary costs (Miles, 1972).

Definition of Value

A product or service is generally considered to have good value if that product or service has appropriate performance and cost. Or, by reverse definition, a product is considered not to have good value if it lacks either appropriate performance or cost. It can almost truthfully be said that, by this definition, value can be increased by either increasing the performance or decreasing the cost (Miles, 1972).

Value, in the context of Value Engineering, is considered to be the amount of money that we receive in return of a product or service (Zimmerman, et al., 1982). It is defined as a fair return or equivalent in goods, services, or money for something exchanged. Value is commonly represented by the relationship shown in *Eq. 2.1* below:

$$\boldsymbol{Value = \frac{Function}{Resources}} \qquad (Eq.\ 2.1)$$

Where **function** is measured by the performance requirements of the customer and **resources** are measured in materials, labor, price, time, etc. required to accomplish that function. For example, in a road construction project, the function could be "comfortable ride", "saving time", "safe drive", "connecting towns", "connecting people" etc.., and resources may include money, machineries, manpower, construction materials etc.

Value engineering focuses on improving value by identifying alternate ways to reliably accomplish a function that meets the performance expectations of the customer (SAVE International, 2007).

However, Dell'Isola, 1997, indicated that three basic elements provide a measure of value to the user: function, quality and cost. These elements can be interpreted by the relationship indicated in *Eq. 2.2* below:

$$\boldsymbol{Value = \frac{Function + Quality}{Cost}} \qquad \text{(Eq. 2.2)}$$

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.

Therefore, we can say that:

Value = the most cost-effective way to reliably accomplish a function that will meet the user's needs, desires, and expectations.

According to Zimmerman, et al., 1982, there are four types of value.

i. Use value: is a value received from the delivered function. It usually represents the properties and qualities which perform a function.
ii. Esteem value: encompasses our emotional regard for the item which we are purchasing.
iii. Exchange value: is the amount that we are willing to accept in trade for an item. Sometimes this amount is expressed in monetary terms, or it is a defined poduct or a certain quality that is acceptable in trade for other items. Bureau of Indian Standards, 2003, defined esteemed value as "The monetary sum a user is willing to pay for functions providing prestige, appearance and/or other esteem functions".

iv. Cost value: is the amount of money that we are willing to incur to produce an item. The cost value of a construction project would be its actual construction cost.

2.3. Global Experience of Value Engineering

The year 2007 marks 60 years of the life of the value management service. During the first four decades North American thinking dominated its development. However, during the past ten years developments in principally Europe, Australia and China (notably Hong Kong) have seen the divergence of ideas and practices which have impacted the progress of the value methodology in North America. Interestingly, over the whole period value management has continuously improved, unlike other management fads that emerge, are applied with gusto and then die to be replaced by another.

The early years of Value Management have been dominated by the US practice. A watershed occurred in the mid-1980s with the international use of the method in construction. Whilst there has been interest by some countries in taking forward Value Management by franchising the US methodology, it was also taken and melded in to a diverse range of international construction markets and cultures (Kelly, et al., 2004).

According to Dell'Isola, 1997, approximately twenty one countries have active Value Engineering practitioners. 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).

Due to the origin of Value Engineering being in the USA and extensive application in the construction industry coupled with availability of resources, substantial part of this study reflects the practices of the western world.

2.3.1. United States of America (U.S.A)

At most levels of government in the United States, Value Engineering is encouraged and in many cases required. When contemplating any Value Engineering program or study in the public sector, the guidelines and policies of the various governing layers must be taken into account (Clark, 1999).

Most transportation Value Engineering studies done in the United States are being undertaken because the projects under review are on the NHS or cost more than $25 million, as required by regulation. The $25 million project cost threshold was identified most often as a key statutory trigger to warrant a study. According to a study carried out by Wilson, 2005, 66% of the responding agencies identified the statutory requirement as the primary motive to complete the study. Nevada reported that they plan to lower the threshold from $25 million to $10 million when their draft Value Engineering policy is enacted. Florida, Pennsylvania, and Ohio reported cost thresholds of $20 million. New Hampshire indicated that their cost threshold was $50 million, whereas Virginia and Alaska use $5 million and $4 million thresholds, respectively (Wilson, 2005).

a) Public Contracts in U.S.A.

On May 21, 1993, the Office of Management and Budget (OMB) issued Circular number A-131, which set forth its requirement that all “federal departments and agencies... use value engineering as a management tool, where appropriate, to reduce program and acquisition costs.” (Clark, 1999)

All federal acquisitions are governed by the Federal Acquisition Regulations (FAR). These regulations require that all federal acquisitions offices have a value engineering program. Value engineering clauses are mandatory for all construction projects of $100,000 or more. According to SAVE international, U.S. government agencies are realizing an average of more than $20 for every dollar invested. The FAR outlines two basic value engineering approaches. The first is an incentive approach in which contractor participation is voluntary and the contractor uses its own resources to develop and submit any value engineering change proposals (VECPs). The contract provides for sharing of savings and for payment of the contractor's allowable development and implementation costs only if a VECP is accepted. This voluntary approach should not in itself increase costs to the Government.

The second approach is a mandatory program in which the Government requires and pays for a specific value engineering program effort. The contractor must perform value engineering of the scope and level of effort required by the Government's program plan and included as a separately priced item of work in the contract Schedule. No value engineering sharing is permitted in architect engineer contracts. All other contracts with a program clause share in savings on accepted

VECP's, but at a lower percentage rate than under the voluntary approach. The objective of this value engineering program requirement is to ensure that the contractor's value engineering effort is applied to areas of the contract that offer opportunities for considerable savings consistent with the functional requirements of the end item of the contract.

Value Engineering Change[1] Proposals (VECP)

VECP, mandated to be a part of all construction contracts estimated at $100,000.00 or more, is the government's way capitalizing on the experience of construction contractors. Government Design efforts, in the past, have been very restrictive, with many design criteria and guide specifications to guide the effort. This has proven to not always be in the best interest of the project. Prior to VECP the contractors may disagree with the methods and materials specified in a contract, however, there was no incentive for them to bring these concerns to the attention of the Government, hence you had much more projects built, by the plans and specifications, that was not the best value to the Government. When the FAR made VECP clauses a requirement in Government contracts, this gave the contractors the incentive they needed to be pro-active and recommend better ways of constructing these projects. There have been many valuable VECPs in Government construction contracts, however, there have been, and continue to be, contractors that abuse the system by identifying a defect in a specification during bid preparation and wait until after award to identify this defect to the Government. They identify it in the form of a VECP. This is unethical and illegal but it happens and is very difficult, if not impossible, to control. This practice has given many Contracting Officers and Project Managers a negative attitude toward VECPs (Simpkins, 2000).

The VECP allows the contractor to be proactive and use construction/ engineering knowledge to improve a facility at on-site stage. However, it is disadvantageous in that the contract may be delayed while the design team investigates the viability of the change. For this reason changes tend to be relatively superficial (Kelly, et al., 2004).

The Government "trigger" as to when a full-blown VE Study is required is a moving target. The FAR is intended to be a guide with enough latitude for each service community to mold to fit their needs. There are many differences among services and even within the same service on how the VE program is accomplished. The Air Force requires this study for all projects over $10 million.

[1] Simpkins, 2000, stated is as ‘Contractor’ but it is corrected here to read as ‘Change’.

These studies typically cost about $30,000. For smaller scope jobs, there can be Value efforts less than that required in a full study (Simpkins, 2000).

b) Private Contracts in U.S.A.

According to Simpkins, 2000, all construction management companies he have researched offer value engineering, as part of their pre-award services, however, do not have rigid guidelines on how these efforts are to be conducted. This is neither surprising nor an indication that they do not have quality value engineering programs. It simply shows that any bureaucratic organization such as the Government will generally have more written rules and regulations than their non-bureaucratic counterparts. Furthermore, all companies interviewed were very similar in their approach to value engineering and each company had a long list of successful projects and value engineering proposal that have been made possible.

Kelly and Male identified four formal approaches to North American Value Engineering defined as:

1) *The Charrette* is a meeting following the compilation of the client's brief, attended by the full design team and those members of the client's organization who have contributed to the brief. This meeting is conducted under the chairmanship of the Value Engineering (Kelly, et al., 2004).

   A charrette is a meeting where participants work together intensely to find a solution to a problem or resolve an issue within a specified time limit. It is applicable to military and civil works construction projects. In the design phase, a charrette helps resolve controversial issues. In the construction phase it is useful to resolve an impasse between the user and contractor and in the case of civil works projects, community groups, and the government. A charrette may enlarge the degree of public involvement in civil works projects, reducing feelings of alienation from government.

   A charrette combines effectively with value engineering techniques. Charrettes generate alternative solutions to problems. The setting encourages openness and creativity. All suggestions from the group–however outrageous–should be examined to encourage thinking about better approaches. Anyone can participate in a charrette (Department of Defense, 2011).

2) *The 40-hour study* is an examination of the design developed. This is carried out by an independent team of design professionals who have not been involved with the design until the time of the study, again under the chairmanship of the Value Engineering.
3) *The Value Engineering Audit* is a study of the proposals made by a subsidiary of a large holding company for a vote of capital to fund a project. This study will be undertaken by a Value Engineering team in order to ensure that the parent company is receiving value for money.
4) *The Contractor's Change Proposal* arises when a clause in the construction contract allows the Contractor to suggest changes to the proposed design in order to reduce construction costs. The Contractor receives a bonus in exchange of the proposal (Kelly, et al., 2004).

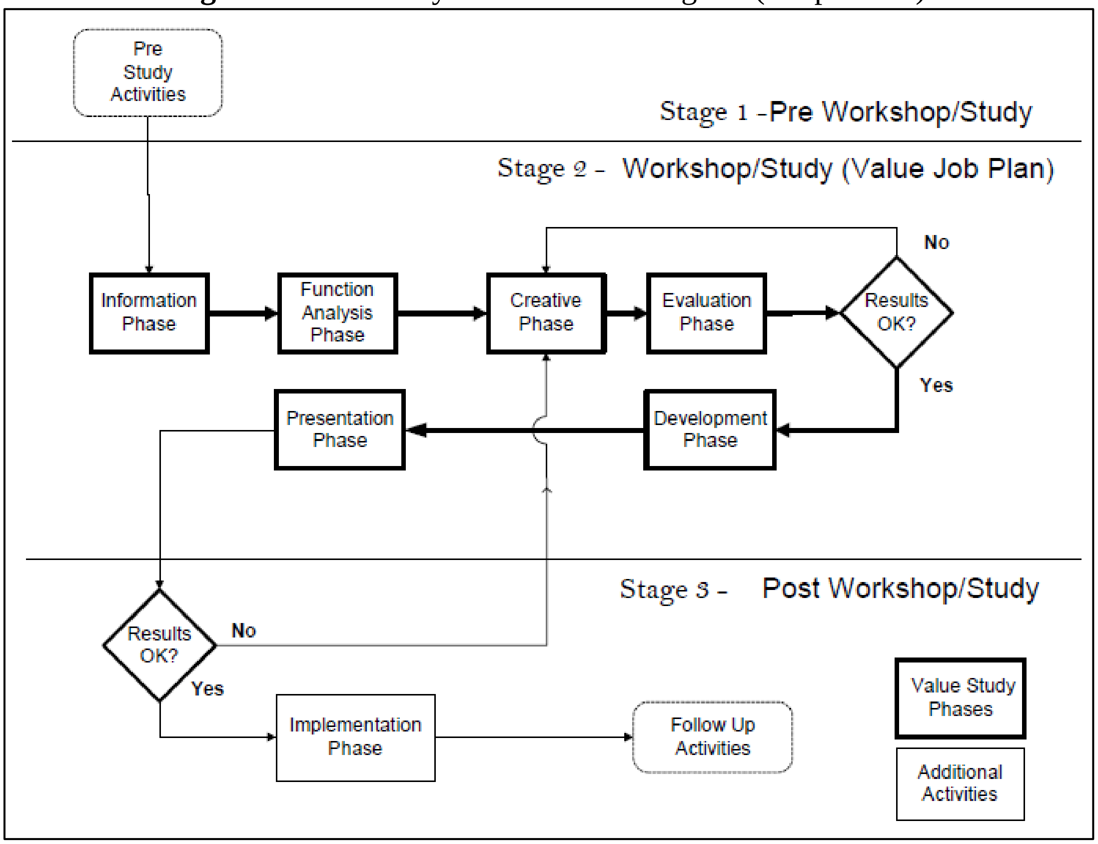
The National Highway System Act of 1995 required the establishment of a program for value engineering analysis for all projects on the National Highways System and this requirement has been updated on October 1, 2012. To this effect, the West Virginia division of highways Value Engineering Manual has set the following criteria to determine which projects require the performance of a Value Engineering analysis.

- **Projects on the National Highway System (NHS):** All projects on the NHS, receiving federal assistance, with an estimated total cost greater than $50,000,000, shall undergo a Value Engineering analysis.
- **Bridge Projects on the NHS:** All bridge projects on the NHS, receiving federal assistance, with an estimated total cost greater than $40,000,000, shall undergo a Value Engineering analysis.
- All required Value Engineering analyses shall be performed, per the Value Engineering manual, prior to Final Design.
- A project meeting the above criteria, to be delivered by the design-build method, shall not be required to have a value engineering analysis performed. (Division of Highways, 2004). This is due to the fact that, under the design-build delivery system, the design-builder should take the full responsibility of developing an economical design and deliver the pre-specified requirements of the client. Therefore, in such cases, it should be up to Contractor to decide whether to apply value engineering in his projects or not.

The Value Engineering study is carried out based on the sequential steps of the Job plan discussed separately in section 2.7 below. According to SAVE International, 2007, a value study generally encompasses three stages (as shown in Fig. 1 below):

i. Pre-Workshop (Preparation)
ii. Workshop (Execution of the six phase Job Plan)
iii. Post-Workshop (Documentation and Implementation)

Fig. 1 Value Study Process Flow Diagram (US practice)



Source: SAVE International, 2007, (Figure 1, Page 12)

2.3.2. United Kingdom (UK)

During its first four decades of life, Value Management developed within the manufacturing sector with only slight leakage in to other areas. From the mid-1980s Value Management has been adopted for use as a value-for-money measure within construction industries of a number of countries. In the UK, the past two decades have seen growth in its development and practice at differing intervention points across a wide range construction project types.

A fertile ground was prepared for developments in Value Management in the UK construction industry during the 1990s by various initiatives that sought to increase the efficiency and effectiveness of the industry. The climate of the 1990s in UK construction was therefore right for the development of innovative systems such as Value Management.

Value Management activity in UK construction began three decades after the early project management consultancies. Aided by the European SPRINT program (Strategic Programme for Innovation and Technology Transfer), a European Standard for value management published, authored by a consortium of the various value associations throughout Europe. A training and qualification system entitled Value for Europe has been configured with its own European Governing Board.

The Value Management as a structured management service has been recognized for over 50 years. It began in the manufacturing industry of the USA in 1947 and migrated to the construction industry in the late 1960s. In the UK, Value Management in construction evolved in the late 1980s. The first UK text book *Value Management in Design and Construction* by *Kelly J., Males S.* and *Graham D.* was published in 1993. Since that time Value Management in construction has evolved to become an established service with commonly understood tools, techniques and styles (Kelly, et al., 2004).

Different value study styles are introduced pursuing the argument that the role of the value manager is one of deciding on, structuring and delivering a study style tailored to a particular value problem, be it for a project, project programme, service or organizational function. Irrespective of the type of value problem it is postulated that the stages in its solution comprise three generic phases:

- *Orientation and diagnostic phase*: in this phase the value manager(s) and value team will be preparing themselves for the study, and the value manager(s) will meet with the commissioning client, project sponsor and key players who will be involved in the study, reviewing documents and possibly conducting interviews and briefings. The study style chosen by the value manager may also include understanding and structuring the value problem in detail. This may include exploring competing value problems, discussing possible solutions and exploring the way forward on completion of the workshop phase.

The agenda for the workshop phase will be developed and the method and manner in which this will be conducted worked out. This phase will also set in train the process for, or as a minimum consider, the implementation of options and solutions developed from the workshop phase.

- *Workshop phase*: This is the stage where alternative and/or complementary views on the value problem will be brought together to explore and reach a way forward, hopefully through agreement. A workshop/study report will normally be produced, including an action plan to ensure that value solutions and options will be implemented in the post workshop phase.
- *Implementation phase*: This was identified as one of the key areas where value management falls down. To ensure this problem is minimized, implementation meetings and workshops have been used. As a minimum, during the orientation and diagnostic phase an implementation strategy will be discussed with commissioning clients and wherever possible those responsible for implementation will be interviewed and identified in the action plan at the close of the workshop phase (Kelly, et al., 2004).

2.3.3. Japan

Contrary to the approaches of North America, Australia and United Kingdom, in Japan Value Engineering is not an event but rather a continuous process carried out within a philosophy of continuous improvement across all phases of the construction process. The term Value Engineering is used by the Society of Japan Value Engineers (SJVE). SJVE has strong links with SAVE International to the extent of reciprocity in respect of training structures, qualifications, etc.

The founding structures of Value Engineering, function definition, evaluation based up on the lowest cost to perform function, the use of FAST diagrams, the job plan, and the use of creativity are essentially the same as for the USA. The focus on elements and components rather than on the form of the project to meet the strategic requirements of the client is also similar to the USA. The differences lie in the continuous process of involving the design team and the use of an in-house Value Engineering facilitator. A function of private sector procurement being design and build means that the Contractor carries out Value Engineering. In public sector projects where design is commonly divorced from construction there are two Value Engineering opportunities, one with the design team and the other with the Contractor.

Differences in culture also impact the approach to Value Engineering. Whereas the North American approach seeks a demonstrable financial return in a short focused exercise, the Japanese seek satisfaction from a holistic assessment of the problem with a range of possibilities which can be considered long term and determined by consensus amongst the team. The Japanese system is therefore intuitive and future oriented as against the North American system of clear returns now (Kelly, et al., 2004).

2.3.4. Saudi Arabia

In Saudi Arabia, the General Directorate of Military Works (GDMW), under General Otaishan, retired, of the Saudi Arabian Ministry of Defense and Aviation (MoDA), has had a full time program for more than eight years. The GDMW has saved from $ 30 million to $ 70 million per year. Through the efforts of GDMW, the Value Engineering concept has spread in Saudi Arabia. Recently, a Saudi Chapter of SAVE International was established which includes three Saudi professionals who are Certified Value Specialists (CVS), and eight Saudi Associate Value Specialists (AVS).

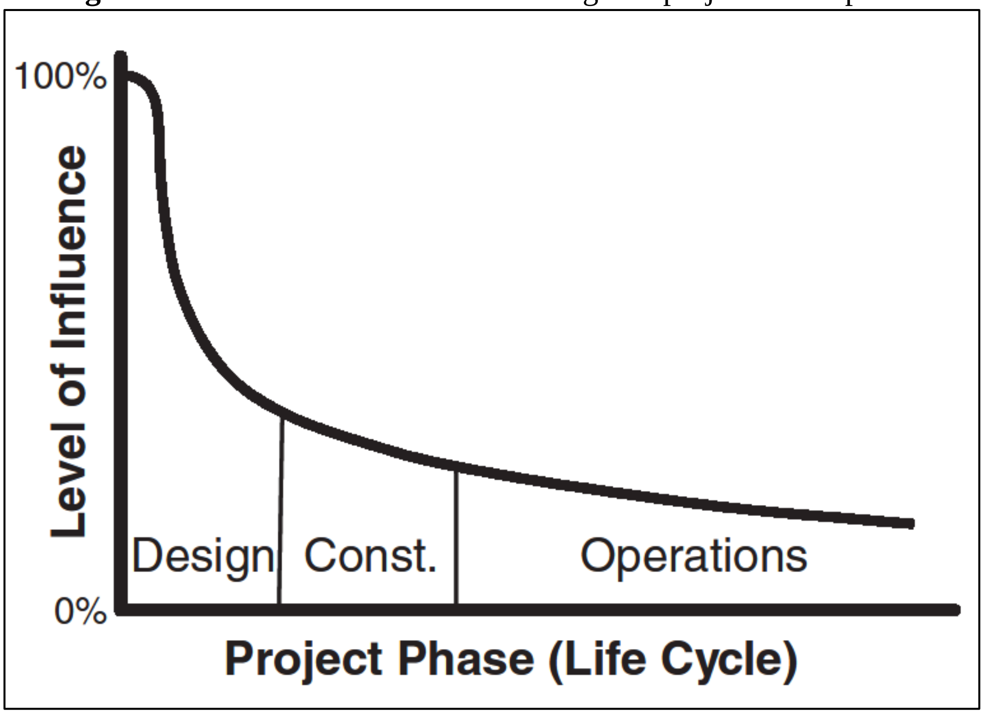
In the government sector, the ministry of municipalities, Saudi Arabian Basic Industries (SABIC), GOSI – the Saudi Agency of Social Security, High Commission for Development of Arriyadh, and Saudi Consolidated Electric Company have initiated programs. In the private sector, Saudi Aramco and several other private investors (e.g.: ALJ Real Estate Development, Jeraisy Corporation and Saudi German Hospital) have used Value Engineering.

2.4. Effective time to apply value engineering

In the United States, Value Engineering has been used to improve transportation projects for more than 30 years (Wilson, 2005). Value Engineering techniques can be used to improve productivity or the "benefit to cost ratio" in nearly every aspect of a state's transportation program, including preliminary engineering, traffic operations, maintenance, standard plans and specifications, and design criteria and guidelines (AASHTO, 1987). It was initially applied during construction, in the form of Value Engineering Change Proposals to reduce overall construction costs. However, many transportation agencies now recognize that greater benefits can be realized if Value Engineering is introduced earlier in the development of the project. This is because "the [planning and] design phase accounts for 80% to 90% of the impact on [project] quality and cost" as indicated in Fig. 2 below (Wilson, 2005). Benefits include:

- Improved functionality of the project – a "second look" at the design produced by the architect and engineers assures that all reasonable alternatives have been explored;
- Significant savings – both during construction and over the life cycle;
- More reliable cost estimates and scope statements – both are checked thoroughly assuring that nothing has been omitted or underestimated; and consequently
- Best value will be obtained over the life of the building (Department of Defense, 2011).

Fig. 2 Level of influence on cost throughout project development



Source: Wilson, David C, 2005, (Figure 7, Page 21)

Early in the development of Value Engineering, architects and engineers were resistant to the implementation of Value Engineering. The typical approach to planning and design was to (1) proceed with design until an established time – For example, Schematic or design development, or (2) wait until a cost overrun surfaced. In time, it became apparent that more savings were being lost than realized. Eventually, the U.S. government and owners, who recognized continual cost overruns and poor results, encouraged the design community to embrace Value Engineering. As a result, the application of Value Engineering moved to earlier design phases and was integrated in to the design process.

Value Engineering should be performed as early as possible – before commitment of funds, approval of systems, services, or designs – to maximize results. The potential savings is much greater the earlier Value Engineering is applied. When Value Engineering is applied later, two things increase: the investment required to implement any changes, and resistance to change (Dell'Isola, 1997).

Value methodologies can be applied during any stage of a project's development cycle, although the greatest benefit and resource savings are typically achieved early in development during the conceptual stages (SAVE International, 2007). Barbara, 2004, also mentioned that the design development stage is where much of the detail work gets done. A great deal of research and investigation takes place regarding the use of materials, equipment, and systems that will go into the facility. The specifications become more developed at this stage, and more accurate pricing can now take place. It is during the design development process that value engineering and constructability reviews are typically performed.

In the VE process, a thorough analysis is conducted of the design, products, and materials and their application, installation, and execution to determine whether the proposed design solutions are really the best solutions relative to their cost. The purpose of value engineering is to optimize resources to achieve the greatest value for the money being spent. The designers, contractors, building trades, engineers, manufacturers' representatives, and end users are engaged to brainstorm the best possible solutions. A project team that can propose creative and cost-effective solutions can really shine, and adds tremendous value to the overall project.

One of the most underutilized resources available to the design team in the development of their solution is the engagement of the field personnel who actually install the systems, equipment, and products specified and the end users who actually use the facility every day. They can provide great insight into what works and what does not work but are rarely ever called upon to join in the design team discussions (Barbara, 2004). Further, according to Dell'Isola, 1997, the decisions of the owner and the consultants have the most influence over the expenditure of funds during the life cycle of a facility. To ensure optimal results, it is essential to involve the owner and consultant in the value engineering process.

While variations are normally decided and instructed by the engineer it is not uncommon for contractors to put forward ideas either to save cost or time. Indeed this is encouraged by value engineering procedures and can be a useful way of controlling or reducing the final price. The ICE conditions of contract recognize the potential of such proposals and allow for sharing of any changes in value between both parties (Alan, et al., 2004).

2.5. Unnecessary costs in designs

Regarding total costs for a facility, the consultant's fee represents the smallest expenditure of all of the initial costs. Consultant's decision influence about 50% of the facility's total costs. Therefore, the optimum results can be expected when resources are set aside for value engineering early in the design process, focusing on owner and consultant impact. Owners who delight in squeezing design fees invariably promote poor value design decisions. Prudent expenditures during design to improve design decisions can return significant initial and follow-on cost and quality improvements (Dell'Isola, 1997).

Unnecessary cost is that portion of the cost of a product which does not contribute to the basic function, required performance or marketability (IS 11810:2003, 2003). All design projects have unnecessary costs designed in to them. Studies invariably show that all designs have unnecessary costs regardless of how excellent the design team may be. It is impossible to bring together the innumerable details of a construction project with the best functional balance between cost, performance and reliability without a value engineering review. It is an elusive combination and almost impossible to reach in every detail.

Once the designer and the owner are aware of this, it becomes easier for them to accept the fact that a value engineering study team will have ideas that will benefit the project. It should also be stated that the goal of the value consultant is similar to that of the designer, i.e. to ensure a design that meets the owner's required function at the most reasonable life-cycle cost. However, anyone conducting a value engineering study is doing an easier job than the original designer since then value engineering team is reviewing and not conceptualizing.

Design of construction projects are complex. They require investment, experience and talented people. But, regardless of how capable or how overwhelmingly able a designer is, there will always be unnecessary cost hidden in his design. The very nature of construction design demands that countless variables be considered and pulled together by a certain date. The designer is under the gun to meet that due date and he must ensure that a viable, reliable plan is formulated. With that set of circumstances, the design grows and it takes form. Once the project is formed under the pressures of anxious effort, the designer becomes wed to the project as it is, and may be unable to review it for unnecessary cost.

The value engineering team has an objective view point, not having participated in the original design. In fact, one of the requirements of value engineering is that the team members cannot be involved in the original design. The value engineering team may not have the knowledge of the original designer on the project, but they can still improve it. Value Engineering improves designs by viewing them from a parallel yet discrete view point. It does not matter who designed the project.

Unnecessary cost occurs in all designs and it is an important point to consider in any relationship with the designer. He must understand that unnecessary costs in a design are not a reflection on his abilities as a professional, but rather a management problem that needs to be addressed (Zimmerman, et al., 1982).

The main objective of Value Engineering is to improve value, and Value Engineering techniques can overcome many of the roadblocks to achieve good value. Unnecessary costs that lead to poor value are generally caused by one or more of the following:

- **Lack of information.** Insufficient data on the functions the owner/user wants or needs and information on new materials, products, or processes that can meet these needs, within the required cost range.
- **Lack of ideas.** Failure to develop alternative solutions. In many cases, decision makers accept one of the first workable solutions that come to mind. This tendency invariably causes unnecessary costs, which can be eliminated by requiring the development of additional alternate ideas and then making choices based on economics and performance.

- **Temporary circumstances.** An urgent delivery, design, or schedule can force decision makers to reach a quick conclusion to satisfy a time requirement without proper regard to good value. These temporary measures frequently become a fixed part of the design or service, resulting in unnecessary costs.
- **Honest working beliefs.** Unnecessary costs are often caused by decisions based on what the decision maker believes to be true, rather than on the real facts. Honest wrong beliefs can impede a good idea that would otherwise lead to a more economical decision or service.
- **Habits and altitudes.** Humans are creatures of habit. A habit is a form of response – doing the same thing, the same way, under the same conditions. Habits are reactions and responses that people have learned to perform automatically, without having to thin or decide. Habits are an important part of life, but one must sometimes question, "Am I doing it this way because it is the best way, because I feel comfortable with my methods, or because I have always done it this way?"
- **Changes in owner requirements.** Often, the owner's new requirements force changes during design or construction that increase costs and alter the schedule. In too many cases, the owner is not cognizant of the impact of the desired change.
- **Lack of communication and coordination.** Lack of communication and coordination are principal reasons for unnecessary costs. Value Engineering opens channels of communication that facilitate discussion of subjects and allows the expression of opinions without undue concern about acceptability. Also, it creates an environment that promotes listening and responding to varying points of view about becoming defensive.
- **Outdated standards and specifications.** Many of the standards and specifications in use in large construction programs are at least ten years old. As technology progresses, continual updating of data is required, but it is often not accomplished. Value Engineering helps to isolate and focus on new technologies and standards in areas where high costs and poor values may be incurred (Dell'Isola, 1997).

2.6. Initiating value engineering study

2.6.1. Team formation

It takes time and effort to assemble the expertise to conduct an in depth review using the Job Plan. The importance of selecting appropriate team members cannot be overemphasized (Dell'Isola, 1997). Teams should be structured so there is appropriate expertise to evaluate the major problem areas anticipated within the project, e.g., traffic, right of way, structures, soils, paving, etc. including general expertise from the areas of design, construction, right of way, maintenance, or traffic operations makes for a good team balance (AASHTO, 1987). A good rule to follow is to seek out team members with equal or better qualifications than the original design team.

The success of any Value Engineering study is influenced by the qualities of the Value Engineering team, including the Value Engineering team leader, and the technical specialists (Wilson, 2005). The Value Engineering team should have a qualified professional (preferably a Certified Value Specialist) as its coordinator. The Value Engineering team coordinator's (VETC) skills should be more creative, organizational, and motivational than technical.

To improve implementation, a decision-making representative for the owner should attend, or at least be on call, during application of the Job Plan. Several hundred studies have shown that a well-selected team that follows the organized Value Engineering approach always produces savings. The order of magnitude of the results is the only variable (Dell'Isola, 1997).

Opinions are varied as to whether members of the original planning or design team should be included on the Value Engineering team. Previous involvement on the study project may inhibit the objectivity that is required to analyze the project. On the other hand, the original designers can explain the problems involved and the reasons for particular design elements. In any case, the original designer is an excellent resource individual for the team to consult (AASHTO, 1987). Therefore, it is better if members of the original team are not permanently included in the value engineering team as far as objectivity is concerned.

Specific training in the concepts, application, and techniques of Value Engineering is highly desirable for those working as Value Engineering team members. Occasionally, a team may include one or two members who are untrained in Value Engineering but highly skilled in disciplines that are vital to the study (AASHTO, 1987).

According to Dell'Isola, 1997, regardless of the specific technical skills required for a project, there are some universal considerations for a team members:

- The VETC should be a recognized leader in the application of Value Engineering procedures to similar projects as those being studied.
- Team members should be highly qualified, with equal (or more) experience as the design team members. If team members have more and better experience than the design team, then results are practically guaranteed. The technical competence of team individuals is more important than the team's precise composition.
- Disciplines on each team should be mixed. Too many members from the same discipline on a team tend to stifle creativity.
- Team members should have participated previously on Value Engineering study teams. Ideally, no more than one or two inexperienced members should be on a team.

The size and composition of the Value Engineering team depends on the project being studied and the stage of design development (ASTM E 1699 – 00, 2005). The size of an effective team can range from two members to an upper limit of about 16 members though 12 members is probably the largest size that allows each member to interact easily face to face. Optimally, the team size is between six and ten people (Kelly, et al., 2004). However, according to AASHTO (1987), a value engineering team of five to seven persons with diverse backgrounds usually produces the best results. A team of less than five tends to limit the amount and variety of creative inputs, and a team of more than seven can be unwieldy.

2.6.2. Project selection

Before a value study can be made, a project must be selected for the study (Iyer, 2009). It is important to select projects that provide the maximum opportunity to improve the public investment by quality enhancement or life-cycle cost savings (AASHTO, 1987). It is true that any item can be subject to value study and at any point of time in its life cycle and that it will yield an average minimum of 10% return on investment. However, wisdom dictates that any such effort should be directed towards getting the maximum return, considering the limitations in Value Engineering resources available. Therefore, projects have to be screened and probable items, chosen (Ilayaraja, et al., 2015).

There are costs associated with value engineering; therefore, it is probably impractical to use it on every project (Ilayaraja, et al., 2015). The United States Federal Highway Administration insists that a Value Engineering study should be performed in all Federal-aid funded projects on the national highway system with an estimated cost (includes design, right-of-way, and construction costs) of $25 million or more, and on other Federal-aid projects where its employment has high potential for cost savings (Clark, 1999).

According to Department of Defense, 2011, opportunities for Value Engineering projects will be derived from a known problem, a cost driver study, or anything indicating that a product or a process should be improved. In the early stages of Value Engineering application within an organization, sophisticated project-selection criteria are not usually needed. Value Engineering can frequently offer substantial benefits, particularly when one or more of the following applies:

- High cost;
- Deficiencies in performance, reliability, or producibility;
- Multiple product applications; or
- Executive management interest.

Once the organization's use of value engineering is more fully established, additional criteria may be applied to select subsequent tasks. Worthwhile candidates usually involve one or more of the following:

- An excessively complex product;
- An accelerated development program;
- An item that field use indicates is deficient in some way, such as high failure rate, low reliability, or low availability;
- An item that uses older technologies for which modernization appears promising;
- A process with long cycle time; or

- A sole-source procurement (Department of Defense, 2011).

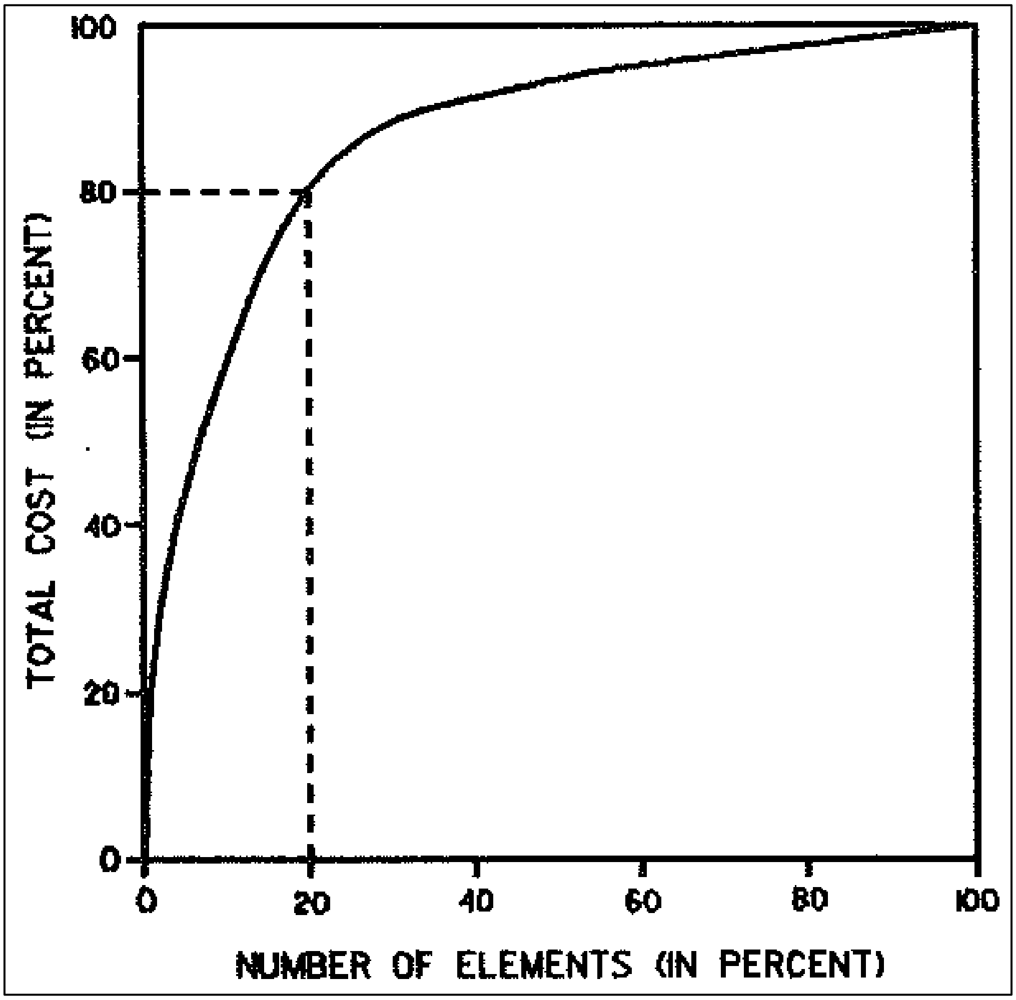
There are many ways to choose the probable items for value effort. Some managements choose the items that they want examined. Where there is a Value Engineering group in the company, the Value Engineering personnel may decide what to evaluate. In still others, the employees are given the opportunity to suggest items from which selection is made (Iyer, 2009).

A generally accepted and usefull approach for selecting both projects and items to be studied within a project is based on Pareto's curve, or law of distribution, shown in Fig. 3 below. The curve is based on the principle that a small number of elements, about 20 percent, account for about 80 percent of the costs. It follows that these few elements generally contain the greatest potential for value improvement. Based on this, not all of a state's projects will be candidates for a successful Value Engineering study (AASHTO, 1987).

Some typical characteristics of potential Value Engineering projects are:

- Projects that substantially exceed initial cost estimates.
- Complex or multi-part items or process that provide unique but costly functions.
- Items using critical or high-cost materials.
- Items requiring difficult construction or fabrication procedures.
- Items that perform a questionable function.
- Items that simply appear too costly to build, operate, or maintain.
- Projects that have grown complex, possibly by development over a long period of time.
- Major structures.
- Projects with complicated or costly traffic control or detours (AASHTO, 1987).

Fig. 3 Pareto's Law of Distribution



Source: AASHTO Guidelines for Value Engineering, 1987, (Figure 1, Page 9)

The Pareto priciple (also known as the Pareto rule or the 80/20 rule), named after economist Vilfredo Pareto, states that for many phenomena, about 80% of the out puts or consequences are produced by 20% of the inputs or causes. In 1897, Pareto happened to be looking after patterns of wealth and income in nineteenth-entury England. He found that most income and wealth went to a minority of the people in his samples. There was a consistent mathematical relationship between the proportion of people (as a percentage of the total relevant population) and the amount of income or wealth that this group enjoyed. To simplify, if 20 per cent of the population enjoyed 80 percent of the wealth, then you could reliably predict that 10 per cent would have, say, 65 per cent of the wealth, and 5 percent would have 50 per cent. The key point is not the percentages, but the fact that the distribution of wealth across the population was predicatbly unbalanced. His another finding was that this pattern of inbalance was repeated consistently whenever he looked at data referring to different time periods or different countries (Koch, 1998).

Pareto's principle is often used in management, economics and business to improve productivity and make better decisions. It helps to realize that often the majority of results comes from a minority of inputs. The paretos principle is a simplified version of the mathematics behind the pareto's distribution. It is also not important that the two numbers add up to 100%. The numbers 20 and 80 are not mathematically fixed, but are used as a rule of thumb. It could be 80-20, 90-10, or even 90-20 (Dunford, et al., 2014).

Iyer (2009) stated the following methods, including Pareto's law, for selection of items for value study are:

1. **Felt Need:** customer feed-backs, changes in user needs or application of the item, advances in technology, or comparisions with competition will bring to light the need for changes or modifications. Employees facing specific problems on their jobs may also want something to be done to remove the deficiency or correct the situation, when they would suggest items for study or attention. The felt needs may be "personal or company-motivated, problem or profit-stimulated or a combination of these." All such information should listed and maintained up-dated. Projects for value study coiuld be selected from the list.
2. **Reviews by standing committees:** various standing committees in the organization would suggest items or areas for attention, as part of their routine work. Examples are design reviews, review of planning documents, new product introduction, quality management reports, etc. A list of such items could form the basis for selection.
3. **Suggestion schemes:** almost all progressive organizations have some suggestion scheme or the other in operation, nowadays. Only, such schemes are normally used to invite suggestions from their employees with the ultimate objective of using or implementing those that are approved by the committee set up to oversee these schemes. For spotting a project for value studies, ALL the suggestions may be scrutinised from the angle of WHAT out of the lot of suggestions received CAN BE

MADE TO WORK. Those that satisfy this test can be ranked for priorities and studies turn.

4. **Seminars:** calling a meeting of all the officers of the organization, giving them an overview of value engineering, illustrating the potential benefits with a few cases and inviting them to suggest items, areas and problems that may be subject to value improvement efforts, would generate a fairly comprehensive list of prospective items for value effort. The management could then short-list the items and/or attach priorities as they deem fit.
5. **Relative ranking:** estimated cost of the items, parts or sub-systems are ranked from the highest to the lowest in terms of money value per unit of the product and total amount for the ultimate product. Generally, potential value improvement is the greatest on those items rnaked with the highest total costs.

   Similarly, relative ranking can be used to list high energy use, low profit margin, highly competitive, most problematic items.

   Pareto's Law

   Ranking can be done by applying Pareto's Law. Table 2 shows the components of an assembly, quantities per assembly, cost of component and cost per assembly. From this tabulation, a relative ranking tabulation, Table 3, can be generated to highlight that the components offering the most promise for cost improvement are Valve body, Screw spindle, Hand wheel, and, possibly, Nuts.

Table 2 Brass wheel valve – parts and costs

Part	Quantity per assy.	Cost per part (Rs.)	Cost per assembly (Rs.)	Percentage assembly
Fiber Washer	1	1.00	1.00	1
Check Nut	1	4.00	4.00	4
Valve Body	1	35.00	35.00	35
Hollow Nut	1	10.00	10.00	10
Small Washer	1	0.50	0.50	0.5
Nuts	2	1.25	2.5	2.5
Screw Spindle	1	27.00	27.00	27
Large Washer	1	0.50	0.50	0.5
Hand Wheel	1	16.00	16.00	16
Floating Piece	1	3.50	3.50	3.5
Total cost of assembly			100.00	100

Table 3 Relative cost ranking

Part	Percentages	
	In descending order	cummulative
Valve Body	35.0	35.0
Screw Spindle	27.0	62.0
Hand Wheel	16.0	78.0
Hollow Nut	10.0	88.0
Check Nut	4.0	92.0
Floating Piece	3.5	95.5
Nuts	2.5	98.0
Fiber Washer	1.0	99.0
Large Washer	0.5	99.5
Small Washer	0.5	100.0

ABC Analysis

This is an extension of the relative ranking technique. Listing every item, the unit costs, multiplying unit cost by annual usage, and arranging in descending order of magnitude, will enable categorising the high expenditure items, or “A” items (20% in number, and 80% in cost), the low expenditure items, or “C” items (70% in number, and 10% in costs), and the rest, middle group, or “B” items. Cost concentrations of items became visible, making decision easy.

Modified ABC Analysis

Considerations of other factors than costs, like excessive scarp, re-work, test, inspection time, etc. can improve the selection process.

6. **Preliminary Assessment of Value Index, Value Gap, Value Mis-Match, Index of Cost Savings Potential:**

Value Index

Value Index= Worth/Cost

By definition, Worth is the least cost for performing the function.

The worth of all secondary functions is ZERO for value engineering purposes. And, worth is associated with the necessary function(s) and not with the present design of the team.

Experience has shown that low value indices (or COST to WORTH ratios greater than 2) will usually indicate good potential for value efforts.

Value Gap

By definition, Value Gap = COST – WORTH

A high figure shows good potential for value improvements.

Index for Savings Potential

Index of cost savings potential = (estimated study savings/estimated cost of study) x probability of implementation

Where:

Estimated savings = Present Cost (before VE) – Estimated Cost (after VE)

Present Cost (before VE) = Quantity x Present cost per unit

Estimated Cost (after VE) = Quantity x Estimated cost of proposed, per unit

Estimated Cost of study = Estimate of cost of VE study + Estimate of cost of implementation

probability of implementation = 0.0 for no chance of implementation. 1.0 for certainty, with no chance for not being implemented. Interpolate for the range.

The item with highest index should be considered for the value study, first.

7. **Brainstorming sessions in own training programmes**

   If the company runs its own training programmes, (as many major organisations do at present for their key personnel as a regular feature) – especially in Value Engineering – the participants could be put through a brainstorming session during every programme and a list of probable items for the study can be prepared. These can then be short-listed by the top management and prioritised.

   Note: when an organization commences a Value Engineering programme, and when a team attempts their maiden studies, it would be asvisable to select comparatively easier projects, problems and simple items. Otherwise, if the measure of success in the first few items happens to be low, the managements and the team members are likely to become despondent and show reluctance to continue the value work.

8. **A combination of two or more methods**

2.6.3. Value engineering study duration

The duration for executing the Job Plan in a value study depends on several factors: the size and complexity of the project, the stage of project development, the estimated cost of the project, etc.

A typical duration for the Workshop Stage is five-days, which does not include the Pre-Workshop and Post-Workshop efforts.

Projects with a concise scope or a low level of complexity may be performed in less time. Sufficient time should be allotted to adequately apply the value methodology process and document the team's findings. Shortening the time needed to execute the Job Plan phases may result in a less-than-optimal result.

Projects of very large scope or complexity may require 10-15 days or more to achieve the study's objectives. Consideration of these factors is important to ensure that the proper time is allocated and needs to be addressed as part of the upfront planning for a value study (SAVE International, 2007).

2.6.4. Relationships with design consultant

The quality and completeness of information provided by the owner and the designer on the background of their project directly affects the quality of the Value Engineering team study (Zimmerman, et al., 1982).

"People problems" are sometimes more difficult to resolve than technical problems. Many of the people problems encountered in a value engineering study are motivated by a resistance to change. In the value engineering context, Donald E. Parker defines a "roadblock" as "a decision, attitude, or situation which inhibits progress."[2] Roadblocks are natural hazards to the benefits that would flow from value engineering changes, and both value engineering practitioners and managers must be able to deal with them effectively. Any change can meet resistance. Understanding why roadblocks occur and responding diplomatically with the facts will go a long way toward developing a solution (Department of Defense, 2011).

The intention is not to dispute the work that the design engineer has accomplished. It is to come up with new and different alternatives and comparisons of designs that will reduce the cost of the project. In most cases, the design engineer can provide valuable information that will give a better

[2] Donald E. Parker, *Value Engineering Theory*, The Lawrence D. Miles Value Foundation, Washington, D.C., 1998, revised edition, 56.

feel to the circumstances that led to the project, and indicate areas that he feels have high costs (Zimmerman, et al., 1982).

2.7. Value Engineering Job Plan

The "*systematic application of recognized techniques*", referred to in the definition of Value Engineering, is embodied in the Value Engineering Job Plan. The Job Plan is an organized plan of action for accomplishment of Value Engineering studies. Among the many techniques used to solve problems, only the Value Engineering approach calls for function analysis followed by the application of creative thinking techniques. The Value Engineering Job Plan is a systematic approach that has been used, tested, and proven to work (Division of Highways, 2004).

To apply the Value Engineering Job Plan, two important factors must be recognized:

- An effective Value Engineering effort must consider all phases of the Job Plan. Omissions of any one of the phases will hamper accomplishment of the objectives. The amount of attention given to each phase, however, may differ from one project to another.
- Execution of the plan requires a team effort. The cooperation and active participation of several people produces the most effective results. Group dynamics play an important role and illustrate that results of a team of five professionals is greater than the sum of five individual efforts (Division of Highways, 2004).

Value Engineering techniques create changes to optimize design on purpose rather than letting changes occur by accident. The Value Engineering job plan is built around the scientific approach to plroblem solving (Dell'Isola, 1997). It is a proven fromat for reducing cost in a project and it helps to maximize the effectiveness of a Value Engineering study. The job plan provides the value practitioner with the following:

1. *An organized approach*. Value studies on construction projects could go on for extended periods of time if the studies were not organized and scheduled procedures were not used. The length of the study is restricted in order to get the job done quickly and to allow the designer to complete the design. Following a job plan allows project studies to accomplish more in a short period of time.

2. *It forces a concise description of the purpose*. The Value Engineering jon plan directs the study team to define the requirements of the project and to assess its true *function*. It utilizes function analysis to delineate the components of the project that are performing the required function and those that are support functions.
3. *It zeroes in on high cost areas*. It allows the Value Engineering team to identify the concentration of cost, and to associate cost required to achieve a purpose.
4. *It forces people to think deeper than their normal habit solutions*. People are accustomed to using the first idea that enters their minds. The job paln directs and motivates people to make several comparisons and to analyze in detail how the total system works, as well as the function of each part.
5. *Objective approach*. The job plan allows an objective look at the project, concentrating on the life-cycle of the facility.

   Participants in a Value Engineering study should be cautioned about the tendency to disregard the step-by-step approach of the job paln. Where the job plan is disregarded, the study tends to degenrerate in to a design review. The review will find the obvious high-cost savings.
6. *Universal approach*. The job plan is universal in its approach. It has been applied to manufacturing, systems processes, construction projects and software. In the construction field, Value Engineering has shown excellent returns. Highways, bridges, wastewater plants, chemical plants, power plants, buildings, transportation systems and other areas have beenvalue engineered successsfully. As long as there is a function required and money spent, the job plan will work (Zimmerman, et al., 1982).

According to SAVE International, 2007, a value study generally encompasses three stages. These are:

i) Pre-Workshop (Preparation)
ii) Workshop (Execution of the six phase Job Plan, i.e. *Information phase*, *Function Analysis phase*, *Creative phase*, *Evaluation phase*, *Development phase* and *Presentation phase*)
iii) Post-Workshop (Documentation and Implementation)

Although SAVE international considers only the first six (06) phases as "VE job plan phases", many literatures however mention the following eight (08) sequential phases, which are substantially covered by implementing the pre-workshop, workshop and post-workshop stages mentioned by SAVE International.

1. ***Information Phase***: The team reviews and defines the current conditions of the project and identifies the goals of the study (SAVE International, 2007). The information phase of the Value Engineering job plan involves defining the project, obtaining background information that leads to the project design, limitations of the project, and a sensitivity to the costs involved in owning and operating a facility. The purpose of this phase is for Value Engineering team to gain as much information and knowledge as possible on the project design (Zimmerman, et al., 1982).
2. ***Function Analysis Phase*****:** The team defines the project functions using a two-word active verb/ measurable noun context. The team reviews and analyzes these functions to determine which need improvement, elimination, or creation to meet the project's goals.
3. ***Creative Phase***: The team employs creative techniques to identify other ways to perform the project's function(s).
4. ***Evaluation Phase***: The team follows a structured evaluation process to select those ideas that offer the potential for value improvement while delivering the project's function(s) and considering performance requirements and resource limits.
5. ***Development Phase***: The team develops the selected ideas into alternatives (or proposals) with a sufficient level of documentation to allow decision makers to determine if the alternative should be implemented.
6. ***Presentation Phase***: The team leader develops a report and/or presentation that documents and conveys the adequacy of the alternative(s) developed by the team and the associated value improvement opportunity.
7. ***Implementation phase***: assure that approved proposals are rapidly and properly translated into action, to achieve the savings or project improvements that were proposed.
8. ***Audit phase***: assure the desired results have been attained, properly documented, and reported.

Although the job plan divides the study into a distinct set of work elements, judgment is necessary to determine the depth to which each phase is performed as a function of the resources available and the results expected (Department of Defense, 2011).

2.8. Value engineering in ERA contract documents

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.

The FIDIC 4th edition does not have a provision for value engineering. However, the FIDIC MDB harmonized edition have a provision for value engineering under Clause 13.2 which 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."

The proposal shall be prepared and eventually designed by the Contractor at his own expense. Design liability insurance is to be provided by the Contractor and included in the costing of the proposal (Robinson, 2013).

Value Engineering Change Proposal (VECP) is a proposal seeking to change the existing design, process or procedure to improve value. It invariably includes before and after cost and performance details to support the value improvement claimed (IS 11810:2003, 2003). Value Engineering Change Proposal (VECP) allows the contractor to be proactive and use construction/engineering knowledge to improve a facility at on-site stage. However, the contract may be delayed while the design team investigates the viability of the change. For this reason changes tend to be superficial (Kelly, et al., 2004).

The contractor may be reluctant to make proposals if there is no financial benefit to him. Since the proposal is made at the contractor's risk, the contractor may be unwilling to accept the risk of delays to the works, pending consideration of his proposal by the engineer (and the employer). If the proposal reduces cost, then the contractor is entitled to a fee amounting to 50% of the cost saving. It should also be considered that the adoption of the contractor's proposal may result in an increase in cost and yet be of benefit to the employer (Robinson, 2013).

In general, this implies that if a contractor's value engineering change proposal is approved by the engineer and has a reduction in the contract value, excluding adjustments for changes in legislation and costs, provided that this reduction in contract value is greater than the reduction in value to the employer considering any reductions in quality, anticipated life or operational efficiencies, then the contractor will be entitled to half of the difference between the reduction in contract value and the reduction in value to the employer.

Though this can be considered as an incentive to the contactors to apply value engineering studies, Adugna, 2015, found out that the Ethiopian roads authority has not applied value engineering on its completed projects up the time of his study. Both external and internal reasons as to why value engineering was not applied have been identified by Adugna, 2015.

The internal reasons are:

- Company's limited capacity to maintain experienced staffs with different specialization: their salary is expensive.
- Key staffs turnover.

The external reasons are:

- Unavailability of sufficient number of experts in different discipline in the country.
- There is no provision in the contract regarding incentive related to value engineering as stated on FIDIC-2006 for projects using FIDIC-IV.
- There is no provision for bonus for completion before completion time.
- Consultants' staffs are not matured enough to approve/accept innovative ideas. (Adugna, 2015)

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*.

The proposal shall be prepared at the cost of the Contractor and shall include the items listed in Sub-Clause 13.3 [Variation Procedure]" (FIDIC, 1995) which is of similar content with clause 14.2 of the design-build and turnkey except that the proposal has to be submitted to the Employer's representative. It may be noted that the value engineering clause in both conditions of contract does not allow the contractor to share any savings resulting from implementation of the value engineering proposal which may discourage contractor's to initiate value engineering studies.

In case of design services, section 8.0 of the terms of reference of design service contracts deals with the services of design review through technical panel of experts who are highly qualified with respect to road design data collection, analysis and subsequent reporting. The design review shall be carried out on selected design service contracts. The panel of experts is expected to review, comment and inform the Ethiopian roads authority any deficiency with respect to design qualtiy from the implied or expressed terms of the terms of reference for design services. The technical panel of experts shall comprise of the following members.

1) Senior Road/Highway Engineer (Chair person and Permanent member)
2) Senior Pavement/Material Engieer (Permanent member)
3) Senior Hydrologist/Hydraulics Engineer (Permanent member)
4) Senior Geotechnical Engineer (Ad-hoc member)
5) Construction Contract Engineer (Permanent member)
6) Senior Structural Design Engineer (Permanent member)
7) Transport Economist /Traffic Engieer (Ad-hoc member)
8) Construction/Supervision Engineer (Permanent member)
9) Employer’s Representative (Permanent member)
10) Senior Design Consultant Representative (Secretary and Permanent member)

As per the terms of reference, the employer, in close liaison and coordination with the design consultant, shall ensure the successful implementation of the design review services through the panel of experts. The employer is required to include a provisional sum on the contract price of design contracts out of which the design consultant shall pay members of the panel a fee, perdeim, and provide vehicles if site visit is deemed mandatory..

This provision of the terms of reference for design review by panel of experts seems very helpful in terms of assuring the quality of design works with respect to the employer’s requirements, correcting omissions and reviewing calculations made by the designer. However, the involvement of the design consultant as a permanent member through out the process may hinder the objectivity of the design review. Moreover, the approach is vulnerable to conflict of interest sincce all payments and facilities are provided by the design consultant on behalf of the employer. Therefore, the approach can not be considered as value engineering.

Under the current situation of the construction industry, where there is no professional certified or trained with value engineering concepts and principles, a typical value engineering study team for a road project may be established using the following set of professionals. However, it has to be noted that the team composition depends on the scope and pahse of development of the project in hand.

1) Team Leader/Facilitator cum Senior Highway Engineer (preferred if acquired value engineering training in addition to the relevant engineering technical knowledge and experieance)
2) Senior Pavement/Material Engieer
3) Senior Hydrologist/Hydraulics Engineer
4) Senior Geotechnical Engineer
5) Senior Construction Contract Engineer
6) Senior Structural Design Engineer
7) Senior Transport Economist /Traffic Engieer
8) Employer’s Representative
9) Design Consultant’s Team Leader/Representative (to be invited as and when required)

The significance of each professional should be properly evaluated with respect to the project’s scope/requirements before assigning. The team members must also be very skilled in the discipline they represent while serving on the team.

2.9. Promoting value engineering

The US Defense Department’s annual VE awards program recognizes individuals and organizations that have made significant contributions to the Department by identifying VE-related changes resulting in cost savings or cost avoidance, quality improvements, or efficiencies. In addition, special recognition is given to initiatives that demonstrate innovative approaches and applications that expand the benefits of VE beyond their traditional scope (i.e., software; environmental protection and conservation; energy conservation; organization; process; service; performance; reliability; quality; etc.) (Department of Defense, 2011).

2.10. Summary of literature review

Value engineering is a management technique, conducted by a team of experts, used to improve the value of a product by removing unnecessary costs and maintaining the desired function at the lowest possible life cycle cost.

Value engineering was originally practiced in the United States of America, during World War II, and gradually spread in to different parts of the world including Europe, Australia, Japan, Saudi Arabia and Hong Kong following its success in eliminating significant unnecessary costs in a product. It was introduced in to the construction industry between 1963 and 1965. Nowadays, value engineering is acknowledged and adopted as an important management tool to improve the value of a product.

Although the procedures and practices of conducting value engineering slightly differ from country to country, the basic principles, however, remain the same. Different counties have set criterion to implement value engineering study in highway projects. The criterion mainly concentrates on the project's estimated total cost and the project's delivery system. The value engineering studies are conducted according to a carefully prepared value engineering manual. However, projects to be delivered by design-build method are not required to undergo a value engineering analysis and the choice is left to the design-builder.

In the United States of America, most of the government organizations have incorporated mandatory provisions to promote value engineering practices in their respective industry. Generally, two approaches are available for public projects. The first one is voluntary approach and the second one is mandatory approach. In the voluntary approach, contractors are allowed to voluntarily submit value engineering proposals for a percentage-wise sharing as an incentive. In the mandatory approach, the government requires and pays for a specific value engineering effort included as a separately priced item of work in the contract schedule. Though sharing is allowed, the percentage is usually lower than the voluntary approach. In private sectors, however, value engineering services are offered with no rigid guidelines on how the studies should be conducted, as in the case of government organizations. Despite of this, most private companies have managed to deliver significant number of successful value engineering proposals.

The value engineering practices in United States of America have three generic stages. These are the pre-workshop (preparation), workshop phase and post-workshop (documentation and implementation). During the workshop phase, the value engineering job plan is implemented step by step. The value engineering job plan is an organized action plan which involves application of creative thinking techniques. According to SAVE International, 2007, the job plan has six[3] phases.

Value engineering evolved in to the United Kingdom's construction industry in the late 1980s. Though the approaches depend on the problems in hand, the common phases are: Orientation and diagnosis phase, work shop phase and Implementation phase. Value engineering is considered as an event in United States, Australia and the United Kingdom. The value engineering practice in Japan is a very similar to that of United States except that the effort is not an event rather a continuous process throughout all phases of construction and the usage of in-house value engineering facilitator.

Professional associations of value engineering practitioners were also founded in different countries and are actively promoting value engineering practices. These include the United Kingdom Value Engineering Association (established in 1966 but changed its name to the Institute of Value Management in 1972), Institute of Value Management in Australia, Hong Kong Institute of Value Management, Society of American Value Engineers (SAVE) and Society of Japan Value Engineers (SJVE).

Value engineering study is conducted by team of multi-disciplinary experts. The value engineering team members should have an equal or better qualification than the original design team with appropriate expertise in the anticipated problem areas. It is recommended that the team members have acquired a specific training in the concepts, application, and techniques of Value Engineering. However, the team may include one or two members who are untrained in Value Engineering but highly skilled in disciplines vital to the study. To maintain objectivity, it is recommended not to include members from the original planning and design teams except when seeking explanations. In this regard, it is important to convince the original planning and design teams that the intention of the value engineering study is not to dispute the work that they have done rather to come up with new and different alternatives and comparisons of designs that will improve the value of the project.

[3] Some literatures add two phases namely *Implementation phase* and *Audit phases*, thereby making the job plan phases eight. However, these last two phases are similar to the activities categorized under '*Post-Workshop phase*' by SAVE International, 2007.

Projects and items for value engineering study should be selected systematically. Greater return can be guaranteed from conducting value engineering study on projects and/or items with high cost and excessively complex nature. However, a generally accepted and usefull approach for selecting both projects and items to be studied is based on Pareto's curve, or law of distribution. The curve is based on the principle that a small number of elements, about 20 percent, account for about 80 percent of the costs.

The duration of a value engineering study depends on, among others, the project scope, complexity, stage of development and the estimated cost. Though consideration of these factors is vital in allotting sufficient time for the study, projects of very large scope or complexity may require 10-15 days or more to achieve the study's objectives.

The Ethiopian Roads Authority is the sole government organization responsible for the planning, design, supervision, construction, maintenance of federal road projects in Ethiopia. The roads authority adopts the FIDIC 4^{th} edition general conditions in the majority of its government financed projects and the FIDIC MDB Harmonized edition general conditions in its projects funded by financial institutions. The FIDIC 4^{th} edition does not have any provision for value engineering but the harmonized edition allows contractors to submit value engineering proposals, under Clause 13.2, and share from implemented savings as an incentive. However, Adugna, 2015, found out that ERA has not applied value engineering on its completed projects up to the time of his research due to different reasons.

2.11. Gaps Identified

As the road network demand for the country is enormous, ERA is forced to undertaking a revised and new Federal Road Network Development Master Plan which will provide basis for preparing future programs. The new Master Plan identifies potential road projects based on the needs of economic sectors (agriculture, industry, mining, tourism etc) and the needs of the existing federal road network. Potential Road projects identified by federal Master Plans are subject to detail economic feasibility study using HDM-4 or RED models to ensure the projects will have sufficient economic return from investment before they are implemented (ERA, 2014).

Having reviewed different literatures and from experiences of the author, the following gaps have been identified with regard to value engineering in the design and implementation of Ethiopian federal road projects.

i) Majority of the design consultants are local firms with limited capacity in terms of hiring experienced permanent professionals necessary to deliver the design services in line with the client's requirement. Furthermore, the fee for expertise of some professions is exaggerated due to lack of such manpower in the local market. Hence, the design consulting firms tend to deploy the required professionals on the basis of freelance which creates an opportunity for the key professionals to be engaged in numerous design projects at a time. This may result in poor emphasis by design professionals towards improving the value for money of road construction projects.
ii) Absence of a policy/statutory requirement to enforce projects with a certain limit of engineer's estimate to undergo further cost optimization studies such as value engineering study.
iii) Absence of value engineering incentive clauses in contracts, other than the FIDIC MDB harmonized version, to motivate construction stakeholders and strive for achieving the best value for money.
iv) Absence of recognition for high achievements with respect to improving value of a road construction project
v) Absence of professional associations in the country to promote value engineering practices.
vi) Lack of standardized guidelines and manuals for implementing value engineering in road construction.
vii) Absence of sufficient skilled road design and construction professionals in the local market

Chapter - Three

Methodology

3.1. Study Design

Based on the specific objectives, the research can be classified as exploratory type of research since it explores the costs and benefits of contractors and consultants from conducting Value Engineering studies under the current scenario and the possible incentives to promote value engineering in the Ethiopian federal road projects.

The research approach adopted is a mixed type of research approach, i.e. both qualitative and quantitative approaches, since the study involves collection and analysis of both numerical and non-numerical data.

3.2. Study Participants

The main participants of the study are the Ethiopian Roads Authority (the client) and Construction and Consulting firms engaged in the road construction industry.

3.3. Sampling Design

Sample design is a definite plan determined before any data are actually collected for obtaining a sample from a given population (Kothari, 2004).

i) Study Population

The Ethiopian Roads Authority is the sole organization responsible, as a client, for the design, construction and maintenance of different federal road projects throughout the country. The design and supervision services are outsourced to local and/or international consulting firms and, similarly, the construction works are outsourced to local and/or international construction firms. Hence, the population for this study has been identified to be the number of road design and construction projects currently being administered by the Ethiopian Roads Authority. These projects have been identified by interviewing, questionnaire distribution and reviewing documents available within Ethiopian Roads Authority.

The study population also includes the local and international consulting and construction firms who are participating in the road infrastructure sector and working with the Ethiopian Roads Authority. The list of projects, including their respective Consultants and Contractors, incorporated in the study population is shown in *Annex – 1*.

ii) Sampling Technique

If the population from which a sample is to be drawn does not constitute a homogeneous group, then stratified sampling technique is applied so as to obtain a representative sample. In this technique, the population is stratified into a number of non over lapping subpopulations or strata and sample items are selected from each stratum. If the items selected from each stratum is based on simple random sampling the entire procedure, first stratification and then simple random sampling, is known as *stratified random sampling* (Kothari, 2004).

Accordingly, the population for this study has been stratified in to two strata as '*Road Construction Projects*' and '*Road Design Projects*' after which simple random sampling technique is used to select representative projects from each stratum as discussed in the succeeding paragraphs.

Value methodologies can be applied during any stage of a project's development cycle, although the greatest benefit and resource savings are typically achieved early in development during the conceptual stages (SAVE International, 2007). For this reason, a sampling frame which includes all NCB and ICB construction projects with to date progress exceeding 50% and/or substantially completed within the last 3 years (i.e. since 2013) was established from the study population. In addition, it has been observed from the literature review that value engineering is more effective when applied in mega projects with higher cost (refer section 2.6.2 above). Thus, only Asphalt Concrete road projects were taken in to account while establishing the sampling frame.

Similarly, for design projects, all NCB and ICB design projects whose Final Detailed Engineering Design Report has been submitted to the client and/or completed within the last 2 years (i.e. since 2014) were included in the sampling frame for the '*Road Design*

Projects' stratum. Based on the above criterion, a sampling frame has been established and is shown in *Annex – 2*.

After defining the sample frame, simple random sampling technique has been adopted using Microsoft Excel software in selecting the study units from the sampling frame of each stratum since it gives equal chance to each study unit. Simple random sampling also avoids bias since the selection is less likely to be consciously or unconsciously influenced by human choice.

The list of all consultants and contractors engaged in federal road projects has been extracted from the study population to explore the *costs and benefits of contractors and consultants from conducting Value Engineering studies under the current scenario* and the *possible incentives to promote value engineering practice* in federal road projects. The population of consulting and construction firms is shown in *Annex – 2*. Out of these firms, those consultants who have more than 01 design projects, those consultants who have more than 01 construction supervision projects and those construction firms who have more than 01 construction projects have been selected as study units and are shown in *Annex – 3*.

iii) Sample Size

Size of sample is an important aspect for the representativeness (Yogesh, 2006). The determination of sample size in quantitative and qualitative research is based upon the two different philosophies. In quantitative research you are guided by a predetermined sample size that is based upon a number of other considerations in addition to the resources available. However, in qualitative research you do not have a predetermined sample size but during the data collection phase you wait to reach a point of data saturation. When you are not getting new information or it is negligible, it is assumed you have reached a data saturation point and you stop collecting additional information.

The sample size in qualitative research does not play any significant role as the purpose is to study only one or a few cases in order to identify the spread of diversity and not its magnitude. In such situations the data saturation stage during data collection determines the sample size (Kumar, 2011). For the purpose of content analysis (i.e. desk/case study) of this research, a sample size of 6 randomly selected projects was studied from each stratum, i.e. a total of 12 projects. The list of randomly selected projects (study units) is shown in *Annex – 3*.

Technically, the size of the sample depends upon the precision the researcher desires in estimating the population parameter at a particular confidence level. There is no single rule that can be used to determine sample size. Generally, 95 to 99 per cent confidence intervals are acceptable i.e. 5 to 1 per cent error (Yogesh, 2006). For the purpose of collecting secondary data through a questionnaire from consultants and contractors, a sampling frame consisting all construction firms, supervision consulting firms and design consulting firms having more than 01 projects have been established. A representative sample size from the sampling frame has been determined using the statistical equation shown in *Eq. 3.1* below at a confidence level of 95% and ± 15% precision (margin of error).

$$n_0 = \frac{Z^2 pq}{e^2} \quad \text{------------------------------ (Eq.3.1)}$$

Where: n_0 = sample size from infinite population
Z = Z score found from statistical tables, which is 1.96 for 95% confidence level
e = the desired level of precision (margin of error)
p = the estimated proportion of an attribute that is present in the population (0.1 assumed)
q = 1 – p

However, since the population for this study is finite in number, the sample size (n_0) can be adjusted using *Eq. 3.2* below:

$$n = \frac{n_o}{1 + \frac{(n_o - 1)}{N}} \quad \text{------------------------ (Eq. 3.2)}$$

Where: n = sample size from finite population
N = Population size (Glenn, 1992)

Table 4 Determination of sample size

S.N.	Description	N[4]	n_o	n
1	Construction firms	14	15.37	7.6 (say 8)
2	Design/Supervision consulting firms	24	15.37	9.6 (say 10)
	Total	38		18

As shown in Table 4 above, the sample size required is 18. Accordingly, two questionnaires were distributed to a randomly selected 18 firms (i.e. a total of 36 questionnaires) and the responses were analyzed. The random selection of firms was done with the help of Microsoft Excel software by way of assigning a random real number between 0 and 1 to each firm using the *RAND function* and sorting these numbers in an ascending order.

3.4. Data Collection

This study involves the collection and analysis of available primary and secondary data. According to Kothari, 2004, *primary data* are those which are collected afresh and for the first time, and thus happen to be original in character. The *secondary data*, on the other hand, are those which have already been collected by someone else and which have already been passed through the statistical process. The methods of collecting primary and secondary data differ since primary data are to be originally collected, while in case of secondary data the nature of data collection work is merely that of compilation.

Thus, unstructured interview was used for the purpose of collecting preliminary information and easily identifying the areas and locations of the target study units. After gathering preliminary information, the necessary primary and/or secondary data were collected through a survey using a properly designed questionnaire and content analysis of documentary materials. The content analysis includes desk/case studies of the randomly selected projects and/or study units from the available documents.

The data collected is the population for this study and is shown in *Annex – 1*. The population is further scrutinized to sort out only the applicable projects for this study, thereby establishing the sampling frame out of which study units were selected.

[4] See section 5.2 and/or *Annex – 3* for more.

Chapter - Four

Analysis and Discussion

4.1. Introduction

The data collected have been analyzed to respond the requirements of the objective of the study. The analysis of the questionnaires and archival documents for case study is summarized in the following sub-topics.

5.2. Questionnaire Analysis

Out of the total study population, the construction and consulting firms involved in more than 01 project are to be selected for questioning. Accordingly, 14 construction firms and 24 consulting firms (i.e. a total of 38 firms) have been found to have being involved in more than one project. The sample size determination in Table 4 above revealed that 18 firms are sufficient to represent the whole population. Thus, the questionnaire shown in *Annex – 4* was distributed to 18 randomly selected firms out of the 38 firms.

5.2.1. Response Rate

Two questionnaires were distributed to senior staffs of each firm and the response rate is as shown in Table 5 below.

Table 5 Questionnaire response rate

Category	Distributed No.	Returned No.	Percentage of Returned
Consultant	2x10=20	15[5]	75.0 %
Contractor	2x8=16	13[6]	81.3 %
Total	36	28	77.8 %

5.2.2. Qualifications of Respondents

The educational qualifications, years of experience and exposure on construction projects of the respondents are indicated in Table 6, Table 7 and Table 8 respectively.

[5] Four (04) are from foreign consulting firms and eleven (11) are from domestic consulting firms.
[6] Four (04) are from foreign construction firms and nine (09) are from domestic construction firms.

Table 6 Educational level of respondents

Educational Level	Construction	Consultancy	Total	%
BSc	9	7	16	57.1 %
MSc	4	8	12	42.9 %
PhD	0	0	0	0.0 %
		Total	28	100.0 %

As shown in Table 6 above, the majority of the respondents, i.e. 57.1%, are Bachelor of Science holders whereas 42.9% are Masters of Science holders.

Table 7 Experience of respondents

Experience	Construction	Consultancy	Total	Percentage
<5	2	1	3	10.7 %
6-10	3	2	5	17.9 %
10-20	8	8	16	57.1 %
>20	0	4	4	14.3 %
		Total	28	100.0 %

As shown in Table 7 above, the majority of the respondents, i.e. 89.3%, have more than 6 years of experience in the construction industry.

Table 8 Project exposure of respondents

Project Exposure	Construction	Consultancy	Total	%
<5	3	3	6	21.4 %
6-10	8	7	15	53.6 %
>10	2	5	7	25.0 %
		Total	28	100.00 %

As shown in Table 8 above, the majority of the respondents, i.e. 78.6%, have been involved in more than 6 road projects.

Therefore, the questionnaire responses obtained from the participants are believed to be reflective of the actual situation.

The questionnaire has tried to assess the awareness of respondents on value engineering. Only 32.2% (i.e. 9 of 28) respondents mentioned that they have been engaged in a road project with value engineering related practices that reduce cost and improve quality/productivity simultaneously. The participants also mentioned to have been engaged in value engineering practices in the following projects:

1) "Construction of 31.5km road project under Humbo – Arbaminch"
2) "*Wukro – Adigrat – Zalambesa* road upgrading project"
3) "*Mojo – Ejere – Arerti*"

4) "*Sawla – Laska*"
5) "*Dilb – Densa – Kulmesu*"
6) "*Zarima – Shire*"
7) "*Bonga – Mizan* project"
8) "*Yello – Nehile* project"
9) "*Agula – Berhale* project"
10) "Flood affected section under *Humbo – Arbaminch* road project"
11) "*Gedo – Bako*"
12) "*Guder – Wayu*"
13) "*Konso – Yabelo* road upgrading project"
14) "*Dansha – Abderafi – Maikadra* road project"

Therefore, it can be concluded that there is awareness of value engineering and value engineering is being practiced in federal road projects.

5.2.3. Analysis of responses with respect to study objective

The questionnaire was carefully designed to get the necessary information and respond the requirements of the study objectives. According to the outcomes obtained from the questionnaire, the objectives of the study have been addressed as follows.

i) ***Costs and benefits of contractors and consultants from conducting Value Engineering studies under the current scenario*****:** The costs and benefits as mentioned by the participants are shown in Fig. 4 through Fig. 7 below.

Fig. 4 Costs of consultants from conducting VE under current scenario

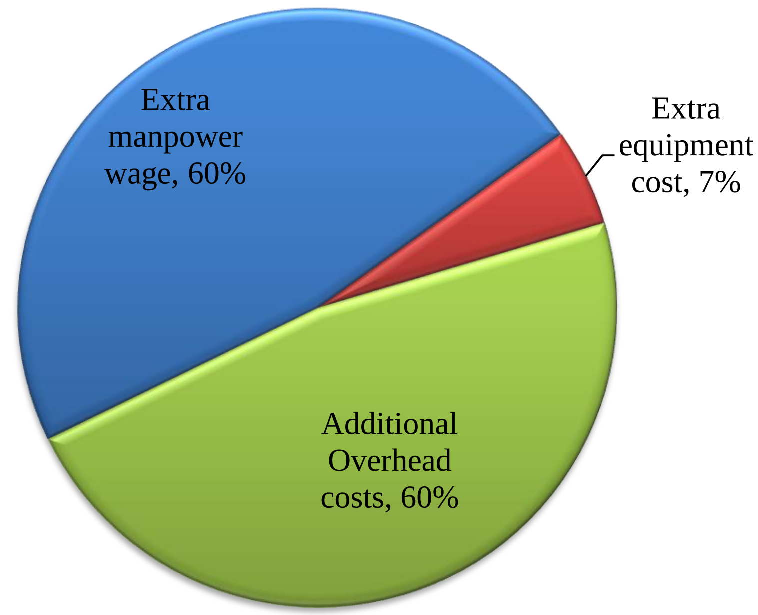


Fig. 5 Costs of contractors from conducting VE under current scenario

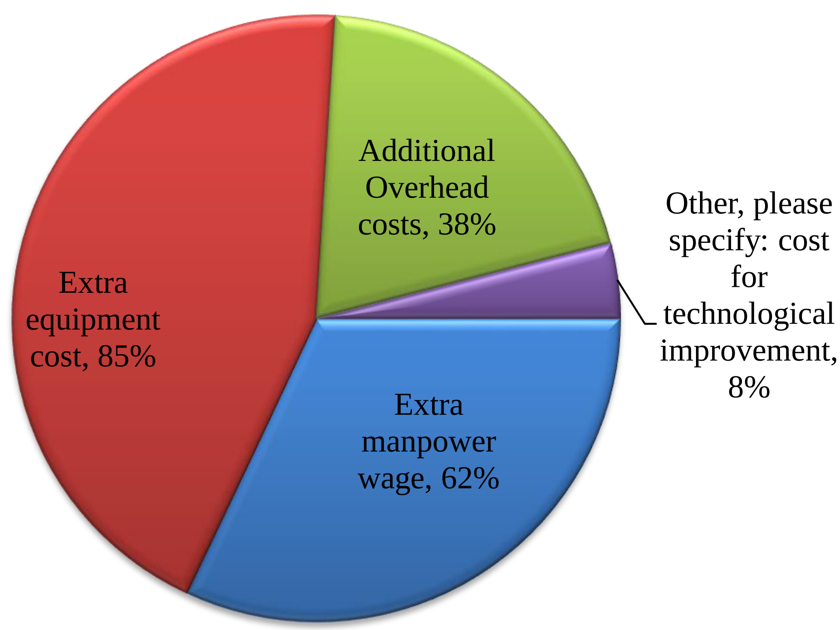


Fig. 6 Benefits of consultants from conducting VE under current scenario

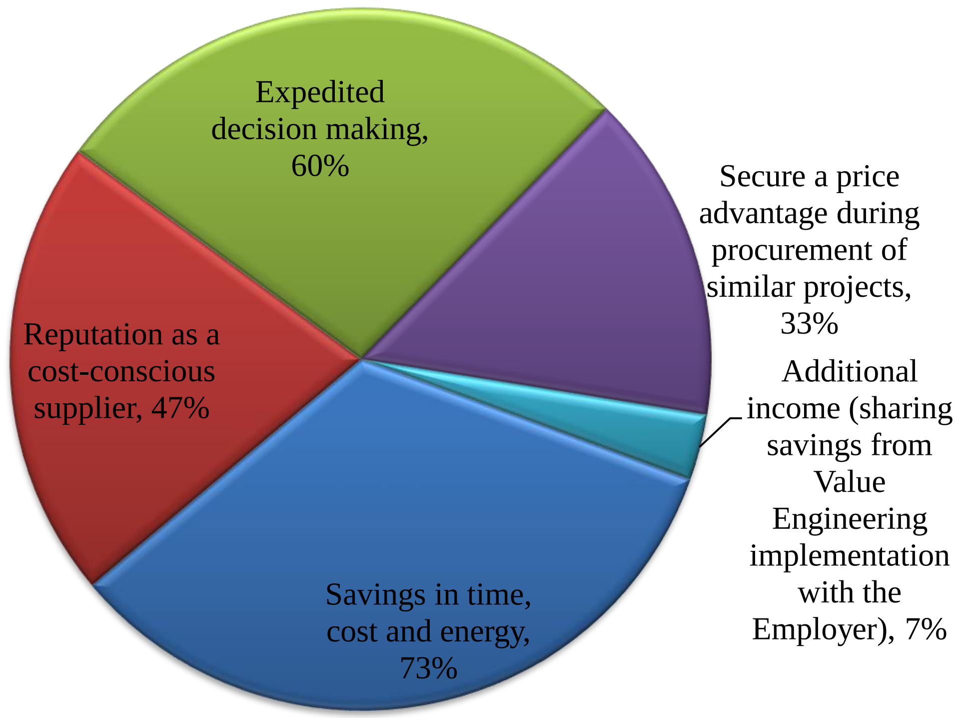
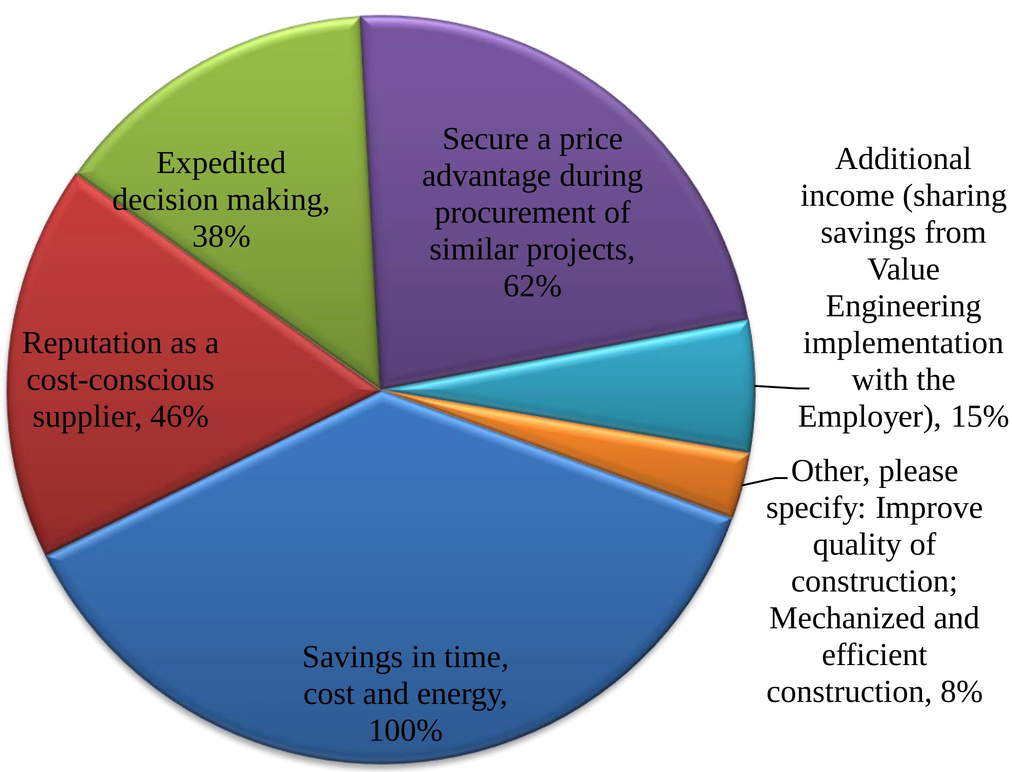


Fig. 7 Benefits of contractors from conducting VE under current scenario



ii) ***To point out the possible incentives to promote value engineering practice in federal road projects*****:** from the literature review and author's observations, the following were identified to contribute in promoting value engineering.

- Acknowledging/awarding good achievements of value engineering related tasks
- Formulating a policy/statutory requirement (*to enforce projects with a certain limit of Engineer's estimate to undergo Value Engineering study*)
- Including Value Engineering Incentive Clauses in contracts (*to enable the contractor propose alternatives and share the savings*)
- Including Value Engineering in curriculums of concerned academic institutions
- Preparing seminars and workshops *via* professional associations (*e.g. Ethiopian Civil Engineers Association*)

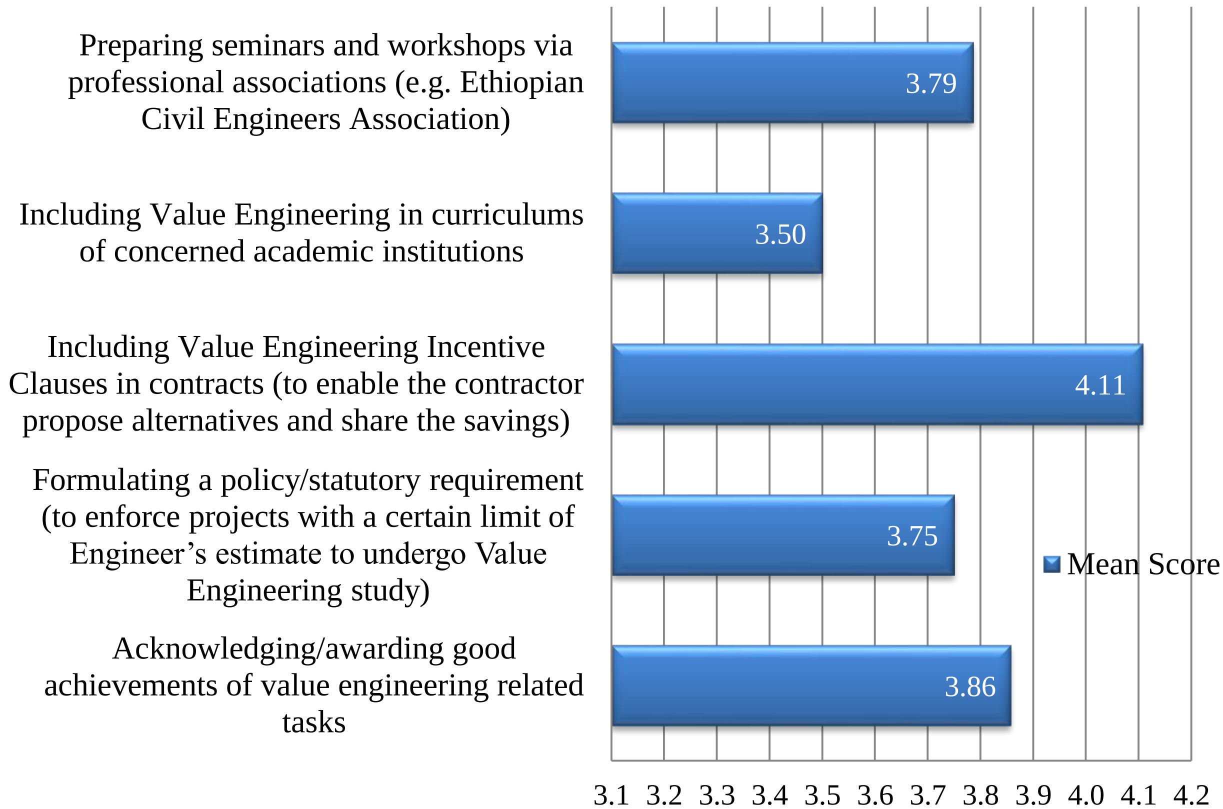
To find out the degree of significance, the questionnaire used the so called Likert's scale with ranges from 0 to 4. The range used in the questionnaire is from 0 to 4 (i.e. 0 = *No significance*, 1 = *Minor significance*, 2 = *Average significance,* 3 = *High significance* & 4 = *Extreme significance*) because the number '0' gives sense for '*No significance*' than the number '1'. However, for analysis purpose, a range from 1 to 5 has been used since multiplying by '0' will nullify the frequency for '*No significance*'. The frequency analysis using the mean score of each case is shown in Table 9 and Fig. 8 below.

Table 9 Frequency analysis for possible incentives to promote VE

	1	2	3	4	5	Total	Mean Score	Rank
Acknowledging/awarding good achievements of value engineering related tasks	0	2	6	14	6	28	3.86	2
Formulating a policy/statutory requirement (*to enforce projects with a certain limit of Engineer's estimate to undergo Value Engineering study*)	1	4	6	7	10	28	3.75	4
Including Value Engineering Incentive Clauses in contracts (*to enable the contractor propose alternatives and share the savings*)	0	1	7	8	12	28	4.11	1
Including Value Engineering in curriculums of concerned academic institutions	0	5	9	9	5	28	3.50	5
Preparing seminars and workshops *via* professional associations (*e.g. Ethiopian Civil Engineers Association*)	1	2	8	8	9	28	3.79	3

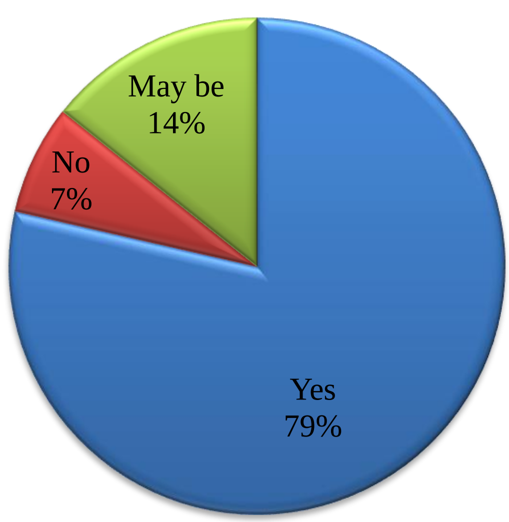
Therefore, according to the mean score, "*Including Value Engineering Incentive Clauses in contracts (to enable the contractor propose alternatives and share the savings)"* has extreme significance in promoting value engineering practices in federal road projects followed by *"Acknowledging/awarding good achievements of value engineering related tasks"* and *"Preparing seminars and workshops via professional associations (e.g. Ethiopian Civil Engineers Association)"*.

Fig. 8 Mean score for possible incentives to promote VE



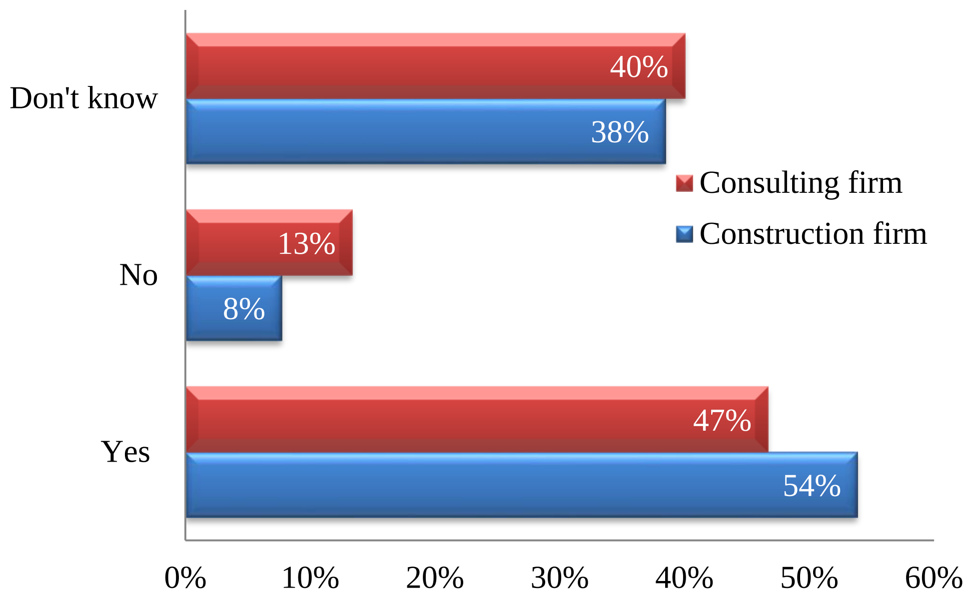
iii) ***Can value engineering contribute to minimize the growing cost overrun, delay and durability problems?*** To address this objective the questionnaire questioned the same with three choices namely '*Yes*', '*No*' and '*May be*'. The responses are shown in Fig. 9 below.

Fig. 9 Responses on contribution of VE



iv) ***Who is interested to apply Value Engineering? Contractor or Consultant?*** To address this matter the questionnaire questioned whether the respondent's company has a plan/strategy to apply value engineering in road projects and improve value for money spent. Three choices namely '*Yes*', '*No*' and 'Don't know' were provided and the responses are shown in Fig. 10 below.

Fig. 10 Responses on interest in Value Engineering



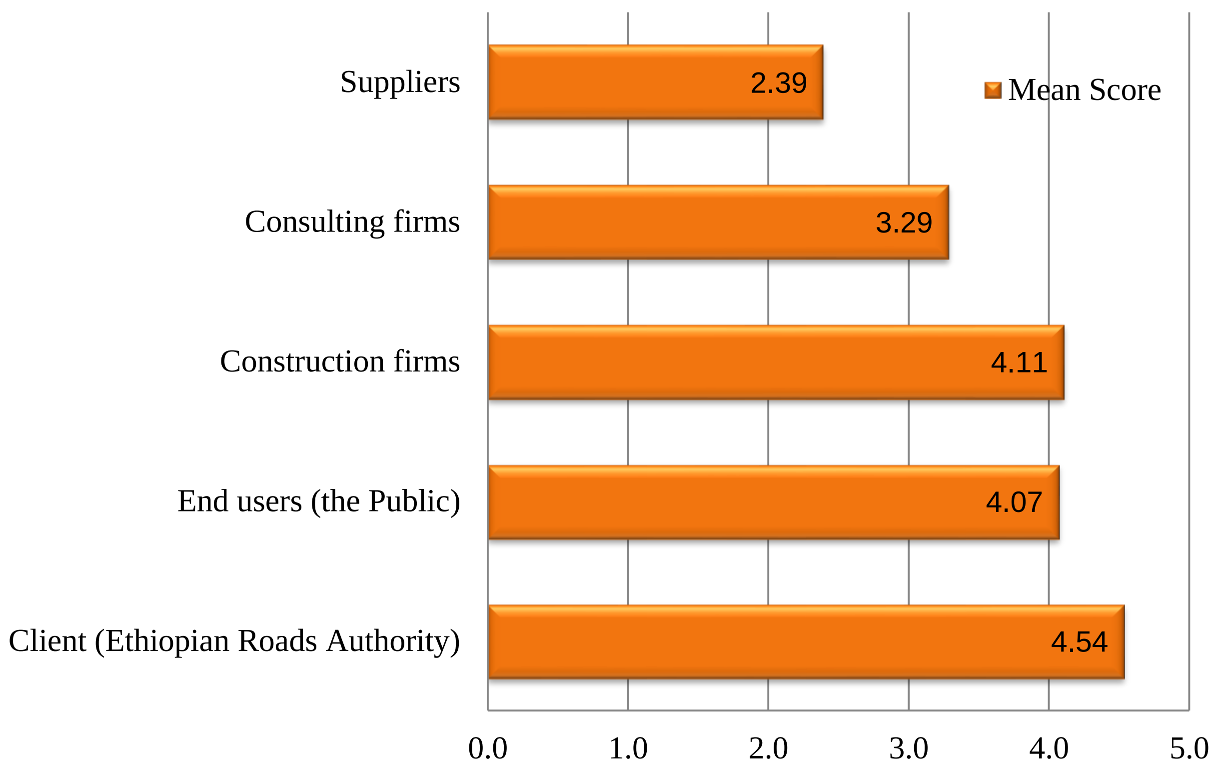
v) ***Who can benefit much from Value Engineering?*** The main stakeholders involved in federal road construction are: The Client (Ethiopian Roads Authority), End users (the Public), Construction firms, Consulting firms and Suppliers.

To find out the degree of benefit obtained, the questionnaire used Likert's scale with ranges from 0 to 4. The range used in the questionnaire is from 0 to 4 (i.e. 0 = *No benefit*, 1 = *Less benefit*, 2 = *Average benefit*, 3 = *High benefit* & 4 = *Extreme benefit*) because the number '0' gives sense for '*No benefit*' than the number '1'. However, for analysis purpose, a range from 1 to 5 has been used since multiplying by '0' will nullify the frequency for '*No benefit*'. The frequency analysis using the mean score of each case is shown in Table 10 and Fig. 11 below.

Table 10 Frequency analysis for stakeholders' benefit from VE

	1	2	3	4	5	Total	Mean Score	Rank
Client (Ethiopian Roads Authority)	0	1	1	8	18	28	4.54	1
End users (the Public)	0	2	7	6	13	28	4.07	3
Construction firms	0	0	6	13	9	28	4.11	2
Consulting firms	1	4	12	8	3	28	3.29	4
Suppliers	8	7	9	2	2	28	2.39	5

Fig. 11 Mean score for stakeholders' benefit from VE



5.3. Case Study

The cases of the randomly selected study units have been scrutinized and discussed in this section, under their respective strata, to study the impacts of value engineering practices in relation to cost, time and durability.

5.3.1. Road Design Projects

The design consultants are required to provide the road design services in line with the client's terms of reference (ToR). The terms of reference states that the objectives[7] of the consultancy services are:

Phase I:

1. Route selection and Survey
2. Feasibility study including Preliminary Design
3. Environmental and Social Impact Assessment (EIA)

Phase II[8]:

4. Detailed engineering design including preparation of bidding documents
5. Resettlement Action Plan (RAP)

The design consultants shall also perform all necessary services and activities to fulfill the above stated objectives whether or not a specific activity is stated in the Scope of Services in the Terms of Reference. Furthermore, as per the ToR, the design consultants are required to:

- Identify at least three possible route options which satisfy the requirements of connecting the stated start and end points via specified control points, as well as satisfying the required geometric design standards.
- Use a recognized package such as *HDM-4* for the purpose of the economic data and evaluation of the project. The economic evaluation results are usually summarized in terms of economic decision criteria such as *IRR* or *NPV* and an investigation of how robust or reliable the results are through the use of *Sensitivity Analysis* or *Risk Analysis*.

[7] Usually the same as the 'scope' for all design services.
[8] The progression of the Consultancy from Phase I to Phase II depends on the results of the Feasibility Study, and the EIA. If the results show that the road is not viable for the proposed construction, then Phase II shall not be undertaken.

- To perform sensitivity analysis based on change in project cost by 20% and changes in benefits by 20%.
- To follow and make use of the latest version of ERA Design Manuals and Standard Specification and Bidding Documents.
- Determine the surface and subsurface conditions along the length of the road.
- To carry out the geometric design using a recognized software package, such as MX Road, Inroads, and Eagle Point as approved by ERA.
- To prepare optimized pavement designs over homogeneous sections.
- To prepare the design for the cut and fill slopes, and any slope stability measures and structures that may be required.

To assess the impacts of any value engineering practices in federal road projects, randomly selected study units from the *Road Design Projects* stratum have been identified as shown in Table 11 below. The random selection was done with the help of Microsoft Excel software by way of assigning a random real number between 0 and 1 to each design project using the *RAND function* and sorting these numbers in an ascending order.

Table 11 Randomly selected design projects

S.N.	Design Project Name	Designation[9]
1	Adura - Jikawo	DP-1
2	Mekaneyesus - Semada - Saint	DP-2
3	Iteya - Robe - Seru	DP-3
4	Morka-Gircha-Chencha	DP-4
5	Edo-Serofta-Werqa	DP-5
6	Muketuri - Alem Ketema	DP-6

Legend:
On progress
Completed

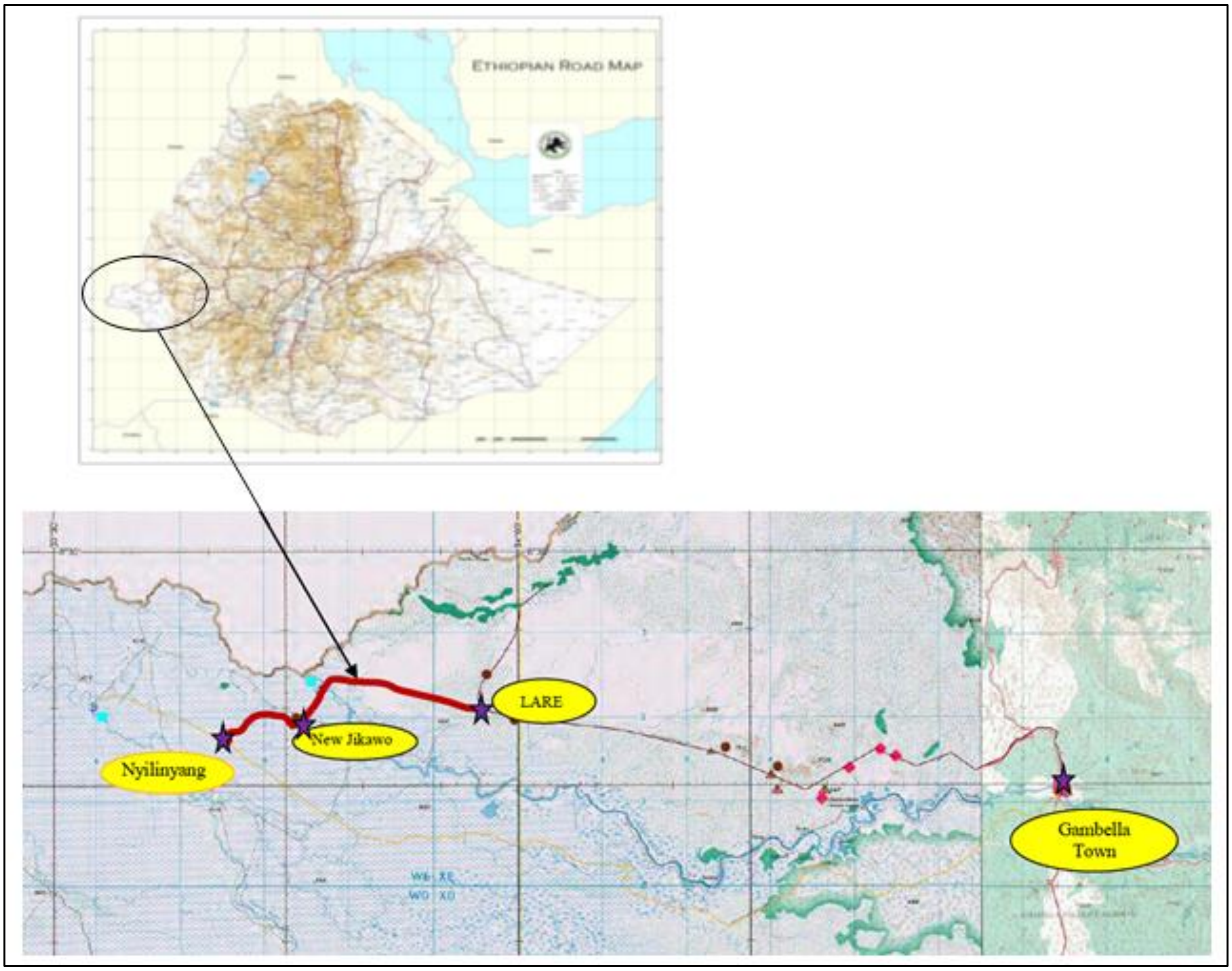
Case 1: *Adura - Jikawo* road design project (DP-1)

The project road is located in western part of Ethiopia in *Gambella* Regional state. During the Route selection process it was recommended and agreed that, the Detailed Feasibility Study and Detailed Engineering Design of the project has to be carried for the selected route that connects *Nyilinyang* to *Lare* town by connecting the two major roads *Gambella*-

[9] The designation is only for analysis purpose.

Itang –Lare – Pagak and *Gambella- Eliya –Adura –Matar* roads instead of connecting *Adura* to *Jikawo*. The location map of this projet is shown in Fig. 12 below.

Fig. 12 Location map: Adura – Jikawo road design project (DP-1)



Source: design consultant

The main objectives of the Consultancy services are divided into two phases:

Phase I:

i. Route Selection and Survey;

ii. Feasibility Study, including Preliminary Design, Environmental and Social Impact Assessment (ESIA)

Phase II:

iii. Detailed Engineering Design,

iv. Preparation of bidding documents, and

v. Preparation of Resettlement Action Plan

The key contract details of this project are tabulated in Table 12 below.

Table 12 Contract details of DP-1

Project Name	Consultancy Services for Route selection, Feasibility and EIA Studies, Detailed Engineering Design, Resettlement Action Plan and Tender Document Preparation for Adura – Jikawo Road Project *(Lare – New Jikawo- Nyilinyang)*
Funding	Government of the Federal Democratic Republic of Ethiopia
Consultant	*CORE Consulting Engineers Plc in JV with WHITEKNIGHT CM consultant plc.*
Region / Zone	Western part of Ethiopia, in Gambella Regional State, Nuer Zone
Starting Point Description	*Lare Town*, Can be accessed through Gambella- Itang –Lare –Asphalt road, 74km from Gambella town.
Ending Point Description	*Nyilinyang***,** can be accessed through Gambella- Iliya – Nyilinyang Gravel road, 122km from Gambella town.
Length (km)	34.4km
Contract Signature	28^{th} April 2015
Commencement Date	12^{th} June 2015
Project Period	8 months
Planned Duration	Phase 1: Route selection, Feasibility and EIA Study, 5 months
	Phase 2: Detailed Design and Tender Document Preparation, 3 months
Actual Duration[10]	Phase 1: Route selection, Feasibility and EIA Study, 9 months (including 4 months idle time)
	Phase 2: Detailed Design and Tender Document Preparation, 5 months
Project cost	ETB 4,616,099.98

Source: design consultant

<u>Route selection</u>: All potentially possible alternative routes were thoroughly observed and identified on Google Earth, Global Mapper and soft copy of the 1:50,000 scale topographic

[10] The original duration of the project was 8 months and the project commencement date was in June 2015 where the area becomes inaccessible due the rainy season. Even after the rainy season its effect continues up to mid of December, mainly due to Baro river flooding most of the project area, particularly the swampy area, becomes inaccessible until mid of December 2015. For this reason and other stuff problems the duration of the service becomes 14 months including 4months of idle time.

Map on the computer before dispatching to site reconnaissance. Then reconnaissance site visit and consultation was undertaken to further refine the proposed route.

During the consultation process possible alternative routes based on the contract control points i.e *Adura* and *Old Jikawo* were presented to the stakeholders and as an outcome of the consultation the control point *Adura* does not give meaning being *Kebele* seat within *Makuwe* Woreda while *Nyilinyang* is seat for the *Makuwe Woreda* and *Nuer* Zone. Similarly, *Jikawo* in the Contract, representing *Old Jikawo*, which is *Kebele* seat, does not give meaning; rather continue up to *Lare* by giving the connection to *Lare* will be meaningful. (The existing road from Gambella to Lare is asphalt standard and the section of the road from *Lare* to *Jikawo* is gravel road.) Connecting *Nyilinyang* with *Lare* will fill the missing link and enhances the economic as well as social development of the project area.

Accordingly, three possible alternatives routes were proposed for comparison purposes based on the findings obtained from the desk top study, the physical observation of the ground reconnaissance and taking into consideration the interest of the local people, Region, Zone and *Woreda* Officials. Then, Multi-Criteria analysis was employed for comparison of the alternatives routes. In this method five important and pertinent parameters are considered. Parameters related to *Engineering*, *Social*, *Environmental*, *Economic* and *Administrative* conditions are considered.

Based on the Multi-Criteria analysis carried out for the alternate routes, Alternative Route 1 (*Adura – Nyilinyang town – Leitchuor – Nibnib - Kuachtiang* town – *Turley – Banyrial – Mading – Lare* town) was the most preferred route among the three proposed alternatives routes. Alternate Route 1 was therefore recommended and selected.

<u>Feasibility Study</u>: The economic cost-benefit analysis of this specific project road has been performed using the HDM 4 (Version 1.2) model. For the purpose of economic appraisal two mutually exclusive project scenarios have been considered, namely “without the project” and “with the project” cases. Under without the project scenario either do-nothing or do-minimum intervention (i.e. so as to maintain the existing road in its present condition) has been assumed. In the case of with the project scenario, two alternatives have been examined. Both alternatives are described below:

> Alternative 0: Do-minimum (Alt-0): Maintenance consisting of grading once per one and half year undertaken and gravelling undertaken once every seven years to sustain current service levels.
>
> Alternative 1: Double Bituminous Surface Treatment-DBST- (Alt-1): Pavement improvement option consisting of 30mm surface thickness with initial IRI of 4.
>
> Alternative 2: Asphalt Concrete-AC- (Alt-2): Pavement improvement option consisting of 50mm surface thickness with initial IRI of 3.

Based on the results of economic evaluation and supported with the sensitivity analysis, *the investment for the improvement of Nyilinyang-Lare road to Double Bituminous Surface Treatment was observed to be most economically viable option for implementation with EIRR of 12.3%.* The project's NPV of 97.97 million ETB in economic terms also confirmed its desirability.

Risk Analysis: not reported other than sensitivity analysis, which is the simplest form of risk analysis.

Geometric Design: The horizontal and vertical alignment design was carried out from a DTM prepared from topographic survey data. The project is designed with DC-5 Standard. Based on the traffic analysis, the project road mid-life traffic reaches 417 vpd; and hence falls under the standard of DC5 (300-1,000 AADT) according to ERA's Design Manual 2013. Hence, it was recommended that the project road shall be designed as DC5 road and each of the design parameters shall be verified under the same standard.

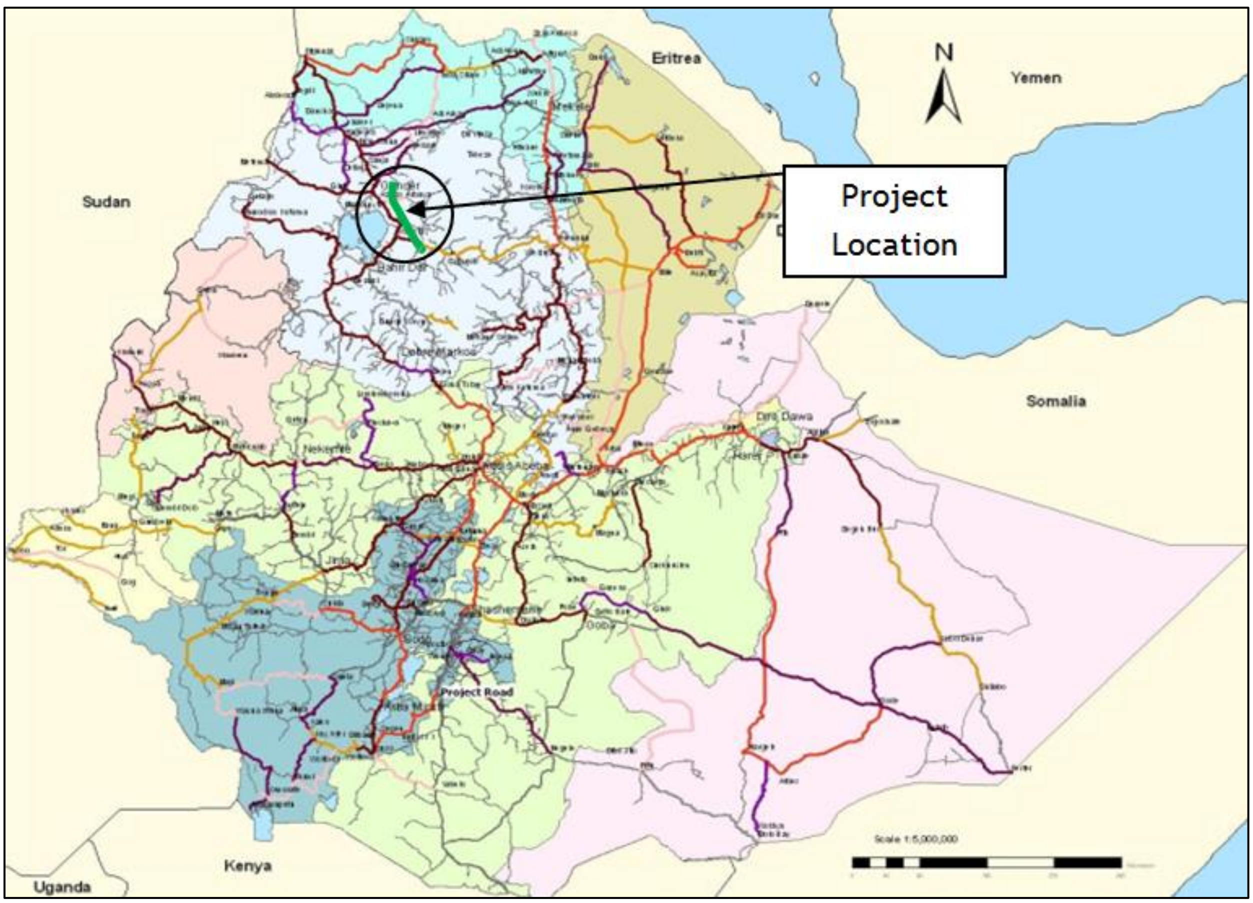
Pavement Design: The Pavement design of the project road was carried out according to ERA's 2013 Pavement Design Manual Volume I. The pavement structures that correspond to the design traffic and subgrade strength classes were selected from ERA's 2013 Pavement design manual.

Departure from standard: the road project traverses through a very flat terrain, and keeping the minimum longitudinal gradient of 0.5% was difficult. However, considering a sufficient crown slope provision for drainage purpose, this value has been relaxed applying a crown slope of 3%.

Case 2: *Mekaneyesus - Semada - Saint* road design project (DP-2)

The *Mekaneyesus –Semada –Sayint* Project is located in the Northern part of Ethiopia. It starts at *Mekaneyesus* and traverses through *Semada* and terminates at *Sayint*. The area served by the road lies across *Amhara* Regional State and connects the two Zones of South *Gondar* and South *Wollo*. The total project length, i.e. from *Mekaneyesus* to *Sayint* is approximately 160 kilometers. The location map of this project is shown in Fig. 13 below.

Fig. 13 Location Map: Mekaneyesus-Semada-Saiynt road design project (DP-2)



Source: design consultant

The main scopes of the consultancy services are:

Phase I: Feasibility & EIA Studies and Preliminary Engineering Design, which includes

- Route Selection and Survey
- Feasibility Study, including Preliminary Engineering Design
- Environmental and Social Impact Assessment (EIA)

Phase II: Detailed Engineering Design, which includes

- Detailed Engineering Design
- Resettlement Action Plan (RAP)
- Preparation of Tender Document.

The key contract details of this project are tabulated in Table 13 below.

Table 13 Contract details of DP-2

Project Name	Consultancy Services for Route selection, Feasibility and EIA Studies, Detailed Engineering Design, Resettlement Action Plan and Tender Document Preparation for *Mekaneyesus – Semada -Saiynt* road project
Funding	Government of the Federal Democratic Republic of Ethiopia
Consultant	*Omega Consulting Engineers PLC*
Region / Zone	*Amhara* National Regional State/South *Gonder* and South *Wello* Zones
Starting Point Description	*Mekaneyesus (Este)*
Ending Point Description	*Sayint (Ajibar)*
Length (km)	160 km
Contract Signature	22nd July 2014
Commencement Date	7th August 2014
Project Period	12 months
Project Cost	ETB 7,017,242.50 including VAT
Planned Duration	Phase 1: 7 months
	Phase 2: 5 months
Actual Duration	Phase 1: 11 months (July 14, 2015)
	Phase 2: 20 months (March 31, 2017)

Source: design consultant

<u>Route selection</u>: From the desk study, using digital terrain model built from SRTM 30m Grid and 1:50,000 topographic maps having a minimum width of 10 km, three alignment options were identified for detailed investigation. All the members of the design team visited the site to assess the existing site conditions and were able to acquire necessary data in their respective fields to enable them analyze alternative alignment options.

The three project road alternatives were evaluated using environmental, social, engineering and economic criteria with the multi-criteria analysis weighing factors adopted from the Route Selection Manual of ERA. Based on the evaluation carried out for the alternate routes, and consultation with regional, rural and local authorities the Consultant selected Alternative-2 as the best alternative route (*Mekaneyesus –Mikre –Tsedey – Wogeda (Simada) – Sayint*).

Feasibility Study: For deciding which intervention is economically viable, three different improvement options and maintenance strategies were considered and inputted into HDM-4 model for economic analysis. The details of alternatives considered are as follows:

Case 0: Base case (Do-minimum)

Case 1: Upgrade to Double Bituminous Surface Treatment (DBST)

Case 2: Upgrade to Asphalt Concrete (AC)

The analysis revealed that the project is feasible with both alternatives of AC and DBST. The NPV and IRR of AC alternative is less than that of DBST at base case. The sensitivity analysis also confirmed that the NPV and IRR of AC is less than that of DBST alternative. In light of this, DBST alternative is more feasible to accommodate the traffic and function of the road.

However, using DBST along sections having gradients above 8% and in a very hot climate would be inappropriate; since the *Beshilo* river valley section (Km 88+200 – 139+100) is characterized by Rugged terrain ranging from mountainous to Escarpment and having very hot climate, the Consultant adopted AC surfacing for this section of the project road. The rest of the project road is recommended to have a DBST surface.

Risk Analysis: not reported other than sensitivity analysis, which is the simplest form of risk analysis.

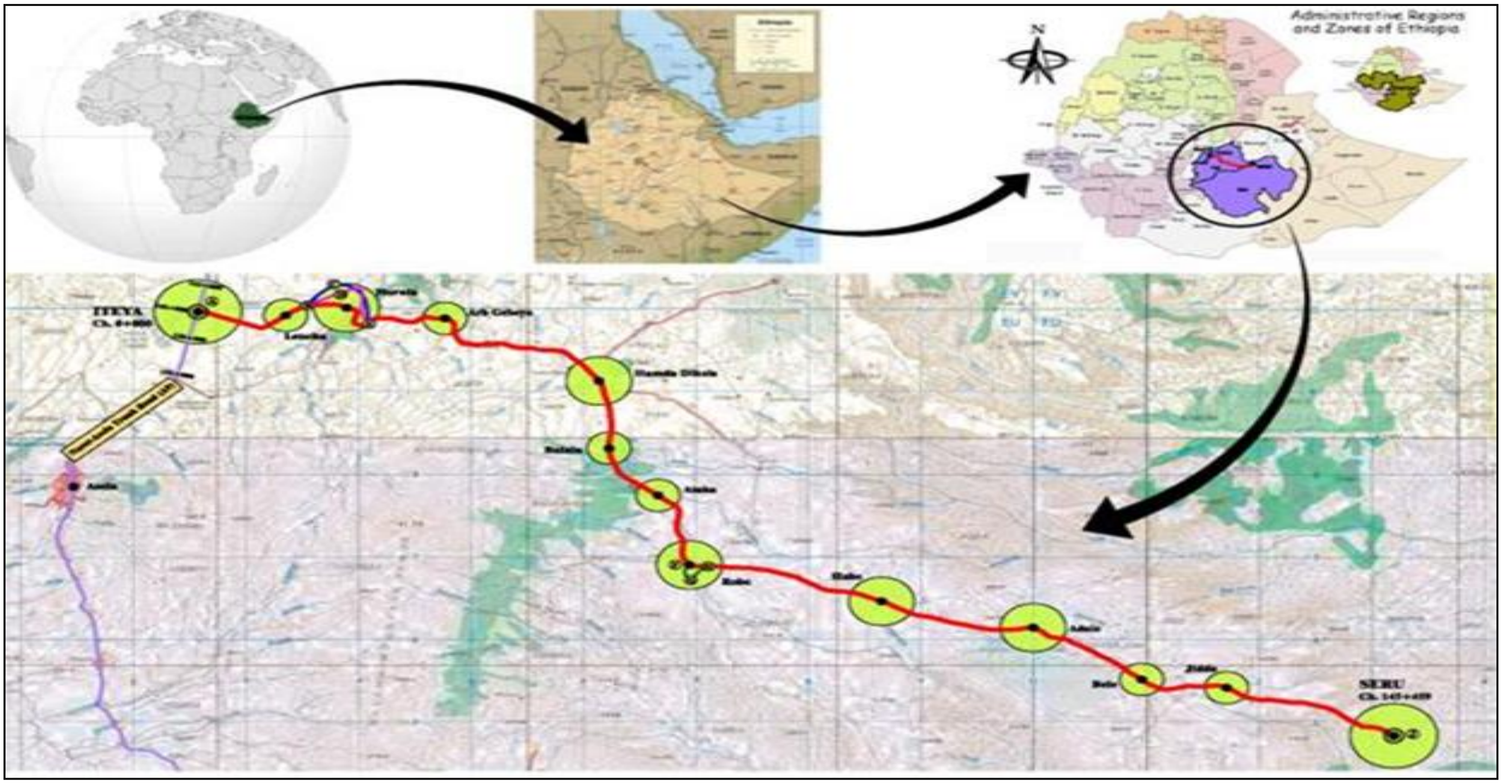
Geometric Design: From the data collected from the topographic surveying, a digital terrain model (DTM) of the road corridor was developed. The DTM formed the basis for the design of the horizontal and vertical road alignments. The topographical data included Point No., Easting, Northing, Elevation and point description for each point surveyed. By importing this data into the AutoCAD CIVIL 3D Software, a DTM covering the entire project length was constructed. Based on this DTM, contours (for design purpose) have been generated with intervals of 2m and 5m for intermediate and major contours respectively along the project road. As the DTM is the digital representation of the terrain, all subsequent design and quantifications greatly depend on its accuracy. The geometric design of the road was performed with the help of AutoCAD CIVIL 3D and Eagle Point Road Design software. Based on the result of Feasibility study, the road is generally designed to the DC4 standard of the ERA`s 2013 Geometric Design Manual (GDM).

Pavement Design: The Pavement design of the project road was carried out according to ERA's 2013 Pavement Design Manual Volume I. The pavement structures that correspond to the design traffic and subgrade strength classes were selected from ERA's 2013 Pavement design manual.

Case 3: *Iteya - Robe - Seru* road design project (DP-3)

The project road passes through mainly flat and rolling terrain except some escarpment sections and terminates at the town of *Seru*. The project road passes through different *Weredas* such as *Iteya, Hurutaa, Diksiis, Robe, Habee, Adele* and ends at the *Seru*, traversing a length of about 144 Kilometers. The proposed project road has a major regional and national importance in facilitating economic, administrative and social relationship within the region of *Oromia* in particular and the Country in general. The existing project road is an all-weather gravel road. The project location map is shown in Fig. 14 below:

Fig. 14 Location Map: Iteya-Robe-Seru road design project (DP-3)



Source: design consultant

The scope of consultancy service mainly comprises of the following two phases:

Phase I:

i. Route Selection and Survey

ii. Feasibility Study, including Preliminary Design, Environmental and Social Impact Assessment (ESIA)

Phase II:

iii. Detailed Engineering Design

iv. Preparation of bidding documents, and

v. Preparation of Resettlement Action Plan

The key contract details of this project are tabulated in Table 14 below.

Table 14 Contract details of DP-3

Project Name	Consultancy Services for Feasibility Environmental Impact Assessment (EIA) Studies, Assessment of Financing Options, Preparation of Resettlement Action Plan (RAP), Detailed Engineering Design and Tender Document Preparation for the *Iteya-Robe-Seru* Road Project
Funding	Government of the Federal Democratic Republic of Ethiopia
Consultant	LEA Associates South Asia Pvt. Ltd. (LASA), India in JV with Net Consult Consulting Engineers and Architects, Ethiopia.
Region / Zone	Oromia Regional State, Arsi Zone
Starting Point Description	Outskirt of *Iteya Town*, approx.146km south west of Addis Ababa.
Ending Point Description	*Seru Town*
Length (km)	144.3km
Contract Signature	28th May 2013
Commencement Date	12th July 2013
Project Period	12 months
Planned Duration	Phase 1: 6 months (24 weeks)
	Phase 2: 6 months (24 weeks)
Project Cost	USD 402,270.00
	ETB 9,821,373.75

Source: design consultant

Route selection: In brief, the design consultant undertook the route selection activity keeping into account the following parameters:

- Topography
- Alignment design
- Dodging the geo – hazard locations with problematic soils
- Avoiding the environmental sensitive locations
- Minimizing the cultural land acquisition
- Connectivity to villages and towns
- Connectivity to market places
- Traffic connectivity to major economic sources
- The shortest alignment

The desktop study and the site visits in combination with the above mentioned parameters, the project road was divided in four distinctive categories which includes the stretches for minor geometric improvement along with alternate routes and presented in Table 15 below.

1. Sections do not warrants for any alternate route – *Project stretch type 1*
2. Sections warrants for the alternate routes from the geometric considerations and urban congestion which needs auxiliary socio economic scrutiny and stakeholder's preference – *Project stretch type 2*
3. Long stretches of the project road with satisfactory geometry and having some intermittent sharp curves, which needs modification – *Project stretch type 3*
4. Realignments in bridge approaches to enhance safety – *Project stretch type 4*

Table 15 Route selection of DP-3

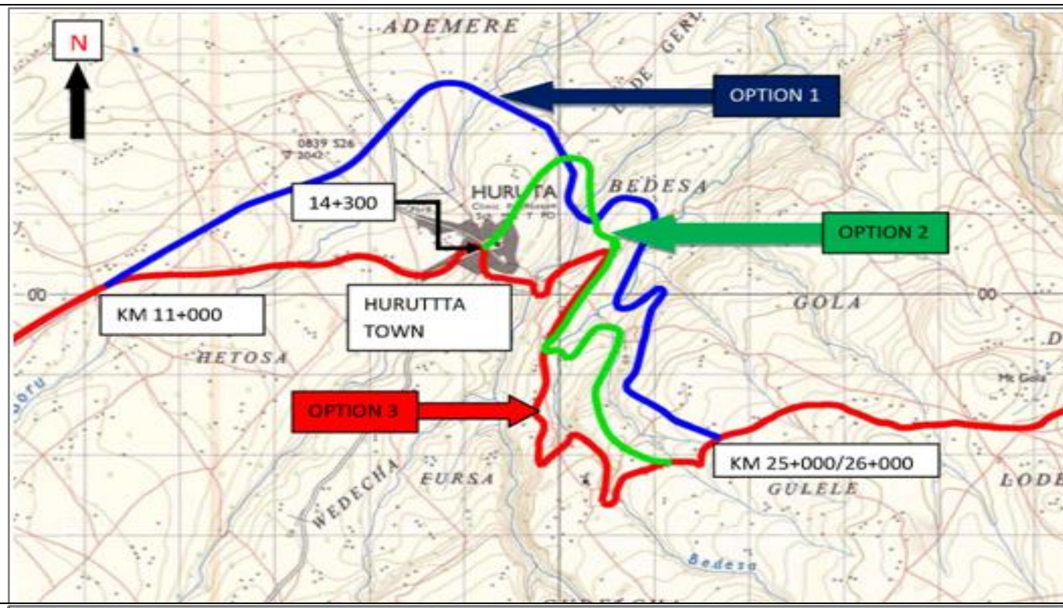
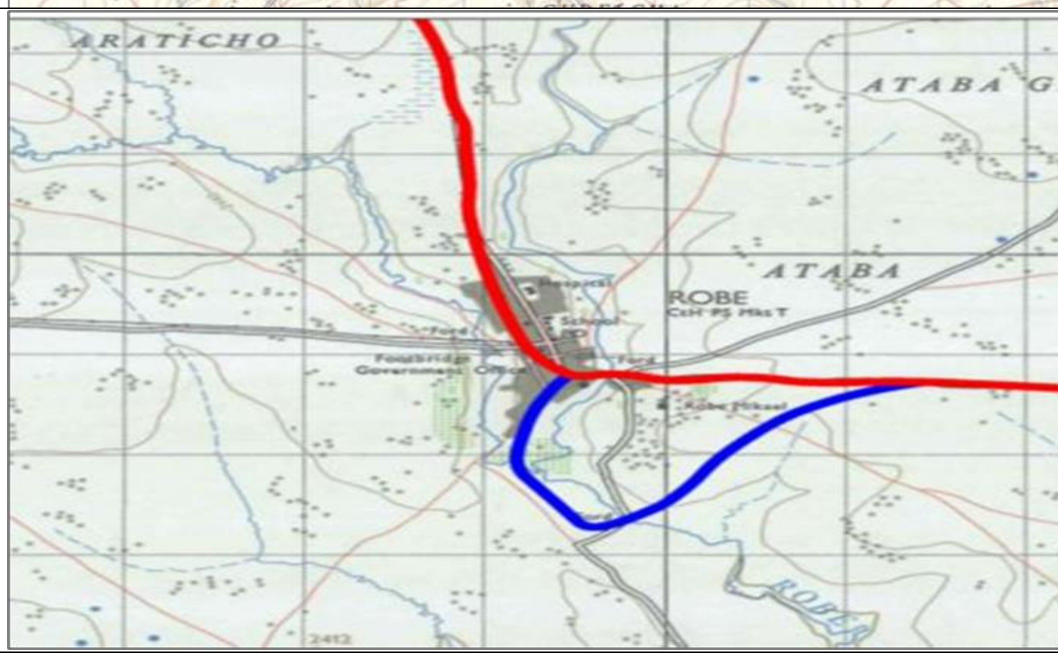
Chainage (km)		Section	Remarks
From	To		
0+000	11+000	Iteya - Hurrutta	Project stretch type 1
11+000	**25+000**	**Hurrutta urban area and escarpment terrain**	Project stretch type 2
25+000	27+500	Hurrutta -Ch'ange	Project stretch type 3
27+500	28+100	Re-alignment due to Bridge	Project stretch type 4
28+100	30+300	Hurrutta -Ch'ange	Project stretch type 3
30+300	30+800	Re-alignment due to Bridge	Project stretch type 4
30+800	74+000	Ch'ange -Diksis-Bolale- Robe	Project stretch type 3
74+000	**76+000**	**Robe Urban Area**	Project stretch type 2
76+000	101+000	Robe-Habe -Adele	Project stretch type 1
101+000	110+000	Adele-Bele	Project stretch type 3
110+000	125+000	Bele- Seru	Project stretch type 1
125+000	143+800	Bele- Seru	Project stretch type 3

Source: design consultant

Based on above findings, the two stretches of the project corridor warrants for the route selection at the following locations:

1. km 11+000 to km 25+000 (at *Hurrutta* Town)
2. km 74+000 to km 76+000 (at *Robe* Town)

Table 16 Route alternatives between km 11+000 – 25+000 and km 74+000 – 76+000

km 11+000 to km 25+000 (at Hurrutta Town): 1) Option-1 (km 0/000-km 15/781) 2) Option-2 (km 0/000- km 15/550) 3) Option-3 (Existing Road)	
km 74+000 to km 76+000 (at Robe Town): 1) Option-1 (Bypassing Town) 2) Option-2 (Existing Road)	

Source: design consultant

Based on the assessment carried out for the alternate routes, it was recommended that the Alternate-Option-3 for *Hurrutta* and Option-2 for *Robe* with AC surfacing is selected. The primary reason for this is that this route provides the lowest construction cost and should provide the highest economic return, and that there are no overriding social, environmental or strategic reasons for not selecting this alternative. Same has been discussed with client in the site visit after submission of route selection report. Envisioning the importance of the project road, which is presently connecting five *Woreda* towns and further providing the way to *Seikh Hussain* a holy place, it is recommended to implement the project road.

Feasibility Study: Traffic in the different road sections triggered requirement of different design class at different years over the analysis horizon. The design consultant took the alternatives and interventions shown in Table 17 below for evaluation using HDM-4 package. Frequent routine and periodic maintenance operations that are traditionally carried out by road agencies to keep the road functional and operational do constitute the interventions for the 'without-project' scenario. The design consultant appreciates it will be most logical to consider this as the 'Without-project' case for comparing the economic benefits against the 'With-Project' alternatives discussed in Table 17 below.

Table 17 With-Project Alternatives for HDM-4 analysis of DP-3

Description	Road Sections	Paved Year (Open to Traffic)	Remarks
Alternative 1	Section-I (km0+000 to km 15+000)	2018	• A higher Design Road Class gets considered right from the start for all sections. • Pavement Surface – Asphalt Concrete (AC) with DBST (Double Bituminous Surface Treatment) paved shoulders for all the four sections
	Section-II (km15+000 to km 49+600)	2018	
	Section-II (km49+600 to km 74+900)	2018	
	Section-II (km74+900 to km 145+500)	2018	
Alternative 2	Section-I (km0+000 to km 15+000)	2018	• A higher Design Road Class gets considered right from the start for all sections. • Pavement Surface – DBST (Double Bituminous Surface Treatment) with SST (Single Surface Treatment) paved shoulders for all the four sections
	Section-II (km15+000 to km 49+600)	2018	
	Section-II (km49+600 to km 74+900)	2018	
	Section-II (km74+900 to km 145+500)	2018	
Alternative 3	Section-I (km0+000 to km 15+000)	2018	• A higher Design Road Class gets considered right from the start for all sections. • Pavement Surface – Asphalt Concrete (AC) with DBST
	Section-II (km15+000 to km 49+600)	2018	

	Section-II (km49+600 to km 74+900)	2018	(Double Bituminous Surface Treatment) paved shoulders for all the four sections.
	Section-II (km74+900 to km 145+500)	2018	• The adopted pavement surface will be "COMPOSITE PAVEMENT" having cement treated sub-base (Base Course) plus Natural Base course

Source: design consultant

The results of economic analysis over the Analysis Horizon of 20 years (including 3 years of construction) are as shown in Table 18 below.

Table 18 Results of Economic Analysis for the Competing Alternatives of DP-3

Parameters	Unit	Alternative 1	Alternative 2	Alternative 3
EIRR	(%)	15.4	17.9	14.8
NPV	(Mill ETB)	641.06	884.72	584.04
Cost	(Mill ETB)	1868.49	1568.44	1925.50
NPV/Cost	Ratio	0.343	0.564	0.303
BCR (estimated as (1+NPV/C))	Ratio	1.343	1.564	1.303
FYRR (Project opens in 2018)	(%)	12.10		

Source: design consultant

The IRR and NPV of Alternative-2 is the highest of all alternatives and the cost for Alternative-2 is also the lowest of all. However, the design consultant recommended Alternative-1 considering the social benefits of the development of road. Further, the design consultant solidifies his above recommendation by comparing the properties of DBST and AC as pavement surface as shown in Table 19 below.

Table 19 Comparison of DBST and AC

S. N.	Characteristics	Asphalt Concrete	DBST	Remarks
1	High resistance to fatigue and the ability to withstand high strains.	Asphalt Concrete is a structural layer and has the high resistance to fatigue and ability to withstand high strains	DBST is not a structural layer and don't have the ability to withstand high strains	Asphalt Concrete fulfils all the requirement of surfacing and for Trunk Roads/ Primary Roads Asphalt Concrete is the
2	Sufficient stiffness to reduce the stresses transmitted to the underlying	Asphalt concrete reduces the stresses transmitted to underlying pavement layers.	DBST don't have the structural strength to disperse the load to underlying pavement	

	pavement layers		layers.	preferred surfacing materials; however the DBST can be opted for low volume/ access roads.
3	High resistance to environmental degradation	Asphalt Concrete is a dense graded mix and has the ability to resist the environmental degradation	DBST contains higher amount of air voids and prone to environmental degradation.	
4	Low permeability to prevent the ingress of water and air	Low permeability.	Because of single size of aggregate In DBST, it punctures the binder and makes it more permeable.	
5	Good workability to allow adequate compaction to be obtained during construction	Good workability at specified temperature.	Less workable.	

Source: design consultant

The results of the sensitivity analysis for the preferred alternative, Alternative-1, are tabulated in Table 20 below.

Table 20 Sensitivity analysis results of Alternative-1

S. N.	Cases Analysed	IRR(%)	NPV (million ETB)	NPV/Cost
1	Base case	15.4	641.06	0.343
2	Cost +20%	12.67	382.10	0.211
3	Cost - 20%	12.08	246.07	0.136
4	Cost +20% and B - 20%	9.61	-52.01	-0.029

Source: design consultant

According to the design consultant's interpretation, the EIRR is greater than 10.23% (discounted rate) and NPV is positive, only change in the worst scenario of drop in benefits coupled with increase in cost showing negative in NPV because of using discount rate 10.23% and salvage value as 12%, otherwise thereby confirming the project's viability apropos economic returns. The results of the sensitivity analysis also indicate while cost and benefits do relatively share a balanced risk-weight age.

Risk Analysis: the design consultant has tried to conducted risk analysis though it is not detail and organized in the formal risk management procedures/practices i.e. Identification of Risks, Risk Assessment - magnitude & likelihood of impact, and Risk Response

Planning. The design consultant has identified the areas of concern for this project together with the mitigation measures for some of the risks. The areas identified include earthwork, road side toe soil, rock excavation, rock fill, road alignment and cross section, pavement design, subgrade, sub-base, estimation of quantities, culvert rehabilitation proposal, bridge rehabilitation proposal, traffic diversion, utility relocation, filling using borrow area materials, construction materials, social problem and geotechnical investigations.

Geotechnical: The Geotechnical exploration consisted of field and laboratory-testing programs. The field-testing program consisted of soil borings / rock drillings, performing in-situ tests, obtaining soil, rock and water samples and field observations of the subsurface conditions and ground water table. The laboratory-testing program comprised of testing samples (soil, rock and water) as collected from site to characterize the Geotechnical / Geological properties. Total 29 nos. of boreholes were drilled at different important sites comprising of 14 nos. boreholes at 7 nos. of bridges, 3 nos. of boreholes at 3 nos. of culvert locations, 10 nos. of boreholes at 6 nos. of rock quarries and 2 nos. of boreholes at 2 nos. of hill cut locations etc. along the project corridor having a stretch of around 145 km.

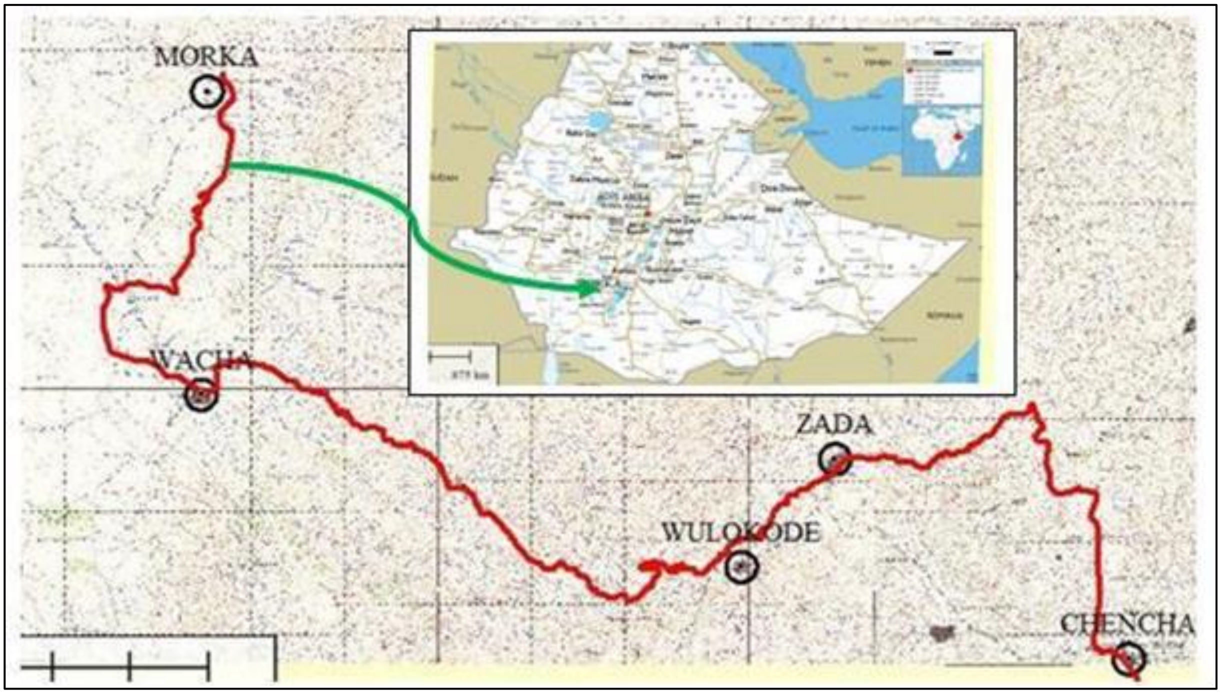
Geometric Design: The Road Design Manual published by Federal Democratic Republic Ethiopia, Geometric Design Manual - 2002, was adopted for the road geometric design works. According to the requirements of the design manual, sections 1 & 2 of the project road fall under DS-3 whereas sections 3 & 4 fall under DS-4. However, the design consultant, in consultation with the employer, has adopted DS-3 for the whole project since the difference between the two is the width of carriageway which is 6.7m in DS-4 and 7m in DS-3.

Pavement Design: This design is to be carried out in accordance with the ERA Pavement Design Manual 2002, Volume-I (Part 1, Flexible pavement Design Guide) and the design life considered is 20 years. The consultant divided the road into homogeneous sections in terms of *traffic loading* and *strength* and propose pavement designs /options in terms of layer type, quality and thickness of pavement appropriately considering the project traffic loadings for each section.

Case 4: *Morka-Gircha-Chencha* road design project (DP-4)

Morka–Gircha–Chencha road project is found in *Gamo Gofa* Zone in Southern Nations Nationalities and People's Regional State. The project road connects four administrative *Woredas* namely *Kucha, Daramalo, Dita* and *Chencha*. The project location map is shown in Fig. 15 below:

Fig. 15 Location map: Morka-Gircha-Chencha road design project (DP-4)



Source: design consultant

The ToR initially specified the road lengths to cover a total of 64km starting from *Morka* at the *Wacha-Sawla* junction to *Chencha* town. As a result of the tasks accomplished in Phase-I, the chosen alignment has been made to cover a length of approximately 72.6km. Also as a result of the findings of Phase-I, due to the very difficult nature of the terrain, it is proposed that the road in the mountain / escarpment sections i.e. from km 19+100 to km 50+450 should be designed to a double Bituminous Surface Dressing standard. The road would therefore have been designed to part gravel and part bituminous surfaced dressed standard with main objective of facilitating better access to the community in the area. It was however commented during the Draft Engineering Report Presentation and also agreed upon to design all the project road with double bituminous surfacing keeping the defined standards of the road sections as nearly 50% of the road would be paved anyway. This would help to ascertain the safety, ride-ability, and users cost parameters along the road alignment at a fairly similar rate and also to keep uniformity along the various *Woreda* towns that the alignment traverses.

The key contract details of this project are tabulated in Table 21 below.

Table 21 Contract details of DP-4

Project Name	Consultancy Services for Feasibility Environmental Impact Assessment (EIA) Studies, Assessment of Financing Options, Preparation of Resettlement Action Plan (RAP), Detailed Engineering Design and Tender Document Preparation for *Morka-Gircha-Chencha* road project
Funding	Government of the Federal Democratic Republic of Ethiopia
Consultant	Metaferia Consulting Engineers in JV with IDCON Infrastructure Development Consultants PLC
Region / Zone	SNNP Regional State, *Gamo Gofa* Zone
Starting Point Description	*Morka* town (located at around 82km from *Wolaita Sodo* town on the main *Sodo-Sawla* road)
Ending Point Description	*Chencha* town (located at Elevation 2733, UTM 37 0691268N, 0342092E)
Length (km)	72.66km
Contract Signature	20th August 2012
Commencement Date	28th September 2012
Project Period	7 months
Planned Duration	Phase I Feasibility Study: 3 months
	Phase II Detailed Design: 4 months
Project Cost	ETB 2,971,456.25 inclusive of 15% VAT and Local Taxes

Source: design consultant

Route Selection: The design consultant has proposed and compared three alternative routes. Alternative 1 mainly traverses through *Morka - Wacha - Zada - Gircha – Chencha*, Alternative 2 which starts from *Morka* town and totally follows a new route up to *Zada* village by leaving *Wacha* town with an approximate 16km to the right and Alternative 3 which passes through *Morka- Wacha- Zada- Mesho– Chencha* avoiding *Gircha* which is one of the given control points on the ToR. After comparing the three alternatives, the design consultant recommended route Alternative-1.

<u>Feasibility Study</u>: The approach for the economic feasibility study of the proposed roads was based on the evaluation of costs and benefits, comparing the base case (or without project case) against the with-project scenario. The consumer's surplus approach has been applied in the evaluation of the *Morka-Gircha-Chencha* road project. The Road Economic Decision (RED) Model has been used in the economic evaluation comparing the existing road without any intervention or the base case and the proposed intervention or project case. The consultant has tried to evaluate three different improvement standards alternatives:

Alternative-1: gravel standard (DS5),

Alternative-2: DBST – on steep grades and town section,

Alternative-3: DBST – the whole section of the proposed road.

The evaluation of each alternative has been carried out using the RED Main Economic Evaluation Module. Vehicle operating costs are calculated using HDM-IV VOC Module and RED-MT Module. The analysis results are shown in Table 22 below.

Table 22 Results of Economic Analysis for DP-4

Improvement Options	NPV (mETB)	EIRR (%)
DS5 (Gravel)	108.715	12.6
Gravel but with DBST on Steep grade & town sections	94.339	12.0
DBST	69.115	11.4

Source: design consultant

The result of the economic analysis indicates that the proposed road project is economically viable in the case of all the three improvement option. Comparing the three options using the economic parameters gravel standard (DS5) is more viable with Economic Internal Rate of Return (EIRR) 12.6% the other two options are 12.0% and 11.4%, respectively. The consultant made a sensitivity analysis in three different scenarios for the three improvement options as shown in Table 23 below. The sensitivity analysis results depicted, as a result of test the third improvement option, DBST, is sensitive in the three scenarios whereas the other two options are sensitive in one and two scenarios. Comparing the three improvement option, DS5 option is less sensitive in the first two scenarios.

Table 23 Sensitivity analysis results of DP-4

Improvement Options	Sensitivity Analysis Scenario	EIRR (%)	NPV
DS5 (Gravel)	1. 15% increase in Capital Cost (Scenario I)	10.9	33.991
	2. 15% decrease in Project Benefits (Scenario II)	10.6	17.684
	3. Scenarios I and II combined (Scenario III)	9.0	-57.039
Gravel but with DBST on Steep grade & town sections	1. 15% increase in Capital Cost (Scenario I)	10.4	8.038
	2. 15% decrease in Project Benefits (Scenario II)	10.1	-6.113
	3. Scenarios I and II combined (Scenario III)	8.6	-92.414
DBST	1. 15% increase in Capital Cost (Scenario I)	9.8	-25.819
	2. 15% decrease in Project Benefits (Scenario II)	9.6	-36.186
	3. Scenarios I and II combined (Scenario III)	8.0	-131.121

Source: design consultant

Due to the very difficult nature of the terrain, the design consultant proposed that the road in the mountain / escarpment sections i.e. from km 19.1 to km 50.45 should be designed to a Double Bituminous Surface Dressing standard. It was, however, commented by the Employer and also agreed upon to design the entire project road with double bituminous surfacing keeping the defined standards of the road sections as nearly 50% of the road would be paved anyway. This is believed to address the safety, ride-ability, and users cost parameters along the road alignment at a fairly similar rate and also to keep uniformity along the various *Woreda* towns that the alignment traverses.

Risk Analysis: The design consultant has identified the following issues as possible risks:

- *Risks resulting from Project Road Area Topography*: The project road lies in an area that constitutes mostly mountainous and escarpment section there by calling for deeper cuts, departures from the road geometry design standards.
- *Risks resulting from Presence of underground water and slide susceptible areas*
- *Risks resulting from Design Investigation Limitations*: The material formation at the surface may or may not be representative of the formation at designed cut depths, especially if such cuts are deep.
- *The Risk of having Potential Project Cost Over run*

The biggest risk associated with the implementation of the project are slides and potential project cost over-run resulting from variation of earthworks quantities related to potential changes of assumed geotechnical conditions huge that couldn't be accurately estimated because of limitations to precisely know the material types at the depths of the cuts.

For instability and slide prone areas, the consultant has recommended control measures like stable slope ratios including benching every 6-10m on big cuts. Gabion support, interceptor ditches and grassing the slope face as well as handling of springs. The design consultant also recommended that the best way of managing the risks in the project, in particular the risk related to project cost over-run and delay in progress, is implementing the project with a Design and Build Contract.

Geotechnical: Field visits were made and visual observation of the sub-grade, slopes and construction materials were also done. DCP tests were done on bridge foundations where possible for presumptive design. The geological formations at the bridge sites were visually observed. Coordinates were measured using hand held GPS instrument. Geotechnical Investigation by Deep Drilling and laboratory tests were conducted for some bridges.

Geometric Design: Geometric design has been carried out with Mx Road design Software. The survey data in the form of X, Y, Z are loaded onto software to prepare a DTM model. The profile of the project corridor has been finalized on the basis of DTM data collected during the topographic survey.

Pavement Design: The *Morka-Gircha* road section has base year AADT of less than 300 and a total traffic loading of less than 1 mESA and hence the ERA Low Volume Road Manual was used for gravel road design whereas the *Gircha–Chencha* road segment accommodates base year AADT in excess of 300 and a total traffic loading of greater than 1 mESA thus ERA Pavement Design Manual Part 1 was utilized for Pavement design.

Case 5: *Edo-Serofta-Werqa* road design project (DP-5)

This project is located in Oromia Region of West *Arsi* Zone, connecting *Dodola Woreda* with *Nansebo Woreda*. The project start, *Edo* Town, is about 300km from Addis Ababa and 56km from the zonal capital, *Shashemene,* along the *Shashemene-Dodola-Goba* main trunk road. It is an existing gravel road that traverses through a predominantly flat terrain for the first 25km and mountainous terrain for the last 25km with the middle 25km rapidly vacillating between rolling and mountainous terrains. The location map of the project is shown in Fig. 16 below.

Fig. 16 Location map: Edo-Serofta-Werqa road design project (DP-5)

Source: design consultant

The key contract details of this project are tabulated in Table 24 below.

Table 24 Contract details of DP-5

Project Name	Consultancy Services for Route selection, Feasibility and EIA Studies, Detailed Engineering Design, Resettlement Action Plan and Tender Document Preparation for *Edo-Serofta-Werqa* road project
Funding	Government of the Federal Democratic Republic of Ethiopia
Consultant	VALUE Engineering PLC
Region / Zone	Oromia Regional States
Starting Point Description	*Edo* Town located in Oromia region, West *Arsi* Zone at approximately $7^0$00’40’’ Latitude and $39^0$02’20’’ Longitude
Ending Point Description	*Warqa* Town located in Oromia region, West *Arsi* Zone at approximately $6^0$35’11’’ Latitude and $39^0$06’12’’ Longitude
Length (km)	≈ 73 km
Contract Signature	2nd September, 2013
Commencement Date	8th October, 2013
Project Period	12 months
Original completion date	7th October, 2014
Project Period (Extension)	5 Months from Commencement Date
Supplementary agreement Signed on	August 04, 2016
Commencement Date (Extension)	August 04, 2016
Revised completion date	January 2017
Original total contract sum	ETB 4,809,300.00
Project Cost (Extension)	ETB 1,697,642.72 Including 15% VAT and Local Taxes
Revised contract sum	ETB 6,506,942.72

Source: design consultant

<u>Route Selection</u>: The design consultant has proposed four alternative routes for the section from *Edo* to *Serofta* and three alternative routes for the section from *Serofta* to *Warqa*. All alternatives were evaluated based on multi-criteria analysis as per ERA Route Selection Manual 2013 which considers engineering aspect, social aspect, environmental aspect and administrative aspect of the corridor. Accordingly, the design consultant selected the most preferred alternative routes for further study and design.

<u>Feasibility Study</u>: The economic evaluation of the project road has been carried out using the HDM-4 Model. The Economic Internal Rate of Returns (EIRRs) has been derived by comparing with improvement and without improvement project options. DBST and

Asphalt concrete improvement options were considered. The Net Present Values (NPVs) have been calculated at 10.23% discount rate.

Based on the results of economic evaluation and supported with the Sensitivity Analysis, the consultant recommended for the project to be upgraded to a road of design standard *DC-5 of Asphalt Concrete* pavement type with EIRR of 31.1%. The project's NPV of 3,019.20 million ETB in economic terms also confirm its desirability.

<u>Geotechnical</u>: Based on confirmations from the test pits, river and erosion gullies, and sides of mountains, it was anticipated that the surface materials may extend to 6m depth without major excavation class change. However, in deep cut, without confirmation of the underlying materials and the presence of hard rock, project costs and completion times can significantly escalate. Moreover, with the risk of encountering hard rock, contractors will usually factor in this risk in their bids. For this reason, geophysical survey has been carried out on selected stretches. This survey was conducted to characterize the geology, estimate the thickness of soil cover, and identify the presence of any geologic structure that has detrimental effect on the performance of the road. Survey data was used in conjunction with other geologic information to estimate the lithology.

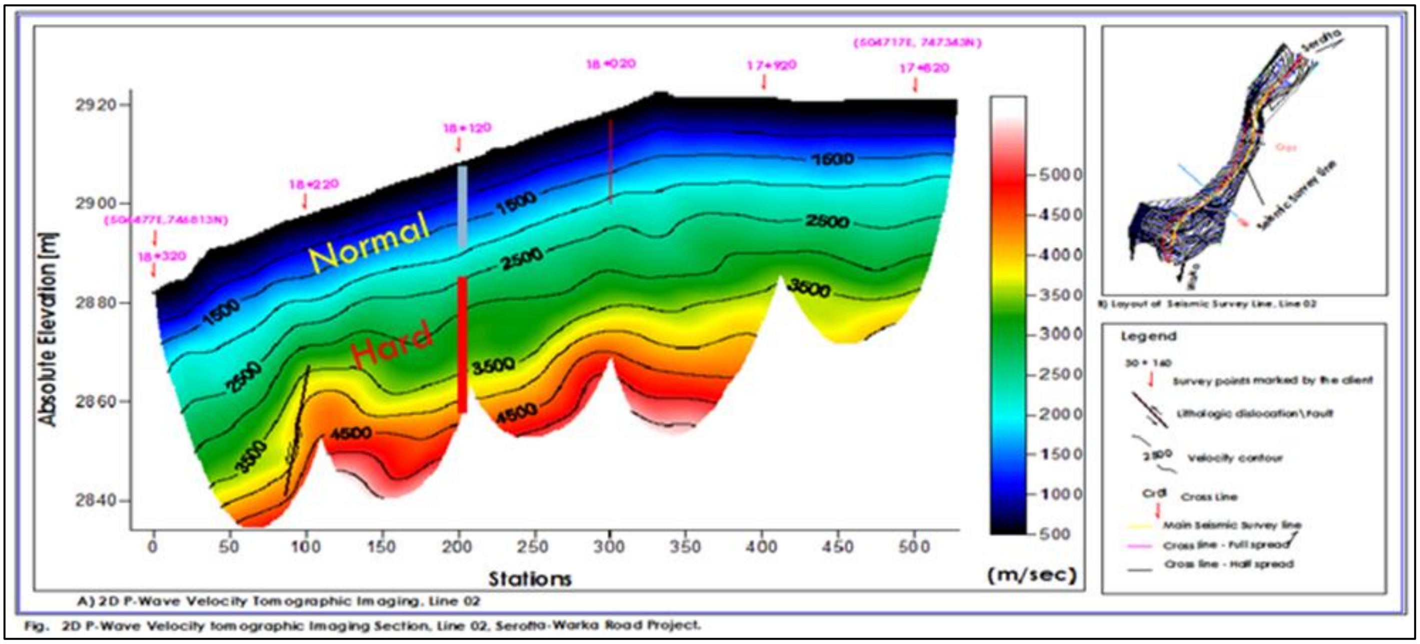
The survey was conducted on the centreline of the proposed alignment and on selected stations across the alignment, and utilized *Refraction Seismic imaging* method. The Seismic refraction survey was primarily used to map subsurface geological boundaries and stratigraphic variations. A key advantage of the technique was that, after processing, it can provide a cross-sectional image of the subsurface. The image shows stratigraphically interpreted data. The different colours have been used to delineate the different geological units. Each of the coloured lines indicates a geological boundary as shown in Fig. 17 below.

Having obtained the factual subsurface condition, analysis of findings have been made based on D8R Caterpillar riper performance, i.e., an engine developing approximately 228kW at the flywheel, so as to be consistent with the project requirements. As per this, the classification of the hardness can be estimated as:

- Seismic velocity less than 1900m/s is in Normal Class excavation.

- Seismic velocity between 1900 and 2400m/s is in Intermediate Class excavation.
- Seismic velocity in excess of 2400m/s is in Hard Class excavation.

Fig. 17 Typical 2D P-wave velocity tomography



Source: design consultant

<u>Geometric Design</u>: Geometric design has been carried out in accordance with ERA Geometric Design Manual 2013 for DC 5 design standard except some departures in Radius of Curvature, Vertical Gradient and Climbing lane.

<u>Pavement Design</u>: The pavement design has been carried out by employing ERA Pavement Design Manual 2013, Volume I. The pavement structures that correspond to the design traffic and subgrade strength classes were selected from ERA's 2013 Pavement design manual.

<u>Departure from standard:</u> The design consultant has made deviation from standard for horizontal radii of curvature, vertical gradient and cross-section due to excessive earthwork excavation and slope instability.

Case 6: *Muketuri - Alem Ketema* road design project (DP-6)

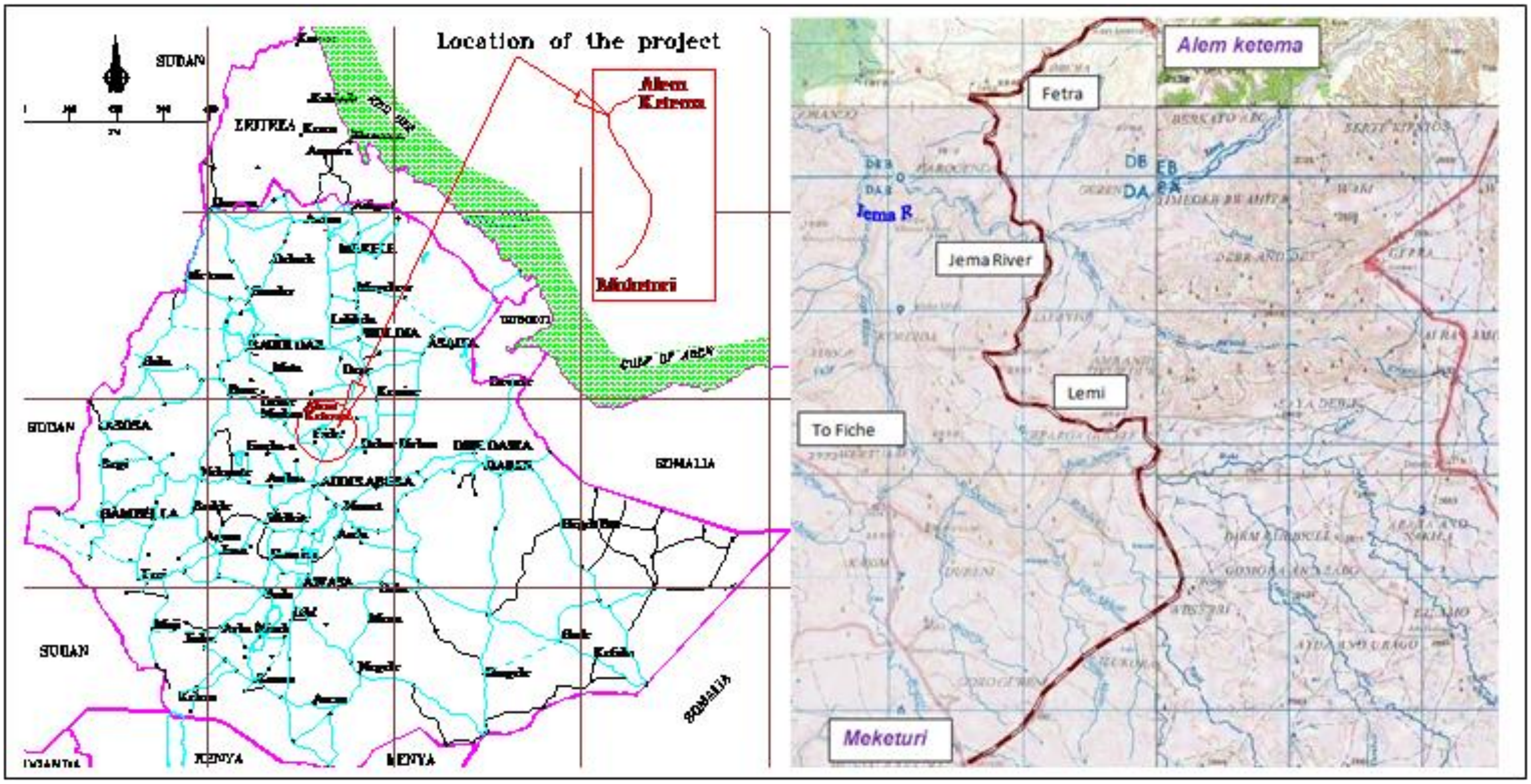
This project road is found in the border of Oromia and Amhara Regional States that starts on *Muketuri* (Oromia Region) and terminates at *Alemketema* (Amhara Region). The project road can be classified and categorized into three sections based on the difficulty for design and construction as well as the terrain type along the route corridor.

The first leg of the road is from *Muketuri* to *Lemi* (48 km stretch) can categorized as flat terrain (99%) and having an agricultural land use for most of the stretches.

The second section of the road is between *Lemi* and *Fetra* which comprises 47 km of complex and mountainous section of which the first 19km and the last 14 km is completely in escarpment type of terrain, while the rest 14 km has rolling terrain which is located in the vicinity of Jemma river crossing. This segment of the road is characterized by complex geometry consisting of sharp curves and steep gradient as well as with possible geotechnical hazards such as mass movement and landslides.

The third and last section of the road starts from *Fetra* to and extends to the end point of the project, *Alemketema*. Having an approximate length of 13kms, this section can be classified as flat for about 7km and has rolling type of terrain for the last 6kms. The project location map is shown in Fig. 18 below:

Fig. 18 Location map: Muketuri - Alem Ketema road design project



Source: design consultant

The key contract details of this project are tabulated in Table 25 below.

Table 25 Contract details of DP-6

Project Name	Feasibility and Environmental Impact Assessment (EIA) studies, Resettlement Action Plan (RAP), Detailed Engineering Design and Tender Document preparation for *Muketuri - Alem Ketema* Road Project
Funding	Government of Ethiopia
Client	Ethiopian Roads Authority
Consultant	Addis Ababa Institute of Technology – Civil Engineering Department
Type of Service	Consulting Service for Feasibility and Environmental Impact Assessment (EIA) studies, Resettlement Action Plan (RAP), Detailed Engineering Design and Tender Document preparation
Project Period	08 months, as per Contract Document
Project Length	103km, as per Contract (113km actual) Lot 1: *Muketuri – Kokebmesk* (km 0+000 – km 58+000) Lot 2: *Kokebmesk – Alemketema* (km 58+000 – 113+000)
Contract Signed on	18th November, 2011
Commencement Date	09th December, 2011 (informed by ERA letter)

Planned Duration	Phase 1: Feasibility Study, 03 months
	Phase 2: Detailed Design, 05 months
Actual Duration[11]	Phase 1: Feasibility Study, 10 months
	Phase 2: Detailed Design, 20 months
Project Cost	ETB 3,229,837.50

Source: design consultant

<u>Route Selection</u>: The design consultant initially identified the following route alternatives from maps as well as aerial photos.

Alternative 1: existing route with realignment near the start of *Jemma* gorge

Alternative 2: route that is realigned near *Jemma* river and *Fetra* town

Alternative 3: route that completely shift to the left of the existing *Jemma* river bridge

The consultant then employed a multi-criteria approach to determine the most viable alternative. The analysis is approached by considering engineering, economic, social and environmental parameters. Based on the assessment, the design consultant selected and recommended alternative no. 1. The consultant further confirmed that this route provides the lowest construction cost and should provide the highest economic return, and that there are no overriding social environmental or strategic reasons for not selecting this alternative.

<u>Feasibility Study</u>: the economic appraisal was done using an appropriate economic return indicators and decision rules particularly Social Net Present Value (SNPV), Economic Internal Rate of Return (EIRR) and Payback period (PBP). It was carried out for an analysis period of 20 years starting from the first year of investments in the project and at discount rate of 12%.

The cost benefit analysis consists of calculating the economic feasibility indicators mentioned above on the basis of the cash flow of annual costs and benefits under ”with” and “without” project throughout the economic analysis period was carried out using HDM4 and conventional method. The following three alternatives were considered based

[11] Due to the mountaneous and escarpment terrain of the road, the design activities such as surveying, material investigation and detail cross-section survey took longer time.

on assessment of current traffic level, observation of road condition and consultation with concerned stakeholders:

- Alternative 1 (Do Minimum): this involves some inescapable improvement of the existing gravel road with adequate yearly maintenance.
- Alternative 2 (DBST): this involves improvement option with double bitumen surface treatment pavement with gravel sub-base and base.
- Alternative 3 (AC): this consists of pavement improvement option consisting of gravel sub-base and base Plus Asphalt Concrete (AC)

Accordingly, after conducting sensitivity analysis, the design consultant recommended Alternative 2 (DBST) as the best alternative with NPV of 1,155 Million and IRR of 30.1%, FYR (18%) for optimal opening period and payback period of 7.5 years of 2016.

Geotechnical: The design consultant has identified geotechnical hazards including landslide, problematic soil, subsurface drainage problem and seismic hazard and recommended appropriate mitigation measures. The analysis and recommendations given regarding landslide are after having preliminary insight of the site conditions and the impact of the intended construction. This, according to the design consultant, is because the detailed analysis of soil properties and a sound knowledge of the underlying soil and rock mechanics are very expensive and requires significant time. In addition, most of the landslides do not need detail investigations.

The foundation design of the bridges was carried out using presumptive bearing value. The material descriptions of the river beds and their banks were used to recommend presumptive bearing value. The design consultant, therefore, highly recommended carrying out detail foundation investigation via drilling during construction period for the three bridges.

Geometric Design: Based on the results obtained from traffic study, the project road was classified as DS4 standard as per ERA geometric design manual and the design was performed in accordance with the manual.

<u>Pavement Design</u>: After determining the design subgrade CBR and design traffic, the appropriate pavement structures were selected from the structural catalogue of ERA Pavement Design Manual 2002.

<u>Departure from standard</u>: The design consultant has made deviation from the standards due to prevailing site condition and problems. The deviations are believed to minimize landslides and other geotechnical hazards, high environmental impacts and degradations, inaccessibility of the road to people and animals, massive retaining walls construction due to slope stakes overlapping and earth work quantity.

5.3.2. Discussion and Results: case study of road design projects

As it can be observed from the six design project cases discussed in section 5.3.1 above, the design consultants have adopted the same procedures in line with the terms of reference and available design manuals of Ethiopian roads authority. Where it is found difficult to comply with the standards, the consultants have compromised certain requirements of the design manual up on approval of the employer. Apart from the value engineering related decisions made by the respective design consultants at different phases of the designs, of which the impacts have not been quantitatively indicated and justified, the author identified only the **refractive seismic study activities implemented in case-5** as a relevant value engineering related practice along with explicit impacts .

<u>Refractive seismic study in case-5</u>: the consultant adopted the seismic study to increase the accuracy of subsurface strata thereby increasing the accuracy of the excavation material categorization and slope stability assessments follow deep cuts encountered in some stretches of the project. The seismic investigation was carried out along seven road segments of the project with the objective of determining the nature and thickness of the subsurface units and engineering characteristics of the foundation rock and soils of the area.

The refraction seismic survey has identified subsurface units on the basis of their compressional wave (P-wave) velocities and determined their thickness to a depth of 40m. It has also clearly indicated sheared and fault zones, associated fracture zones of intensive weathering. The depth to and thickness of the subsurface unit s is determined with an accuracy of up to 10% except for shallow depths (below 5m).

Consequent to the findings of the seismic investigation, the design consultant has revised his assumptions of the subsurface strata determined through soil extensions based on test logs and visualization. The design (mainly benches and back slopes) and excavation quantities were revised accordingly.

The cost and time implications of the refractive seismic study on the design service contract were only *ETB 453,123.00 (including 15% VAT & 10% overhead)* and *20 days from commencement date (and 10 days for mobilization)* respectively. With regard to the time, cost and quality impacts of the refractive seismic study on the construction contract/phase of the project, it is clear that it has saved certain amount by increasing the accuracy of earthwork quantity estimation and slope stability analysis. However, pertaining to the project being at procurement stage at the time of conducting this research and subsequent confidentiality of engineer's estimates, it was difficult for the author to quantify the impacts on cost, time and quality of the construction works.

Nevertheless, the impacts of value engineering related practices with respect to the original cost and time of the randomly selected design projects is shown in Fig. 19 and Fig. 20 below.

Fig. 19 Impact of VE related practices w.r.t. original design cost

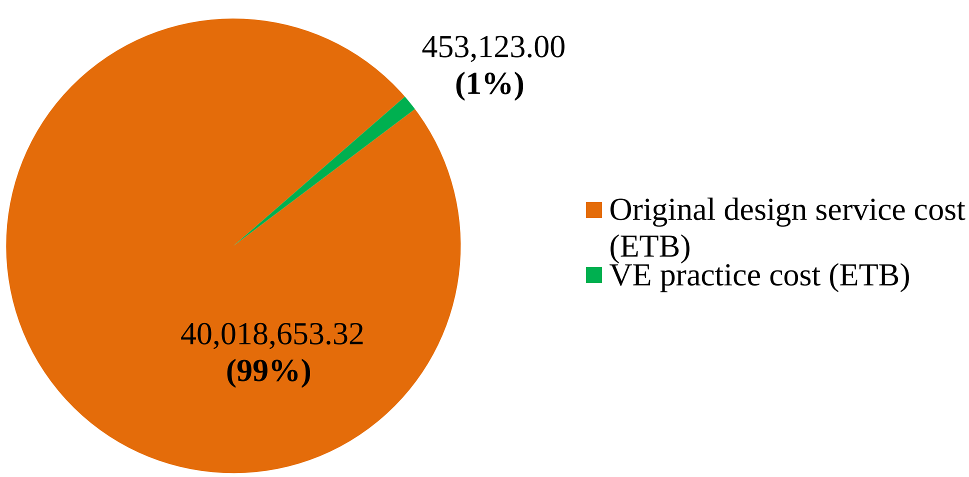
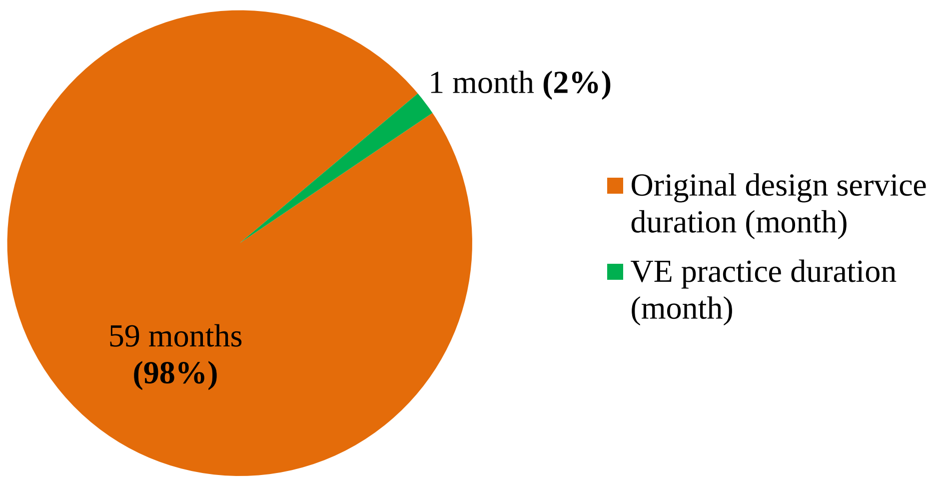


Fig. 20 Impact of VE related practices w.r.t. original design duration



5.3.3. Road Construction Projects

The randomly selected study units from the *Road Construction Projects* stratum are shown in Table 26 below. The random selection was done with the help of Microsoft Excel software by way of assigning a random real number between 0 and 1 to each construction project using the *RAND function* and sorting these numbers in an ascending order.

Table 26 Randomly selected construction projects

S.N.	Construction Project Name	Designation[12]
1	Adiremets - Dejena - Dansha	CP-1
2	Mombasa-Nairobi-Addis Ababa Lot III: Mega-Moyale	CP-2
3	Chanka Dembidolo Contract 3	CP-3
4	Sanja-Keraker	CP-4
5	Contract I: Gedo - Bako	CP-5
6	Bedele metu road upgrading project Lot2, KM 61+000 KM 111+659	CP-6

Legend:
On progress (rows 2, 3, 4, 6)
Completed (rows 1, 5)

Case 1: <u>Adiremets – Dejena – Dansha road project *(CP-1)*</u>

This project is 97.573km long and previously it was all weather existing road constructed by regional road authority to DS6 standard up to km 59+300, but beyond km 59+300 almost there was no access or no existing road of any standard to the Dejena except trail route up to Adiremets. The work under this contract consists of upgrading of the existing 59.3km DS6 standard road to DS4 Asphalt Concrete standard and provision of access with DS4 standard for the remaining length later revised to be DS3 standard with a carriageway width of 7.0m (previously 6.7m) and a shoulder of width 0.5m on mountainous/1.5m on flat and rolling terrain. The location map of the project is shown in Fig. 21 below.

[12] The designation is only for analysis purpose.

Fig. 21 Location map: Adiremets - Dejena - Dansha road construction project (CP-1)

Source: supervision consultant

The key contract details of this project are tabulated in Table 27 below.

Table 27 Contract details of CP-1

Construction contract details	
Contract Title	Construction Works of Endaselassie-Dejena-Dansha road project, Contract 3: Adiremets-Dejena-Dansha
Project Length	97.568 km
Funding	The Government of Federal Democratic Republic of Ethiopia
Employer	Ethiopian Roads Authority.
Contractor	Hunan Huanda Road and Bridge Corporation
Engineer	LEA Associates South Asia Pvt. Ltd., India in association with Core Consulting Engineers P.L.C., Ethiopia (Sub-Consultant)
Conditions of contract	FIDIC IV

Type of Contract	Item Rate Contract
Date of Contract Signature	23rd December 2008
Date of Commencement	10th February 2009
Contract Period (Original)	1096 calendar days
Original completion date	9th February 2012
Extension of Time (EoT-1)	860 calendar days
Extension of Time (EoT-2)	279 calendar days
1st Revised completion date	18th June 2014
2nd Revised completion date	24th March 2015
Original Contract Price	ETB 926,292,277.49 including 10% contingencies, 15% VAT and provisional sum
Value of Variation Orders	ETB (+) 79,541,883.24
Revised Contract Price	ETB 1,106,825,866.27 including 15% VAT and provisional sum
Total price adjustment to date	ETB 274,120,306.91 up to October 2015 (IPC 43)
Currencies & Proportion of Payment	ETB = 48.25% & China RMB Yuan = 51.75%
Amount of Liquidated Damages	0.1% of the value of the remaining works per day
Final Completion date	24th March 2015
Defects Liability Period	365 days

Source: supervision consultant

The variations indicated in Table 28 below were introduced to the original scope of the contract.

Table 28 Variation orders introduced to CP-1

VO No.	Description of work	Amount of varied work (+/-)	Associated EoT
01	Changing in carriage way width from 6.7m to 7.0m	(+) 15,777,688.52	23 working days
02	Supply of additional two type B vehicles	(+) 2,320,590.29	Nil
03	Supply of additional one type B vehicle	(+) 1,141,102.34	Nil
04	Design modifications of bridges on road section of km 34+839, km 38+536 and km 59+046	(+) 1,201,971.21	Nil
05	Change in grading for combined aggregate and mix-proportion	(-) 10,183,074.99	Nil
06	Proposed restoration measure for landslide incidents	(+) 69,283,605.88	160 working days (considered concurrently with culvert increment)
	Total (incl. VAT)	**(+) 79,541,883.29**	

Source: supervision consultant

The supervision consultant, through variation no. 05, has initiated to change the gradation of the asphalt mix design from medium side to coarser side in order to improve strength and skid resistance of the asphalt layer considering possible challenges due to difficult terrain of the road project. This practice could be considered as value engineering related practice with a total saving of ETB 10,183,074.99.

The total revised actual cost of the project including price adjustment, VAT and provisional sum is ETB 1,106,825,866.27. However, if the deduction due to the value engineering related practice of variation no. 5 had not been included, the cost of the project would have been ETB 1,117,008,941.26.

Case 2: Mombasa-Nairobi-Addis Ababa Lot III: Mega – Moyale road project *(CP-2)*

This project is part of the 2nd phase of the Mombasa – Nairobi – Addis Ababa corridor project which aims at promoting trade and regional integration between Ethiopia and Kenya by improving transport communication between the two countries. This project involves widening of the existing road which has an average carriageway width of 5.5m and 0.5m shoulders on both sides, to a 7.0m carriage way and 1.5m shoulders on both sides in flat and rolling sections and 7.0 m carriage way with variable shoulders in mountainous/escarpment sections. The outcomes of this project include reduced transport and shipping cost between Kenya and Ethiopia; reduced transit time for import and export goods; increased volume of Ethiopian transit goods using the port of Mombasa.

The key contract details of this project are tabulated in Table 29 below.

Table 29 Contract details of CP-2

Construction contract details	
Contract Title	Construction Works of Mombasa-Nairobi-Addis Ababa Road Corridor Phase-II Project: Ageremariam – Moyale Section, Lot III: Mega – Moyale (km 192+300 to km 301+630)
Project Length	103.33 km
Funding	African Development Bank (A_fDB)
Employer	Ethiopian Roads Authority.
Contractor	JMC Projects (India) Ltd.
Engineer	LEA Associates South Asia Pvt. Ltd., India in association with Core Consulting Engineers P.L.C., Ethiopia (Sub-Consultant)

Conditions of contract	FIDIC Multilateral Development Bank Harmonised Edition
Date of Contract Signature	7th March 2013
Date of Commencement	2nd September 2013
Type of Contract	Item Rate Contract
Original Contract Price	ETB 1,146,905,005.89
Value of Variation Orders	ETB (+) 600,352,351.45
Revised Contract Price	ETB 1,747,257,357.34
Contract Period (Original)	36 months (excluding DLP)
Time elapsed	1428 days (up to end of July 2017)
Currencies & Proportion of Payment	ETB = 26.35% & USD = 73.65%
Contract Exchange Rate	1USD = 17.9635 ETB
Liquidated Damages	0.05% of the Contract Price per day in the currencies and proportions in which the Contract price is payable limited to a maximum of 10% of final contract price.
Original completion date	1st September 2016
Extension of Time No. 1	211 Calendar days + 90 Calendar days (Interim)
Extension of Time No. 2	214 Calendar days
Final Completion date	31st October 2017
Defects Liability Period	365 days

Source: supervision consultant

The variations indicated in Table 30 below were introduced to the original scope of the contract.

Table 30 Variation orders introduced to CP-2

VO No.	Description	Effective Amount up to Previous	Amount to this variation	Revised Contract Price after this variation
01	Variation Order No.1 (Addition of air conditioning unit to the Engineer's facilities item no. 14.12 (a) and Replacement of Radio Communication item no 14.03(iv) (a) and (b))	1,146,905,005.89	(+) 103,327.3	1,147,008,333.18
02	Variation Order No. 02 (Payment of Bore Wells)	1,147,008,333.18	(+) 7,956,842.8	1,154,965,175.99
03	Variation Order No.-03 (the Change of Pavement Thickness)	1,154,965,176.00	(+) 29,365,785.9	1,184,330,961.90
04	Variation Order no. 04 (Introducing of 1.5 m median in Moyale Town)	1,184,330,961.90	(+) 3,456,110.4	1,187,787,072.34
05	Variation order no.05 (Gender Sensitization Service)	1,187,787,072.34	(+) 1,140,515.8	1,188,927,588.14
06	Variation Order No. 06 (Longitudinal side drain and Service	1,188,927,588.14	(+) 56,010,360.6	1,244,937,948.74

	Road)			
07	Supplementary Agreement no.01 for One Stop Border Post	1,244,937,948.74	(+) 489,271,546.85	1,734,209,495.59
08	Remedial measures for flooding in Buko town	1,734,209,495.59	(+) 13,047,861.75	1,747,257,357.34
	Total	**1,146,905,005.89**	**(+) 600,352,351.45**	**1,747,257,357.34**

Source: supervision consultant

Case 3: <u>Chanka - Dembidolo Contract 3 road project *(CP-3)*</u>

This project is part of the Mekenajo-Dembidolo Road Upgrading Project. The total road length from Mekenajo – Dembidolo of this road has been divided in to three Contracts. Those are as follows:-

Contract 1: Mekenajo – Ayra (km-0.0 to km-52.50)

Contract 2: Ayra – Chanka (km-52.5 up to km-118.0) and

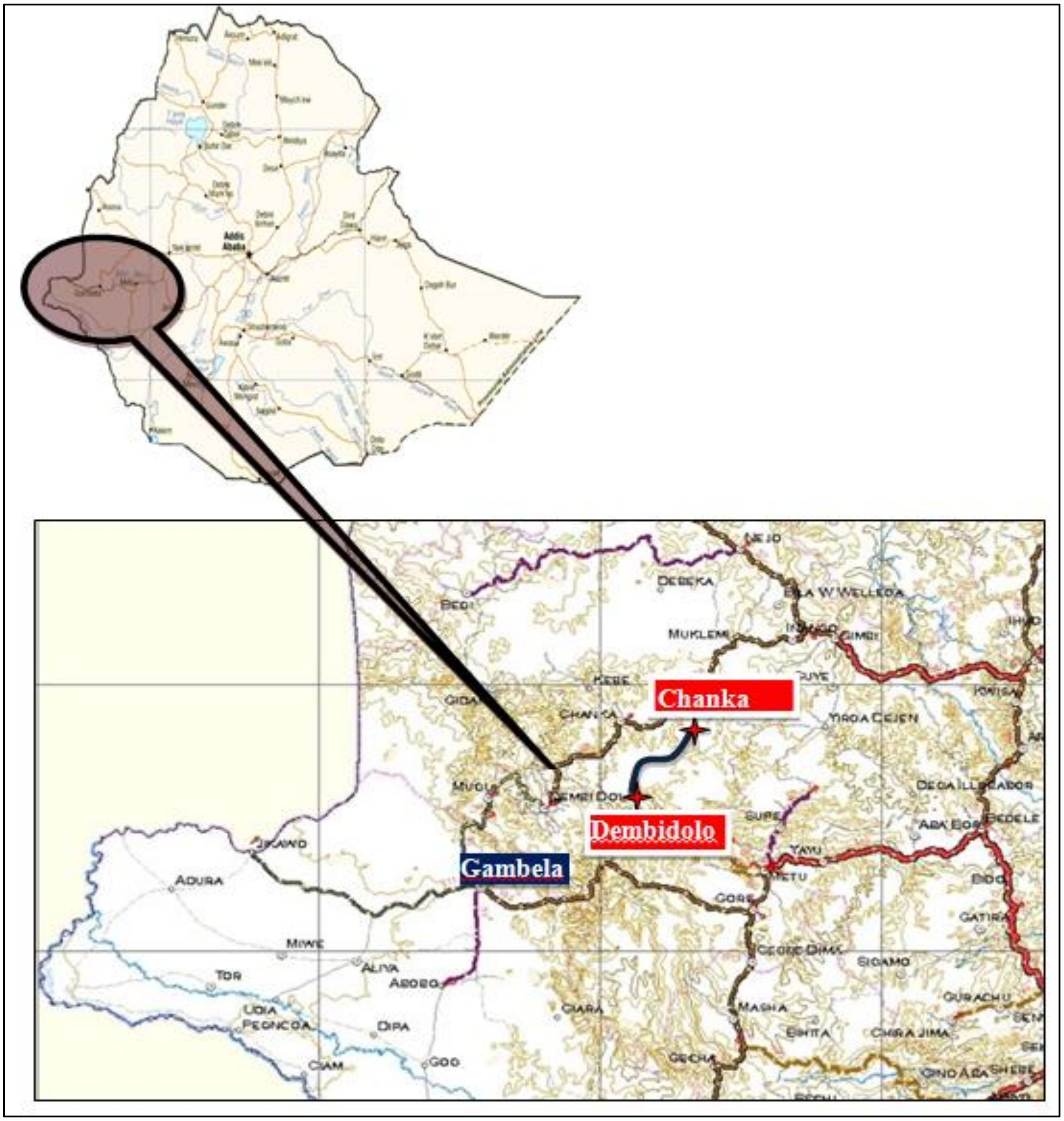
Contract 3: Chanka – Dembidolo (km-118.00 to km-181.60)

Construction work of these three contracts was awarded to the three contractors in 2011 through international competitive bidding; however, the construction works could not be completed within the stipulated time. The original consultant for the three packages M/s *Roughton in joint venture with Beza Consulting Engineers (BCE)* were responsible for supervision of civil works for all three contracts up to July 2014, and then the supervision contract was discontinued and given to three different consultants for the three packages to supervise under individual contracts.

Contract 3: Chanka – Dembidolo (km-118.00 to km-181.60) was awarded to *LEA International Ltd. Canada in joint venture with LEA Associates South Asia Pvt. Ltd. India in sub consultancy with United Consulting Engineers P.L.C, Ethiopia*, to supervise the remaining works from July 2014.

Chanka-Dembidolo Road Project is a total length of 62.6 km and it is located in Oromia National Regional State (ONRS) in western Ethiopia. It starts from Chanka town and ends at Dembidolo town. The location map of the project is shown in Fig. 22 below.

Fig. 22 Location map: Chanka - Dembidolo road construction project (CP-3)



Source: supervision consultant

The key contract details of this project are tabulated in Table 31 below.

Table 31 Contract details of CP-3

Construction contract details	
Contract Title	Construction Works of Mekenajo-Dembidolo Road Upgrading Project, Contract3: Chanka-Dembidolo. (Km.118+000 to 180+600)

Project Length	62.6 km
Funding	World Bank
Employer	Ethiopian Roads Authority.
Contractor	China Highway Group Limited, Hong Kong, China
Engineer	LEA international Ltd., Canada in JV with LEA Associates South Asia Pvt. Ltd., India in Sub Consultancy with United Consulting Engineers P.L.C., Ethiopia.
Conditions of contract	FIDIC Multilateral Development Bank Harmonised Edition
Date of Contract Signature	3rd June 2011
Date of Commencement	7th October 2011
Type of Contract	Item Rate Contract
Original Contract Price	ETB 648,548,842.21
Revised Contract Price	ETB 637,643,478.95 (Estimated)
Contract Period (Original)	910 days
Time Extension Approved	1st EOT 111 Calendar days, 2nd 59 Calendar days and 3rd 113 Calendar days from 20-10-2015 to 09-02-2016
Contract Period (Revised)	1193 days
Currencies & Proportion of Payment	ETB = 30% & EURO = 70%
Contract Exchange Rate	1EURO = 21.36 ETB
Liquidated Damages	0.05% of the Contract Price per day limited to a maximum of 10% of Contract price in the currencies and proportions in which the Contract price is payable.
Original completion date	3rd April 2014
Extension of Time	283 Calendar days
Current Completion date	09-02-2016 (calculated from 20-10-2015)
Defects Liability Period	365 days

Source: supervision consultant

A total of nine (09) variations were introduced in to the scope of the project as shown in Table 32 below.

Table 32 Variation orders introduced to CP-3

VO No.	Description of work	Amount of Varied Work
01	Additional works, to extend Dembidolo town section from Roundabout(end of project) 1.45 to the Hospital and 1.45 to Bus Station	(+) ETB 28,582,626.00

02	Urban drain structures specifications change from concrete structures to stone masonry structures.	(+) ETB 593,987.00
03	Modification of carriage way width from single c/w to dual c/w in Dembidolo roundabout & Gabarobi R/a	(+) ETB 819,224.73
04	Modification of Dembidolo drainage system and outlet channelization	(+) ETB 9,493,828.29
05	Proposal for changing scope of Type 3 drain to Type 2drain	(-) ETB 1,878,747.16
06	Modification of pre-cast walkway to cast in situ walkway	(-) ETB 6,280,244.95
07	Proposal for changing chute drain from pipe to stone masonry	(-) ETB. 2,147,134.66
08	Remedial Measure for Mechara town siltation problem	(+) ETB 542,197.32
09	Providing Access to the local residents	(+) ETB 2,146,189.60
	Total	(+) ETB 31,871,926.17

Source: supervision consultant

The contractor proposed for the change in the rural drain type from Type 3 (concrete lining open drain) to Type 2 (grouted stone pitching trapezoidal open drain) with an official undertaking for not claiming extension of time and not partaking of the cost saving whatsoever associated with the variation in line with sub-clause 13.2 *[Value Engineering]* of the general conditions of contract. After thorough review by the supervision consultant and the employer, variation no. 5 was introduced in to the contract to change the rural drain from Type 3 to Type 2 with a total cost saving of ETB 1,878,747.16.

The contractor had also proposed, in line with sub-clause 13.1 *[Value Engineering]* of the general conditions of contract, for changing the walkway type from Pre-cast to Cast-in-situ concrete considering the advantages of expediting the walkway construction and its cost reduction without detriment to the performance. The proposal was reviewed by the supervision consultant and the Employer and variation no. 6 was introduced in to the contract with a total cost saving of ETB 6,280,244.95.

The idea of changing the type of chute from concrete pipe to stone masonry was initiated by the supervision consultant following absence of details in the contract drawing for concrete pipe chute and an anticipated durability, better service, safety and less cost of the proposed stone masonry chute. Further, the Consultant has also proposed to reduce the total length of the chute from 1.223 km to 0.549 km considering site conditions. The Employer accepted the recommendation, taking in to account the benefits, and variation order no. 7 was issued to the contractor with a gross cost saving of ETB 2,147,134.66.

Generally, these value engineering related practices introduced in to the original contract as variation order nos. 5, 6 & 7 have resulted in a combined gross saving of ETB 10,306,126.77.

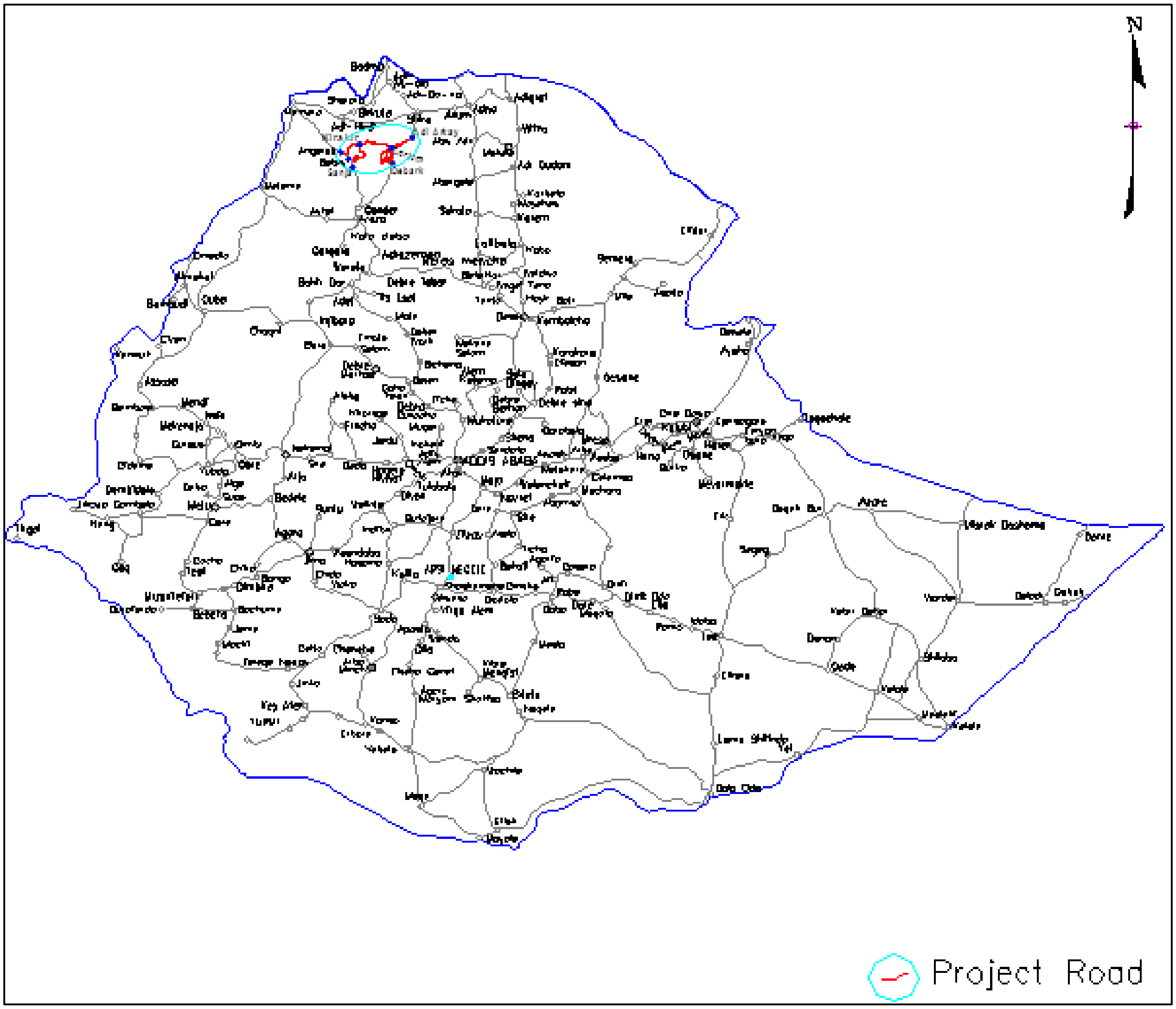
Case 4: Sanja-Keraker road project *(CP-4)*

Sanja-Keraker road project is part of the road network of Gondar District, linking the Amhara and Tigray National Regional States. The road plays a vital role for economic as well as cultural integration between the people of the Amhara and Tigray National Regional States. A combination of flat, rolling and chain of mountains and extremely rugged and difficult terrain are the typical topographic nature of the regions where the route passes through.

The project road is located in the north Gondar Zone of the Amhara National Regional State. The starting point of the project is at a village called Fendika, which is a village at the junction point with Gondar-Humera road and is 10 km North of Sanja town. The junction point is located at a distance of about 720 km north of Addis Ababa (About 70 km north of Gondar). The route passes through few villages, and terminates after about 48 km at Keraker town.

Generally, the works comprises of earthwork for excavation, which is the dominant activity of the Project works, embankment, and sub grade; construction of granular sub-base and base course; construction of double bitumen surface treatment through all road stretch and construction of minor and major crossings with slope protection works and road markings. The location map of the project is shown in Fig. 23 below.

Fig. 23 Location map: Sanja-Keraker road construction project (CP-4)



Source: supervision consultant

The key contract details of this project are tabulated in Table 33 below.

Table 33 Contract details of CP-4

Construction contract details	
Contract Title	Construction and Completion of Sanja-Keraker Road Project
Funding Agency	Federal Democratic Republic of Ethiopia (FDRE)
Employer	Ethiopian Roads Authority (ERA)
Contractor	China Railway No.3 Engineering Group Co. Ltd
Engineer	High Way Engineers and Consultants/HEC/ Plc.

Condition of Contract	FIDIC-IV
Letter of acceptance issued	February 11,2014
Date of Contract Signature	March 05,2014
Date of Commencement	March 17,2014
Type of Contract	Unit Rate Contract
Project Length	47.95km
Road Standard	DBST Asphalt Road (DS4)
Contract Amount	ETB 786,796,548.12 Including the specified provisional sums, 10% contingency and (15%) VAT.
Percent payable in foreign currency	Nil
Percent payable in local currency	100%
Value of variation orders to date	Nil
Total price of adjustment to date	3,120,183.31
Interest to late payment to date	4,434,408.54
Revised contract amount (estimated)	ETB 853,855,101.38 (including VAT, PS & contingency)
Contract Period (Original)	913 Calendar Days
Original completion date	September 14,2016
Revised Contract Period (after EOT 01)	1163 Calendar Days
Revised completion date	May 23, 2017
Limit of Liquidated damage	10% of the value of the remaining work.
Defects Liability Period	365 days from issue Taking Over Certificate of the last section under Clause 48

Source: supervision consultant

In accordance with the original contract design, the project length is 47.2km, which ends at the entrance of *keraker* town without including the whole length the town section. In relation to this, the *Tegede Woreda* Administration office had requested to extend the end of the project in order to address *Keraker* Town section. Accordingly, Variation Order No. 01 was issued to the contractor to include *Keraker* town section (1.2 km) in the scope of this contract with an additional cost of ETB 20,163,174.55 and 67 calendar days of duration. However, this variation of scope could not be considered as value engineering related practice since it was initiated following end-user demand.

Though only one variation order was introduced in to this contract, the revised contract price is estimated to be ETB 853,855,101.38 as compared to the original contract amount of ETB

786,796,548.12 due to different reasons like price adjustment (inflation), Interest on late payment, and quantity increase.

Case 5: <u>Contract I: Gedo - Bako road project *(CP-5)*</u>

The project road, Gedo to Bako, is located in the Western Shoa Zone of the Oromiya National Regional State. The start of the project is at approx. 192 km west of Addis Ababa at the culvert at a distance of nearly 740 meters from the junction of the road to Fincha Hydro Electric Power Station, at Gedo town in the direction to Bako, and ends after passing Bako town for nearly 10 km. The overall length of the project is 66.132 km.

The project road is a portion of the country's road network connecting the capital Addis Ababa with western part of the country. It is the first section of the Gedo-Nekempte Road Rehabilitation Project. According to the Ethiopian road functional classification system, it is one of the Trunk Roads. The location map of the project is shown in Fig. 24 below.

Fig. 24 Location map: Gedo-Bako road construction project (CP-5)

Source: supervision consultant

The key contract details of this project are tabulated in Table 34 below.

Table 34 Contract details of CP-5

Construction contract details	
Project Name	Gedo-Nekempte Road Rehabilitation Project, Contract 1: Gedo-Bako Road Project
Funding Agency	International Development Association (IDA), World Bank, in collaboration with the Federal Democratic Republic of Ethiopia
Letter of Acceptance Issued	01 July 2009
Date of Contract Signature	29 July 2009
Commencement Date	12 October 2009
Revised Commencement Date	22 January 2010
Original Contract Period	913 Cal. days (Excluding Defect Notification Period)
Extension of Time Landmine 1	6 days

Original Completion date	12 April 2012
Revised Completion date 1	28 July 2012
EOT for adverse rainy season 2	16 days (outside the rainy period)
Revised completion date 2	16 October 2012
EOT for quantity variations on minor & major drainage structures	70 days
Revised completion date 3	25 December 2012
EOT for delayed payment of VAT amounts (Dispute Referral N°. 2)	3.98 months
Revised completion date 4	24 April 2013
Date of Taking Over Certificate	20 June 2014
Defects Notification period	365 Calendar Days: from 20 June 2014 to 19 June 2015
Type of Contract	Re-measurable quantities with price adjustment of rates
Original Accepted Contract Amount (including Contingency, provisional sum)	ETB 354,350,909.62
Value of Variation Orders	ETB 21,208,997.33
Revised Contract Amount	ETB 346,629,716.31
Total Price Adjustment	ETB 285,676,715.08
Estimated Final Contract Price	ETB 632,306,431.39 (178.4 % of the Original Accepted Contract Amount), including price adjustment, cost in legislation, re-rating and costs for claims
Contract Length: Original	66.132 km
Maximum amount of Delay Damages	10 % of the Final Contract Price
Delay damages for the works	0.033 % of the Contract Price per day, in same currency as the Contract price is payable.
Currency of Payment	In proportions of 75 % Euro and 25 % ETB and with the Exchange rate of 1 Euro = 13.92 ETB
Conditions of Contract	FIDIC Multilateral Development Bank Harmonised Edition

Source: supervision consultant

The variation orders introduced in to this Contract are described in Table 35 below.

Table 35 Variation orders introduced to CP-5

V.O. N°	Description	Amount of variation	Remarks
1	Re-Alignment of centreline from km 5 - km 11	(-) ETB 6,352,839.49	Reduced 6 working days[13] as earthwork was critical activity

[13] Though it has resulted in reduction of 6 working days, the contract duration was not reduced accordingly.

V.O. Nº	Description	Amount of variation	Remarks
2a	Minor Structures	ETB 15,806,257.93	
2b	Major Structures	(-) ETB 2,426,860.80	
3	Subsoil Drains	ETB 917,854.62	
4	Town Sections	ETB 6,848,781.98	102 calendar days EoT
5a	Cyclopean Concrete (Major structures)	ETB 2,788,940.7	
5b	Lean Concrete	ETB 809,109.00	
7	Gabion Walls	ETB 235,043.55	

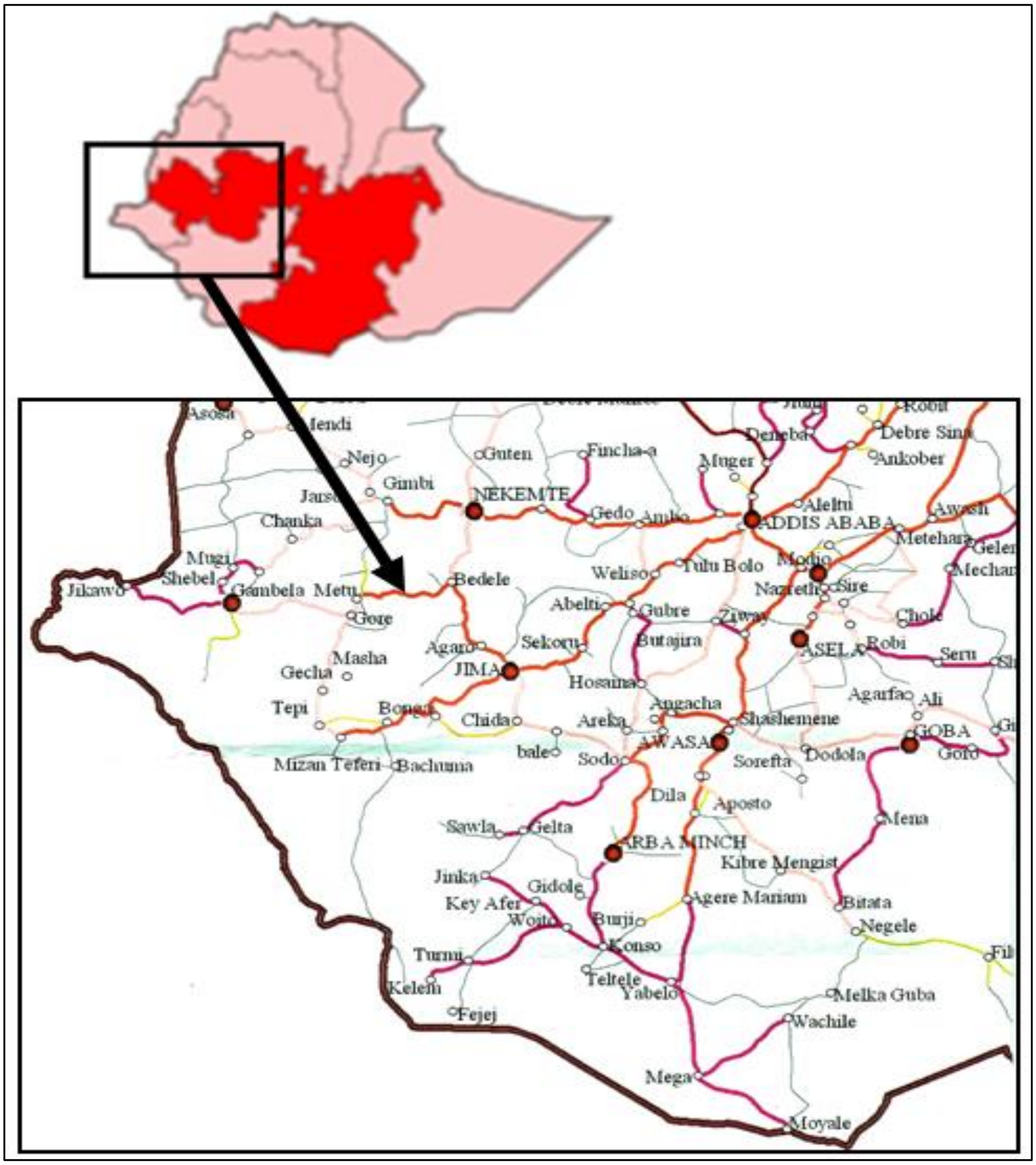
Source: supervision consultant

The variation order no. 1 was initiated by the supervision consultant in an attempt to optimize cost. Realigning the section from km 5+000 to km 11+923 has resulted in cost saving to the Employer. The supervision consultant has also made changes in the scope of major structures through variation order no. 2b which states "*based on hydrology/hydraulics and structural design reports some of the bridges have been converted to slab culverts, three have been returned and need only maintenance including quantity variations as a result of design changes based on geotechnical investigation reports*". Therefore, both variation nos. 1 and 2b could be considered as value engineering related practices with a combined total saving of ETB 8,779,700.29.

Case 6: <u>Bedele-Metu road upgrading project, Lot2: km 61+000 to km 111+659 *(CP-6)*</u>

The Project Road is located in the Mid-Western part of Ethiopia in Oromia Region. Bedele-Metu, with a length of about 112 Km, is part of Trunk Road which starts from Addis Ababa and ends at Gambela. It is a part of the 208 kilometer long *Nekempt-Bedele-Metu* Road, which was built about 30 years ago with asphalt surfaced and currently serves moderate level of traffic. The project involves widening of the existing road which has an average carriageway width of 6m and 1m shoulders on both sides, in rolling and variable shoulders in mountainous / escarpment sections. The project road is located in mid-western Ethiopia in the region of Oromia as shown in Fig. 25 below.

Fig. 25 Location map: Bedele-Metu road upgrading project, Contract 2: km 61+000 to km 111+659 (CP-6)



Source: supervision consultant

The key contract details of this project are tabulated in Table 36 below.

Table 36 Contract details of CP-6

Construction contract details	
Contract Title	Construction works of Bedele-Metu road upgrading project; Contract 2: km 61+000 to km 111+659
Funding	The African Development Bank (*AfDB*)

Contracting Authority	Ethiopian Roads Authority
Length (km)	50.659 Km
Conditions of contract	FIDIC Multilateral Development Bank Harmonised Edition
Type of Contract	Item Rate
Construction Type	Upgrading the existing Gravel Road to Asphalt Standards
Contractor	China International Water and Electric Corporation (*CWE*)
Contract Signing Date	30th November 2012
Commencement Date	15th February 2013
Original Completion Date	14th February 2016
Original Contract Period	36 months
Maintenance Period	365 days
EOT Approved (*Days*)	311 days
Revised Completion Date	21th December 2016
Contract Amount	USD 23,045,120.00 and ETB 200,574,345.00
Contract Exchange Rate	1 USD = 17.70 ETB
Advance Payments	USD 3,621,517.51 and ETB 46,635,645.32
Price Adjustment To-Date	USD 317,450.23 and ETB (-) 3,289,340.48
Interest on Late Payments	Nil
Value of Variations Approved 1	ETB 90,943,381.73 (Including VAT)
Value of Variations Approved 2	ETB 279,178.52 (Without VAT)
Value of Variations Approved 3	ETB 1,241,595.50 (Without VAT)

Source: supervision consultant

The variations shown in Table 37 have been introduced in to the scope of this contract:

Table 37 Variation orders introduced to CP-6

VO No.	Description	Amount of Variation (*ETB*)
1	Implementation of the Design Amendment suggested in the Design Review Report including Remedial Measures against Land Slide	90,943,381.73 (including VAT)
2	Remedial Measures for Embankment Settlement Km 65+148 – Km 65+203 (RHS)	279,178.52 (excluding VAT)
3	Remedial Measures for the embankment failure in between Km 84+800 – Km 84+840 (RHS).and Km 85+360 – Km 85+460 (RHS)	1,241,595.50 (excluding VAT

Source: supervision consultant

5.3.4. Discussion and Results: case study of road construction projects

As indicated in section 5.3.3 above, five projects have incurred additional cost overrun and time and one project has faced only time overrun, due to different reasons. Out of the 28 variation orders introduced in to the contracts, only 5 variation orders have reduction in cost but the reduction in time is not indicated except in one variation.

It can be observed that these value engineering related practices have reduced cost and reduced time (or have no time implication). The implication of these variations on quality and/or function of the road has not been explicitly assessed and recorded. However, it can be deemed to be up to the specification since the changes are made after being scrutinized by the supervision consultant and the employer for compliance with the specification requirements. Moreover, permanent road works are deemed to be thoroughly inspected, tested and approved by the supervision consultant in line with the specifications. The impact of the value engineering related practices with respect to project cost is as indicated in Fig. 26 through Fig. 29 below.

Fig. 26 Impact of value engineering related practices w.r.t. project cost

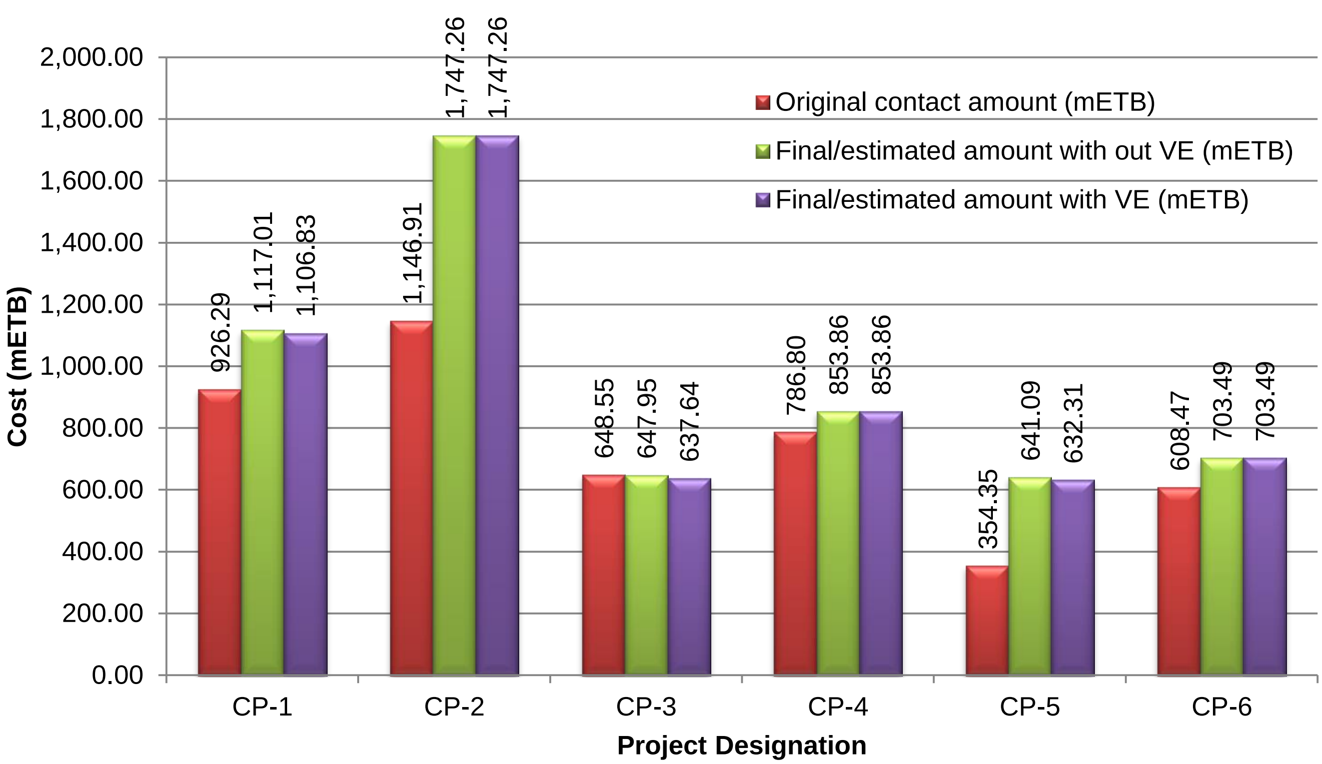


Fig. 27 Impact of value engineering related practices w.r.t. cumulative cost

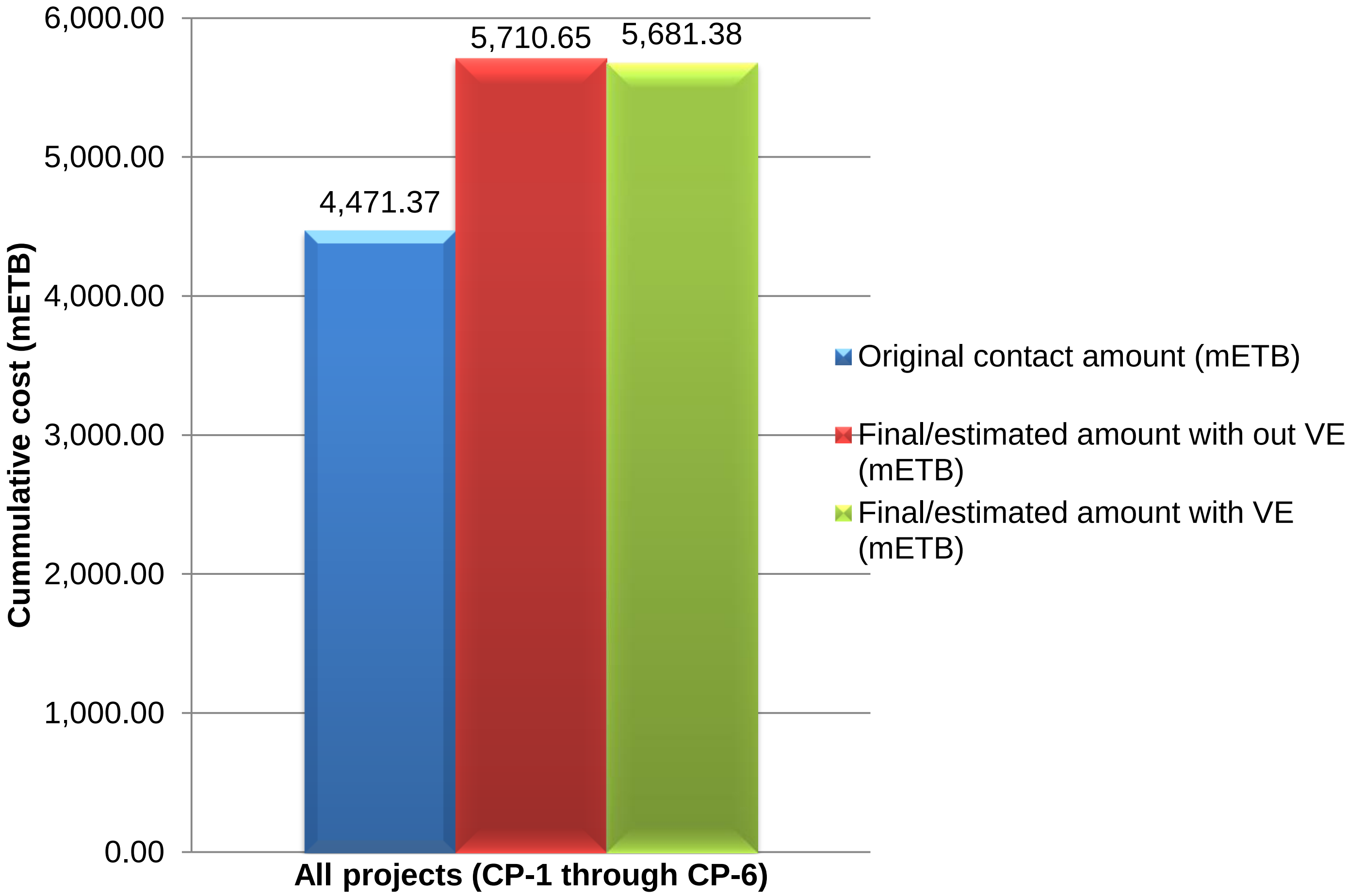


Fig. 28 Impact of value engineering related practices w.r.t. cumulative original cost

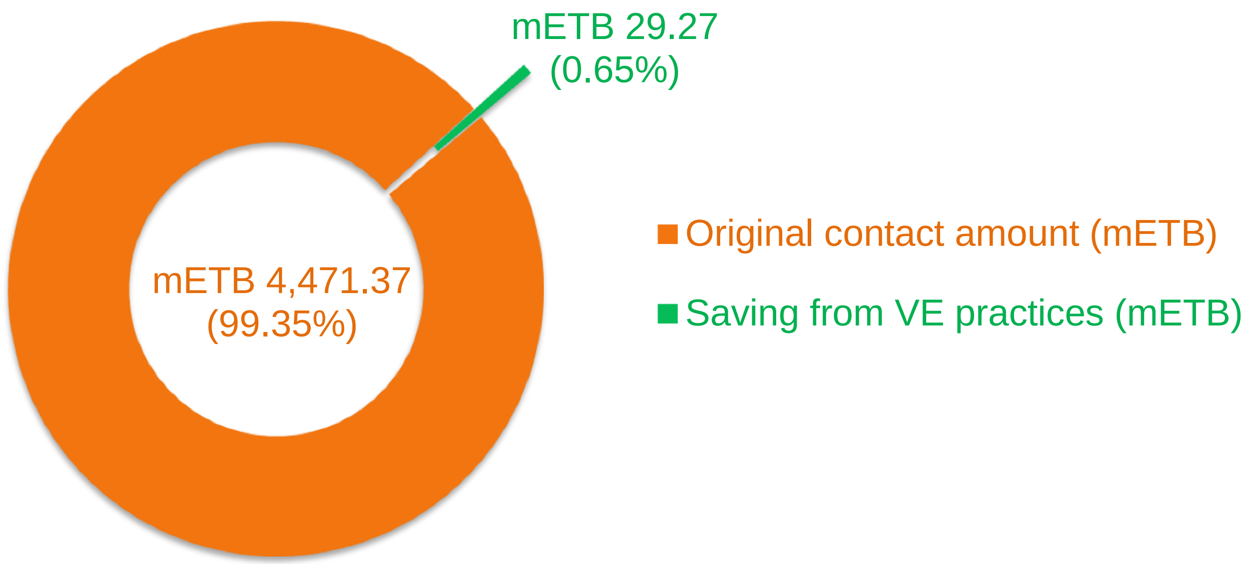
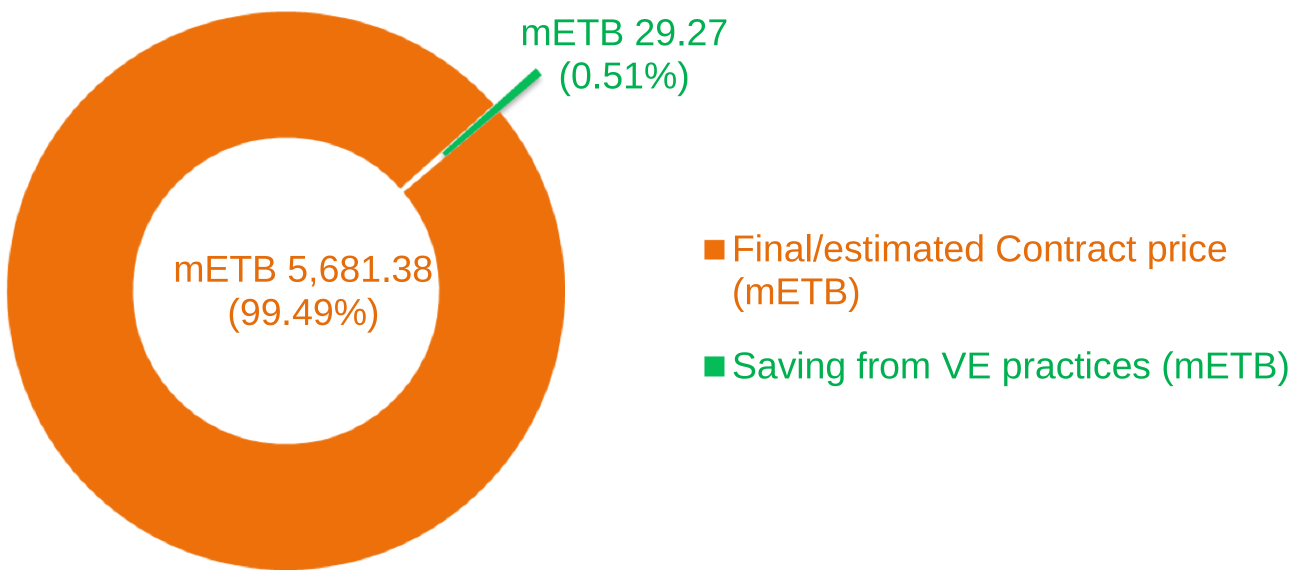


Fig. 29 Impact of value engineering related practices w.r.t. cumulative final/estimated cost



The impact of the value engineering related practices with respect to time is not investigated/ indicated in four projects, but in CP-1 and CP-2 the time implication of the value engineering related practices is indicated as '*Nil*' and '*6 working days*' respectively. Although 6 working days' time implication was stated by the supervision consultant of CP-2, the Employer has objected on the reduction of 6 working days from the contract duration for reasons not clearly mentioned in the

Employer's correspondences. This is probably due to the provisions of sub-clause 8.4 *[Extension of Time for Completion]* of the FIDIC (2006) which states that "*When determining each extension of time under sub-clause 20.1, the Engineer shall review previous determinations and may increase, but shall not decrease, the total extension of time.*" Therefore, in all six projects, the impact of the value engineering related practices with respect to contract time can be considered as 'keeping the original contract duration as it is' and avoiding time overrun.

It can be noted that these benefits, i.e. 0.65% of original cost or 0.51% of revised cost, achieved through the value engineering related practices are very minimal as compared with the potential of value engineering study. According to Division of Highways, 2004, value engineering can provide savings of at least 5% of a project's construction cost using a formal value engineering program.

Chapter – Five

Conclusions and Recommendations

Value Engineering is an effective technique for reducing costs, increasing productivity and improving quality (Atabay, et al., 2013). The general objective of this thesis is to study the impacts of value engineering related practices in design and construction phases of federal road projects administered by the Ethiopian Roads Authority.

Based on the findings of the analysis, the author presented his conclusions, in line with the study objective, and recommendations as follows.

5.1. Conclusions

i) The impact of value engineering related practices in design projects administered by the Ethiopian roads authority is increasing the accuracy of quantity estimation thereby optimizing the construction project cost. Although it was difficult to quantify the impacts of the value engineering related practices on the construction contract due to confidentiality of estimate documents until completion of procurement phase, the impact of the value engineering related practices in design service contracts is found to be increasing the original design service contract amount and duration by **1%** and **2%** respectively[14].

   On the other hand, the impacts of value engineering related practices on construction phase of a project is observed to reduce time (or have no time implication) and reduce cost by **0.65%** of the original contract amount or **0.51%** of the final/estimated contract amount.[15] However, though the impact of these value engineering related practices on quality and/or function of the roads has not been explicitly assessed and recorded, it is deemed to be up to the specification since the changes are made after being scrutinized by the supervision consultant and the employer for compliance with the specification requirements. Moreover, permanent road works are deemed to be thoroughly inspected, tested and approved by the supervision consultant in line with the specifications.

[14] See section 5.3.2
[15] See section 5.3.4

ii) Consulting firms mainly incur *extra manpower* and *additional overhead costs* whereas construction firms mainly incur *extra equipment costs*, *additional overhead costs* and *extra manpower wage* from conducting value engineering studies under the current scenario.

On the contrary, both consulting and construction firms will benefit from *expedited decision making, saving in time, cost and energy*, *reputation as a cost-conscious supplier* and *securing a price advantage during procurement of similar projects*. In addition to this, construction firms will benefit from *improved quality of construction* and *mechanized and efficient construction*.[16]

iii) "*Including Value Engineering Incentive Clauses in contracts (to enable the contractor propose alternatives and share the savings)"* has extreme significance in promoting value engineering practices in federal road projects followed by "*Acknowledging/awarding good achievements of value engineering related tasks*" and "*Preparing seminars and workshops via professional associations (e.g. Ethiopian Civil Engineers Association)"*. Whereas, "*Formulating a policy/statutory requirement (to enforce projects with a certain limit of Engineer's estimate to undergo Value Engineering study)"* and "*Including Value Engineering in curriculums of concerned academic institutions"* are of relatively low significance.[17]

iv) Value engineering can minimize the cost overrun, delay and quality problems in the federal road projects.[18]

v) 54% of the construction firms and 47% of the consulting firms have a plan/strategy to apply value engineering in road projects and improve value for money spent.[19]

vi) Among the main stakeholders involved in federal road construction, The Client (Ethiopian Roads Authority) can get extreme benefit followed by Construction firms, End users (the Public), Consulting firms and Suppliers. [20]

[16] See section 5.2.3
[17] See section 5.2.3
[18] See section 5.2.3
[19] See section 5.2.3
[20] See section 5.2.3

5.2. Recommendations

i. The concerned government authority has to take the lion-share in formulating an appropriate policy aimed at safeguarding better value for money being spent in the road construction industry using a formal value engineering program.

ii. The life-cycle costs of road projects should be given the utmost attention while designing and introducing variations to a contract. The evaluation of variations has to explicitly indicate the time implications, cost implications and quality implication.

iii. Federal road design projects need to undergo value engineering study prior to floating a tender in order to optimize the available resource and improve value.

iv. Professional associations should strive to create the awareness of value engineering through training and workshops.

5.2.1. Areas recommended for further studies

- Developing appropriate guidelines for value engineering application in road construction projects.
- The effects of refractive seismic study in cost, time and quality of construction phase of Edo-Serofta-Werqa road project.

References

AASHTO. 1987. *AASHTO Guidelines for Value Engineering.* Washington, D.C. : American Association of State Highway and Transportation Officials, 1987.

Adugna, Gudina. 2015. *Investigation of the Application of Value Engineering in Selected and Completed Federal Road Projects.* Addis Ababa : Addis ababa Institute of Technology, Addis Ababa University, 2015. Masters of Engineering Independent Project.

AfDB. 2011. *Country Strategy Paper (2011 - 2015).* s.l. : African Development Bank Group, 2011.

AfDB Group. 2015. *FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA COUNTRY STRATEGY PAPER 2016-2020.* s.l. : African Development Bank Group, 2015.

Alan, C. Twort and J., Gordon Rees. 2004. *Civil Engineering Project Management.* 4th. Great Britain : Elsevier Butterworth-Heinemann, 2004.

ASTM E 1699 – 00. 2005. *Standard Practice for Performing Value Analysis (VA) of Buildings and Building Systems.* United States : ASTM International, 2005.

Atabay, Senay and Galipogullari, Niyazi . 2013. *Application of Value Engineering in Construction Projects.* Istanbul : David Publishing, 2013. pp. 39-48. Vol. I. 2328-2142.

Barbara, J. Jackson. 2004. *Construction Management - Jump Start.* United States of America : SYBEX Inc., 2004.

Becker, H.J. and Behailu, D.D. 2006. *Public Private Partnership in Road Projects in Ethiopia.* Berlin : Technische Universität Berlin Institut für Land- und Seeverkehr, 2006.

Brown, James. 1992. *Value Engineering: A Blueprint.* 1st. New York : Industrial Press Inc., 1992. 0-8311-3038-5.

Clark, Jennifer Anne . 1999. *VALUE ENGINEERING FOR SMALL TRANSPORTATION PROJECTS.* Worcester : Worcester Polytechnic Institute, 1999. Masters of Science Thesis.

Dell'Isola, Alphonse J. 1997. *Value Engineering: Practical Application for Design, Construction, Maintenance & Operations.* United States of America : R.S. Means Company, Inc., 1997. 0-87629-463-8.

Department of Defense, United States of America. 2011. *Value Engineering: A Guidebook of Best Practices and Tools.* USA : Office of Deputy Assistant Secretary of Defense Systems Engineering, 2011.

Department of Transportation, Utah. *Manual of Instruction: Value Engineering.* s.l. : Utah Department of Transportation Engineering Services.

Division of Highways, West Virginia Department of Transportation. 2004. *Value Engineering Manual.* West Virginia : WVDOH Office Services Division (Available at http://www.transportation.wv.gov/highways/engineering/files/WVVEMANUAL.pdf), 2004.

Dunford, Rosie, et al. 2014. The Pareto Principle. 2014, Vol. 1.

ERA. 2014. *Road Sector Development Program 17 years Performance Assessment Report.* Addis Ababa : Ethiopian Roads Authority (Available at www.era.gov.et/web/guest/program), 2014.

FIDIC. 1995. *Conditions of Contract for Design-Build and Turnkey.* 1st. Lausanne : Fédération Internationale Des Ingénieurs-Conseils (FIDIC), 1995. 2-88432-010-5.

Getachew, Tsegaye. 2009. *Design Risk Management in Ethiopian Federal Road projects.* Addis Ababa : Addis Ababa Institute of Technology, Addis Ababa University, 2009. MSc. Thesis.

Girmay, Kahssay. 2003. *CLAIMS IN INTERNATIONAL PROJECTS IN ETHIOPIA.* Addis Ababa : AAiT, 2003.

Glenn, D. Israel. 1992. Determining Sample Size. University of Florida : Institute of Food and Agricultural Sciences, 1992.

Ilayaraja, K and Eqyaabal, Zafar. 2015. *Value Engineering in Construction.* Tamil Nadu : Indian Journal of Science and Technology, 2015. Vol. Vol 8(32). 0974-5645.

IS 11810:2003. 2003. *Indian Standard GUIDELINES TO ESTABLISH A VALUE ENGINEERING ACTIVITY (first revision).* New Delhi : Bureau of Indian Standards, 2003.

Iyer, S. S. 2009. *VALUE ENGINEERING: A HOW TO MANNUAL.* 3rd. s.l. : New Age International (P) Ltd., 2009. 978-80-224-2405-8.

Kelly, John, Male, Steven and Graham, Drummond. 2004. *Value Management of Construction Projects.* United Kingdom : Blackwell Science Ltd., 2004. 978-0-632-05143-4.

Koch, Richard. 1998. *The 80/20 Priciple: The Secret of Achieving More with Less.* London : Nicholas Brealey Publishing, 1998. 1-85788-167-2 HB.

Kothari, C. R. 2004. *Research Methodology: Methods and Techniques.* 2nd. New Delhi : New Age International (P) Ltd., Publishers, 2004. 978-81-224-2488-1.

Kumar, Ranjit. 2011. *Research Methodology: a step-by-step guide for beginners.* 3rd. California : SAGE Publications Inc., 2011. 978-1-84920-300-5.

Leuderalbert, Ken. 2015. Federal Highway Administration. *Federal Highway Administration Web site.* [Online] December 11, 2015. [Cited: June 28, 2016.] http://www.fhwa.dot.gov/ve/2011/.

Miles, Lawrence D. 1972. *Techniques of Value Analysis and Engineering.* 2nd. USA : McGraw-Hill Book Company, 1972.

Robinson, Michael D. 2013. *An Employer's and Engineer's Guide to the FIDIC Conditions of Contract.* 3rd. s.l. : John Wiley & Sons Ltd., 2013. 978-1-118-38560-9.

Russell, Jeffrey S., et al. 1994. *CONSTRUCTABILITY RELATED TO TQM, VALUE ENGINEERING, AND COST/BENEFITS.* s.l. : ASCE, 1994. Vol. 8. 0887-3828/94/0001-0031.

SAVE International. 2007. *Value Standard and Body of Knowledge.* s.l. : June, 2007.

Simpkins, William J. 2000. *Value Engineering in Government and Private Sector Construction.* Florida : University of Florida, 2000.

Transportation Department, IDAHO. 2011. *Constructability Review Guidelines.* 2011.

Turkey Wakjira. 2011. *Risk Factors Leading to Cost Overrun in Ethiopian Federal Road Construction Projects & its Consequences.* Addis Ababa : Addis Ababa Institute of Technology, Addis Ababa University, 2011. MSc. Thesis.

U.S. General Services Administration. 1992. *Value Engineering Program Guide for Design and Construction: Volume 1- Internal Operations and Management.* s.l. : U.S. General Services Administration, 1992.

Wilson, David C. 2005. *Value Engineering Applications in Transportation: A Synthesis of Highway Practice.* WASHINGTON, D.C. : Transportation Research Board, 2005. 0-309-09756-8/ 0547-5570.

Yogesh, Kumar Singh. 2006. *Fundamentals of RESEARCH METHODOLOGY and STATISTICS.* New Delhi : New Age International (P) Ltd., Publishers, 2006. 978-81-224-2418-8.

Zimmerman, Larry W. and Hart, Glen D. 1982. *VALUE ENGINEERING: A Practical Approach for Owners, Designers and Contractors.* New York : Van Nostrand Reinhold Company Inc., 1982. 0-442-29587-1.

Annex – 1

Study Population

Population: Road Construction Projects currently being administered by the Ethiopian Roads Authority (ERA)

Updated as of 31-Oct-2016

No.	Contract Name	Contractor's name	Consultant's name	Pavement Type	Contract Amount (ETB)	Length (km)	Commence ment Date	Actual cumulative progress to date (%)	Remark
1	Bonga-Felegeselam	CGC Overseas	**DANA & AEC**	**Asphalt**	878,031,840.59	52	1-Apr-13	**52.15**	The Engineer has recommended 117 cal days
2	Woito-Turmi-Omorate-namraputh, Contract 3: Km 120-211 Km (Turmi-Omorate/Namraputh)		**Gondwana Engineering**	**Asphalt**	794,855,085.55	91	29-May-13	**92.70**	Reduction in progress figure against previous is due to revision of contract amount following issuance of variation order
3	Nekempt-Bedele		**Roughton in JV with Beza**	**Asphalt**	1,069,939,846.12	98	22-Feb-12	**99.67**	
4	Menebegna-Shambu-Bako Road Upgrading Project Contract 2: Shambu-Bako		**Katib & Core**	**Asphalt**		60		**0.00**	Under mobilization
5	Bahirdar-Zema River	**Sinohydro**	**Net**	**Asphalt**	1,236,755,640.33	92	11-Oct-13	**62.48**	150 cal days of EoT has been granted to the contractor
6	Bedele metu road upgrading project Lot2, KM 61+000 KM 111+659	**China International Water & Elec. Corp.(CIWEC)**	**LEA International**		700,962,680.08	52	15-Feb-13	**71.36**	The Engineer recommended 282 calendar days and it is under the employers review
7	Konso-Yabelo	**China Tiesiju Civil Eng'g Group**	**Prome Omega**	**Asphalt**	1,191,296,596.13	105	15-Jan-15	**33.50**	
8	Mizan-Dima	**China No. 17 Metallurgical**	**Aarvee/Net**	**Asphalt**	1,223,491,206.61	92	3-Oct-13	**50.76**	Engineer recommended 394 calendar days and ERA has accepted the same and forwarded to the Banks Approval
9	Injibara - Chagni - Pawi Junction	**CCCC**	**Best**	**Asphalt**	2,283,309,548.60	100	12-Jan-13	**92.32**	355 days has been entitled to the contractor amicably

10	Lot 1: Sodo-Omo River	**Hunan-Hunda RBC**	**AEC**	**Asphalt**	1,328,412,050.02	76	2-Jun-15	**10.64**	
11	Bonga-Meyachida Road upgrading Project Contract 2: Felegeselam--Ameya-Chida	**Jiangxi Zhongmei Engineering Company (JZEC)**	**Net**	**Asphalt**	909,633,974.07	57	1-Apr-13	**53.02**	
12	Kombolcha-Bati-Mille, contractI: Kombolcha-Burka		**ICT**	**Asphalt**	1,655,565,399.37	60	5-Sep-13	**91.39**	The Engineer has recommended 114 days
13	Zagora-Gassay	**China Railway 7th Group (CRSG)**	**Yerer Engi JV with White Knight**	**Asphalt**	485,177,003.42	45	25-Jun-14	**77.59**	The Engineer has recommended 329 cal. Days of EoT due to RoW problem and its under the Employers review
14	Zema River-Felege Brihan		**Hamda**	**Asphalt**	1,130,938,771.88	83	10-Jun-15	**18.21**	
15	Lot 2: Omo River-Tercha		**TCDSC**	**Asphalt**	1,674,383,031.77	83	2-Jun-15	**11.56**	
16	Sanja-Keraker	**China Railway 3rd Engineering Group**	**HEC**	**Asphalt**	786,796,666.46	48	17-Mar-14	**85.84**	
17	Gashena-Bilbila		**MCE/Span**	**Asphalt**	1,442,916,047.83	90	12-Feb-14	**53.71**	
18	Chanka Dembidolo Contract 3	**China Highway Group**	**LEA in JV with Unicone**	**Asphalt**	701,394,069.46	65	7-Oct-11	**98.46**	Due to expiry of the contract completion period, the Employer has issued notice to recover delay damage.
19	Hawassa Ageremariyam LOT III, Yirgachefe-Ageremariyam	**The Arab Contractors**	**Beza Consulting**	**Asphalt**	1,015,221,295.68	74	1-Apr-13	**44.67**	156 cal days of EoT has been recommended by the Engineer
20	Bedele metu road upgrading project Lot1, Km 0+000 KM 61+000	**HAWK International**	**Roughton**	**Asphalt**	733,238,354.70	61	22-Apr-13	**56.78**	
21	Gedo-Fincha-Menebegna Road Project, Contract 1: Gedo-Fincha		**Galander Engi Jv Beza Consult**	**Asphalt**	1,142,567,662.24	81	26-Mar-14	**23.32**	The Engineer has recommended 14 working days of EoT
22	Kombolcha-Bati-Mille Road ,Contract II, Buka-Mille	**Shandong**	**ICT**	**Asphalt**	1,335,066,666.10	73	2-Sep-13	**89.91**	the Engineer has recommended 105 days

23	Mobasa-Nairobi-Addis Abeba Lot III: Mega-Moyale	**JMC Project (India) ltd**	**LEA International**	**Asphalt**	1,187,787,072.28	109	2-Sep-13	**88.85**	
24	Bilbila-Sekota	**China First Highway**	**Best**	**Asphalt**	2,042,059,919.33	90	12-Jun-15	**18.71**	
25	Dessie-Kutaber		**Pan Arab /Omega**	**Asphalt**	1,877,782,028.92	68	20-May-14	**59.33**	
26	Ambo-Woliso	**ELSAMEX-ACOASFAL**	**Pan Arab /Omega**	**Asphalt**	1,198,954,124.04	64	9-Mar-15	**11.91**	The Engineer has recommended 14 working days of EoT
27	Albereketi-Gelemso-Mechara,Contract 1:Albereketi-Gelemso	**Al Asab**	**Khatib jv with Alami**	**Asphalt**	1,012,102,686.09	56	25-May-15	**24.37**	
28	Albereketi-Gelemso-Mechara,Contract 2:Gelemso-Mechara-Micheta			**Asphalt**	982,246,411.15	46	16-Nov-15	**10.09**	
29	Gidami-Mugi	**Berehagos GC**	**UNICONE**	**Gravel**	424,157,390.33	91	4-Jun-08	**89.54**	The Engineer has recommended 169 cal days of EoT and it is under the Employers review
30	Arbaminch-Belta		**Net**	**Asphalt**	564,572,728.82	60	12-Apr-10	**83.75**	
31	Aleta-Wondo-Daye	**ALEMAYEHU KETEMA**	**CORE**	**Asphalt**	428,506,133.56	51	5-Sep-08	**90.63**	Engineer's recommendation of 572 cal days of EoT is under the Employer's review
32	Werei Ridge Adwa		**Towers Consultant**	**Asphalt**	604,213,752.69	68	6-Sep-11	**67.24**	148 days of EOT has granted to the contractor
33	Adura-Akobo and Adura-Burbe	**SATCON**	**CORE**	**Gravel**	833,462,865.17	126	16-Mar-09	**64.07**	The new consultant has forwarded his EoT determination and same is under review by ERA
34	Sawla-Laska		**Beza**	**Asphalt**	836,498,342.78	52	21-Sep-11	**82.16**	EOT of 246 cal days is recommended by the engineer and it is under review by the Employer
35	Efeson(Ataye)-MehalMeda	**Yencomad**	**CORE**	**Asphalt**	1,352,642,535.82	60	24-Apr-15	**28.13**	
36	Jaragedo-Zagora-Jibarsa Mariyam-Debretabor		**Classic**	**Asphalt**	1,248,512,271.19	88	29-May-13	**78.53**	129+82 Calendar days of EoT has been granted to the contractor due to adverse climate condition

37	Ankober -Awash Arba Road Upgrading Project Contract 1:Ankober -Dulecha	**Sunshine**	**C-Tech**	**Asphalt**	858,761,475.70	40	17-Mar-16	**10.07**	
38	Kong-Begondi-Wenbera	**ECWC**	**CORE**	**Gravel**	826,169,974.69	67	11-Jan-13	**90.81**	The Engineer has recommended 593 calendar days of EOT which is under the Employers review. The contractor is granted an interim EoT of 21 calendar days
39	Dima-Raad Bridge		**CCD**	**Asphalt**	926,796,267.06	60	16-Mar-15	**21.37**	
40	Ankober -Awash Arba Road Upgrading Project Contract 2:Dulecha-Awash Arba		**DIWI with Engi Zewdie**	**Asphalt**	693,519,819.68	53		**0.00**	Under mobilization
41	Mazoria-Durame-Durgi-Omo Nada, Contract 1: Mazoria-Hadero		**Beza**	**Asphalt**	288,252,845.07	38	26-Aug-15	**53.79**	37 cal days of EoT has been recommended by the Engineer
42	Salayish-Omo	**Akir**	**CORE**	**Asphalt**	855,612,334.62	79	18-Jan-12	**58.49**	174 calendar days of EoT has been approved by the Employer. Further 87 days of interim EoT has been given.in addition EoT claim No 2 & 3 are under employers review
43	Sembo-Gindeber		**CCC/Gondwana/ Rama**	**Asphalt**	522,505,909.49	59	1-Jul-10	**85.17**	
44	Azezo Gorgora	**Gemeshu Beyene GC**	**Classic**	**Asphalt**	730,706,949.39	53	27-Feb-13	**93.37**	98 cal days of EoT has been granted to the contractor due to RoW obstruction
45	Abus- Alemketema		**Core**	**Asphalt**	1,279,347,769.11	48	25-Feb-13	**43.16**	The Contractor has been granted 450 days EoT due to quantity increment
46	Adaba-Angetu	**Macro General Contractor and Trading**	**Net**	**Asphalt**	1,249,684,230.55	102	18-Nov-14	**24.79**	Engineers recommendation of 398 days EoT is under the Employers review which extends the completion date up to December 21,2018
47	Ditchoto-Galafi Junction-Elidehar-Belho	**Defence Construction Enterprise (DCE)**	**Eng.Zewdie**	**Asphalt**	2,663,664,021.75	81	22-Oct-15	**4.88**	
48	Dalol/Musli-Bada		**CDSC**	**Asphalt**	1,251,685,263.89	42	29-Jan-16	**13.36**	

49	Belta-Otolo	**Diriba-Defersha**	**Pure Consult**	**Asphalt**	748,099,415.74	35	12-Sep-11	**78.92**	1050 cal days of EoT has been approved by the Employer
50	Otolo-Sawla	**FAL Trading**	**Robust Consulting**	**Asphalt**	737,964,421.28	59	8-Sep-11	**94.01**	Engineers recommendation of 350 days EoT is under the Employers review
51	Mazoria-Durame-Durgi-Omo Nada, Contract 2: Hadero - Durgi	**Aster Mengistu**	**Beza**	**Asphalt**	321,431,179.90	34	7-Oct-11	**84.28**	Due to delay on ROW obstruction removal and introduction of new median on Mudula town s and the Engineer has recommended 158 cal days of EoT starting from the day obstruction fully removed (i.e 11 Nov 2015)
52	Yalo nehile lot 1	**Bridge construction**	**ICT**	**Gravel**	497,787,857.03	45	9-Feb-13	**83.69**	
53	Yalo nehile lot 2	**Zeluel Yohaness BC**	**ICT**	**Gravel**	333,240,366.63	23	22-Jan-13	**79.58**	progress decreased due to revised project cost
54	Mazoria-Durame-Durgi-Omo: Durgin - Gibe River	**Kiflom Gebrehiwot GC**	**Rama**	**Asphalt**	341,623,093.28	27	29-Apr-13	**70.11**	The Engineer has recommended 158 cal days which is under the Employers review
55	Koka-Adulala	**ASER Construction Plc**	**Net**	**Asphalt**	613,165,000.00	52	9-Mar-15	**43.54**	
56	Contract 1: Aysid-Kong (DB)	**Yemane Germay GC**	**Net**	**Gravel**	602,600,000.00	72	10-Mar-15	**46.71**	

Population: Road construction projects completed between ***2013*** and ***31st October 2016***

No.	Project Name	Pavement type	Contractor's Name	Consultant's Name	Original Contract Amount (ETB)	Length (km)	Actual Contract Amount (ETB)	Commencement date	Original completion date	Actual completion date	Remark (Value Engineering practices/ EOT/ Cost claims/ Variations/ Dispute decisions)
1	**Dedebit - Adiremets**	**Asphalt**	Sur Construction Plc	United Consulting Engineers	801,212,552.61	86	944,079,843.21.70	1-Apr-10	31-Mar-13	12-Aug-14	EOT of 16.4 months (500 calendar days) granted.
2	**Adiremets - Dejena - Dansha**	**Asphalt**	Hunan-Hunda RBC	LEA International Ltd., and CORE Consulting Engineers P.L.C.	926,292,277.49	76	1,189,047,035.43	10-Feb-09	9-Feb-12	16-Jan-14	
3	**Dansha-Abdurafik-Maykadra**	**Asphalt**	Sur Construction Plc	HEC	1,607,687,055.79	119	1,762,084,263.14	24-Dec-13	24-Dec-16	24-Dec-16	Substantially Completed
4	**Maytsebri - Shire**	**Asphalt**	ERCC	Sheladia	747,432,284.82	68	747,432,284.82	1-Oct-09	1-Sep-12	7-Sep-14	
5	**Zarema - Maytsebri**	**Asphalt**	ERCC	Sheladia	912,631,312.54	71	928,865,828.81	1-Oct-09	1-Sep-12	2-Oct-14	761 calendar days of EoT has been granted to the Contractor under various head of claims
6	**Tsegede Junction - Ketemanigus**	**Asphalt**	RAMA	ConAbe Consult PLC	516,442,158.68	23	473,717,943.53	30-Nov-12	29-Nov-14	6-Jun-16	Substantially Completed
7	**Dima - Fiyelwuha**	**DBST**	Gemshu Beyene Constr. Plc	Core Consulting Engineers Plc.	777,078,942.55	86.6	938,065,401.73	31-Aug-11	30-Aug-14	30-Aug-15	365 calendar days of EoT granted to the Contractor due to the increased volume of Earthworks.

8	**Abiadi - Hawzen - Fireweyni**	**Asphalt**	CRTG	Net Consult PLC	874,321,450.10	101	995,767,290.60	23-Feb-12	23-Feb-15	9-May-16	under DLP
9	**Hawsawa - Abala - Ireti**	**Asphalt**	Jiangxi - Zhongmei Eng Co Ltd.	ICT	746,341,435.30	94	1,104,433,162.00	21-Aug-08	20-Feb-12	9-Jan-14	The cost of the project is revised due to increase in quantity of work and change in alignment, 697 calendar days of EoT has been granted to the Contractor.
10	**Mekelle - Seret Village**	**Asphalt**	Defence construction Enterprise	Net	482,679,383.60	65	658,041,659.26	17-Apr-11	22-Apr-14	2-Mar-16	* 543 days of EoT has been approved due to VO. In addition, the Engineer has recommended additional 286 calendar days??? * Substantially completed during end of October 2016.
11	**Semera - Didigsala**	**DBST**	SATCON Construction plc.	Engineer Zewdie Eskinder & Co. plc	328,257,356.71	49.5	370,521,263.80	15-Mar-08	4-Feb-11	4-May-14	Substantially completed on 4th May 2014
12	**Kebridehar - Shilabo**	**DBST**		BEZA Consulting Engineers plc.	530,998,645.36	104	533,579,444.11	14-Apr-08	14-Apr-11	3-Sep-14	Substantially completed on 3rd September 2014
13	**Yalo - Didigsala**	**Gravel**	Terra Construction	Engineer Zewdie Eskinder & Co. plc	132,496,185.40	50	164,496,185.40	1-Jul-08	30-Jun-10	27-May-15	Variations amounting ETB 25,685,643.32 have been issued.
14	**Shekosh - Kebridehar**	**DBST**	ERCC	BEZA Consulting Engineers plc.	291,162,655.91	113.5	291,162,655.91	1-Apr-07	31-Mar-10	2014	
15	**Mekenajo - Ayra**	**Asphalt**	China Highway Group Ltd.	Sheleldia	633,534,840.56	52		7-Oct-11	3-Apr-14	31-Mar-17	

16	**Ayra - Chanka**	**Asphalt**	Chian International Water and Electric Corporation (CIWEC)	Renardet	669,143,993.90	70		7-Oct-11	3-Apr-14	15-Dec-16	
17	**Bonga - Mizan**	**Asphalt**	Keangnam Enterprise Ltd.	ICT in association with ICTE in subconsultancy with Transcom	742,938,845.66	119	1,052,507,574.98	23-Apr-08	22-Feb-11	28-Feb-16	
18	**Jima - Bonga**	**Asphalt**	Keangnam Enterprise Ltd.	LEA International with LASA in JV with Core consulting engineers	686,102,036.19	110	696,809,155.03	21-Apr-08	20-Feb-11	28-Feb-14	
19	**Yabelo - Mega**	**Asphalt**	China Tiesiju Civil Engineering Group Co. Ltd	RENARDET Consulting Engineers	770,007,996.78	98	770,007,996.78	23-Dec-10	22-Dec-13	6-May-14	
20	**Alaba - Alemgebeya - Wulbareg**	**DBST**	Sunshine Construction Plc	United Consulting Engineers	389,838,761.51	68	451,156,689.60	15-Oct-09	14-Apr-12	June 4,2014	
21	**Ageremariam - Yabelo**	**Asphalt**	The Arab Contractors	Gauff		95					
22	**Aposto - Irbamuda**	**Asphalt**	Keangnam Enterprises Ltd	SAI Consulting Engineers Pvt Ltd	660,938,029.00	94	572,591,732.88	28-Apr-09	27-Apr-12	29-Jun-14	
23	**Irbamuda - Wadera**	**Asphalt**	Aydeniz/KMC	Grontmij/ Carl Bro A/S		109					
24	**Wadera - Negelle**	**Asphalt**	China Metallurgical Construction	J Burrow/ Omega		65					
25	**Humbo-Arbaminch Lot-1**	Asphalt	DMC	AEC		75					

26	**Humbo-Arbaminch Lot-2**	Asphalt	DMC	CDSCo with FORTRESS		32					
27	**Sawla-Kako Lot-1**	**Gravel**	Orchid Business Group			23					
28	**Seru-Sheikhusein Lot-1**	**Gravel**	Samson Chernet	Stadia		20					
29	**Seru-Sheikhusein Lot-2**	**Gravel**	Yoseph Teketel	Niche Infrastructure Consulting Engineers Plc.	100,291,415.15	36					
30	**Yabelo - Metagefersa Lot 1**	**Gravel**	Giga Construction	GOGOT		36					
31	**Yabelo - Metagefersa Lot 2**	**Gravel**	Awash Welday	Pure Consult		39					
32	**Yabelo - Metagefersa Lot 3**	**Gravel**	Shed General	Transnational Engineering		30					
33	**Dejen - Lumame**	**Asphalt**	Kajima	Oriental Consultants	836,511,250.00	29	836,511,250.00	24-Apr-12	15-Jun-14	15-Jun-14	
34	**Lumame - Debremarkos**	**Asphalt**	Kajima	Oriental Consultants	1,369,965,423.7 9	39	1,369,965,423.79	24-Sep-13	30-Jun-15	4-Jan-16	
35	**Wolkite - Arekit**	**Asphalt**	CGGC	Comptranl in JV with Beza	717,440,576.41	60	823,954,624.16	7-Oct-11	6-Apr-14	25-Jun-15	
36	**Arekit - Hosaina**	**Asphalt**	HAWK	Comptranl in JV with Beza	618,998,415.32	65.5	662,076,812.35	7-Oct-11	6-Apr-14	9-Jun-15	
37	**Chancho - Derba - Becho**	**Asphalt**	ECWC (ERCC)	Core Consulting Engineers Plc.	553,453,126.00	31	640,522,212.48	26-Jul-12	26-Dec-14	1-Feb-16	
38	**Gindeber - Gobensa**	**TST**	Yencomad	BEST CORE	755,409,675.00	33	814,513,682.47	6-Apr-10	4-Oct-13	12-May-15	
39	**Lot I: Mehalmeda - Abus**	**DBST**	Sunshine Construction Plc	Engineer Zewdie Eskinder & Co. plc	802,248,392.71	70	756,318,930.79	15-Sep-11	1-Mar-16	1-Mar-16	Original completion date was 15 Sep 2014. However, due to Extension of

											Time the completion date was revised to be 1 March 2016.
40	**Contract I: Gedo - Bako**	**Asphalt**	China Highway Group Ltd.	DHV in association with CWCE	354,350,909.00	65	559,239,788.00	12-Oct-10	12-Apr-12	20-Jun-14	Up on granting of EoT, the completion date was revised to be 23 April 2013. However, the Contractor completed June 2014.
41	**Contract II: Bako - Nekemt**	**Asphalt**	China Highway Group Ltd.	Houdal in association with CWCE	391,160,814.07	66	515,173,472.00	12-Oct-10	12-Apr-12	5-Jun-14	After granting of EoT, the contract completion date was revised to be 02 March 2013 but could not be completed.
42	**Menabegna - Lemlem Bereha**	**Asphalt**	Sur Construction Plc	Engineer Zewdie Eskinder & Co. plc	637,283,361.83	70	1,332,577,809.03	22-Dec-10	22-Dec-13	14-Mar-16	

Population: Road Design Projects currently being administered by the Ethiopian Roads Authority (ERA)

Updated as of 31-Oct-16

No	Project Name	Consultants Name	Lengt h (km)	Original Contract Amount (ETB)	Date of Contract			Latest Submitted Deliverable	Remark
					signing date	Commencement Date	Completion date		
1	**Hamusit - Estie**	Bahirdar University	76	4,200,166.70	30-Jan-12	20-Mar-12	21-Dec-13	Draft Tender Document	Substantially Completed
2	**Maytemen - Maygaba - Maytsebry**	GOGOT Consulting Engineers plc	110	7,736,812.98	1-Jul-14	29-Jul-14	29-Jul-15	Final Route selection report	The project is delayed due to the consultation process was not finalized on time. The local administrative bodies need the road to pass along Waldeba Monastery but the Monastery refused the project to pass through the Monastery territory.
3	**Mekaneyesus - Semada - Saint**	Omega	160	7,017,242.50	22-Jul-14	7-Aug-14	7-Aug-15	Draft LAP Report	Except Engineering Cost Estimate and Final Engineering Report and Tender Document all design documents have been delivered
4	**Amba Gowergis - Arba Tsguar - Abiadi Junction.**	Core Consulting	290	13,795,400.00	31-Jul-14	26-Aug-14	26-Aug-15	Consultancy Completion Report	Substantially Completed
5	**Jiga - Quarit - Arebgebey - Sekela - Tilili**	Ethio Infra Eng. Plc. Jv with Omega Consulting Eng. Plc.	125	9,250,600.00	15-Sep-14	12-Nov-14	12-Sep-15	Draft Tender Document	
6	**Wukiro - Abrihaweatsbiha - Abi Adi Junction**	Omega JV with Ethio Infira	120	8,257,051.75	31-Dec-14	2-Feb-15	4-Nov-16	Draft Engineering Design Report and Draft Tender Document	Additional 17.6km design work recently included (Wukro Town 5.3km and from Edagaarbi - Maykenetal 12.3km)
7	**Ketema Nigus -**	Core Consulting	120	5,994,375.00	25-Mar-15	23-Apr-15	23-Sep-16	Draft Material	

	Adi Selam - Maygaba							and Soil Investigation Report	
8	**Debecha - Feresbet - Adiat**	NET	123	7,541,700.00	8-Apr-15	30-Apr-15	30-Apr-16	Engineering Drawing	Additional 21km Bahir Dar - Horticulture access road has been included
9	**Debre markos - Deuga tsion - Mota**	UNICON	123	6,625,555.85	16-Apr-15	1-May-15	1-May-16	Final RAP Report	Except Engineering Cost Estimate, Final Engineering Reprort and Tender Document all design documents have been delivered
10	**Adishehu - Dela - Samri**	IDCON	60	4,635,880.00	20-Oct-15	26-Jan-16	26-Jan-17	Final Route Selection Report	
12	**Gugftu -Tenta**	RDDC	54	6,293,481.48	28-Dec-12	23-Jan-13	23-Jan-14	Final Tender Document	Substantially Completed
13	**Tenta - Gashena**	Yerer Engineering	130	6,532,605.00	31-Dec-12	31-Jan-13	30-Jan-14	Draft Tender Document	The original design scope has been substantially completed but recently new 25km design has been included through a Supplementary agreement
14	**Gelago - Tewodros ketema**	GOGOT Consulting Engineers plc	90	6,130,856.06	25-Jul-14	7-Aug-14	7-Aug-15	Draft Tender Document	Substantially Completed
15	**Wukiro - Atsbi - Koneba**	STADIA	60	5,167,180.00	15-Jan-15	9-Feb-15	9-Feb-16	Draft Tender Document	Substantially Completed
16	**Dela - Chilena - Merewa Tsertsera - Alamata**	GONDOWANA	125	8,516,842.50	30-Mar-15	19-Jun-15	18-Oct-16	Route Selection	
17	**Adiremet - Awra - Dansha**	Abay Engineering Plc	90	5,098,985.00	27-Apr-15	20-May-15	20-May-16	Final EIA Report	
18	**Rama - Chila - Adi Daro - Semema**	Yerer Engineering	60	6,966,355.00	29-Apr-15	4-Jun-15	4-Feb-16	Specific Design Report	
19	**Jikawo - Toha**	Omega Consulting Engineers plc.	95.1	7,829,821.00	28-Apr-15	23-Jun-15	24-Jun-15	Final Route Selection Report	Contract duration 16 months
20	**Tepi - Mizan**	Unicone	47.8	3,736,847.65	27-Feb-15	1-Apr-15	30-Mar-16	Final Bidding Documents	Contract duration 12 months. The project is substantially completed and also forwarded to

									procurement for further action.
21	**Shishinda - Tepi**	Raey	76.5	5,118,081.22	16-May-14	5-Jun-14	5-Jun-15	Draft Bidding Documents	Contract duration 12 months.
23	**Dima –Jeba-Omorate**	Yerer in JV with Icon Engineering	166	7,409,887.92	25-Dec-12	4-Feb-13	28-Feb-15	Draft Tender Documents	Contract duration 10 Months
24	**Kurmuk - Sherkole**	STADIA	50.5	5,299,142.50	13-Jan-15	15-Feb-15	15-Apr-16	Draft Tender Documents	Contract duration 12 Months
25	**Adura - Jikawo**	CORE Consulting Engineers PLC. In JV with WHITEKNIGHT	36		28-Apr-15	12-Jun-15	28-Feb-16	Final Tender Document	Contract duration 8 Months
26	**Abobo Meti Lot 2: Km 76 – Meti (Kubito Mazoria)**	Gondwana Engineering Plc	86	8,465,150.00	22-Aug-15	12-Jun-15	14-Feb-16	Final EIA Report	Contract duration 16 Months
27	**Yaso - Gelesa**	Omega Consulting Engineers plc.	100	6,452,132.50	8-Dec-14	1-Feb-15	7-Apr-16	Draft EIA Report	Contract duration 16 Months
28	**Koncho - Kamash - Soge - Nekempt**	Beza Consulting Engineers plc.	235	11,103,700.00	30-Apr-15	1-Jun-15	4-Aug-17	Draft Route Selection Report	Contract duration 24 Months
29	**Jimma - Agaro - Dedesa**	RDDC in JV with Goggot	76	5,617,606.25	29-Jan-16	29-Feb-16	30-Jun-17	Draft EIA Report	Contract duration 16 Months
30	**Burka-Midagha - Tolla - Harer**	Robust Consulting				14-Apr-14		Final Engineering design Report and Final Resettlement action Plan Report	Contract duration 16 Months
31	**Ali Ethiopia-Deghamedo**	SG Consulting Engineers PLC in Jv with Wide Engineering Consultant PLC	160	8,239,179.60	29-Aug-14	26-Sep-14	26-Mar-16	Final Engineering design Report and Final Resettlement action Plan Report	
32	**Raitu – Shakisa Elkere**	Gondwana Engineering Plc	160	9,478,817.50	10-Oct-14	5-Nov-14	28-Feb-16	Draft Tender Document	

33	**Mesel-Kora-Teru**	SABA Engineering (Uganda) Plc in JV with GOGOT Consulting Engineers Plc	160	11,056,668.39	25-Dec-14	27-Feb-15	27-Jun-16	Feasibility Report	
34	**Wachile - Mega**	AEC	106	4,423,503.62	25-Dec-12	27-Jan-13	16-Jan-14	Consultancy completion report	
35	**Harar-Kombolcha-Ejersagoro-Fugnanbira-Bombas**	Whiteknight Construction Management Consultants Plc.	90	5,973,100.00	7-Feb-14	26-Feb-14	25-Feb-15	Final Engineering design Report and Final Resettlement action Plan Report	
36	**Fik-Segeg-Gerbo-Denan (240 Km)**	Construction Design Share Company (CDSCO) in JV with Arcon Design Build PLC.	240	11,092,066.25	14-Jul-12	30-Sep-14	30-Mar-16	Environmental Assessment Report	Contract duration 16 Months
37	**Filtu-DoloOdo-Dolo Bay**	Civil Works Consulting Engineers plc.	224	10,439,412.50	31-Dec-14	17-Feb-15	17-Oct-16	Final Inception	
38	**Remiti - Burka**	Yerer Engineering Plc in JV with Icon Engineering Plc	226	11,120,160.48	10-Oct-14	1-Nov-14	1-Mar-16	Materials and Site Investigation Report	Contract duration 16 Months
39	**Warder-Kebridehar**	Ethiopian Construction Design & Supervision Works Corporation Building &Urban Design & Supervision Works Sector JV with ARCON Design and Build PLC. in JV with ARCON	140	14,741,563.88	14-Jul-12	15-Oct-15	15-Feb-17	Environmental Assessment Report	Contract duration 16 Months

		Design Build Plc.							
40	**Mehal Meda – Gishe Rabel – Mekoy - MilaMille**	CORE Consulting Engineers P.L.C	130	8,708,375.00	8-Sep-15	12-Oct-15	3-Feb-17	Draft Design Standard Report	Contract duration 16 Months
41	**Guder – Kegna – Delessa – Balami - Gonderaba**	Transnational Engineers Plc.	170	5,932,089.88	7-Feb-14	1-Mar-14	15-May-15	Draft Tender Document	Contract duration 14.5 Months
42	**Kelela-Akesta**	MH Engineering PLC Consulting Engineers & Architects	40.3	4,627,276.61	13-Oct-14	4-Nov-14	4-Nov-15	Draft Tender Document	Contract duration 12 Months
43	**Tarmaber - Molale - Mehalmeda**	MH Engineering PLC Consulting Engineers & Architects	115	5,691,205.85	28-Jan-15	26-Feb-15	26-Feb-16	Draft Engineering Design Report	Contract duration 12 Months
44	**Damashi River (Chiri Town)-Maji-Hana**	C-Tech Engineering plc in JV with Icon Engineering plc.	116	8,151,168.03	31-Aug-15	42,293.00	16-Feb-17	Inception Report and Route Selection	**Contract duration 16 Months. The Contract has been proposed to be terminated due to overlapping and/or missing of control points.**
45	**Kamba - Darmalo - Beto**	Pure Consulting Engineers plc.	40	4,271,387.50	25-Mar-14	16-Oct-15	1-Dec-17	Environmental Assessment Report	Contract duration 12 Months
46	**Jinkka - Tolta - Gelila - Laska**	MH Engineering PLC	132	5,858,611.23	20-Sep-13	11-Nov-13	12-Oct-16	Draft Tender Document	Contract duration 12 Months
47	**Dodola - Kibremengist**	SABA Engineering (Uganda) Plc in JV with GOGOT Consulting Engineers Plc	180	9,367,838.21	25-Dec-14	1-Jan-15	May-17	Final Route Selection	Contract duration 16 Months
48	**Edo-Serofta-Werqa**	VALUE Engineering plc.	70	4,809,300.00	2-Sep-13	8-Oct-13	1-Feb-17	Draft Tender Document	Contract duration 12 Months. The completion date of the project has been extended to February, 2017 owning to the additional services has been issued
49	**Solemo-Shakiso**	Gondwana Engineering Plc	60	5,362,047.50	27-Jan-16	1-Mar-16	Jun-17	Draft Route Selection	Contract duration 16 Months

50	**Adola-Melka Desta-Haranfema**	NET Consult	74.5	6,003,805.00	10-Oct-14	21-Nov-14	1-Nov-17	Draft RAP and Engineering Report	Contract duration 12 Months. The Completion date has been extended to November 2017
51	**Daye- Girga-Melka Desta**	Metaferia Consulting Engineering plc in association with Spice Consulting plc	60	5,834,571.00	30-Jun-14	30-Jul-14	30-Dec-16	Material & Site investigation (Draft) and Specific Design Standard Report	Contract duration 12 Months
52	**Dilla-Bule-Harowacho**	Civil Works Consulting Engineers plc	70	5,302,132.50	30-Sep-15	10-Feb-16	12-Oct-16	Final Inception Report and Route Selection Report	Contract duration 12 Months
53	**Maji-Kibish(Maji-Tum-Tulgit)**	Omega Consulting Engineers plc.	60	5,626,283.00	14-Aug-14	2-Oct-14	16-Jul-16	Draft Bidding Document	Contract duration 12 Months and EOT of 287 days
54	**Morka-Gircha-Chencha**	Metaferia Consulting Engineering plc in JV with Idcon infrastructure Development Consultants plc.	72	2,971,456.25	20-Aug-12	28-Sep-12	30-Nov-16	Draft Tender Document and Engineering Cost Estimate	Original contract duration 7 Months
55	**Ageremariam-Gelana-Derba-Nechsar-Arbaminch**	EDGE Consult Enterprise, Consulting Architects and Engineers	165	4,932,925.00	28-Jul-14	17-Oct-14	Nov-16	Route Selection Report	Contract duration 16 Months
56	**Alaba-Angacha-Wato**	Beles Consulting plc.	51.4	5,173,995.00	18-Jul-14	5-Sep-14	Dec-16	Final Material and site investigation report	Contract duration 12 Months
57	**Hoja Dure - Goro - Kenate**	Acute Engineering PLC	56.72	3,176,300.00	2-Oct-14	5-Nov-14	1-Sep-16	Final Route Selection Report	Contract duration 12 Months

Population: Design Projects Completed between ***2014*** and ***31st October 2016***

No.	Project Name	Consultant's Name	Length (km)	Original Contract Amount (ETB)	Revised Contract Amount (ETB)	Contract Dates				Remark (Under construction / Floated OR any Value Engineering Practices)
						Signing date	Commencement Date	Original Completion date	Actual Completion date	
1	**Guliso - Chaliya - Dilla - Babo - Kondala - Begi**	ELDA Engineering Consultants	173	7,451,511.25	5,556,311.25	16-Sep-13	4-Nov-13	28-Apr-15	27-Oct-16	Not Floated so far
2	**Chida- Sodo**	DANA & Associates Engineering Consultants PLC in Joint Venture with SPICE Consulting Engineers PLC	165	5,985,763.23	6,348,798.25	29-May-12	12-Jun-12		1-Aug-14	The project's actual designed length is 214.72. All three lots are under construction.
3	**Daya - Chiri - Nansebo**	GOGOT Consulting Engineers PLC	72.8	5,483,919.90	5,483,919.90	30-Apr-13	6-Jun-13			
4	**Dri - Masha**	Transnational Engineering	156	3,765,049.69	3,765,049.69	12-Aug-11	17-Sep-11	17-Jul-12	1-Dec-14	Lot 1 (km 0+000 to km 78+000) is currently floated bu not awarded till now.
5	**Aykel - Zufan - Angereb**	Core Consulting	140	6,247,462.50	6,247,462.50	30-Jan-13	14-Mar-13	12-Jan-14	1-Dec-15	
6	**Wachile - Mega**	AEC	106.59	5,123,503.63	5,123,503.63	25-Dec-12	27-Jan-13	27-Jan-14	1-Sep-16	
7	**Negelle - Wachile**	Gondwana Engineering	131	6,041,410.00	6,041,410.00	?	1-Feb-13	1-Feb-14	1-Mar-16	
8	**Babile - Fik**	Gondwana Engineering	129							
9	**Iteya - Robe - Seru**	LEA Associates South Asia Pvt. Ltd. in JV with NET Consulting Engineers Plc	144.3	18,671,313.75	-	28-May-13	17-Jun-13	17-Jun-15	Mar-16	Lot I is under construction
10	**Deggolo - Kelela**	DANA & Associates Consulting Engineers	70	7,102,863.45	-	23-Sep-14	29-Oct-14	29-Oct-15	May-16	Under construction

11	**Jihur - Zemero - Degolo - Guzmzo**	Associated Engineering Consultants (AEC)	136	4,998,079.86	-	6-Jun-12	21-Jun-12	18-Apr-13	Feb-15	
12	**Debrebirhan - Deneba**	NET Consulting Engineers Plc	46	4,648,760.00	-	30-Jul-14	15-Sep-14	15-Sep-15	Jul-16	Construction not yet started
13	**Muketuri - Alem Ketema**	Addis Ababa Science & Technology University	112	3,229,837.50	-	18-Nov-11	9-Dec-11	9-Aug-12	Jun-15	Contract 1 has been awarded to a construction firm.

Annex – 2

Sampling Frame

Sampling Frame: Road Construction Projects currently being administered by the Ethiopian Roads Authority (ERA)

Updated as of 31-Oct-2016

No.	Contract Name	Contractor's name	Consultant's name	Pavement Type	Contract Amount (ETB)	Length (km)	Commence ment Date	Actual cumulative progress to date (%)	Remark
1	Bonga-Felegeselam	**CGC Overseas**	**DANA & AEC**	**Asphalt**	878,031,840.59	52	1-Apr-13	**52.15**	The Engineer has recommended 117 cal days
2	Woito-Turmi-Omorate-namraputh, Contract 3: Km 120-211 Km (Turmi-Omorate/Namraputh)		**Gondwana Engineering**	**Asphalt**	794,855,085.55	91	29-May-13	**92.70**	Reduction in progress figure against previous is due to revision of contract amount following issuance of variation order
3	Nekempt-Bedele		**Roughton in JV with Beza**	**Asphalt**	1,069,939,846.12	98	22-Feb-12	**99.67**	
5	Bahirdar-Zema River	**Sinohydro**	**Net**	**Asphalt**	1,236,755,640.33	92	11-Oct-13	**62.48**	150 cal days of EoT has been granted to the contractor
6	Bedele metu road upgrading project Lot2, KM 61+000 KM 111+659	**China International Water & Elec. Corp.(CIWEC)**	**LEA International**		700,962,680.08	52	15-Feb-13	**71.36**	The Engineer recommended 282 calendar days and it is under the employers review
8	Mizan-Dima	**China No. 17 Metallurgical Construction**	**Aarvee/Net**	**Asphalt**	1,223,491,206.61	92	3-Oct-13	**50.76**	Engineer recommended 394 calendar days and ERA has accepted the same and forwarded to the Banks Approval
9	Injibara - Chagni - Pawi Junction	**CCCC**	**Best**	**Asphalt**	2,283,309,548.60	100	12-Jan-13	**92.32**	355 days has been entitled to the contractor amicably
11	Bonga-Meyachida Road upgrading Project Contract 2: Felegeselam--Ameya-Chida	**Jiangxi Zhongmei Engineering Company (JZEC)**	**Net**	**Asphalt**	909,633,974.07	57	1-Apr-13	**53.02**	
12	Kombolcha-Bati-Mille, contractI: Kombolcha-Burka		**ICT**	**Asphalt**	1,655,565,399.37	60	5-Sep-13	**91.39**	The Engineer has recommended 114 days

13	Zagora-Gassay	**China Railway 7th Group (CRSG)**	**Yerer Engi JV with White Knight**	**Asphalt**	485,177,003.42	45	25-Jun-14	**77.59**	The Engineer has recommended 329 cal. Days of EoT due to RoW problem and its under the Employers review
16	Sanja-Keraker	**China Railway 3rd Engineering Group**	**HEC**	**Asphalt**	786,796,666.46	48	17-Mar-14	**85.84**	
17	Gashena-Bilbila		**MCE/Span**	**Asphalt**	1,442,916,047.83	90	12-Feb-14	**53.71**	
18	Chanka Dembidolo Contract 3	**China Highway Group**	**LEA in JV with Unicone**	**Asphalt**	701,394,069.46	65	7-Oct-11	**98.46**	Due to expiry of the contract completion period, the Employer has issued notice to recover delay damage.
20	Bedele metu road upgrading project Lot1, Km 0+000 KM 61+000	**HAWK International**	**Roughton**	**Asphalt**	733,238,354.70	61	22-Apr-13	**56.78**	
22	Kombolcha-Bati-Mille Road ,Contract II, Buka-Mille	**Shandong**	**ICT**	**Asphalt**	1,335,066,666.10	73	2-Sep-13	**89.91**	the Engineer has recommended 105 days
23	Mobasa-Nairobi-Addis Abeba Lot III: Mega-Moyale	**JMC Project (India) ltd**	**LEA International**	**Asphalt**	1,187,787,072.28	109	2-Sep-13	**88.85**	
25	Dessie-Kutaber	**China First Highway**	**Pan Arab /Omega**	**Asphalt**	1,877,782,028.92	68	20-May-14	**59.33**	
30	Arbaminch-Belta	**Berehagos GC**	**Net**	**Asphalt**	564,572,728.82	60	12-Apr-10	**83.75**	
31	Aleta-Wondo-Daye	**ALEMAYE HU KETEMA**	**CORE**	**Asphalt**	428,506,133.56	51	5-Sep-08	**90.63**	Engineer's recommendation of 572 cal days of EoT is under the Employer's review
32	Werei Ridge Adwa		**Towers Consultant**	**Asphalt**	604,213,752.69	68	6-Sep-11	**67.24**	148 days of EOT has granted to the contractor
34	Sawla-Laska	**SATCON**	**Beza**	**Asphalt**	836,498,342.78	52	21-Sep-11	**82.16**	EOT of 246 cal days is recommended by the engineer and it is under review by the Employer
36	Jaragedo-Zagora-Jibarsa Mariyam-Debretabor	**Yencomad**	**Classic**	**Asphalt**	1,248,512,271.19	88	29-May-13	**78.53**	129+82 Calendar days of EoT has been granted to the contractor due to adverse climate condition

41	Mazoria-Durame-Durgi-Omo Nada, Contract 1: Mazoria-Hadero	**ECWC**	**Beza**	**Asphalt**	288,252,845.07	38	26-Aug-15	**53.79**	37 cal days of EoT has been recommended by the Engineer
42	Salayish-Omo	**Akir**	**CORE**	**Asphalt**	855,612,334.62	79	18-Jan-12	**58.49**	174 calendar days of EoT has been approved by the Employer. Further 87 days of interim EoT has been given.in addition EoT claim No 2 & 3 are under employers review
43	Sembo-Gindeber		**CCC/Gondwana/ Rama**	**Asphalt**	522,505,909.49	59	1-Jul-10	**85.17**	
44	Azezo Gorgora	**Gemeshu Beyene GC**	**Classic**	**Asphalt**	730,706,949.39	53	27-Feb-13	**93.37**	98 cal days of EoT has been granted to the contractor due to RoW obstruction
49	Belta-Otolo	**Diriba-Defersha**	**Pure Consult**	**Asphalt**	748,099,415.74	35	12-Sep-11	**78.92**	1050 cal days of EoT has been approved by the Employer
50	Otolo-Sawla	**FAL Trading**	**Robust Consulting**	**Asphalt**	737,964,421.28	59	8-Sep-11	**94.01**	Engineers recommendation of 350 days EoT is under the Employers review
51	Mazoria-Durame-Durgi-Omo Nada, Contract 2: Hadero - Durgi	**Aster Mengistu**	**Beza**	**Asphalt**	321,431,179.90	34	7-Oct-11	**84.28**	Due to delay on ROW obstruction removal and introduction of new median on Mudula town s and the Engineer has recommended 158 cal days of EoT starting from the day obstruction fully removed (i.e 11 Nov 2015)
54	Mazoria-Durame-Durgi-Omo: Durgin - Gibe River	**Kiflom Gebrehiwot GC**	**Rama**	**Asphalt**	341,623,093.28	27	29-Apr-13	**70.11**	The Engineer has recommended 158 cal days which is under the Employers review

Sampling frame : Road construction projects completed between 31st October *2013* and *31st October 2016*

No.	Project Name	Pavement type	Contractor's Name	Consultant's Name	Original Contract Amount (ETB)	Length (km)	Actual Contract Amount (ETB)	Commence ment date	Original completio n date	Actual completion date	Remark (Value Engineering practices/ EOT/ Cost claims/ Variations/ Dispute decisions)
1	**Dedebit - Adiremets**	**Asphalt**	Sur Construction Plc	United Consulting Engineers	801,212,552 .61	86	944,079,843.2 1.70	1-Apr-10	31-Mar-13	12-Aug-14	EOT of 16.4 months (500 calendar days) granted.
2	**Adiremets - Dejena - Dansha**	**Asphalt**	Hunan-Hunda RBC	LEA International Ltd., and CORE Consulting Engineers P.L.C.	926,292,277 .49	76	1,189,047,035. 43	10-Feb-09	9-Feb-12	16-Jan-14	
3	**Dansha-Abdurafik-Maykadra**	**Asphalt**	Sur Construction Plc	HEC	1,607,687,0 55.79	119	1,762,084,263. 14	24-Dec-13	24-Dec-16	24-Dec-16	Substantially Completed
4	**Maytsebri - Shire**	**Asphalt**	ERCC	Sheladia	747,432,284 .82	68	747,432,284.8 2	1-Oct-09	1-Sep-12	7-Sep-14	
5	**Zarema - Maytsebri**	**Asphalt**	ERCC	Sheladia	912,631,312 .54	71	928,865,828.8 1	1-Oct-09	1-Sep-12	2-Oct-14	761 calendar days of EoT has been granted to the Contractor under various head of claims
6	**Tsegede Junction - Ketemanigus**	**Asphalt**	RAMA	ConAbe Consult PLC	516,442,158 .68	23	473,717,943.5 3	30-Nov-12	29-Nov-14	6-Jun-16	Substantially Completed
8	**Abiadi - Hawzen - Fireweyni**	**Asphalt**	CRTG	Net Consult PLC	874,321,450 .10	101	995,767,290.6 0	23-Feb-12	23-Feb-15	9-May-16	under DLP
9	**Hawsawa - Abala - Ireti**	**Asphalt**	Jiangxi - Zhongmei Eng Co Ltd.	ICT	746,341,435 .30	94	1,104,433,162. 00	21-Aug-08	20-Feb-12	9-Jan-14	The cost of the project is revised due to increase in quantity of work and change in alignment, 697 calendar days of EoT has been granted to the Contractor.

10	**Mekelle - Seret Village**	**Asphalt**	Defence construction Enterprise	Net	482,679,383.60	65	658,041,659.26	17-Apr-11	22-Apr-14	2-Mar-16	* 543 days of EoT has been approved due to VO. In addition, the Engineer has recommended additional 286 calendar days??? * Substantially completed during end of October 2016.
15	**Mekenajo - Ayra**	**Asphalt**	China Highway Group Ltd.	Sheleldia	633,534,840.56	52		7-Oct-11	3-Apr-14	31-Mar-17	
16	**Ayra - Chanka**	**Asphalt**	Chian International Water and Electric Corporation (CIWEC)	Renardet	669,143,993.90	70		7-Oct-11	3-Apr-14	15-Dec-16	
17	**Bonga - Mizan**	**Asphalt**	Keangnam Enterprise Ltd.	ICT in association with ICTE in subconsultancy with Transcom	742,938,845.66	119	1,052,507,574.98	23-Apr-08	22-Feb-11	28-Feb-16	
18	**Jima - Bonga**	**Asphalt**	Keangnam Enterprise Ltd.	LEA International with LASA in JV with Core consulting engineers	686,102,036.19	110	696,809,155.03	21-Apr-08	20-Feb-11	28-Feb-14	
19	**Yabelo - Mega**	**Asphalt**	China Tiesiju Civil Engineering Group Co. Ltd	RENARDET Consulting Engineers	770,007,996.78	98	770,007,996.78	23-Dec-10	22-Dec-13	6-May-14	

21	**Ageremariam - Yabelo**	**Asphalt**	The Arab Contractors	Gauff		95					
22	**Aposto - Irbamuda**	**Asphalt**	Keangnam Enterprises Ltd	SAI Consulting Engineers Pvt Ltd	660,938,029.00	94	572,591,732.88	28-Apr-09	27-Apr-12	29-Jun-14	
23	**Irbamuda - Wadera**	**Asphalt**	Aydeniz/KMC	Grontmij/ Carl Bro A/S		109					
24	**Wadera - Negelle**	**Asphalt**	China No. 17 Metallurgical Construction	J Burrow/ Omega		65					
25	**Humbo - Arbaminch (Lot 1)**	**Asphalt**	DMC	AEC		75					
26	**Humbo - Arbaminch (Lot 2)**	**Asphalt**	DMC	CDSCo with FORTRESS		32					
33	**Dejen - Lumame**	**Asphalt**	Kajima	Oriental Consultants	836,511,250.00	29	836,511,250.00	24-Apr-12	15-Jun-14	15-Jun-14	
34	**Lumame - Debremarkos**	**Asphalt**	Kajima	Oriental Consultants	1,369,965,423.79	39	1,369,965,423.79	24-Sep-13	30-Jun-15	4-Jan-16	
35	**Wolkite - Arekit**	**Asphalt**	CGGC	Comptranl in JV with Beza	717,440,576.41	60	823,954,624.16	7-Oct-11	6-Apr-14	25-Jun-15	
36	**Arekit - Hosaina**	**Asphalt**	HAWK	Comptranl in JV with Beza	618,998,415.32	65.5	662,076,812.35	7-Oct-11	6-Apr-14	9-Jun-15	
37	**Chancho - Derba - Becho**	**Asphalt**	ECWC (ERCC)	Core Consulting Engineers Plc.	553,453,126.00	31	640,522,212.48	26-Jul-12	26-Dec-14	1-Feb-16	
40	**Contract I: Gedo - Bako**	**Asphalt**	China Highway Group Ltd.	DHV in association with CWCE	354,350,909.00	65	559,239,788.00	12-Oct-10	12-Apr-12	20-Jun-14	Up on granting of EoT, the completion date was revised to be 23 April 2013. However, the Contractor completed

											June 2014.
41	**Contract II: Bako - Nekemt**	**Asphalt**	China Highway Group Ltd.	Houdal in association with CWCE	391,160,814 .07	66	515,173,472.0 0	12-Oct-10	12-Apr-12	5-Jun-14	After granting of EoT, the contract completion date was revised to be 02 March 2013 but could not be completed.
42	**Menabegna - Lemlem Bereha**	**Asphalt**	Sur Construction Plc	Engineer Zewdie Eskinder & Co. plc	637,283,361 .83	70	1,332,577,809. 03	22-Dec-10	22-Dec-13	14-Mar-16	

Sampling frame: Road Design Projects currently being administered by the Ethiopian Roads Authority (ERA)

Updated as of 31-Oct-16

No	Project Name	Consultants Name	Length (km)	Original Contract Amount (ETB)	Date of Contract			Latest Submitted Deliverable	Remark
					Signing date	Commence ment Date	Completion date		
1	**Hamusit - Estie**	Bahirdar University	76	4,200,166.70	30-Jan-12	20-Mar-12	21-Dec-13	Draft Tender Document	Substantially Completed
3	**Mekaneyesus - Semada - Saint**	Omega	160	7,017,242.50	22-Jul-14	7-Aug-14	7-Aug-15	Draft LAP Report	Except Engineering Cost Estimate and Final Engineering Report and Tender Document all design documents have been delivered
4	**Amba Gowergis - Arba Tsguar - Abiadi Junction.**	Core Consulting	290	13,795,400.00	31-Jul-14	26-Aug-14	26-Aug-15	Consultancy Completion Report	Substantially Completed
5	**Jiga - Quarit - Arebgebey - Sekela - Tilili**	Ethio Infra Eng. Plc. Jv with Omega Consulting Eng. Plc.	125	9,250,600.00	15-Sep-14	12-Nov-14	12-Sep-15	Draft Tender Document	
8	**Debecha - Feresbet - Adiat**	NET	123	7,541,700.00	8-Apr-15	30-Apr-15	30-Apr-16	Engineering Drawing	Additional 21km Bahir Dar - Horticulture access road has been included
9	**Debre markos - Deuga tsion - Mota**	UNICON	123	6,625,555.85	16-Apr-15	1-May-15	1-May-16	Final RAP Report	Except Engineering Cost Estimate, Final Engineering Report and Tender Document all design documents have been delivered
12	**Gugftu -Tenta**	RDDC	54	6,293,481.48	28-Dec-12	23-Jan-13	23-Jan-14	Final Tender Document	Substantially Completed
13	**Tenta - Gashena**	Yerer Engineering	130	6,532,605.00	31-Dec-12	31-Jan-13	30-Jan-14	Draft Tender Document	The orginal design scope has been substentialy completed but recently new 25km design has been included through a Supplymentary

									agreement
14	**Gelago - Tewodros ketema**	GOGOT Consulting Engineers plc	90	6,130,856.06	25-Jul-14	7-Aug-14	7-Aug-15	Draft Tender Document	Substantially Completed
15	**Wukiro - Atsbi - Koneba**	STADIA	60	5,167,180.00	15-Jan-15	9-Feb-15	9-Feb-16	Draft Tender Document	Substantially Completed
20	**Tepi - Mizan**	Unicone	47.8	3,736,847.65	27-Feb-15	1-Apr-15	30-Mar-16	Final Bidding Documents	Contract duration 12 months. The project is substantially completed and also forwarded to procurement for further action.
21	**Shishinda - Tepi**	Raey	76.5	5,118,081.22	16-May-14	5-Jun-14	5-Jun-15	Draft Bidding Documents	Contract duration 12 months.
23	**Dima –Jeba- Omorate**	Yerer in JV with Icon Engineering	166	7,409,887.92	25-Dec-12	4-Feb-13	28-Feb-15	Draft Tender Documents	Contract duration 10 Months
24	**Kurmuk - Sherkole**	STADIA	50.5	5,299,142.50	13-Jan-15	15-Feb-15	15-Apr-16	Draft Tender Documents	Contract duration 12 Months
25	**Adura - Jikawo**	CORE Consulting Engineers PLC. In JV with WHITEKNIGHT	36		28-Apr-15	12-Jun-15	28-Feb-16	Final Tender Document	Contract duration 8 Months
30	**Burka-Midagha -Tolla - Harer**	Robust Consulting				14-Apr-14		Final Engineering design Report and Final Resettlement action Plan Report	Contract duration 16 Months
31	**Ali Ethiopia-Deghamedo**	SG Consulting Engineers PLC in Jv with Wide Engineering Consultant PLC	160	8,239,179.60	29-Aug-14	26-Sep-14	26-Mar-16	Final Engineering design Report and Final Resettlement action Plan Report	
32	**Raitu – Shakisa Elkere**	Gondwana Engineering Plc	160	9,478,817.50	10-Oct-14	5-Nov-14	28-Feb-16	Draft Tender Document	
34	**Wachile - Mega**	AEC	106	4,423,503.62	25-Dec-12	27-Jan-13	16-Jan-14	Consultancy completion report	

35	**Harar-Kombolcha-Ejersagoro-Fugnanbira-Bombas**	Whiteknight Construction Management Consultants Plc.	90	5,973,100.00	7-Feb-14	26-Feb-14	25-Feb-15	Final Engineering design Report and Final Resettlement action Plan Report	
41	**Guder – Kegna – Delessa – Balami - Gonderaba**	Transnational Engineers Plc.	170	5,932,089.88	7-Feb-14	1-Mar-14	15-May-15	Draft Tender Document	Contract duration 14.5 Months
42	**Kelela-Akesta**	MH Engineering PLC Consulting Engineers & Architects	40.3	4,627,276.61	13-Oct-14	4-Nov-14	4-Nov-15	Draft Tender Document	Contract duration 12 Months
46	**Jinkka - Tolta - Gelila - Laska**	MH Engineering PLC	132	5,858,611.23	20-Sep-13	11-Nov-13	12-Oct-16	Draft Tender Document	Contract duration 12 Months
48	**Edo-Serofta-Werqa**	VALUE Engineering plc.	70	4,809,300.00	2-Sep-13	8-Oct-13	1-Feb-17	Draft Tender Document	Contract duration 12 Months. The completion date of the project has been extended to February, 2017 owning to the additional services has been issued
53	**Maji-Kibish(Maji-Tum-Tulgit)**	Omega Consulting Engineers plc.	60	5,626,283.00	14-Aug-14	2-Oct-14	16-Jul-16	Draft Bidding Document	Contract duration 12 Months and EOT of 287 days
54	**Morka-Gircha-Chencha**	Metaferia Consulting Engineering plc in JV with Idcon infrastructure Development Consultants plc.	72	2,971,456.25	20-Aug-12	28-Sep-12	30-Nov-16	Draft Tender Document and Engineering Cost Estimate	Original contract duration 7 Months

Sampling frame: Design Projects Completed between *2014* and *31st October 2016*

No.	Project Name	Consultant's Name	Length (km)	Original Contract Amount (ETB)	Revised Contract Amount (ETB)	Contract Dates				Remark (Under construction / Floated OR any Value Engineering Practices)
						Signing date	Commence ment Date	Original Completion date	Actual Completio n date	
1	**Guliso - Chaliya - Dilla - Babo - Kondala - Begi**	ELDA Engineering Consultants	173	7,451,511.25	5,556,311.25	16-Sep-13	4-Nov-13	28-Apr-15	27-Oct-16	Not Floated so far
4	**Daya - Chiri - Nansebo**	GOGOT Consulting Engineers PLC	72.8	5,483,919.90	5,483,919.90	30-Apr-13	6-Jun-13			
5	**Dri - Masha**	Transnational Engineering	156	3,765,049.69	3,765,049.69	12-Aug-11	17-Sep-11	17-Jul-12	1-Dec-14	Lot 1 (km 0 to 78) is currently floated but not awarded till now.
6	**Aykel - Zufan - Angereb**	Core Consulting	140	6,247,462.50	6,247,462.50	30-Jan-13	14-Mar-13	12-Jan-14	1-Dec-15	
7	**Wachile - Mega**	AEC	106.59	5,123,503.63	5,123,503.63	25-Dec-12	27-Jan-13	27-Jan-14	1-Sep-16	
8	**Negelle - Wachile**	Gondwana Engineering	131	6,041,410.00	6,041,410.00		1-Feb-13	1-Feb-14	1-Mar-16	
9	**Babile - Fik**	Gondwana Engineering	129							
10	**Iteya - Robe - Seru**	LEA Associates South Asia Pvt. Ltd. in JV with NET Consulting Engineers Plc	144.3	18,671,313.75	-	28-May-13	17-Jun-13	17-Jun-15	Mar-16	Lot I is under construction
11	**Deggolo - Kelela**	DANA & Associates Consulting Engineers	70	7,102,863.45	-	23-Sep-14	29-Oct-14	29-Oct-15	May-16	Under construction
12	**Jihur - Zemero - Degolo - Guzmzo**	Associated Engineering Consultants (AEC)	136	4,998,079.86	-	6-Jun-12	21-Jun-12	18-Apr-13	Feb-15	
13	**Debrebirhan - Deneba**	NET Consulting Engineers Plc	46	4,648,760.00	-	30-Jul-14	15-Sep-14	15-Sep-15	Jul-16	Construction not yet started
14	**Muketuri - Alem Ketema**	Addis Ababa Science & Technology University	112	3,229,837.50	-	18-Nov-11	9-Dec-11	9-Aug-12	Jun-15	Contract 1 has been awarded to a construction firm.

Sampling frame: Construction and Consulting Firms

Ongoing and Completed Construction

No.	Name of Construction Firm	No of Applicable Projects
1	Akir	2
2	ALEMAYEHU KETEMA	2
3	Aster Mengistu	1
4	Aydeniz/KMC	1
5	Berehagos GC	1
6	CCCC	1
7	CGC Overseas	3
8	CGGC	1
9	Chian International Water and Electric Corporation (CIWEC)	2
10	China First Highway	1
11	China Highway Group Ltd.	4
12	China No. 17 Metallurgical Construction	2
13	China Railway 3rd Engineering Group	3
14	China Railway 7th Group (CRSG)	1
15	China Tiesiju Civil Engineering Group Co. Ltd	1
16	Defence construction Enterprise	1
17	Diriba-Defersha	1
18	DMC	2
19	ECWC/ERCC	4

Ongoing and Completed Supervision

No.	Name of Supervision Consultants	No of Applicable Projects
1	Aarvee	1
2	Associated Engineering Consultants (AEC)	2
3	Best	1
4	Beza	6
5	CCC	1
6	CDSCo	1
7	Classic	2
8	Comptranl	2
9	ConAbe Consult PLC	1
10	CORE Consulting Engineers P.L.C.	5
11	CWCE	2
12	DANA	1
13	DHV	1
14	Engineer Zewdie Eskinder & Co. plc	1
15	FORTRESS	1
16	Gauff	1
17	Gondwana Engineering	2
18	Grontmij/ Carl Bro A/S	1
19	HEC	2

Ongoing and Completed Design

No.	Name of Design Consultants	No of Applicable Projects
1	Addis Ababa Science & Technology University	1
2	Associated Engineering Consultants (AEC)	3
3	Bahirdar University	1
4	Core Consulting	3
5	DANA & Associates Consulting Engineers	1
6	ELDA Engineering Consultants	1
7	Ethio Infra Eng. Plc.	1
8	GOGOT Consulting Engineers PLC	2
9	Gondwana Engineering Plc	3
10	Icon Engineering	1
11	IDCON infrastructure Development Consultants plc.	1
12	LEA Associates South Asia Pvt. Ltd.	1
13	MH Engineering PLC Consulting Engineers & Architects	3
14	NET Consulting Engineers Plc	3
15	Omega	3
16	Raey	1
17	RDDC	1
18	Robust Consulting	1
19	SG Consulting Engineers PLC	1

20	FAL Trading	1
21	Gemeshu Beyene GC	1
22	HAWK International	2
23	Hunan-Hunda RBC	1
24	Jiangxi Zhongmei Engineering Company (JZEC)	3
25	JMC Project (India) Ltd	1
26	Kajima	2
27	Keangnam Enterprise Ltd.	3
28	Kiflom Gebrehiwot GC	1
29	RAMA	1
30	SATCON	1
31	Shandong	1
32	Sinohydro	1
33	Sur Construction Plc	3
34	The Arab Contractors	1
35	Yencomad	1

20	Houdal	1
21	ICT	4
22	J Burrow	1
23	LEA International Ltd	5
24	Metaferia Consulting Engineering	1
25	Net Consult Consulting Engineers PLC	6
26	Omega	2
27	Oriental Consultants	2
28	Pan Arab	1
29	Pure Consult	1
30	Rama	2
31	RENARDET Consulting Engineers	2
32	Robust Consulting	1
33	Roughton	2
34	SAI Consulting Engineers Pvt Ltd	1
35	Sheladia	3
36	Span	1
37	Towers Consultant	1
38	Transcom	1
39	Unicone	1
40	United Consulting Engineers	1
41	White Knight	1
42	Yerer	1

20	STADIA	2
21	Transnational Engineers Plc.	2
22	UNICON	2
23	VALUE Engineering plc.	1
24	Whiteknight Construction Management Consultants Plc.	2
25	Wide Engineering Consultant PLC	1
26	Yerer Engineering	2

Annex – 3

Selected Study Units

Randomly Selected Road Construction Projects

S.N.	Construction Project Name
1	Adiremets - Dejena - Dansha
2	Mobasa-Nairobi-Addis Abeba Lot III: Mega-Moyale
3	Chanka Dembidolo Contract 3
4	Sanja-Keraker
5	Contract I: Gedo - Bako
6	Bedele metu road upgrading project Lot2, KM 61+000 KM 111+659

Randomly Selected Road Design Projects

S.N.	Design Project Name
1	Adura - Jikawo
2	Mekaneyesus - Semada - Saint
3	Iteya - Robe - Seru
4	Morka-Gircha-Chencha
5	Edo-Serofta-Werqa
6	Muketuri - Alem Ketema

Selected Construction and Consulting Firms

Ongoing and Completed Construction

S.No.	Name of Construction Firm	No of Applicable Projects
1	Akir	2
2	ALEMAYEHU KETEMA	2
3	Aster Mengistu	1
4	Aydeniz/KMC	1
5	Berehagos GC	1
6	CCCC	1
7	CGC Overseas	3
8	CGGC	1
9	Chian International Water and Electric Corporation (CIWEC)	2
10	China First Highway	1
11	China Highway Group Ltd.	4
12	China No. 17 Metallurgical Construction	2
13	China Railway 3rd Engineering Group	3
14	China Railway 7th Group (CRSG)	1
15	China Tiesiju Civil Engineering Group Co. Ltd	1
16	Defence construction Enterprise	1
17	Diriba-Defersha	1
18	DMC	2
19	ECWC/ERCC	4

Ongoing and Completed Supervision

S.No.	Name of Supervision Consultants	No of Applicable Projects
1	Aarvee	1
2	Associated Engineering Consultants (AEC)	2
3	Best	1
4	Beza	6
5	CCC	1
6	CDSCo	1
7	Classic	2
8	Comptranl	2
9	ConAbe Consult PLC	1
10	CORE Consulting Engineers P.L.C.	5
11	CWCE	2
12	DANA	1
13	DHV	1
14	Engineer Zewdie Eskinder & Co. plc	1
15	FORTRESS	1
16	Gauff	1
17	Gondwana Engineering	2
18	Grontmij/ Carl Bro A/S	1
19	HEC	2

Ongoing and Completed Design

S.No.	Name of Design Consultants	No of Applicable Projects
1	Addis Ababa Science & Technology University	1
2	Associated Engineering Consultants (AEC)	3
3	Bahirdar University	1
4	Core Consulting	3
5	DANA & Associates Consulting Engineers	1
6	ELDA Engineering Consultants	1
7	Ethio Infra Eng. Plc.	1
8	GOGOT Consulting Engineers PLC	2
9	Gondwana Engineering Plc	3
10	Icon Engineering	1
11	IDCON infrastructure Development Consultants plc.	1
12	LEA Associates South Asia Pvt. Ltd.	1
13	MH Engineering PLC Consulting Engineers & Architects	3
14	NET Consulting Engineers Plc	3
15	Omega	3
16	Raey	1
17	RDDC	1
18	Robust Consulting	1
19	SG Consulting Engineers PLC	1

20	FAL Trading	1
21	Gemeshu Beyene GC	1
22	HAWK International	2
23	Hunan-Hunda RBC	1
24	Jiangxi Zhongmei Engineering Company (JZEC)	3
25	JMC Project (India) Ltd	1
26	Kajima	2
27	Keangnam Enterprise Ltd.	3
28	Kiflom Gebrehiwot GC	1
29	RAMA	1
30	SATCON	1
31	Shandong	1
32	Sinohydro	1
33	Sur Construction Plc	3
34	The Arab Contractors	1
35	Yencomad	1

20	Houdal	1
21	ICT	4
22	J Burrow	1
23	LEA International Ltd	5
24	Metaferia Consulting Engineering	1
25	Net Consult Consulting Engineers PLC	6
26	Omega	2
27	Oriental Consultants	2
28	Pan Arab	1
29	Pure Consult	1
30	Rama	2
31	RENARDET Consulting Engineers	2
32	Robust Consulting	1
33	Roughton	2
34	SAI Consulting Engineers Pvt Ltd	1
35	Sheladia	3
36	Span	1
37	Towers Consultant	1
38	Transcom	1
39	Unicone	1
40	United Consulting Engineers	1
41	White Knight	1
42	Yerer	1

20	STADIA	2
21	Transnational Engineers Plc.	2
22	UNICON	2
23	VALUE Engineering plc.	1
24	Whiteknight Construction Management Consultants Plc.	2
25	Wide Engineering Consultant PLC	1
26	Yerer Engineering	2

Summary of Selected Firms

Description	No. of selected firms
Ongoing and Completed Construction	14
Ongoing and Completed Supervision	17
Ongoing and Completed Design	12
Overlapping firms (i.e. Design & Supervision)	-5
Total	**38**

Annex – 4

Questionnaire

Addis Ababa University (AAU)
Addis Ababa Institute of Technology (AAiT)
School of Civil and Environmental Engineering
MSc program in Construction Technology and Management

Questionnaire

Dear Respondent,

I am currently undertaking a Master of Science (MSc) degree in Construction Technology and Management at Addis Ababa Institute of Technology (AAiT). By responding to this questionnaire, your will help me realize my final thesis work on the subject "***The Impacts of Value Engineering practices in Ethiopian federal road projects***".

Value engineering is a non-specific term applied to any exercise to find out possible savings, economies and better 'value for money' by investigating alternative designs, construction processes, ways of planning and meeting risks, etc. for a proposed project. It is an effective technique for reducing costs, increasing productivity and improving quality.

The survey aims at understanding the costs that contractors and consultants may incur from applying Value Engineering study under the current scenario and the possible incentives to promote Value Engineering in the Ethiopian federal road projects.

This questionnaire has four (04) parts and it takes on average 10 minutes of your time. Please read each question or statement carefully and try to answer all questions honestly and to your best knowledge. Your answers will be treated confidentially and only for academic purpose. I greatly appreciate your cooperation and contribution to the success of this study by genuinely participating in this questionnaire.

Thank you,

Dawit Belay
Post Graduate Student (Construction Technology and Management)
School of Civil and Environmental Engineering
Addis Ababa Institute of Technology
Addis Ababa University

<u>Part – I</u>: *Respondent's Information*

1.1. Company Name (Optional): ____________________________________

1.2. Type of your organization

☐ Client (ERA) ☐ Domestic Construction firm

☐ Domestic Consulting firm ☐ Foreign Construction firm

☐ Foreign Consulting firm

1.3. Your position: ______________________________

1.4. Your level of education

☐ BSc degree ☐ MSC degree ☐ PhD degree

1.5. Years of experience of the respondent

☐ < 5 years ☐ 6 to 10 years ☐ 10 to 20 years ☐ > 20 years

1.6. In how many projects have you been involved **for more than 6 months**?

☐ < 5 projects ☐ 6 to 10 projects ☐ > 10 projects

<u>Part – II</u>: *Awareness of Value Engineering*

2.1. Have you been engaged in a road project with value engineering related practices that reduce cost and improve quality/productivity simultaneously?

☐ Yes ☐ No

2.2. If the answer to Question 2.1 is "Yes", could you mention which project/s?

i. _

ii. _

iii. _

iv. _

2.3. Among the following FIDIC versions, with which one are you familiar? *(circle one)*

A. MDB Harmonized edition B. 4th edition 1987 C. both versions

2.4. If your answer for Question 2.3 is "A" or "C", did the Contractor proposed Value Engineering recommendations as per clause 13.2. of the MDB Harmonized edition?

☐ Yes ☐ No

2.5. If your answer for Question 2.4 is "Yes", were the value engineering proposals approved by the client?

☐ Yes ☐ No

2.6. Do you think value engineering can contribute to minimize the growing cost overrun, delay and durability problems in road projects?

☐ Yes ☐ No ☐ May be

<u>Part-III</u>: *Value Engineering study*

3.1. Have you ever participated in Value Engineering training?

☐ Yes ☐ No ☐ Don't Know

3.2. If your answer for Question 3.1 is "Yes", who was the hosting firm of the value engineering training?

i. _

ii. _

iii. _

iv. _

3.1. Does your company have a formal policy/ program on Value Engineering study?

☐ Yes ☐ No ☐ Don't Know

3.2. Does your company have a plan/strategy to apply Value Engineering study in road projects and improve value for money spent?

☐ Yes ☐ No ☐ Don't Know

3.3. What benefits do you think your company will get from applying Value Engineering in road projects **under the current scenario**?

- ☐ Savings in time, cost and energy
- ☐ Reputation as a cost-conscious supplier
- ☐ Expedited decision making
- ☐ Secure a price advantage during procurement of similar projects
- ☐ Additional income (sharing savings from Value Engineering implementation with the Employer)
- ☐ Other, please specify: ____

____

____

3.4. What costs do you think your company will incur from applying Value Engineering in road projects **under the current scenario**?

- ☐ Extra manpower wage
- ☐ Extra equipment cost
- ☐ Additional Overhead costs
- ☐ Other, please specify: ____

____

____

Part-IV: ***Promoting Value Engineering***

4.1. What do you think will significantly promote Value Engineering in the road construction industry? (*Please indicate the degree of significance by marking √ under each preference. 0 = No significance, 1 = Minor significance, 2 = Average significance, 3 = High significance & 4 = Extreme significance*)

	0	1	2	3	4
Acknowledging/awarding good achievements of value engineering related tasks					
Formulating a policy/statutory requirement (*to enforce projects with a certain limit of Engineer's estimate to undergo Value Engineering study*)					
Including Value Engineering Incentive Clauses in contracts (*to enable the contractor propose alternatives and share the savings*)					
Including Value Engineering in curriculums of concerned academic institutions					
Preparing seminars and workshops *via* professional associations (*e.g. Ethiopian Civil Engineers Association*)					

4.2. Who do you think can benefit much from applying Value Engineering in federal road projects? (*Please indicate the degree of benefit by marking √ under each preference. 0 = No benefit, 1 = Less benefit, 2 = Average benefit, 3 = High benefit & 4 = Extreme benefit*)

	0	1	2	3	4
Client (Ethiopian Roads Authority)					
End users (the Public)					
Construction firms					
Consulting firms					
Suppliers					

Thanks you for your assistance and cooperation

I look forward to receiving your input at the soonest possible time