Addis Ababa University

Addis Ababa Institute of Technology

School Civil & Environmental Engineering

Impact of Design Cost On performance of DBB Road projects: In the case of Ethiopian Federal Roads

By: Seyoum Admasu Seifu

A Thesis Submitted to School of Civil and Environmental Engineering in Partial Fulfillment of Requirements for the Degree of Masters of Science In Civil Engineering (Construction Technology and Management Stream)

Advisor: Dr. Abraham Assefa

October,2020

Addis Ababa University

Addis Ababa Institute of Technology

School Civil & Environmental Engineering

Impact of Design Cost On performance of DBB Road projects: In the case of Ethiopian Federal Roads

By: Seyoum Admasu Seifu

Approved By Board of Examiners:

Dr. Abraham Assefa (Advisor)	_____ Signature	_____ Date
Professor Abebe Dinku (Dr.-Ing) (Internal Examiner)	_____ Signature	_____ Date
Dr. Biruktawit Taye (External Examiner)	_____ Signature	_____ Date
_____ Chairman	_____ Signature	_____ Date

October, 2020

DECLARATION

I, the under signed declare that this thesis work is my original work and has not been presented for degree in other university. All sources of materials used have been duly acknowledged.

Name: Seyoun Admasu Seifu

Signature_____

Addis Ababa University, School of Graduate Studies, Addis Ababa Institute of Technology, Department of Civil & Environmental Engineering(Construction Technology and Management)

Date, October,2020

DEDICATION

This research is dedicated to my uncle Abate Bekele whose death is itching my heart

ACKNOWLEDGEMENT

First of all I would like to thank almighty GOD, who gave me inspiration and strength to start and complete this thesis work. Hadn't been his invaluable help even the possible would be impossible. Then I would like to express my sincere appreciation and gratitude to my advisor, Dr.Abraham Assefa for his invaluable guidance, kindness, support, and encouragement throughout the course of my research work. I would appreciate his cooperation in sharing his experience and kindness in treating his student and advisee.

Furthermore, I give my special thanks to ERA for sponsoring and funding to conduct research work and to AAiT, Addis Ababa University, for their collaborative effort to provide master's program.

I would also like to thank all people and organizations and firms who supported and provide me the required data to conduct this study. I give my special thanks to ERA Design management team leader to Engineer Delelegn and north region directorate team leader Engineer Gizachew for their valuable support in providing me data for the research work.

Last not least I would thank my beloved wife Meron G/Medhin for her invaluable encouragement and cooperation through this thesis work, and for all of my life.

- Besides gaining knowledge thorough formal education , what I learned during the post graduate program study is that distance won't matter, what matters is commitment, because I was regularly traveling 47 km to attend morning class at 9.00A.M. I always trust in almighty GOD because everything is possible for him.

Abstract

Design cost is one of the main factors which affects design and project performance; in terms of cost, time and quality. The main objectives of the study was to identify and assess factors affecting design cost and to assess the impact of design cost on design and project performance taking DBB road projects in the case of Ethiopian federal roads. The study had important implication in addressing the impact of design cost on project performance. Seven factors affecting design cost of highway projects have been identified. Among these factors: consultant related factors, market condition related and consultant selection related factors ranked first to third position to highly impact design cost. The study has also identified ten factors affecting design performance of highway projects. Among these; Overall quality of design firm, complexity of the project condition ranked first to second position to impact design performance and both Overall size of design firm and complexity of the project function ranked third position.

The impact of design cost on design and project performance was also assessed by this study, and it revealed that design cost highly impact both design as well as project performance.

Taking 89 DBB road projects of federal Road Authority as case study, the findings of this thesis revealed that, design cost of DBB road projects of Ethiopian federal road projects is too less relative to its construction cost which is less than 1% of its construction cost. The study has also revealed that design cost per kilometer of DBB road projects has an inverse relationship comparative to its kilometer coverage, which is as project length coverage increases design cost per kilometer for that particular project would substantially decreases.

Keywords: Design Cost, Design-Bid-Build, Design and Road Construction Project Performance

Table of Contents---------- **Pages**

Lists of Tables----------xii
Lists of Figures----------xvi
Lists of Abbreviations----------xviii
CHAPTER-ONE ----------1
1.1 : Introduction----------1
1.2 : Problem Statements----------6
1.3 : Objectives----------7
1.3.1 : General Objective----------7
1.3.2 : Specific Objectives----------7
1.4 Scope and Limitation of the research----------8
1.5 : Research Questions----------8
1.6 : Significance and Beneficiaries of the stud----------8
1.6.1 Significance----------8
1.6.2 Beneficiaries----------8
1.7 : Research outlines ----------9

CHAPTER-TWO ----------10

LITERATURE RIVIEW----------10

2. Performance ----------10
2.1: Performance Definition----------10
2.2: Design Performance----------13
2.3: Design Quality----------21
2.3.1. Definition of Design quality---------- 21
2.3.2. Design Quality Measurement---------- 22
2.3.3. Design Quality Attributes---------- 23

2.3.4. Factors affecting Design Quality---------- 24

2.3.5. Design Deficiency----------27

2.4: Project complexity----------29

2.5: Engineering Efforts vs. Construction Cost----------30

2.6: Impact of Design Cost/ Design fees ----------30

2.6.1. On Design Quality----------30

2.6.2. On project performance----------33

2.7: Effect of Design on construction cost----------35

2.8: Project Delivery Methods---------- 36

2.8.1. Design Bid Build project delivery system----------37

2.8.2.1. DBB Project delivery selection factors opportunities and obstacles check lists----------38

2.8.2. Design -Build Delivery System----------41

2.8.2.2. DB project delivery selection factors opportunities and obstacles check list---------- 41

2.9: Effect of constructability or build -ability on project performance----------46

2.10: Cost Estimating and Management steps----------48

2.11: Selection and Appointment of a Consulting Engineers---------- 51

2.11.1: According to Budget Guidelines 2009 for Consulting Engineering Services by consulting Engineers of British Colombia----------51

2.11.2: Consultant Selection According to AASHTO guide 2008----------52

2.12: Value Engineering (VE) ----------52

2.12.1. VE Applicability----------54

2.12.2. Planning and schematic design (VE1) ----------55

2.12.3. Design Development (VE2) ----------55

2.12.4. Construction (VE3) ----------55

2.12.5. Benefits of VE----------55

2.12.6. VE Practice in Ethiopia----------55

2.13: **Remuneration**----------**56**

2.13.1: Methods of remuneration----------56

2.13.1.1. Time Based Remuneration---------- *57*

2.13.1.2. Percentage of cost of construction----------*57*

2.14: Cost of construction for Engineering projects----------59

2.15: Methods of Payments for consulting services----------62

2.15.1: According to AASHTO, 2008 consultants contracting guide----------62

2.15.1.1 Cost plus Fixed Fee----------*62*
2.15.1.2 Lump sum----------*63*
2.15.1.3 Cost per unit of work----------*63*
2.15.1.4 Specific rates of compensation----------*64*
2.16: Basic Cost Elements of Consultant ----------67

2.16.1: Direct Salary---------- -67

2.16.2: Fringe benefits----------67

2.16.3: Overhead----------67

2.16.3.1: Functional Overhead----------*67*

2.16.3.2: Administrative overhead----------*67*

CHAPTER-THREE ----------69

3. RESEARCH METHODOLOGY---------- 69
3.1 : Introduction----------69

3.2 : Research Strategy----------69

3.3 : Research Design----------70
3.4 :Data collection methods and sampling Techniques----------70
3.5 : Research Conceptual Framework---------- 72
3.5.1: Conceptual framework of the thesis work----------72

3.5.1.1: Mediation Effect----------*72*

3.5.1.2: Moderation Effect---------- *75*

3.6: Correlations of variables---------- 76

3.6.1: Correlations among design cost and design performance, Design cost and project performance, and design and project performance----------76

CHAPTER-FOUR ----------**77**

4. ANALYSIS AND DISCUSSIONS---------- 77

4.1. Profiles of Respondents and questionnaire response rate----------77

4.2. Quantitative Analysis----------79

4.3. Pearson Correlation---------- 79

CHAPTER-FIVE----------**112**

5. CONCLUSIONS AND RECOMMENDATIONS----------112

5.1.CONCLUSIONS-:----------112

5.2.RECOMMENDATIONS----------114

References ----------116

Appendices----------123

Appendix -1: Questionnaire ----------123

Appendix-2: Lists of the Respondents Company or organization Name----------135

Appendix-3: Survey of design cost of DBB road projects of Ethiopian federal road

for the time periods 2004 to 2007 EC or (2011-2014GC)----------136

Lists of Tables.----------**Pages**

Table 1.1: The contributions of Sectors to GDP and GDP growth ----------2

Table 1.2: The contribution and shares of the construction sector in the industry ----------3

Table 1.3: Breakdown of cost of RSDP V by Federal government (in Million ETB) ----------3

Table 1.4: International versus Local Contractors----------4

Table 1.5: International versus Local Consultants----------4

Table 1.6: Contractors versus Consultants in terms of total financial cost ---------- 5

Table 1.7: Total federal roads budget Versus Feasibility and EIA study----------5

Table-2.1: Advantages and Disadvantages of Key Performance Indicators----------12

Table 2.2: Design Process and design outcome---------- 13

Table 2.3: Input criteria for design performance evaluation----------14

Table 2.4: Design Success Indicators----------15

Table 2.5: Design quality attributes---------- ---------23

Table 2.6 Summary of factors affecting design quality----------26

Table 2.7: Summary of impact of discounted fees----------32

Table 2.8: Summary of Pearson correlation----------36

Table 2.9: Summary of constructability ---------- 47

Table 2.10: Cost Estimating Process----------48

Table 2.11: Cost Estimating Management Process----------49

Table 2.12: Minimum percentage fees for projects of average complexity----------58

Table 2.13: Minimum percentage fees for projects of above average complexity----------59

Table 2.14: Categories of Service Offered By Consulting Engineers for Transportation and Infrastructure Projects----------65

Table 4.1: Summary of Respondents----------77

Table 4.2: Summary of the results of the analysis carried out for identified factors showing Whether the respondents agree or not with identified factors ----------79

Table 4.3: Project related factors affecting design cost----------83

Table 4.4: Procurement and contract related factors affecting design cost----------83

Table 4.5: Market Condition Related Factors affecting design cost ----------84

Table 4.6: Consultant Related Factors affecting design cost ----------84

Table 4.7: Method of Consultant Selection factors affecting design cost ----------85

Table 4.8: Client Related Factors affecting design cost ----------86

Table 4.9: Project Delivery methods related affecting design cost ----------86

Table 4.10: Input variables affecting design performance ----------88

Table 4.11: Impact of design code and standards on design quality ----------89

Table 4.12: Impact of copying and modifying design from previous work on design quality --- 89

Table 4.13: Summary of design performance related factors affecting project performance-----92

Table 4.14: Summary of impact of reduced design fees on performance of triple project constraints, quality, time and cost----------93

Table 4.15: Mean value of bidding with the intention of doing less than the requirement --------93

Table 4.16: Summary of factors affecting project performance----------94

Table 4.17: Summary of factors affecting triple project performance measures----------95

Table 4.18: Summary of Descriptive Statistics showing mean values of factors----------96

Table 4.19: Summary of average mean value for variables i.e. design cost, design performance and project performance----------98

Table 4.20: Summary of regression output----------99

Table 4.21: Low income countries Monthly Minimum and mean wage ----------100

Table 4.22: Lower-middle-income countries Monthly Minimum and Mean Wage----------101

Table 4.23: Upper-Middle-Income Countries Monthly Minimum and Mean Wage----------102

Table 4.24: Performance of DBB federal road projects----------106

Table 4.25: Percentage of Design service cost of highway projects relative to its construction cost----------108

Table 4.26: Monthly Salary of key staffs working under design firm ----------109

Table 4.27: Design Cost of DBB Federal Road Project for 2004 E.C (2011 to 2012GC) -------136

Table 4.28: Design Cost of DBB Federal Road Project for 2005E.C (2012 to 2013GC) --------137

Table 4.29: Design Cost of DBB Federal Road Project for 2006 E.C (2013 to 2014GC) -------139

Table 4.30: Design Cost of DBB Federal Road Project for 2007E.C (2014 - 2015GC) ---------140

Lists of Figures----------Page

Figure 1.1: Research outline/ Organization of the research work----------9

Figure 2.1: Design Process used by ERA---------- 17

Figure 2.2: Road and highway projects can benefit from design using building information modeling (BIM). ----------40

Figure 2.3: Typical Design -Bid-Build Project Delivery System----------49

Figure 2.4: Typical Design -Build Project Delivery System----------45

Figure 2.5: Evolution of Project Knowledge through Project Development----------50

Figure 2.9: The stages of VE application----------54

Figure 2.10: Mode of Payments for consulting services----------61

Figure 3.1: Model: Without Mediator----------72

Figure 3 .2: Mediator Model----------72

Figure 3.3: Model for moderator----------75

Figure 3.4: Relationship b/n Design cost, design performance and project performance----------76

Figure 4.1: Summary of Respondents Profile concerning qualification----------78

Figure 4.2: Summary of Respondents Profile concerning Experience----------78

Figure 4.3: Summary of factors affecting design cost of highway projects ----------87

Figure 4.4: Mean Values of impact of design cost, on design and performance and impact of design performance on project performance ----------98

Figure 4.5: Average Design Fees or Design cost per kilometer in (ETB) ----------103

Figure 4.6: Design cost per kilometer versus Project length for 2004 and 2005EC ----------104

Figure 4.7: Design cost per kilometer versus Project length for 2006 and 2007EC----------105

Figure 4.8: Salary trend of key staffs at different time interval (2006 to 2012EC) ----------110

Figure 4.9: Average Monthly Salary of key staffs for the period of (2006-2012EC) ---------- 111

LISTS OF ABBREVIATIONS

AASHTO	American Association of State Highways and Transportation Official Standard
ASCE	American Society of Civil Engineers
ADB	African Development Bank
BIM	Building Information Modeling
CII	Construction Industry Institute
CIRIA	Construction Industry Research and Information Association
DBIA	Design-Build Institute of America
EC	Ethiopian Calendar
ERA	Ethiopian Roads Authority
FIDIC	Federation Internationale des Inginieurs Conseils/International Federation of Consulting Engineers/
FHWA	Federation of Highway Authority
GDP	Growth Domestic Product
KPI	Key Performance Indicator
NBE	National Bank of Ethiopia
OTA	Oklahoma Turnpike Authority
PMI	Project Management Institute
RSDP	Road Sector Development Program
TOR	Term of Reference
WSDOT	Washington State Department of Transport

CHAPTER-ONE

1.1 Introduction

Ethiopia is one of the developing countries in the horn of Africa showing significant improvement in achieving its national economic development through implementation of transformation plan. According to the report of National Bank of Ethiopia 2018/2019, the economy has recorded better Real GDP growth of 9 percent in 2018/2019 compared to that of 2017/2018 which was 7.7 percent.

Industrial growth plays its role in the development of the country's economy contributing 12.6 growth rate in the industry output, with an increased share in total GDP with a share of 28.1% in 2018/19 than previously recorded in 2017/18 which was 27% according to report of National Bank of Ethiopia 2018/2019.

Among the industrial sectors, Construction industry is also one of the major contributors for the development of the nation. It has shown a 15 % expansion with a contribution of 72.5% to the industrial output, signifying the leading role of the sector in roads, railways, dam and residential house construction as revealed in the reports of NBE (2018/19).

It is obvious that the existence of adequate and better infrastructure will play its vital role in scaling-up the living condition of the nation due to the fact that it lays a way for other sectors.

Road construction project is one of the key players in construction industry. Due to its paramount importance, huge amount of capital budget is being allocated by the government of Ethiopia to finance the sector. According to NBE (2018/19), total investment in road construction and expansion including urban roads increased by 12.6% to ETB 37.3 billion when financially compared to that of the previous fiscal year 2017/18 with ETB 33.1 billion. The federal roads construction and expansion shares 86.9 % of the total roads investment of the country which is ETB 32.4 billion which is greater than 2017/18 fiscal year budget which was ETB 25.695 billion.

On behalf of the Federal Democratic Republic of Ethiopia, the implementation of the federal road sector development is being undertaken under the administration of Ethiopian Roads Authority (ERA).

Accordingly, ERA, set twenty five years implementation plan with five phases each phase consisting of consecutive of five years. Through the implementation of RSDP, road network coverage is significantly increasing time to time. During 2018/19 fiscal year as a whole in the country the total road network coverage including regional and woreda road sreached a total of 138,127km with annual growth rate of 9%. Among this, the coverage of the federal roads network is 28,699km which is 20.8% of the total road network of the country. The coverage of the federal roads network consists of 15,886km (55.4%) asphalt roads and 12,813km (44.6%) gravel roads. At the end of 2018/19 road density per 1000 square km increased to 125.6km with 9% than previous year with density 115.2km. However, road density per 1000 population increased to 1.26km in 2018/19 from 1.22km in 2017/18. Table 1.1: Shows contribution of sectors to GDP and Real GDP growth.

Table 1.1: The contributions of Sectors to GDP and GDP growth

	Years	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
	Growth in Real GDP	10.3	10.4	8.0	10.1	7.7	9.0
Contribution of sectors to GDP growth	Agriculture	2.3	2.5	0.9	2.5	1.3	1.3
	Industry	2.2	2.7	4.7	4.8	3.1	3.6
	Services	4.9	4.2	3.4	3.0	3.4	4.1

Construction sector plays its vital role in the construction industry. Table 1.2: Depicts percentage share of construction in the industry and growth rate of construction sector.

Table 1.2: The contribution and shares of the construction sector in the industry

Years	2014/15	2015/16	2016/17	2017/18	2018/19
Share of construction in the industry %	67.5	69.1	69.3	71.4	72.5
Growth rate of Construction %	31.6	25.0	20.70	15.70	15.0

Source: NBE (2018/19)

For the undertaking of design service and construction of road projects, Ethiopian government allocates budget. On behalf of the government, Table 1.3: shows the budget cost break down carried out by ERA,

Table 1.3: Breakdown of cost of RSDP V by Federal government (in Million ETB)

I/N	Years	2016	2017	2018	2019	2020
1	Total amount of Federal roads	34,166.9	41,589.5	51,091.7	66,847.9	71,045.8
2	For Feasibility and EIA study	110.7	116.3	122.1	128.2	134.6
Percentage of Feasibility study and EIA		0.324	0.28	0.239	0.192	0.189

Source: ERA, (RSDP-V), 21 years assessment report (2019)

1.1.1: Participation of local and international contractors and consultants in road sector development

Implementation of RSDP, involves local and international contactors and consultants. In the last decades, due to capacity and competency limit by the local contractors and consultants, their participation was not encouraging relative to the international companies. However, at recent time, there is substantial improvement in participation even in heavy design and

construction projects. Accordingly, in the last two decades many federal road design and construction projects have been executed by local and international stakeholders (contractors and consultants).

ERA's 21 years, RSDP performance assessment report depicted number of projects awarded and the amount of money invested so far in the last 21 years (1997-2018), taking local and international contractors and consultants comparatively. Table 1.4: Shows comparison between international and local contractors engaged in the road sector development program in terms of number of projects awarded and total cost of projects.

Table 1.4: International versus Local Contractors

I/N	Source /Type of Contractors	Number of projects awarded/contracted	Percentage	Total cost of the project (cost in million ETB)	Percentage
1	International contractors	151	20.6%	134,501.7	50.9%
2	Local contractors	582	79.4%	129,718.3	49.1%
Total		733	100	264,220.0	100

Table 1.5: Indicates the participation of international and local consultants in the road sector development program in terms of number of projects awarded and total amount of project cost allocated.

Table 1.5: International versus Local Consultants

I/N	Source /Type of Contractors	Number of projects awarded/contracted	Percentage	Total cost of the project (cost in million ETB)	Percentage
1	International consultants	218	24%	3163.0	38%
2	Local consultants	702	76%	5221.9	62%
Total		920	100	8384.9	100

Table 1.6: Shows comparison between contractors and consultants total project cost.

Table 1.6: Contractors versus Consultants in terms of total financial cost

I/N	Description	Total cost of the project (cost in million ETB)	Percentage
1	Contractors total project cost	264,220.0	96.92%
2	Consultants total project cost	8,384.9	3.08%
Total amount of cost		272,604.9	100%

Here, based on the comparisons made above, the amount of cost paid to the consultancy service is very small sharing only 3.08 % of total construction cost of the road projects.

However, the total amount of cost indicated for the consultancy service in the ERA's performance assessment report did not specify whether it is for design or supervision services.

On the other hand, the cost breakdown of RSDP five conducted by Federal roads authority indicated that the amount of cost for feasibility and Environmental Impact Assessment is significantly low below 1% relative to total amount of budget planned for expansion and construction of the federal road projects. Table 1.7: shows budget cost breakdown made by ERA for road construction and feasibility study and environmental impact assessment for five consecutive years 2016 to 2020 GC.

Table 1.7: Total federal roads budget Versus Feasibility and EIA study (Cost in Million ETB)

I/N	Description	Fiscal years/Periods				
		2016	2017	2018	2019	20120
1	Total amount of Federal roads budget	34,166.9	41,589.5	51,091.7	66,847.9	71,045.8
2	Feasibility study and EIA	110.7	116.3	122.1	128.2	134.6
3	Total Amount	34,277.6	41,705.80	51,213.8	66,976.1	71,180.4
Percentage of Feasibility and EIA Studies		0.323%	0.279%	0.238%	0.191%	0.189%

Source: ERA (RSDP, PHASE V, October 2015.)

Even though, the construction and expansion of the federal road network is significantly increasing, as indicated by previously done/ conducted researches the sector is bound by problems such as non-performance of construction projects. Due to the non-performance, most projects undergo cost overruns, delay and quality compromise.

Accordingly, the aim of this thesis is to identify and assess impact of design cost on performance of Design and Design-Bid -Build Road Projects.

1.2 Statement of the Problem

Prior to the commencement of the construction process, at pre construction phase, important documents such as detailed design documents and technical specifications regarding the project under consideration should be prepared. Design serves as a base for engineering cost estimate and for predicting project duration. In the preparation of such documents, specially, design and technical specifications, design consultants have undeniable significant role. It is obvious that in the execution of design task, a variety of experienced, skilled and qualified professional key staffs get involved in the design process. To arrive at economical and sustainable design, which satisfies the need of the client, the existence of capable and competent design firms, having qualified professionals play a significant role.

Nonperformance of design can affect the progress of the project. According to Tilley and McFallan (2000), deficiencies occurring in design and documentation provided by consultants have been steadily increasing over the past 12 to 15 years and have also caused corresponding increases in the extent of inefficiency within the construction process. The study further elaborated that poor quality design and documentation has directly contributed to increases in the variations of quantities, rework, cost over-runs, extensions of time and contractual disputes.

Taking the case of our country, due to lack of capacity in competence by local design consultants to deliver quality design service, design products they deliver to clients or to their customer are questionable due to the ambiguousness of the design product with enormous discrepancies to address the requirements stipulated.ERA RSDP report PHASE V, October 2015. Page 10 and Getachew Tsegaye (2009)

Consequently, most federal road construction projects of Ethiopia due to (nonperformance of design products such as, design errors and omissions, design change, inaccurate BOQ and design deficiency most projects undergo cost overrun, time delay with quality of substandard.

However, it is obvious that nonperformance of design can affect the performance of the project, and studies had been conducted regarding the risk of design on project performance, the question, what is the root cause for non-performance of design is not well addressed.

Based on the scope and complexity of the project conditions, design firms should be paid fair and equitable fees for the design service they rendered to provide quality design service which satisfy their clients or customers need. Whenever there is fair design cost or design fees for the design services, the design firm can hire a well-qualified professional for the undertaking of design activities. However, if the design cost is less, as indicated in some literatures, in order to minimize cost and maximize profit the firm tend to hire junior un experienced professional with low salary or copy and modify from other previously done design projects. Consequently, this leads to design errors, and omissions, inaccurate BOQ, design change, incomplete design resulting in project delay, cost overruns and inferior quality.

So, the aim of this research is to identify and assess the Impact of **Design Fees or Design Cost on Design and Project Performance of DBB road projects** in the case of federal roads projects.

1.3 Objectives

1.3.1: General Objectives

I. The general aim of this thesis is to investigate factors affecting design cost of DBB Road Projects

1.3.2: Specific Objectives

I. To identify and assess factors affecting design cost
II. To identify and assess the impact of design fees or design cost on design performance
III. To assess the impact of design cost on performance DBB road projects

1.4 Scope and limitation of the research study

Due to limitation in time, and cost, the scope of the thesis work is limited to federal roads construction projects under Ethiopian Roads Authority. The study tries to cover only road projects procured under traditional or (Design Bid Build) delivery methods. The Research questionnaires are distributed only to client and consultants working with duty station in Addis Ababa city, and do not involve local contractors. Due to the emergence of corona virus pandemic (COVID-19) in the country, an interview was not conducted.

1.5 Research Questions

- What are factors affecting Design Cost of DBB road projects?
- What is the impact of design cost on design and project performance in construction projects?
- What is the influence of design on project performance?

1.6 Research Significance and Beneficiaries of the study

1.6.1: Significance:

- In this research ,identified factors affecting design cost in the literature and in this study can be used as input to arrive at realistic design cost estimate
- The impact of fees or cost on design and project performance will be addressed
- Addresses the types and methods of design cost estimation with their cons and pros
- It can provide clues regarding the effect of the fees on the commitment of a firm if fees paid to it for its service is to low

1.6.2: Beneficiaries:

- The output of the research can generally benefit all stakeholders involved in the construction industry, such as clients, consultants, contractors and financers
- The main beneficiaries are consultants(design firms) and clients
- Government statutory and policy makers

1.7 :Research Outline

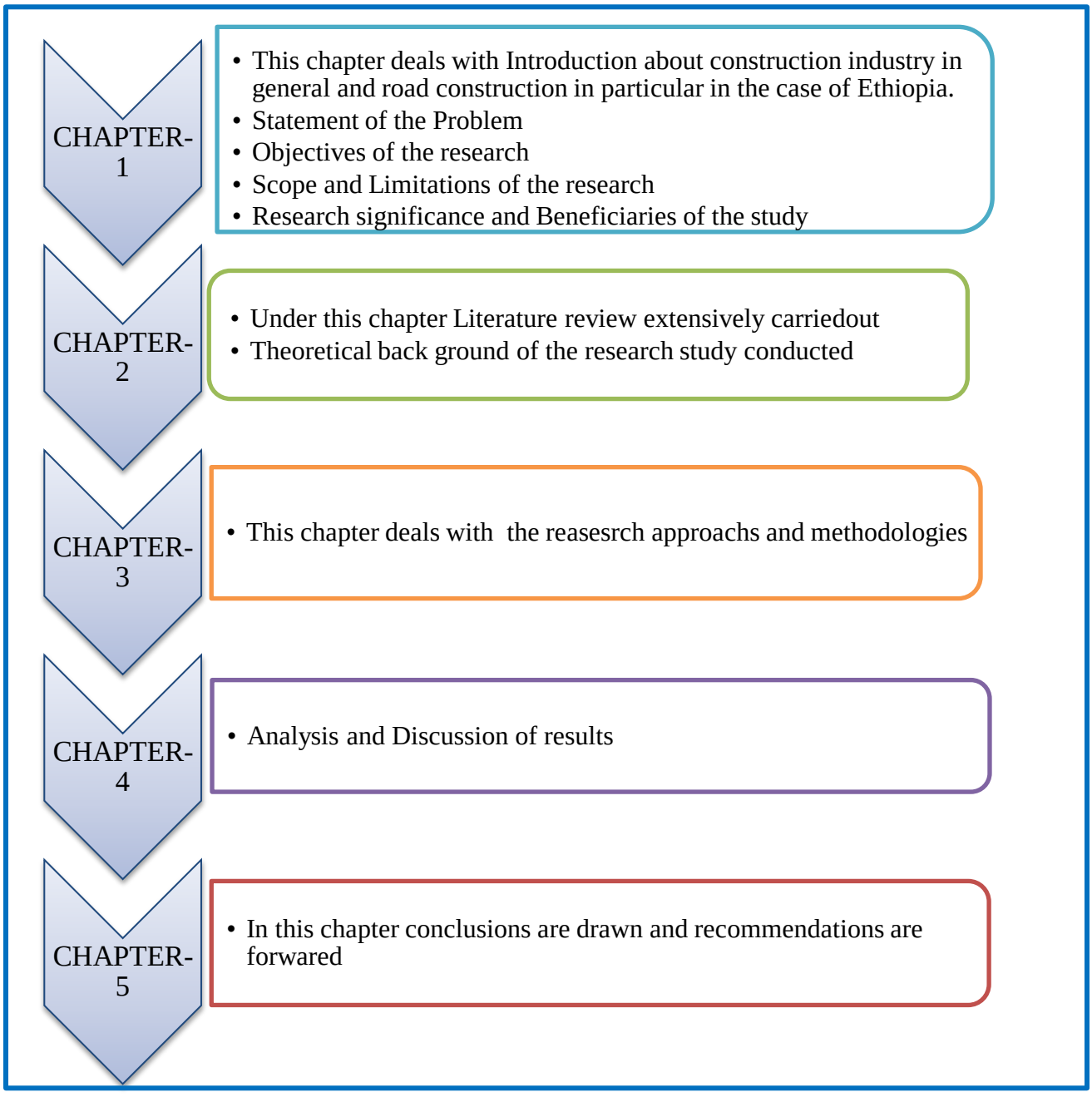


Figure 1.1: Shows Research outline/ Organization of the research work

CHAPTER-TWO

2. LITERATURE REVIEW

2.1 Performance

Performance measurement is a systematic way of evaluating the inputs and outputs in manufacturing operations or construction activity and acts as a tool for continuous improvements (Sinclair and Zairi, 1995; Mbugua et al., 1999).

Definition of performance:

a) According to Berman (2006) performance is defined as " *effective and efficient use of resources to achieve results."*

b) Rhinesmith (1993) defines "*performance as the* ***accomplishment of assignment given*** *measures against cost, standard of accuracy, speed and completeness."*

Alarcon et al (1998), classified project performance indicators according to their types as follows:

I. **Results indicators**: they attempt to measure the level of success a project has achieved at the end of the project such as cost deviation, schedule deviation.

II. **Processes indicators**: they measure the performance of the most important processes that occur in construction phase, such as, design, construction, planning, and procurement.

III. **Variables:** decisions, strategies, and others that are not a process but affect the performance of the project. E.g. Type of contract.

According to Mbugua et al., (1999), performance indicators specify the measurable evidence necessary to prove that a planned effort has achieved the desired result.

Liu and Walker, (1998) also defined performance as is an individual contribution to the execution of the task required in completing the construction project. In order to determine the extent to which a project has been successful, the performance of each participant should be measured, evaluated and prioritized at every stage of the project phases.

According to Egan (1998) Performance Indicators for Industry can be measured in terms of Cost predictability (design), Time predictability (design), and Cost predictability (const.) Time predictability (const.)

The methods of measurement of performance can be in terms of the technical performance, the financial performance and the overall performance. The areas of measurement are at the planning & design level, the marketing level and manufacturing level etc., and for the overall performance are at the level of a firm or strategic business unit. Furthermore, he proposes a model of performance measurements in terms of outputs and resources to be measured at different levels. Outputs are measured to determine whether they help to accomplish objectives (effectiveness).However, when it is not possible to obtain a precise measurement, it is usual to refer to performance indicators.

The main objectives of key Performance Indicators are:

- To enable measurement of project and organization performance throughout the construction industry (KPI Working group 2000)
- To provide a method of benchmarking companies performance against others from the same industry
- To track and demonstrate long term developments and improvements in performance (construction industry excellence, 2007).

Ofri (2001) described that Key Performance Indicators (KPIs) has the following advantages:

Table-2.1: Shows Advantages and Disadvantages of Key Performance Indicators

Advantages of KPIs According to Ofrin(2001)	Disadvantages of KPIs According to Chan (2004)
➢ Would provide specific targets to be achieved and could be used to measure / systematically, and thus monitor progress in the effort to improve industry ➢ Would guide routine activity in the administration of the industry development program and also stimulate innovation during implementation ➢ Would help to identify deficiencies in the program, guide corrective action and indicate additional areas where action could be taken ➢ The indicators could be used to compare the performance of a country's construction industry from one period to another ➢ The targets derived from the indicators could be raised over time as the administrating agency gains experience or greater executive capacity or good progress is made in the industry development effort.	➢ Certain project information related to monetary is sensitive and confidential, and so the stakeholders may not be willing to disclose it for analysis ➢ There is limitation in calculating the accident rate which relies on accurate record of the total accidents that have occurred and the total number of workers engaged in construction projects in a year ➢ Calculation of project values and profit also involves some problem since it is confidential in nature and that besides this the concept of value and profitability is not appropriate if the project is publicly funded

Cost, Time and Quality are the triple project performance measure of project. The success or failure of the project depends on the achievement of these parameters.

Performance Outcome of the project can be measured in terms of the following metrics**:**

- **COST:** Project Cost Growth, Construction Cost Growth, Startup Cost Growth Construction Phase Cost Factor, Startup Phase Cost Factor
- **SCHEDULE:** Project Schedule Growth, Construction Schedule Growth, Startup Schedule Growth, Construction phase duration factor, Startup phase duration, Factor actual overall project duration ,Actual total project duration, Construction phase duration,
- **CHANGES**: Change Cost Factor, Change Schedule Factor
- **REWORK** : Field Rework Cost Factor, Field Rework Schedule Factor

2.2: Design Performance

According to Construction Industry Research and Information Association (CIRIA, 2001) and Nasma Budawara (2009), design performance consists of the following Design process and Design outcome elements as shown in Table 2.2

Table 2.2: Design Process and design out come

A. Design Process	**B. Design Outcome**
I Conception Activities ➢ Identification of needs and ➢ Development of needs II Development activities ➢ Design schedule development, Detailed design, Estimating time and cost and design review	I. Realization of the design ➢ Construction cost at planning stage ➢ No. of change order ➢ HSE II. Satisfaction with the design ➢ Clients brief satisfaction, End users satisfaction and Client satisfaction

Nasma Budawara (2009) has also described Design Key Performance Indicators (KPIs), to be:

Contextual compatibility, Functional performance, Physical Performance**,** Cost**,** Time, Quality**,** safety,Risk,constructability,Maintainability and Sustainability.

According to the Construction Industry Institute (CII), Design task force 1986 and 1987, in evaluating Design Effectiveness the following input variables which can impact the effectiveness of the design has been identified as follow:

Accuracy of design documents, Usability of design documents, Cost of design, Constructability, economy of design, Performance against Schedule, Ease of start-up and Security.

Nasma Buduwara (2009) taking Fayek (2001) and Jergeas (2008) as a source of reference has summarized the input criteria for the evaluation of design performance as follow:

Table 2.3: Input criteria for design performance evaluation

➢ Overall size of the firm ➢ Level of competition in the market ➢ Overall quality of the design firm ➢ Size of design contract ➢ Continuity of man-hour commitment for the project ➢ Level of scope definition ➢ complexity of the project function ➢ Complexity of design process	➢ Complexity of project condition (Types of problems, Number and magnitude) ➢ Quality of owners' Profile ➢ Quality of primary vendors profile ➢ Complexity of tendering process for construction ➢ Complexity of construction process ➢ Economic (market conditions)

Yuanyuan Yin et.al (2011) by reviewing different literatures has summarized thirteen relevant Design Success Indicators as shown in Table 2.4:

Table 2.4: Design Success Indicators

Indicators	Description
Collaboration	Ability to make compromise, Communication quality, Information sharing
Cross -functional integrity	Establishing common language, Functional openness, Helping and cooperating with others
Culture and climate	Ability to track market trend, Awareness of market, Climate change, Good understanding of business culture
Customer - based indicators	Customer acceptance ,Customer satisfaction, Purchase repeat rate, No. of customers
Design development process indicators	Availability of raw materials, Design process plan, Design Methods, Environmental Friendly
Design Effectiveness	Achieving Design Brief, Meet design quality Guide lines, No. of Design Reviews, Understand design rationale, Technical performance attainment, Delivery to the brief, Development cost reduction and identifying improvement action for future projects
Design Efficiency	Application of Computer -Aided Design, Design Development Time
Financial Indicators	Attain profitability goals, Break-even time, Investment Return Rate and Meet market share goals
Innovation	Newness of technology, Provide competitive advantage, Newness to customers
Management Skill	Building high moral within team, Conflict management, Decision Making and Investigating resource planning
Market Environment	Leading to future opportunities, Market familiarity, Market potential and Market Chance
Organizational factors	Internal Design policy, Internal/External relations, Organizational structures, Market chance
Product level Indicators	Perceived value, Product adaptability, Product Flexibility, Uniqueness

Nasma Budawara (2009) described in her study project performance indicators as follows:

Construction Cost, Construction Time, cost predictability, time predictability, defects, client's satisfaction with the product or service.

UK KPIs working group in 2000 presented a KPI frame work that consists of the following main groups such as:

- Time :From the perspective of client, and stakeholders, or the general public, the first criteria to measure success of the project will be the completion time
- Cost: the degree to which the general conditions promote the completion of a project within the estimated budget
- Quality: the totality of features required by a product or service to satisfy a given need; fitness for purpose. In other words, quality in construction industry emphasizes the capability to establish requirements with conformance to the quality standard
- Client satisfaction: a function to make comparison between a perception of an outcome by an individual and the expectation of the outcome
- Health and Safety: the degree to which the general conditions promote the completion of a project without major fatalities or injuries.

Key performance indicators help to measure the performance of project as well as for tracking and benchmarking purpose. Depending on the perception of the authors KPI of project may vary.

According to Lathan(1994), KPI are highlighted in terms of : client satisfaction, public interest, productivity, project performance, quality, research and development, training and recruitment and financial.

Egan (1998) expressed KPI in terms of: construction cost, construction time, defects, client satisfaction with services and products, profitability, productivity, safety, time and cost predictability design time and cost predictability.

In the undertaking of design task, there should important design procedure to be followed. Figure 2.1: Shows design process used by Ethiopian Roads Authority.

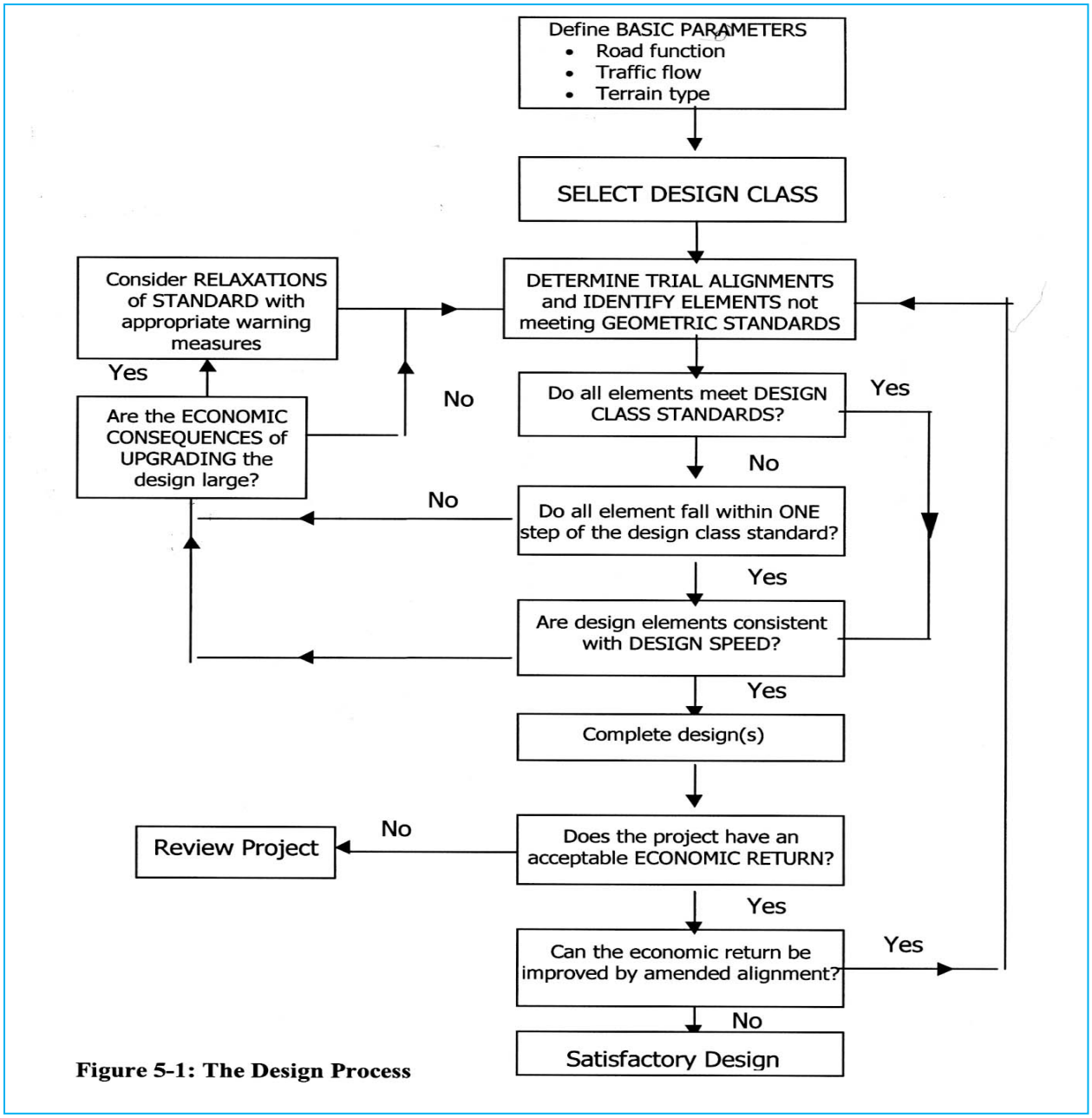


Figure 2.1 Design Process used by ERA

Source: ERA Geometric Design Manual, 2002, Design Control & Criteria

Based on the literature reviews made, studies conducted to assess the performance of construction projects, revealed that most projects fail to meet its primary objectives to be finalized within the estimated duration and allocated budget with desired quality. Consequently, Cost and Time overruns in construction projects frequently occur in most construction projects due to some factors. Previously conducted researches identified factors affecting the performance of the project. Poor design quality is one which affects the overall performance and efficiency of construction project implementation. Declining standard of design quality has contributed significantly to a similar decline in construction efficiency.

A study conducted by Grau et al.,(2012) highlighted that conflict between designer and contractors are attributable to poor design planning, inaccuracy of design document, high build cost of design option and un reasonable design fees.

Indian Project Management Institute (PMI) survey (2012) also revealed that change in scope/ design is one of the major factors for project schedule and cost overruns in the execution phase of the project. A study conducted by Eradius E. and David A. (2013) by taking seven road projects in to consideration, showed that these projects experienced an average of 26% cost and 32% time overruns due to inadequate Design. Furthermore, according to the study of Adnan E. and Mohamed A.(2017) rework due to design errors and omissions significantly impacted project performance. Study of AftabHameed(2012) also strengthen that design is one of the major factor affecting the performance of construction project in terms of time and cost. According to Research by consultants, Ove Arup & Partners, based on experience of public and private sector procured projects in various EU Member States that, Design change and poor project management are cost changing factors which have major effect potentially up to 20% change for affected cost element (planning/Design fee).Defective design is one factor which affects project performance.

According to the study of (Andi and Minato 2003) defective design has caused 30 % cost and time overrun in construction projects. Rework is also one of the factors which influence project performance. According to study of Love and Edward's (2004b) rework can seriously affect an individual, an organization and project performance indirectly.

According to Adnan E. and Mohamed A. (2017), rework cause related to design ranked on third position having high impact on project performance. Their study have also revealed through reviewing different literatures that under design related causes that the following factors: professionalism, inadequate procurement methods, design errors and omissions, competitive/ low design fees, incomplete information for design and incomplete design are the main cause for rework. The construction cost growth for all projects in the study was 9.65 percent. Thus, the difference between final construction cost and the initial estimate was less than ten percent.

Rafiq Muhammad Choudhry et al.(2017) has identified causes of discrepancies between design and construction in three categories; namely in tendering phase, in design phase and in construction phase. In the tendering phase he identified factors such as, selection of contractors on the bases of lowest bid, contractors did not consider that design is exotic/complex or difficult to build and that the contractor do not have the required expertise as the main causes for the occurrence of discrepancy during tendering stage. In the design phase he identified twenty factors as the main causes of discrepancy. Among these factors data provided to designer are incomplete, appropriate authorities do not check that the structure is designed according to the building by-laws, codes and government rules, and too little time is given to the designer for completion of design documents are ranked 1st, 2nd and 3rd position consecutively as the main causes of discrepancy between Design and Construction in design phase. In the category of construction phase twenty four factors were taken as the causes of discrepancy and among these factors; owners proposes changes due to financial problem, appropriate authorities do not check carefully that the structure is constructed according to the approved building plans and contractors lack skilled man power are ranked 1st, 2nd and 3rd position consecutively as the main causes of discrepancy in construction phase. The study further revealed that in overall project phase; design phase, construction phase and tendering, are ranked 1st, 2nd and 3rd position consecutively as the main causes of discrepancy between design and construction.

In the case of our country Ethiopia , study conducted by Getachew Tsegaye (2009), taking ten road projects of ERA as case study revealed that *design risk is one of the source of risk which has high impact on time, cost and quality parameters* with high probability of occurrence. His study has also revealed that incomplete/inadequate survey data, incomplete/poor specification, unforeseen ground condition and lack of experienced design team has high impact

on time, cost and quality with high probability of occurrence. According to his findings: 90% of the project encountered omission of work, 70% of the project faced error in estimation quality, 30% of the project were found with inadequate/ incomplete survey data, lack of design detail, and poor drainage assessment where as 40% of the project encountered scope change due to late implementation of design.

Solomon S. (2015) also argues that ERA'S project implementation phase is affected by problems associated with project development core process and the output they deliver. He also argues that negligence and slack performance, overload of design professionals, poor cooperation and collaboration between design professionals, inadequate consideration of constructability, and competitive fees leads to compromise on quality and due effort can contribute towards poor design by resource base.

Regarding TOR used by ERA, Solomon S.(2015) also argues that even though the authority follows similar qualification requirement of world bank, FIDIC and ADB for the procurement of design services, that it fails to adapt proper TOR by considering important elements such as; complexity of the project and scope of the project in to account. Consequently, without taking these elements into consideration, the same TOR is being used for all types project with similar design time.

Getu Tilahun (2014), taking ERA's 16 years RSDP performance assessment published report, indicated that, as a result of defective design or design problems federal road projects undergo:

- variation cost of 8% with 22% time overruns from the contract amount,
- change in quantity of 7% and above
- due to dispute and claims 2% of the contract amount cost overruns encountered
- 40% and above time overruns of the design contract due to absence of well-prepared contract document

Consequently, in order to improve the gaps in design management, he highlighted that the authority should make improvement in the under mentioned areas:

Regarding quality of design service contract document:

That a specific TOR should be prepared as to introduce clear job description for each professionals and implementing quality assurance and quality control with the firm and the client is necessary to improve the gaps in design management.

Regarding quality of construction cost estimation

Introducing standard CMS for the sectors, establishing index for construction works and introducing quality surveyor in the design team can improve the gaps.

Quality of design outcome:

To achieve quality design outcome it is important to have adequate design time, introducing design manager as a team leader(well experienced professional both in design and construction, strictly applying the design manual, introducing quantity surveyor in the design team, use of advanced software and use of experienced professionals.

DESIGN QUALITY

2.3.1: Definition of Design quality:

I. According to Mc George (1998), Design quality is defined as "...a good design will be effective i.e. *serve the purpose for which it was intended and constructible with the best possible economy and safety."*

II. According to Tilley (1998), *it is defined as "the ability to provide the contractor with all the information needed to enable construction to be carried out as required efficiently and without hindrance."*

Whereas quality is defined as *"conformance to established requirements" by* Farrington (1987)

According to Lawson (1980), Design is defined as *"highly organized mental process capable of manipulating many kinds of information, blending them all into a coherent set of ideas and finally generating some realization of those ideas,"* and Charette et al (1999), also defined that in the design phase, the needs stated in the Program stage are translated into plans and specifications.

According to Arditi and Gunaydin(1997), Quality is to mean:

I. Satisfying Client's Requirement in terms of :adequacy function, operation and maintenance, meeting timelines and budget and life cycle cost

II. Satisfying the requirements of the design consultants by providing: a defined scope of work and adequate budget to provide field information to guide in design

III. Satisfying Contractors requirements for: provision of well detailed and accurate set of design drawing, specifications and other documents to assist the contractor in the pricing of his tender

IV. Satisfying the requirements of public regulatory agencies as to: protection of public property, including utilities, environmental concerns, public health and safety, conformance with relevant laws, regulations, codes and policies.

2.3.2: Design Quality Measurement

The most comprehensive approach tries to measure issues directly related to quality is outlined as follows by (ASCE, 2000):

1. Meeting the requirements of the owner as to: function and appearance; completion on time and within budget; life cycle cost and maintainability.

2. Meeting the requirements of the design professional as to: defined scope, adequate budget, reasonable schedule, timely decisions by owner, interesting work for the staff, realistic risk sharing, reasonable profit, a satisfied client and finished project which result in positive recognition and recommendation for future work.

3. Meeting the requirements of the contractor as to: a well-defined set of plans, specifications, and other contract documents, a reasonable schedule, timely decisions by the owner and design professional, fair treatment, realistic risk sharing, reasonable profit, a satisfied owner, and positive recommendation for future work.

4. Meeting the requirements of regulatory agencies as to: public health and safety; environmental consideration; protection of public property, including utilities; and conformance with applicable laws, regulation, codes, standards, and policies

2.3.3: Design Quality Attributes

Design has a significant effect in the achievement of required project goals in terms of cost and quality. Table-2.5: Shows factors attributable to design quality.

Table-2.5: Design quality attributes

- Consideration of whole life–cycle issues
- Extent of client involvement in the design process
- Availability of experienced design personnel
- Balance in the ratio of junior to senior staff use
- Material efficiency
  - ✓ ensuring the efficient use of materials
- Economy
  - ✓ ensuring design solutions are cost effective
- Relevancy
  - ✓ ensuring project requirements are met
- Constructability
  - ✓ incorporating constructability principles
- Innovation
  - ✓ incorporating innovation in the design solution
- Expressiveness
  - ✓ provides symbolic expression and feeling
- Functionality
  - ✓ effectively serves the purpose for which it was intended
- Timelessness and durability
  - ✓ design will gracefully endure the passing of time
- Site compatibility
  - ✓ effectively uses and makes due allowance for site conditions
- Competence and experience of the person managing the design process
- Material selection
  - ✓ ensuring the availability, suitability and compatibility of materials
- Proper examination of design proposals (to prevent ambiguity, omissions and errors)
- Provision of in-house and external training to ensure continuing professional development of design staff
- Design service contracted for, is compatible with the design requirements of the project
- Consideration of ecological sustainability issues
- Aesthetics
  - ✓ the finished product is visually pleasing

2.3.4: Factors affecting Design Quality

Tilley and Mc Fallan (2000) investigated in their study those factors affecting Design Quality. According to their study; unrealistic expectations by clients, low fee structures; and insufficient profits –being generated to enable the training of staff to impact design quality. Meanwhile Proliferation of 'backyard' operators – prepared to work for minimal fees; low fee structures; and insufficient overall design time was issues identified having greatest impact on design quality.

A survey conducted by Zidan (2013) has also revealed causes that affect the quality of design and contract documentation taking the case of Syrian construction industry. Insufficient time for overall design, lowest price offer method of designer selection, requirement change by client and lack of documentation were the identified factors affecting design quality.

According to ACIF and APCC (2002) the identified causes of Design Problems are: insufficient client's brief, design detail is not known, problem of constructability, compliance problem of statutory regulations, inadequate time for design and reduced design fees.

According to Shady K. (2009), the most severe factors agreed by the clients and consultants which affects design quality are lack of qualified consultant's staff, absence of an experienced overall design manager and Lack of time available for checking and correlating all the information on all design documents are ranked first, second and third having Relative Importance Index (RII) of 69%, 68% and 67% respectively.

Researchers identified some Factors affecting Quality of Design by taking factors related to Design process, factors related to time and cost of design, factors related to coordination, factors related to selection strategy and biding philosophy, factors related to design management, client related factors, and tendering process. Their findings are summarized as below:

To identify and assess factors affecting the Quality of design output, previously many research studies have been conducted by different authors. Summary of the identified factors affecting design quality with their author have been depicted in Table 2.6.

Table 2.6: Shows summary of factors affecting design quality:

1. Design Process Related factors affecting design quality

	Factors affecting design quality	Author
1	In adequate/ineffective use of new technology	Linda Love(1998)
2	Copying and modifying from previous work to minimize time and cost	Gall.et.al.,(2002)
3	Insufficient and missing input information from the client	Tilley et.al.,(2002)
4	Lack of qualified consultants staff	Tilley et.al.,(2002)
5	Insufficient design review with relevant parties	Bubshat and Abdulrazzak(1996)
6	Lack of time for design review	Bubshat and Abdulrazzak(1996)
7	Slow of payment system for design service	Abolnour (1994)

2. Factors related to time and cost

	Factors affecting design quality	Authors
1	Tight design schedule or inaccurate time estimates	Tilley et.al.,(2002)
2	Reduced design fee levels	Tilley et.al.,(2002)

3. Factors related to coordination/poor coordination

	Factors affecting design quality	Author
1	Lack of data integration across design disciplines	Tilley et.al.,(2002)
2	Inadequate design coordination between design disciplines	Tilley et.al.,(2002)

4. Factors related to selection strategy and biding philosophy

	Factors affecting design quality	Authors
1	Selection of designer on the basis of lowest price selection strategy(lowest bid approach)	Defraites(1989)
2	Selection of designer on the basis of reputation instead of efficiency	Gallo et.al.,(2002)

5. Factors related to Design management

	Factors affecting design quality	Author
1	Absence of high cost experienced design team to project	ASCE(2002)
2	Absence of an experienced overall design manager	ASCE(2002
3	Allocation of staff to more than one project in the same time	Love et.al.,(2006)

6. . Client Related factors

	Factors affecting design quality	Author
1	Unstable client's requirement	Othman et.al.,(2005)
2	Long waiting for clients decision	Tilley, p (2005a)
3	Last minute change by clients	Tilley, p (2005a)
4	Unwillingness of clients to pay fees commensurate with design of high quality services	Love and Edwards(2004)

7. Factors related to Tendering Process

	Factors affecting design quality	Author
1	Reluctance by tenderers to ask questions that might reveal competitive edge	Mclennan and Parminter(2004)
2	Tight tender time	Mclennan and Parminter(2004)

2.3.5: Design Deficiency

Design deficiency has a great impact on construction process efficiency. According to Tilley and McFallan (2000), deficiencies occurring in design and documentation provided by consultants have been steadily increasing over the past 12 to 15 years and have also caused corresponding increases in the extent of inefficiency within the construction process. The study further elaborated that poor quality design and documentation has directly contributed to increases in the variations of quantities, rework, cost over-runs, extensions of time and contractual disputes. As a result of these problems, contractors have indicated that decreases in project quality and increases in overall project costs and duration. Consequently, to manage the work load 72% time and 64% cost allowance has been expended. Of major concern, are the additional costs – that to a large degree end up being absorbed by contractors – which are caused by the delays and disruption in trying to clarify inadequate, impractical, conflicting or ambiguous design and specification documentation? A Study by Olawale, Y. and Sun M. (2010) revealed that design change is one of the first ranked time and cost control inhibiting factor.

According to the study of Shady K. (2009), out of the forty well recognized and identified causes of design deficiencies, the top three factors affecting design quality based on the degree of severity are: lack of qualified design consultants staff, absence of overall design manager and lack of time available for checking and correlating all the information on all design documents.

The overall price of design and documentation deficiency to clients and developers, are higher project costs and longer project durations, with most contractors adding a percentage to the tender price submitted for a project to allow for poor quality design and documentation. The actual percentage added is generally determined by the contractors' assessment of the quality of design and documentation provided.

On the other hand, it has been found that the most occurred factors-for causes of design deficiency were: Reduced design fees levels, selection of designers on the basis of lowest price selection strategy, allocation of staff to more than one project in the same time; unstable client's requirements, last minute changes by the client and unwillingness of client to pay fees.

According to Shady K. (2009) Causes of Design and Documentation Deficiencies are:

In sufficient project briefs based on targets that are not realistic, devaluation of ethics and professional standards of business practice, the selection of consultants based submission of lowest bid regardless of value for money, absence of integration linking the stakeholders to the project and between various phases of the project, the ineffective or low use of technology to carryout design documentation activities, poor communication between contracting parties, poor understanding of the requirements for the optimization of designs and provision of quality documentation, absence of an overall experienced design coordinators who is to be appointed by the client, the recruitment of less skilled and experienced human resource due to inadequate availability of personnel.

Figure2.2: Depicts the impact of efforts/cost made during design phase on cost and performance. If high effort is made at early design stage, it indicates that we can save cost of design change. An effort made at construction stage is not critical as efforts made at early design stage, because it is not so easy to save cost of design change at construction stage. When using a drafting-centric workflow, most of the effort happens during the construction documentation phase when the ability to impact project cost and performance is declining and the cost of making design changes is increasing. Generally, the graph shows that effort made at early design stage has a critical impact on cost of design change saving than efforts made at construction stage.

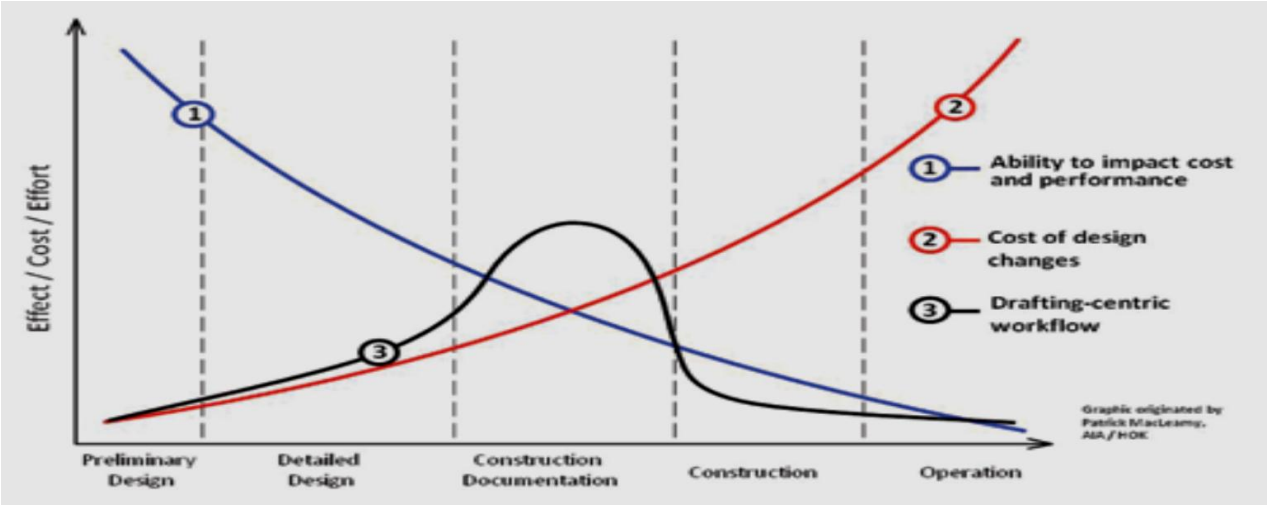


Figure 2.2: Road and highway projects can benefit from design using (BIM).

2.4: Project Complexity:

Complexity is one of the critical project characteristics that affect the project objectives for time, cost, and quality. The higher the complexity of project is, the greater the time, and cost of that project. He defined project complexity with the following dimensions:

I. Organizational complexity – the number of departments, people, interactions, and interdependencies.

II. Technological complexity - technology type, interdependencies, and differentiation.

III. Integration - number of interdependent components

Vidal and Marle (2008) conducted research to understand project complexity and identify the implications of complexity on project management. They used several studies in the field of project management and project complexity, from which they characterized project complexity through factors that are classified into the following four families:

2.1. The size of the project - number of stakeholders, resources, deliverables, and departments

2.2. The variety of the project system - variety of stakeholders, resources, deliverables, and departments

2.3. Interdependencies within the project system - dependencies on resources, departments, processes, and deliverables

2.4. Context dependence: local lows, environment complexity, technological degree of innovation

However, failure to define the scope of services properly by the Client might result in an unrealistic fee set by the tenderers. Therefore, proper definition of consultancy deliverables and scope of incentives or consequences for breach or default are particularly important to obtain a reasonable consultancy fee.

2.5. Engineering Effort vs. Project Cost

Engineering decisions, whether delivered by public works employees or private sector consultants, are the key factors in the initial cost and long-term value in public works projects. Engineering costs are typically less than 15 percent of a project's construction costs and no more than 2 percent of life cycle costs. But the decisions that are made during the engineering phase regarding the layout, design, materials, size, equipment and other facets of a project are critical to how long a facility lasts, how much it costs to maintain and how well it addresses the problem

it was intended to solve. Money invested in quality design at the front end of a project often can save significantly on overall project costs.

Getachew T.(2009) taking (Construction Industry Institute, 1986) as a reference has shown that by incorporating construction knowledge during the early stage of design facility has an opportunity to impact cost and quality and that its influence on performance measure such as; Cost and Quality diminish with the passage of time during the life of the project.

According to Cavanaph et al. (1978), making changes in early stages of the design phase require the least amount of time, cost and effort.

2.6. Impact of Design fee or Design Cost:

2..6.1. On Design Quality

Reduced design fee levels have a highly detrimental effect on both design quality attributes and construction process.

According to DeFraites (1989), "*overall project quality is greatly determined by the level of professional services provided and that the quality of these services is generally determined by how the services are selected and how the fees are negotiated." Where the designers are selected on the basis of low design fees, then the level and quality of the service provided is likely to be limited and that this generally translated in to additional project cost to the owner."*

I. In case of design the two attributes affected most being:

- innovation – incorporating innovation in the design solution; and
- provision of in-house and external training – to ensure continuing professional

Development of design staff and

II. In case of construction process:

- Inadequate or insufficient design work being carried out; and
- Insufficient design coordination – causing clashes between the services and building elements Tilley and Mc Fallan (2000). Paying Low design fee for design service can influence design quality required.

According to Shady K.(2009) reduced design fee level is the main cause of design deficiency.

PN.Okonkwo and J.Wium (2018) in their study cited that low professional fees can influence conditions/ attitudes that create risk for consulting Engineers.

Taking survey study conducted by UK (Hoxely,2000) as reference they have shown what has been revealed in the survey as below: For projects with 'low fees', that consulting Engineers: give less consideration to design alternatives and to checking and reviewing of drawings,

consider the risks of design error occurring as being higher, produce simpler designs to minimize the commitment of resources to a design task, judge the number of claims for additional fees to be higher on projects with low fees, think that low fees engender mistrust between client and consulting engineer, and bid low with the intention of doing less than in the enquiry, and making up fees with claims and variation

PN.Okonkwo and J. Wium (2018) has also identified risks associated with discounted fees.

There are problems associated with discounted fees. Table 2.7: Shows impact of discounted fees.

Table 2.7 Summary of impact of discounted fees:

✓ absence of innovation in design ✓ inability to carryout proper quality control on site ✓ huge financial implication of redesigns can erode profit ✓ inability to afford competitive salary	✓ poor quality design and documentation ✓ professional indemnity claims ✓ decreased quality of service/ inability to perform value engineering and ✓ design errors

According to the study of Lowry (1996), with organizations offering reduced fees in order to just to win work can influence the required quality of service due to the increase in competitive pressure which leads to: a decline in professional standards resulting in poor services to clients, a decline in the standards of the capability of recent graduate and junior staff disproportionate ratio to junior staff, resulting in poor handling on of accumulated knowledge.

Abolnour (1994), also argue that 'most of the offices pay small salaries for their engineers in order to maximize profit on one hand, and compete with low design fees in the market on the other hand.'

'Low design fee shortens the required time for the design process in order to maintain profit. As a result, the structural engineer will not find enough time to design and review the project structure accurately.' Abolnour (1994)

Albonour (1994) had also shown in his study that design deficiency had non-linear inverse relationship with project design fees, and that project costs due to design deficiency increase sharply when design fees are reduced below their optimal level.

Albonour (1994) further argue that ' *Low salaries only attract unqualified or inexperienced engineers and even that those engineers having experience, who choose to stay usually reduce their effort, creativity and care to be equivalent to their salaries.'*

2.6.2: On Project Performance

Design and design cost are interrelated to one another. Low design cost can negatively impact on achievement of quality design requirement. Design cost is one of the key elements of a project budget. Getting it correct right from the beginning is the first step to control cost overrun of projects. If the designing team has not defined scope of work from the early beginning, it is possible to say that the first step for future changes is confirmed or in another way it is the first project fire alarm for the inevitable cost overrun. This implies that every project should have a defined scope before starting to implement and the design team should know their scope and the project design cost should be defined. Failing to adequately fund the design phase can result in increased construction cost growth (Gransberget (al, 2007). According to (Struts et al 2005) in highway projects, the design cost ranges from approximately 1.5% to 5% of the estimated construction cost. The effect of inaccurately estimated consultant design fees create an unintentional limit on the amount of design effort that can be expended on a given project (Carr et al 2005) and actually impact the quality of the construction documents (Mc.Skimming et(al, 2005).

Gransberg and others (2007) investigated the correlation of design fees to construction "cost growth from the initial estimate" termed CGIE. Using 31 projects of the (OTA), Gransberg confirmed that an inverse relationship existed between design fees and construction cost growth.

Their conclusion asserted that as design fees decrease, construction cost growth (from initial estimate to final closeout) increases.

Correlating design fees to design quality, the results support the premise that allocating sufficient funding in design reduces the likelihood of construction cost increases from the initial estimate. *'By reducing design fees to minimize costs, clients and developers again by their own actions, appear to be contributing to the problems that lead to inefficiencies in the construction process and increases in overall project costs*.' Tilleyand Mc Fallan (2000.) Where designers are selected based on low design fees, then the level and quality of the service provided is likely to be limited and generally translates into additional project costs to the owner (Abolnour, 1994).

As design costs are usually a small portion of the total project cost, conventional wisdom holds that it is unnecessary to conduct a detailed design cost estimate that accounts for all the uncertainty (Brown 2002). The design fee contingency tends to be a small percentage of the total project costs, making its value seem inconsequential.

Gransberg‟s measurement of cost growth from the initial estimate was a departure from other studies that measured cost growth only from the bid price. Gransberg's study provided quantitative data on design costs. However, the sample size was small. Of the 31 projects investigated, 13 were roadway projects and 18 were bridge projects. The average design cost for all projects was 5.2 percent.

The roadway projects design costs averaged two percent, whereas the bridge projects exhibited design costs nearly four times higher (7.6 percent). He then concluded “bridge design projects should command a relatively higher design fee than roadway projects due to the increased complexity of design." [Gransberg et al.2007].

'Mandelson, (1997); Grifth and Sidwell, (1995)' study revealed that problems encountered during construction can be traced back to design process. Among the total problems encountered during construction design problem can contribute as high as 75% the total problems.

“It is unwise to pay too much, but it is worse to pay too little. When you pay too much you lose a little money. When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing it was bought to do. The common law of business balance prohibits paying a little and getting a lot - it can’t be done. If you deal with the lowest bidder, it’s well to add something for the risk you run, and if you do that, you will have enough to pay for something better. “John Ruskin (1819 - 1900), English art critic and social thinker.

Alhaji Al.et. al. (2017) Identified 23 factors/ variables causing low -skilled workers performance in construction projects which results in inefficient construction project productivity. Among these factors: Low wages of skilled workers , lack of sufficient skill acquisition center, lack of incentive scheme programs ranked first to third position consecutively.

Lack of standardized salary scale for skilled workers is ranked in the fifth position as the cause of skilled workers low performance.

According to Malinda (2017), among seven identified factors contributing to the poor quality of project documentation are: lack of resource due to low fees, inexperienced consultant personnel and shortage of skilled staff are the top three factors ranked first to third position consecutively.

2.7: The Effect of Design on Construction Costs

According to Jergeas(2008), design has a great influence on all the project life specially the construction stage not only in monetary terms but also on time**.** Shortcuts in design are penny-wise and pound-foolish. Firms competing on the basis of price rather than value can develop plans without evaluating options or with minimal details that often require much decision making in the field by the contractor. On a structural project, an engineer could design only the most heavily loaded members then repeat the conservative design throughout the structure, resulting in over sizing and higher construction costs. Since construction costs are typically 85-90 percent of project costs, expansion of these costs is much more significant than the cost of full design services. Study conducted by Machowski and Dale (1995), revealed that design change has significant problem in construction industry having large administration costs.

Report of Queensland (2005) also revealed that poor quality of design documentation has led to 60 to 90% of all variations in construction industry.

Nirajan Mani(2011) by taking 47 road projects and 11 flood control projects investigated the correlation of Basic Design cost versus contract award cost Growth, basic design cost versus total cost growth, basic design cost with construction cost growth, basic design cost versus construction schedule growth, total design cost versus contract award cost growth, total design cost versus total cost growth and total design cost versus construction schedule growth, and basic design cost with final construction growth using Pearson correlation coefficient. The findings he obtained are summarized as shown in Table2.8.

Table 2.8 Summary of Pearson correlation

Pearson correlation	Investigation Result
i. Basic Design cost versus contract award cost Growth	The higher the cost expended in the design, the lower the cost deviation between the bid cost and engineers estimate. i.e. high design cost improve design quality and will reduce error in design, resulting in accurate engineers estimate.
ii. basic design cost versus total cost growth	Higher cost expended in design, the lower the cost deviation b/n final construction cost and engineers estimate
iii. basic design cost with construction cost growth	The Higher cost expended in design, the lower the cost deviation b/n final construction cost and construction contract cost
iv. basic design cost versus construction schedule growth	The Higher cost expended in design, the lower the schedule deviation between final construction duration and construction contract duration.
v. total design cost versus construction schedule growth	The Higher cost expended in design, the lower the schedule deviation between final construction duration and construction contract duration

2.8: Project Delivery Methods

Besides inadequate design and low design fees, project delivery methods will have also impact on project performance. Achievement of a project's objectives in terms of delivering a facility that may typically include meeting specific user and functional requirements; completing the works to a timetable; achieving value for money; completion within a prescribed budget; and meeting long term goals such as sustainability. To achieve these, the procurement strategy for selecting Consultants should, in view of the significant and critical impact of the Consultant's work on the project outcome, adopt technical capability as a significant selection criterion. With this technical focus, the procurement strategy should facilitate the identification and selection of a suitably qualified Consultant team that is capable of generating design solutions that contribute in the development of a sound, functional, efficient, safe and cost effective design.

To enhance quality, the procurement strategy should identify appropriate opportunities for the use of the most appropriate construction delivery, whether by Client-led construction or "design and build". This should strive to make the best use of both the Consultant's and Contractor's expertise or proprietary systems that would achieve construction efficiency, high performance standard or other technical advantages.

2.16.1: Design-Bid- Build Project Delivery System

Highway/transportation projects are typically delivered using the Design-Bid-Build (DBB) delivery method where the owner first finalizes the design using either in-house or consultant design assets, which then produces a set of "biddable" construction documents upon which competing construction contractors will bid. The project is advertised by issuing an Invitation for Bids (IFB). Generally, the winner is chosen on a basis of the lowest, "responsive" and in some cases, "responsible" bid. In DBB there are no contractual obligations established between designer and contractor.

The DBB method has been in use for many years and has worked well for many projects. A study conducted for the California Department of Transportation (Caltrans) found that states using ACMs continued to deliver the bulk of their annual construction budget >95% using DBB (Gransberg and Molenaar 2008).

The traditional (DBB) Delivery system has many drawbacks compared to Design Build delivery system. Many researchers had conduct a comparative study between the DBB and DB project Delivery systems to assess the relative advantages and disadvantages when using such delivery systems.

The overall project schedule is linear, creating longer overall project durations (Venturato and Schroeder 2007). The use of DBB sometimes creates adversarial relationships between the parties involved. Finally, research has shown that DBB projects have a higher average cost growth than projects delivered using ACMs (FHWA 2006). According to Karte H.(2014), as project owners warrants the quality of the construction documents, in the traditional DBB project delivery, poor design quality leads to increased construction cost.

Studies conducted by Warne (2005) and Shrestha et al.(2007) taking highway projects in to account, revealed that cost growth for DBB projects is higher than DB project and that 76% of DB projects were finished ahead of schedule and Schedule growth for DB was 5.2% higher than DBB.

In DBB, the owner "owns" the details of design during construction and, as a result, is financially liable for the cost of any errors or omissions encountered in construction. Public DBB projects are generally awarded on a low-bid basis, through an IFB process. There is no contractual incentive for the builder to minimize the cost growth in this delivery system. In fact, there can be an opposite effect. A builder who submits a low bid and is awarded a project contract may need to look to post-award changes as a means to make a profit on the project after bidding the lowest possible margin.

Most construction road projects of Federal Democratic Republic of Ethiopia are also procured using DBB delivery method. In this type of delivery method the client performs two phase of contracting services to select consultants and contractors for the purpose of design and build operation. Although clients may have some advantages when using this delivery method, owners have complete control over the design because consultants are directly engaged by them.

It has also drawbacks on the other aspect as it contains some limitations which include vertical fragmentation, slow take-up of innovation, low productivity, and a lack of single point responsibility (Ling and Kerh, 2004). Masterman (1992) has found that one of the principal reasons for the construction industry's poor performance is the inappropriateness of the procurement system that has been chosen

2.8.1.1: Project Delivery Selection Factors Opportunities and Obstacles Checklists

Design-Bid-Build (Project Delivery Selection in terms of Schedule Checklist) has opportunities

and obstacles: **Opportunities:** Schedule is more predictable and more manageable, milestone can easier to define, project can easily be shelved, shortest procurement period, elements of

design can be advanced prior to permitting and construction, time to communicate/ discuss design with stakeholders.

Obstacles: Requires time to perform a linear design-bid-construction process, design and construction schedules can be unrealistic due to lack industry input, errors in design lead to change orders and schedule delays, low bid selection may lead to potential delays and other adverse outcomes.

Project Delivery Selection Checklist in terms of Complexity and Innovation

Opportunities: Agencies can have more control of design of complex projects, agency and consultant expertise can select innovation independently of contractor abilities, opportunities for value engineering studies during design, more time for design solutions, aids in consistency and maintainability, full control in selection of design expertise, complex design can be resolved and competitively

Obstacles: Innovations can add cost or time and restrain contractor's benefits**,** No contractor input to optimize costs**,** limited flexibility for integrated design and construction solutions (limited to constructability)**,** difficult to assess construction time and cost due to innovation.

Level of Design Project Delivery Selection Checklist

Opportunities: 100% design by agency, agency has complete control over the design (can be beneficial when there is one specific solution for a project), project/scope can be developed through design, and the scope of the project is well defined through complete plans and contract documents well-known process to the industry

Obstacles: Agency design errors can result in a higher number of change orders, claims, minimizes competitive innovation opportunities, can reduce the level of constructability since the contractor is not brought into the project until after the design is complete.

Figure 2.3: Shows typical Design -Bid-Build Project Delivery System showing Architects, Engineers and contractors point of Engagement which is adapted from (DBIA, 2016). This type of delivery method is characterized by separation of activities. Unless prier activities such as

planning, and design is completed, no opportunity for trade contractors to be engaged at early design stage.

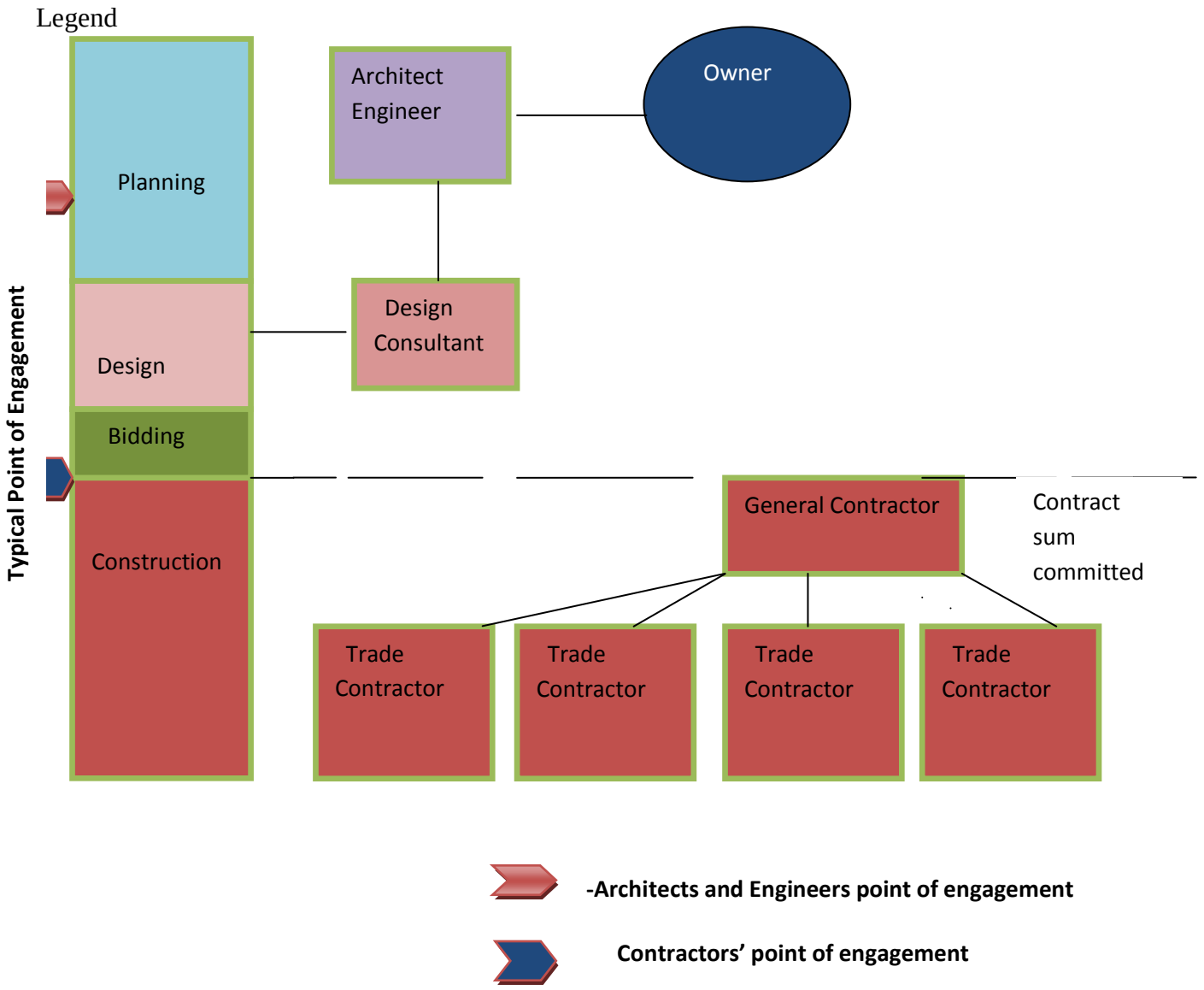


Figure 2.3: Typical Design -Bid-Build Project Delivery System

2.16.2: Design -Build Delivery System

Apart from DBB delivery system, based on the survey study of state of DOT's, (DBIA, 2016), revealed that 91% of highway projects, 65% of bridges and 9% of Rail road's in the state are procured using Design Build Delivery system. The Design-Build Institute of America (DBIA, 2016), compiled many articles related to design build practice and project specific cases studies conducted by researchers. Taking the findings of publications of ((Sanvido&Konchar,1999),(Hale,Shrestha,Gibson&Migliaccio.2009),(Florida,DOT,2014),(Warne Associates,2005), (Shrestha, Migliaccio, Occonor and Gibson, 2007)), showed that DB project delivery system is cheaper than DBB delivery system by an average of 6.7% and has less cost growth up to an average of 20%. DBIA,2016, also taking transportation specific studies conducted by ((FDOT,2014), (Shrestha, 2012), and (FHWA, 2006)) revealed that DB project delivery system is faster than DBB by an average of 53% and cost effective by an average of 3.75%.

Studies conducted by (Rameezdeen)taking 60 commercial projects procured through DBB and DB systems found that the cost growth (the increase of total project cost based on the initial contract sum) for DBB projects is significantly higher than DB projects. The study has indicated also that the mean values of the schedule growth for DBB is higher than DB projects with DBB project 38% and DB projects 13% growth consecutively.

'The greatest motivation and realized benefit to a contracting agency of using design build … is the ability to reduce the overall duration of the project development process by eliminating a second procurement process for the construction contract, reducing the potential for design errors and omissions, and allowing for more concurrent processing of design and construction activities... (FHWA 2006)

2.8.2.1: Project Delivery Selection Factors Opportunities and Obstacles Checklists

In terms of Schedule Checklist it has the following opportunities and obstacles: **Opportunities:** Potential to accelerate schedule through parallel design-build process, shifting schedule risk to D-B team, encumbers construction funds more quickly, industry input into

design and schedule, fewer chances for disputes between agency and design builders, more efficient procurement of long-lead items, ability to start construction before entire design, ROW, etc. is complete (i.e., phased design), allows innovation in resource loading and scheduling by design build.

Obstacles: Request for proposal development and procurement can be intensive, undefined events or conditions found after procurement, but during design can impact schedule and cost, time required to define technical requirements and expectations through RFP development can be intensive, time required to gain acceptance of quality program, requires agency and stakeholder commitments to an expeditious review of design

Project Delivery Selection Checklist in terms of Complexity and Innovation

Opportunities: Designer and contractor collaborate to optimize means and methods and enhance innovation**, o**pportunity for innovation through draft RFP, best value and ATC processes**; c**an use best-value procurement to select design-builder with best qualifications and constructability and VE inherent in process.

Obstacles: Requires desired solutions to complex designs to be well defined through technical requirements (difficult to do)**, q**ualitative designs are difficult to define (example. aesthetics)**, r**isk of time or cost constraints on designer inhibiting innovation**, s**ome design solutions might be too innovative or unacceptable**, q**uality assurance for innovative processes are difficult to define in RFP.

Level of Design Project Delivery Selection Checklist:

Opportunities: Design advanced by the agency to level necessary to precisely define the contract requirements and properly allocate risk**, d**oes not require much design to be completed before awarding project to the design-builder between 10% - 30% complete**, c**ontractor involvement in early design, which improves constructability and innovation**,** plans do not have

to be as detailed because the design builder is bought into the project early in the process and will accept design responsibility.

Obstacles: Must have very clear definitions and requirements in the RFP because it is the basis for the contract, if design is too far advanced it will limit the advantages of design-build, potential for lacking or missing scope definition if RFP not carefully developed, over utilizing performance specifications to enhance innovation can risk quality through reduced technical requirements, less agency control over the design and Can create project less standardized designs across agency as a whole.

Delivery Selection Checklist in terms of Cost

Opportunities: Contractor input into design should moderate cost**,** design-builder collaboration and ATCs can provide a cost efficient response to project goals**, c**osts are contractually set early in design process with design-build proposal**,** allows a variable scope bid to match a fixed budget**,** potential lower average cost growth and funding can be obligated in a very short timeframe

Obstacles: Risks related to design-build, lump sum cost without 100% design complete, can compromise financial success of the project

Source: Guidebook for Selecting Alternative Contracting Methods for Roadway Projects: Project Delivery Methods, Procurement Procedures, and Payment Provisions University of Colorado Boulder, Colorado August 1, 2014

According to Design Build Institute of America (DBIA, 1994) Design Build delivery method has several advantages over the traditional method DBB. Its advantages are listed as below:

I. **Single Responsibility**: Both the design and construction are the responsibility of a single entity. Litigation issues are removed between designer and contractor allowing the owner to focus on the scope need definitions, and decision making rather than coordination between designer and contractor.

II. **Quality:** The owners' expectations and needs are documented with performance specifications and the design builder responsibilities to produce an end product in accordance to these specifications. The Design - Builder warrants that the design is free from error rather than the owner in the case of traditional system. This allows the designer-builder to focus on quality and project performance.

III. **Cost Savings**: Design and construction team working and communicating as a team can better evaluate methods and material options more efficiently.

Value-Engineering and constructability are utilized continuously and more effectively when design and construction team work together.

IV. **Time Savings**: Design and construction can be overlapped. Material/Equipment procurement and construction can begin before designs fully completed. The resulting time saving can lead to reduced project cost and early facility utilization.

V. **Early knowledge of firm cost**: Guaranteed construction cost can be known far earlier using Design-Build than other delivery systems because of the entity responsible for design is continuously able to better estimate cost based on the current project details.

VI. **Impacted Risk Management**: Performance aspects of cost, schedule, quality and responsibility of risk are more appropriately balanced.

Figure-2.4: Indicates a **t**ypical Design -Build project delivery system showing consultants and contractors point of engagement. This type of project delivery system has an advantage for innovation and constructability and early engagement for both design consultant trade contractors simultaneously. Following request for qualification or request for proposal, there is a chance for trade contractors to be engaged at early stage and there is a possibility to carry out the design task as well as the construction activities concurrently.

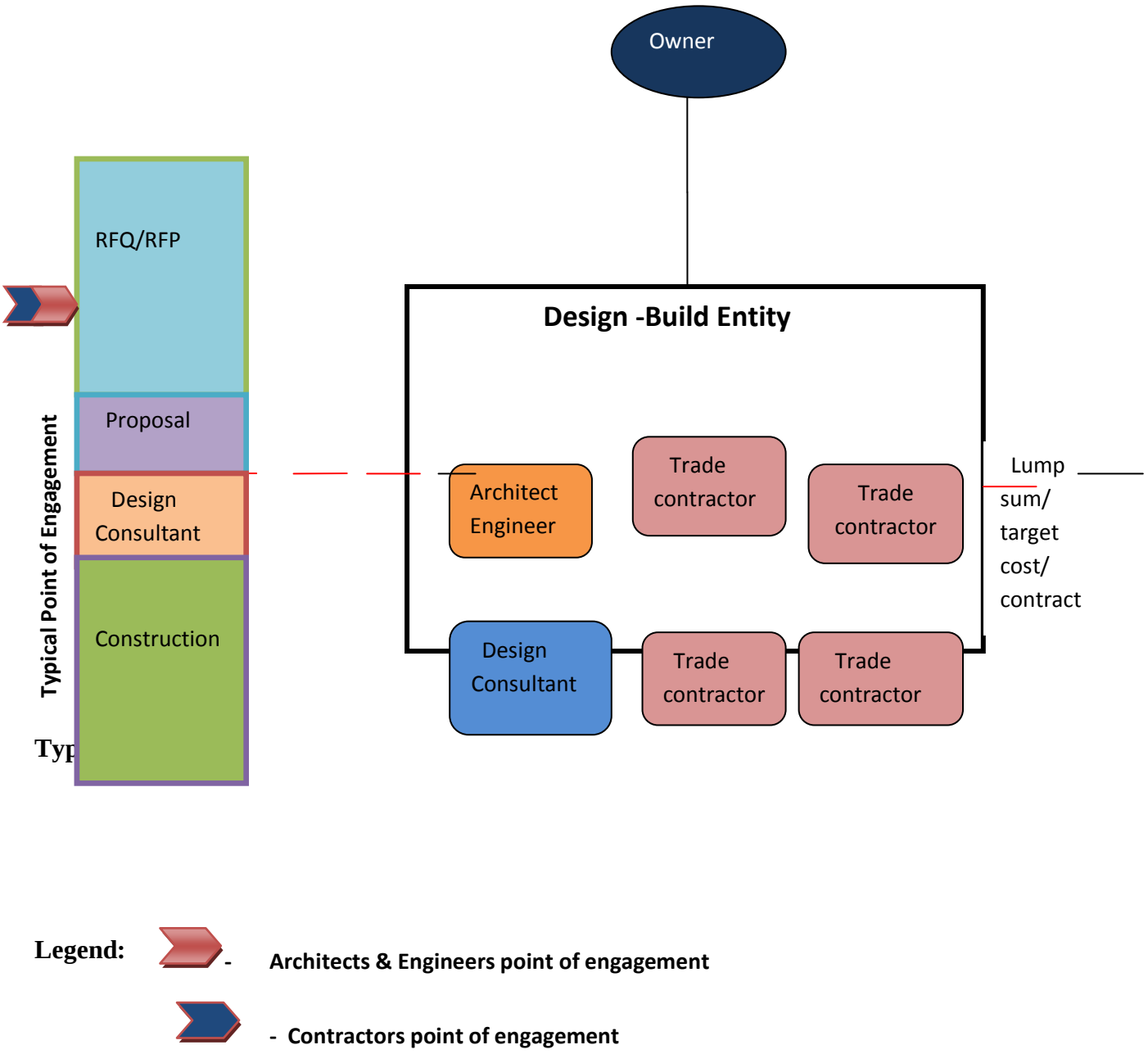


Figure-2.4: Typical Design -Build Project Delivery System showing Architects &Engineers and Contractors point of engagement at the same time during the proposal stage which is adapted from (DBIA, 2016)

Based on the study of Mandelson (1997), Grifth and Sidwel (1995), Getachew T. (2009) problems that encountered during construction can be traced back to design process. Among the total problems encountered during construction, the extent of problem due to design can be as high as 75% of the total problem.

Getachew T. (2009), taking ten federal road projects of Ethiopia roads authority as a case study, indicated that: 90% of the project encountered omission of work,70% of the project faced errors in estimation of quantity,30% of the project found with inadequate/ incomplete survey data, lack of design detail, poor drainage assessment and 40% of the projects encountered scope change due to late implementation of design and that design risks particularly, design errors and omissions contribute to time and cost overruns of the project.

2.9: Effect of Constructability or Build Ability on Project Performance

Definition:

According to Construction Industry Institute of America (CII 1987), constructability is defined as: *'the optimum use of construction knowledge, and experience in planning, design, procurement and field operations to achieve overall project objectives.'*

According to Hassun (2005) 'Build ability: *stresses on the integration of design and construction to achieve the project goal by enriching the knowledge of the designers in construction operation and involving construction expertise in the design process*.'

Eldin (1988) also states that 'constructability is the integration of construction knowledge in to all project phases as an effective means for reducing the project cost and time required for its completion.

Hassun (2005) also argue that constructability issue should be seen as one of the best solution to mitigate problems such as: change of design, cost overrun, and time delay to minimize the number and magnitude of changes, disputes, cost overruns and delay during construction. Getachew T.(2009), citing (CII,1986) argue that 'by incorporating construction knowledge during the early stage of design facility has an opportunity to impact cost and quality,

and that its influence on performance measure cost, quality diminish with the passage of time during the life of the project.'

Grifth and Sidwell, (1995) elaborated that the functional-ability of constructability issue can be well addressed by using Design -Build project delivery system. Table 2.9: Summary of constructability

Constructability: Functional Aims	**Design and Build Functional Ability**
✓ Simplified contractual arrangements	✓ The contract is b/n the client and the contractor, with total responsibility given to the contractor
✓ Integrated design and construction	✓ Promotes an integrated design& construction team in the firm of the main contractor. ✓ Encourage professionals to work towards the real interest of the client
✓ Improve communication	✓ Client-contractor single link & integration of design and construction improve communication b/n building or engineering team members
✓ Increased operational efficiency	✓ Client knows at any time who to contact, i.e. the contractor. The contractor can respond quickly to client's needs.
✓ Reduced project duration	✓ Significant savings in project time are possible through overlapping design and construction aspects. Pre-construction procurement time greatly reduced and earlier start on site is possible.
✓ Reduced cost	✓ Client knows within a reasonable degree of accuracy, the total financial commitment before commencing work on site. More rapid procurement also makes cost savings.
✓ Increased performance	✓ Detailed brief (employer's requirements and contractor's proposals set out the detailed specification for design workmanship, materials and performance.
✓ minimum project changes	✓ Detailed brief reduces likelihood of project changes. If variations occur contractor can respond quickly and directly to client

2.10: Cost Estimating and Management Steps

Cost estimating and cost estimating management processes can be described in terms of a number of steps. Cost estimating can be described in terms of four basic steps. The four steps and a brief description of each step are provided in Table 2.8 below. The descriptions are general in nature and are considered applicable to the estimating process across each development phase.

Table 2.10: Cost Estimating Process

Cost Estimating Step	Description
Determine Estimate Basis	Document project type and scope, including: scope documents; drawings that are available (defining percent engineering and design completion); project design parameters, project complexity, unique project location characteristics; and disciplines required to prepare the cost estimate
Prepare Base Estimate	Prepare estimate, including: documentation of estimate assumptions, types of cost data, and adjustments to cost data; application of appropriate estimate techniques, parameters, and cost data consistent with level of scope definition; coverage of all known project elements; reflecting known project conditions; and checking key ratios to ensure that estimates are consistent with past experience
Determine Risk and Set Contingency	Identify and quantity areas of uncertainty related to: project known's and unknowns; potential risks elements associated with these uncertainties; and appropriate level of contingency congruent with project risks
Review Total Estimate	Review estimate basis and assumptions; including: methods used to develop estimate parameters (e.g., quantities) and associated costs; verify estimate completeness relative to the project scope; check application of cost data including project specific adjustments; reconcile current estimates to the baseline estimate and explaining differences; and prepare an estimate file that compiles information and data used to prepare the project estimate

Table 2.11: Cost Estimating Management Process

Cost Estimating Management Step	Description
Obtain Appropriate Approvals	Obtain management authorization to proceed by: review of current project scope and estimate basis; ensure approvals from appropriate management levels; approve current estimates including any changes from previous estimates; and release estimate for its intended purpose and use
Determine Estimate Communication Approach	Communication is dependent upon the stakeholder who is receiving the information, but all communication should include: determine the mechanism for communicating the cost estimate for its intended purpose; determine the uncertainty that should be communicated in the estimate given the information upon which it is based; and determine mechanism to communicate estimate to external parties
Monitor Project Scope/Project Conditions	Identify any potential deviation from the existing estimate basis, including: changes in project scope; changes due to design development; changes due to external conditions; document the nature and description of the potential deviation; and decide if the deviation impacts the project budget and/or schedule (potential increase or decrease).
Evaluate Potential Impact of Change	Assess potential impact of change, including: cost and time impact of the deviation; document the impact; and recommend whether or not to modify the project scope, budget and/or schedule due to change
Adjust Cost Estimate	Changes to the baseline estimate; including: Appropriate approval of the deviation; change the project scope, budget and/or schedule; and notify project personnel of the change.

Figure 2.5: Shows Evolution of Project Knowledge through Project Development. Here components of uncertainties with know and unknowns at different project development phase are depicted. To arrive at Engineers Estimate through project development phase, uncertainties regarding project cost should be considered.

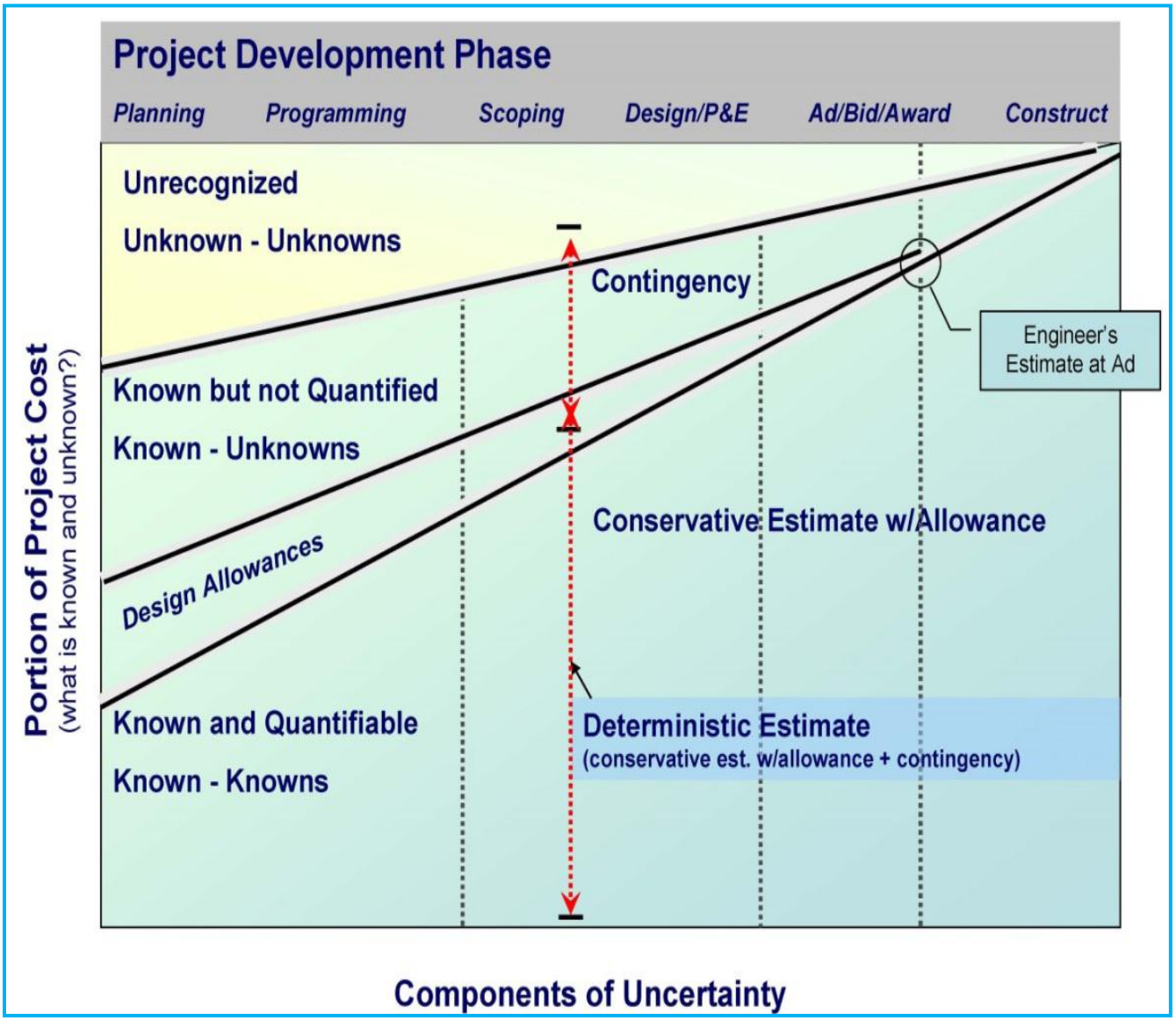


Figure 2.5: Evolution of Project Knowledge through Project Development

Source: WSDOT Project Risk Management Guide 2014

2.11: Selection and Appointment of a Consulting Engineers

2.11.3: According to Budget Guidelines 2009 for Consulting Engineering Services by consulting Engineers of British Colombia

Selection of appropriate consulting firm has a great impact in the achievements of required objectives. According to Skitmore and Marsden, (1998) Any project can be considered as successful when the project is delivered at the time, at the appropriate cost with the expected quality standards and provides the client with a high level of satisfaction .

A successful project is one which meets the requirements of the client at the lowest sustainable project lifecycle cost. Lifecycle cost must be understood within a meaningful context. The long term operation and maintenance of infrastructure or building assets costs are in the order of 80 to 93 percent of the asset's life time costs. At 1 to 2 percent of total costs, the cost of engineering is a relatively small percentage. However, the role of the engineer is pivotal in meeting the client's objectives because it is during the design process that construction, operations and maintenance cost savings are most easily achieved. Selecting engineering services for the apparent least cost is often false economy, and can be a disservice to the project and the Client.

According to Mono policies and Mergers Commission, (1970), ' *Price competition might create serious dangers in relation to quality of services of a particular personal nature or whose quality public is generally incapable of judging. Some clients might accept incompetent service a lower price without appreciating the risk involved.*" According to Mansfield,(1986), *"Allowing fee competition might pave the way for the variety of evils: among them the loss of professional trust and public responsibility, and greater incidence of penny-pinching, inadequate designs which might result in injury and even death*.'

Study of Shady K. (2009), also revealed that selection of designers on the basis lowest price selection strategy (lowest bid approach) ranked first position as one of key factor affecting design quality.

Qualifications-Based Selection (QBS) process is recommended for selecting the most competent and qualified consultant for a specific project.

When the consultant with the best understanding of the project and best qualifications to implement it is appointed, their role becomes one of a "trusted advisor", who shares their client's priorities and interest in achieving the best outcomes for the project.

2.11.4: Consultant Selection According to AASHTO guide 2008

The agency and consulting industry benefit when only qualified companies compete for work. Consultant qualification or pre-qualification by an agency normally serves as the first step towards an open and competitive selection process. Many agencies follow a qualifications based process requiring a formal submission by the consultants including their expertise/experience for the specific work areas. Another approaches used is the pre-qualification of consultants on project-by-project basis. An agency may solicit for pre-qualification of consultants by advertising in the newspapers or on the web. The information provided by a consultant is evaluated by the agency to ensure the consultant meets the requirements advertised.

According to Qualification-based Selection (QBS), a firm is selected based on their superior technical expertise, past experience, adequate staffing, and other criteria pre-established by the agency. Price for services is not a direct consideration in QBS. The submittals received are evaluated and ranked for qualifications and the negotiations for the detailed scope and price are held with the highest ranked firm. If negotiations are not successful within a pre-set time frame, the agency may proceed to negotiate with the next firm in the ranking.

2.12: Value Engineering (VE)

When presenting alternatives, it is a consultant's responsibility to ensure that the Department is presented with clear, objective information on which to make its decisions. Cost effectiveness of an alternative is a major consideration. Thus, thorough analysis of cost effectiveness is a primary consultant responsibility. However, "Best value does not necessarily equate with the lowest initial tender price; It also encompasses various quality considerations as well as longer-term benefits. In obtaining design services, the client should adopt a procurement arrangement that maximizes the ability of all parties in the construction supply chain to add value to the project.

To encourage consultants and contractors continuously improve their performance and to offer better value, clients should give balanced consideration to both price and quality in tender evaluation. The quality attributes may include technical capability, past performance, workmanship, site safety records and environmental performance, etc. As past performance will become one of the key quality criteria to be taken into account, an objective and transparent system for assessing the performance of consultants and contractors project implementation is necessary.

Value engineering is a systematic application of recognized techniques which identify the functions of the product or service, establish the worth of those functions, and provide the necessary functions to meet the required performance at the lowest overall cost. Value engineering concentrates on the effectiveness through stating functions, goals, needs, requirements and desires.

As part of ongoing analysis of cost effectiveness, a consultant is to consider Value Engineering (VE) in the design of all elements of a project. The objective of a VE study is to improve quality, minimize costs, reduce construction time, make the project easier to construct, ensure safe operations and assure environmental and ecological goals. The VE team is to look for the optimum blend of scheduling, performance, constructability, maintainability, environmental awareness, safety and cost consciousness.

Early application of VE helps in more organized implementation of project activities, thus reducing overall cost by avoiding any major changes right in the beginning. However, if the application of VE is done in later stages it may result in higher project cost.

According to Schneiderová Heralová (2015) and Hromada, E (2014) One of the problems with studies on public highway projects is the tendency of them to become a “cost- cutting” tool instead of a value-enhancing tool. Study conducted by Renata.S (2016) by reviewing the annual collected report on value engineering (VE) for projects accomplished within the Federal Aid and Federal Lands High way program for the period 2010 to 2014GC, revealed that through VE project cost saving could be attained increasingly from 3.2% of estimated construction cost in 2011 to 8.32% in 2014 with return of 80:1 to 200:1.

The study also asserted that the quality and cost of highways and other projects in the public works sector can benefited by the application of value engineering methodologies.

During Design Development phase many of ideas are expanded into workable solutions. It consists of:

Preparation of alternative designs and life cycle cost comparison of original and proposed designs, Description of recommended design change, each recommendation is presented with description, sketches, basic design concepts, technical information and cost summaries.

Selected ideas are developed into proposals so that owner and other project stakeholders understand the intent of proposal and benefits to the project.

2.12.1: VE Applicability

VE can be applied at any stage in a project, even in construction. However, the earlier it is applied the higher the return on the time and efforts invested. Thus, the greatest benefit and resource saving is achieved in planning and conceptual stage. At this point major information is established but before major design and development resources are spent.

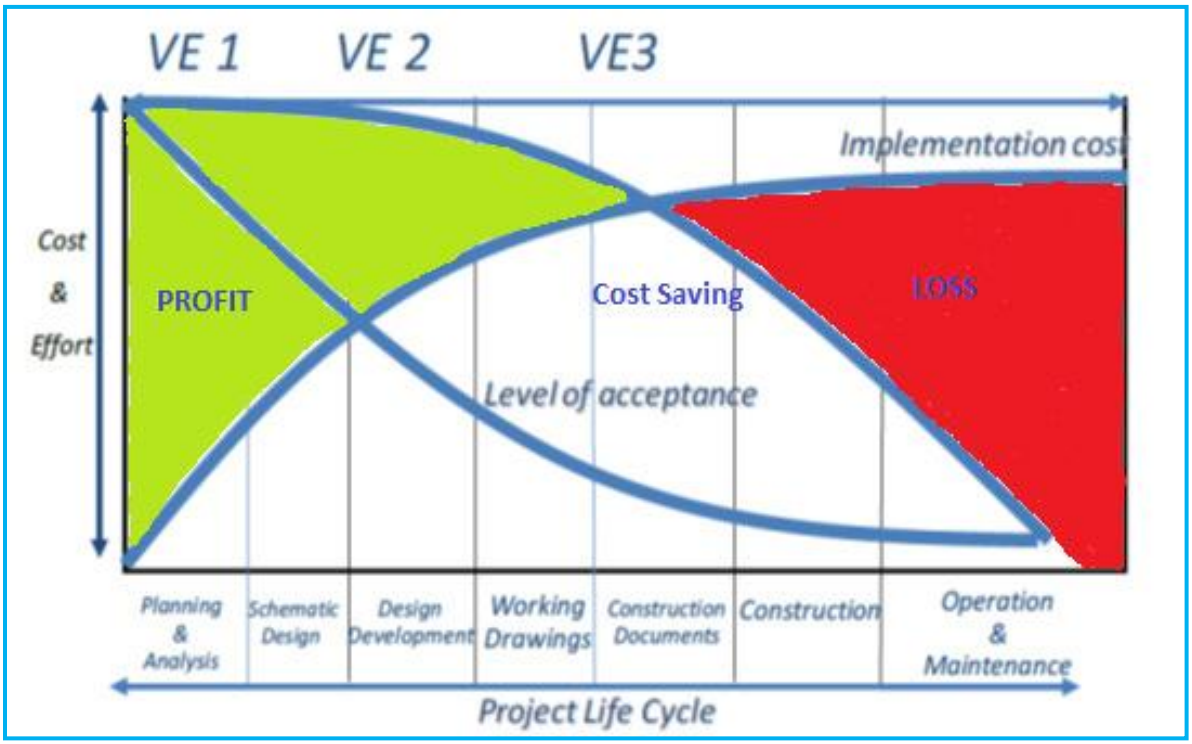


Figure 2.6: The stages of VE application

2.12.2: Planning and schematic design (VE1)

The first VE study VE1 is applied during the planning and schematic design stage to define the project goals, functions, objectives, requirements, design criteria and scope of work. Benefit of starting VE at this stage is that project will be developed with fewer changes, redesigns and greater understanding by all parties of what final function will be. Independent teams can bring alternative and creative solutions from other similar projects.

2.6.3: Design Development (VE2)

The second VE study VE2 is applied in design development stage to generate detailed VE proposals and alternatives to the design and to define technical systems. In this stage of VE, multiple design alternatives are considered and the most cost effective and overall efficient alternative is selected. Suggestions by other personal like constructor, designers are also taken for improvement.

2.6.4: Construction (VE3)

During this phase value engineering is still possible though the use of VE change proposal. But application of VE at this phase is generally costly and difficult to implement due to resistance to change.

2.6.5: Benefits of VE

Value engineering is used: To determine best design alternative, to reduce cost, to identify problems and develop solutions for them, to improve quality, to increase reliability, availability and customer.

2.6.6: Value Engineering Practice in Ethiopia

Even though application of VE has great benefits, there is implementation gap in the case of Ethiopian construction industry. Dawit B. (2017) reviewing different literatures identified that there are gaps of implementing VE in Ethiopian Federal Roads Projects. The author has identified six factors as the cause for the non- performance of VE as mentioned below:

A. Majority of Design consultants are local firms with limited capacity to hire experienced permanent professionals necessary to deliver design service with the client's requirement. The author argued that as there is lack of professional man power in the local market, and due to this reason Design Consulting Firms tend to deploy the required professionals on the basis of freelance. Consequently, this will create an opportunity for the key professionals to be engaged in numerous design projects at a time resulting in poor emphasis by design professionals towards improving the value for money of road construction projects**.**

B. Absence of Policy/ Statutory Requirement to enhance projects with certain limit of engineers estimate to undergo further cost optimization studies such as VE studies**.**

C. Absence of VE incentive clauses in contract other than the FIDIC MDB harmonized version to motivate construction stakeholders**.**

D. Absence of Professional associations in the country to promote VE practices

E. Lack of standardized guidelines and manuals for implementing VE in road construction.

F. Absence of sufficient skilled road design and construction professionals in the local market

2.13: REMUNERATION

2.13.1: Methods of Remuneration

A consulting firm needs to generate adequate remuneration for the services provided and to have healthy financial relations with clients. The client should feel that the fee is commensurate with the real value contributed to the client's business by the consultants' intervention. Clients do not expect to get an excellent professional service for a low price, but they do not want to be overcharged. Consultants seek remuneration that fairly reflects the time spent and the impact achieved in working for particular client, as well as other costs and expenses of the consultancy-the acquisition and development of the consultant's intellectual capital, service marketing, practice management and administration, etc

Depending on the stage of the project, its complexity and how it is well defined engineering fee budgets for a project can be calculated based on fixed Fee or lump sum. Remuneration can also be calculated based on time basis, and on percentage cost of construction.

Remuneration for Transportation and Infrastructure Engineering project services such as, advisory service, preliminary design**,** Resident Engineering, Project Management and Construction Management services can be estimated based on time basis, whereas services such as, final design, tendering, and construction service preferably estimated on fixed fee or percentage of cost of construction.

2.13.1.1: Time Based Remuneration Method

The time basis method is recommended when the scope of engineering services is difficult to determine, cannot be determined, is not well defined, or when the consultant is not in total control of the required time and disbursements at any stage of the project. All time expended on the assignment is billable, including travel, time in the consulting engineer's office and time on the client's premises or elsewhere. The consultant can be expected to closely monitor progress and provide regular status reports on the project.

In addition, the method leads to the consultant closely monitoring changes to their originally defined scope, which can promote an adversarial relationship with the client.

Reviewing the basic considerations involved in costing the consultant's time and establishing time -based fees is important.

2.13.2: Percentage of Cost of Construction

Fee based on the percentage of Cost of Construction may be suitable for engineering services where the cost of the consulting engineering service is a function of the construction or installation costs, and where the project scope and construction or installation budgets are well defined. Client Agreements should clearly define whether the cost of construction is based on an estimate established at commencement of a project or on the completed actual construction cost.

a. Recommended Minimum Percentage Fee Budget Scale for Basic Services for Transportation and Infrastructure Engineering Projects of Average Complexity Cost of Construction Fee.(For less than $1,000,000 use other methods)

Table 2.12: Minimum percentage fees for projects of average complexity

		Fees	
$ 1,000,000-2,000,000	$ 49,000 on first	1,000,000	plus 4.3% on next $1,000,000
2,000,000 - 5,000,000	92,000 on first	2,000,000	plus 4.1% on next 3,000,000
5,000,000 - 10,000,000	215,000 on first	5,000,000	plus 3.9% on next 5,000,000
10,000,000 - 15,000,000	410,000 on first	10,000,000	plus 3.7% on next 5,000,000
15,000,000 - $20,000,000	593,000 on first	15,000,000	plus 3.6% on next 5,000,000
Over $20,000,000	775,000 on first	20,000,000	3.6% on balance

Examples of projects of average complexity: Bridges and other structures of conventional design, simple waterfront facilities, Railways, roads and streets, Conventional levees, flood walls and retaining walls, small dams, Site development, Sewer and water tunnels (free air), storm sewers and drains, irrigation works (except pumping plants), sanitary sewer lines 600 mm and larger, water distribution lines 400 mm and larger, Airports with small facilities

Recommended Minimum Detailed Design Fee as A % Of Cost Of Construction For Transportation and Infrastructure Engineering Projects Of Average Complexity

In the concept of determination of design fee of consulting services, there is an inverse relationship between percentage of fee and construction cost. As construction cost increases percentage of service fees for consultant will decreases.

b. Recommended Minimum Percentage Fee Budget Scale for Basic Services for Transportation and Infrastructure Engineering Projects of Above Average Complexity Cost of Construction Fees. (For Less than $1,000,000 use other methods)

Table 2.13: Minimum percentage fees for projects of above average complexity

		Fees	
$ 1,000,000-2,000,000	$ 68,000 on first	1,000,000	plus 5.8% on next $1,000,000
2,000,000 - 5,000,000	126,000 on first	2,000,000	plus 5.6% on next 3,000,000
5,000,000 - 10,000,000	294,000 on first	5,000,000	plus 5.4% on next 5,000,000
10,000,000 - 15,000,000	565,000 on first	10,000,000	plus 5.3% on next 5,000,000
15,000,000 - $20,000,000	828,000 on first	15,000,000	plus 5.2% on next 5,000,000
Over $20,000,000	1,086,288 on first	20,000,000	plus 5.2% on balance

Examples of projects of above-average complexity: Water, waste water, and industrial waste treatment plants, bridges which are asymmetric or are otherwise complicated, large dams or complication small dams, highways, urban and suburban arterial streets, grade crossing eliminations, highway and railway tunnels, pumping stations, incinerators, intercepting and relief sewer, sanitary sewer lines under 600 mm in diameter, water distribution lines under 400 mm in diameter Complex foundations, additions to or reconstruction of projects, power plants and distribution systems, airports with complex facilities and infrastructure

2.14: Cost of Construction for Engineering Projects

The cost of construction includes the following:

- The total cost of all materials, equipment and labor (including duty, taxes, grants-in-aid and subcontractors' and general contractors' overhead and profit) necessary to complete the work for which the consulting engineer prepares drawings and specifications or for which the consulting engineer is responsible to the client.
- In the event that the client furnishes material, equipment, services or other labor that is incorporated in the work, the cost of construction includes the fair market value of those

materials or equipment as if newly purchased. In addition, the cost of construction includes the current prices of labor or other services at the time of construction. In the event construction does not proceed, market prices at the estimated time of construction shall prevail.

- In the event that the client or contractor furnishes used material or equipment at the client's request, the cost of construction includes the fair market value of those materials or equipment as if newly purchased.

Fee budgets are based on the cost of construction including all extras to the construction contract. No deduction may be made from the consulting engineer's fee because of penalties or damages claimed by the client from the contractor or other sums withheld from the contractor. The cost of construction does not include professional fees and reimbursements payable to the consulting engineers.

Figure 2.7: Shows mode of payments for consulting service. Here, the client pays fees for the consulting firm for the services rendered and consultants' staffs provide service or labor to the firm and the firm will also pays salaries to his staff.

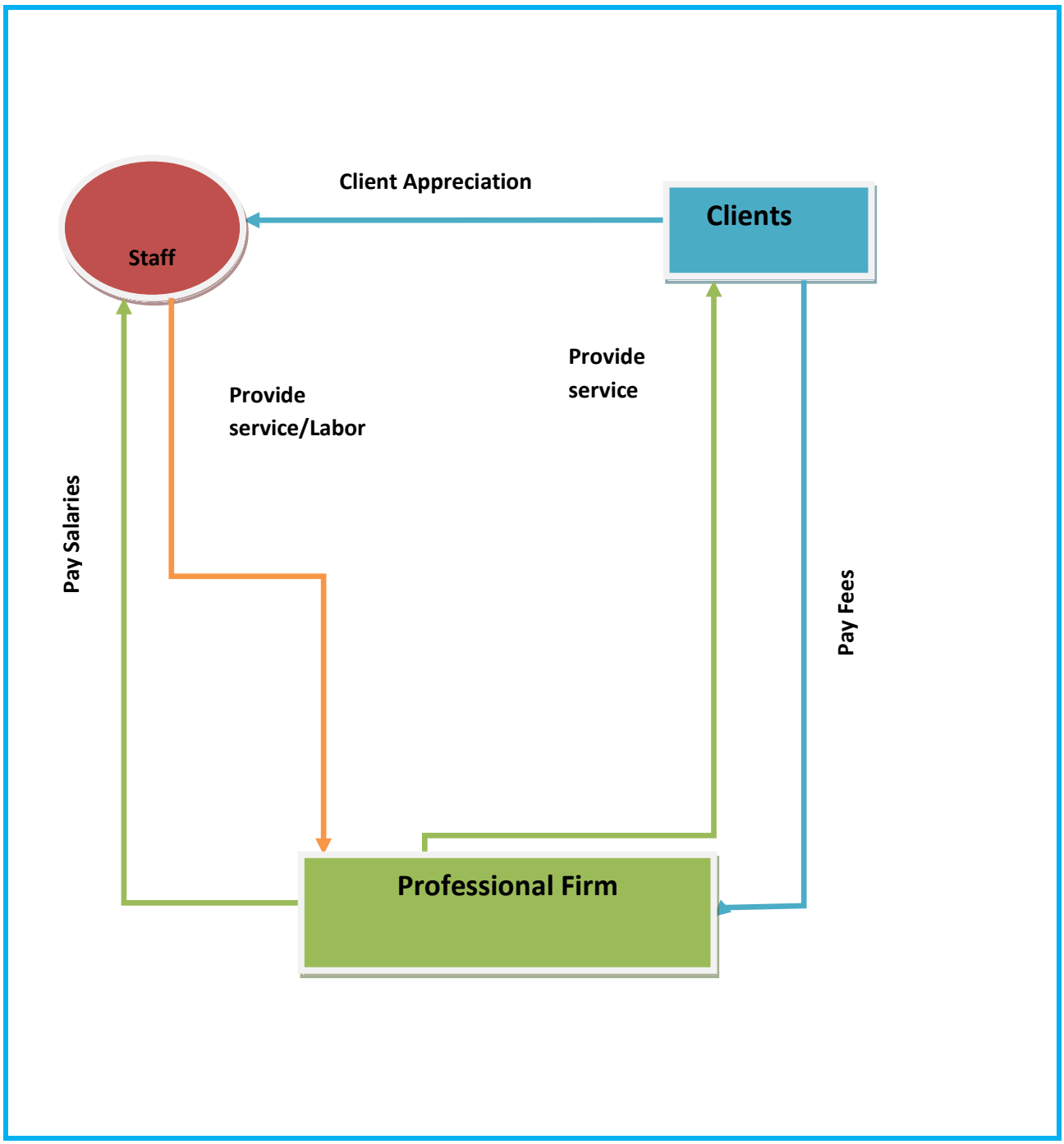


Figure 2.7: Mode of Payments for consulting services adapted from (Webb, 1982)

2.15: Payment Methods for consultant service

2.15.1: AASHTO 2008, consultant contracting guide

According to this guide, there are two basic categories of payment for consultant services: Negotiated Price and Cost Reimbursement. The primary difference between these two categories is that with the use of a Negotiated Price agreement, the consultant is assuming the cost risk of performance, whereas with the Cost Reimbursement category, the agency assumes the risk. Negotiated Price contracts are most appropriate when the scope of services is well defined. On the other hand, Cost Reimbursement contracts should be used when such definitive requirements do not exist and the cost uncertainties of performance are high. Within the above-named broad categories, the most frequently used payment methods are: Cost plus fixed fee, cost reimbursement Lump sum, negotiated price, Cost per unit of work, and cost reimbursement Specific rates of compensation.

These are also the only methods of compensation allowed on Federal-aid highway projects. A single contract may contain different payment methods as appropriate for different elements of the work.

2.15.1.5 Cost plus Fixed Fee

Cost plus Fixed Fee is a Cost Reimbursement payment method. Once negotiated, the fixed fee does not vary, even though the actual cost may. However, it may be adjusted, through negotiation, as a result of significant changes in the work, services, or duration to be performed. Because the fixed fee does not vary in relation to the consultant's ability to control costs, the cost plus fixed fee contract provides for a low risk to the consultant and provides only a minimal incentive for effective cost management. Therefore, an audit at the completion of the work is very important. The fixed fee is based on the scope, complexity, degree of risk, and specialized expertise associated with the project. This type of payment method is suitable for the performance of research, or preliminary exploration or study, where the required level of effort cannot be well defined. It is the most commonly used payment method for preliminary engineering and design.

However, if preliminary studies and other information are sufficient to allow the development of a well-defined and specific scope of services, the lump-sum method might be more appropriate.

The Cost plus Fixed Fee method is used when the Scope of Work is fairly well-defined, but the total engineering effort required to complete the work cannot be estimated precisely. The consultant is paid an agreed-upon amount for a fixed fee, based on actual Scope of Work completed, together with all actual costs incurred in the performance of the work and services. Once both parties have agreed to the work effort in an executed consultant contract, a change in the amount of fixed fee can be made if the scope of work or duration changes.

2.15.1.6 Lump Sum

Lump Sum is a negotiated payment method. Along with cost plus fixed fee, it is the next most commonly used method of payment. It provides for a price which is not subject to any adjustment because of cost changes the consultant might encounter in the performance of the work. Because the consultant assumes full responsibility, in the form of profits or losses, for all the costs under or over the firm negotiated price, it has a maximum profit incentive for effective cost control in contract performance. This type of payment method imposes a minimum administrative burden on the contracting parties. The Lump Sum method of payment is suitable when reasonably definite design or performance specifications are available and whenever fair and reasonable prices can be established and agreed to at the outset. The Lump Sum method is used when the Scope of Work is well-defined and the total engineering effort can be estimated accurately. Once both parties have been agreed to the work effort in an executed consultant contract, a change in the amount of lump sum can only be made if the scope of work changes materially.

2.15.1.7 Cost per Unit of Work

This is a Cost Reimbursement payment method that provides for the payment to the consultant of allowable costs incurred in the performance of the contract, to the extent prescribed in the contract.

This method of payment is suitable for use when the effort per unit of work is well-defined but the number of units is uncertain. It is essential that the consultant have a record of the actual work completed.

2.15.1.8 Specific Rates of Compensation

Cost Reimbursement payment method provides for the acquisition of supplies or services on the basis of direct labor hours at specified fixed hourly rates (rates include wages, overhead, general and administrative expense, and profit), and material at cost. This payment method should be used only when it is not possible at the time of contracting to estimate the extent or duration of the work or to anticipate costs with any reasonable degree of accuracy. This type of contract does not encourage effective cost control and requires almost constant monitoring. It can be used in the acquisition of engineering and design services and work to be performed for On-call contracts and in emergency situations. Examples include expert witnesses, some surveying requirements, geotechnical services and other small, open-ended tasks.

The Specific Rate of Compensation method is used when the Scope of Work and the required work effort cannot be determined at the time the consultant contract is executed. A specific rate of compensation is established for each labor class or employee by multiplying the wage rate by the specific rate factor established in each consultant contract.

Based on the types and conditions of project, consultants may deliver different types of services to their customers or clients. Table 2.14: Shows category of services offered by consulting Engineers for transportation and infrastructural projects.

Table 2.14: Categories of Service Offered By Consulting Engineers for Transportation and Infrastructure Projects

Category of service	**Activities**	
Advisory services	➢ Preparation or review of engineering program ➢ Expert testimony ➢ Appraisals, valuations, studies, reports ➢ Feasibility analysis ➢ Accident investigations ➢ Preliminary concept sketch ➢ Preliminary specification notes ➢ Development of work estimate ➢ Quality assurance	➢ Litigation/ Claims/ Insurance assistance ➢ Detailed analysis of owning and operating costs ➢ Special grants and loans ➢ Translation and interpretation ➢ Project management scheduling assistance ➢ Assistance in preparing purchase enquiries ➢ Value engineering
Preliminary design services	➢ Scope of project ➢ Statement of probable cost ➢ Preliminary design reports, alternative conceptual proposals, sketches, schematics, specifications Scheduling Documents for financing ➢ Investigative surveys, geotechnical	➢ Lifecycle costing ➢ Detailed cost estimates ➢ Engineering surveys, profiles and cross-sections ➢ Quality assurance ➢ Permits and licenses ➢ Environmental assessments ➢ Revision of existing designs
Category of service	**Activities**	

Final design services	➢ Detailed design ➢ Working drawings ➢ Specifications and tender documents ➢ Statement of probable cost ➢ Preparing tender call documents ➢ Reviewing tenders submitted and advising ➢ Detailed cost estimates ➢ Reinforcing bar schedules ➢ Design and documentation not in contract	➢ Provision for Client supplied equipment not in contract ➢ Demolition documents ➢ Tenant improvements ➢ Fast-track construction or sequential tendering ➢ Preparation of shop drawings ➢ Environmental design ➢ Quality assurance
Tender services	➢ Preparing Tender Call Documents ➢ Reviewing tenders submitted and advising ➢ Alternative conceptual proposals ➢ Prequalification of contractors	➢ Coordinating other consultants' documents ➢ Non-tender construction contracts ➢ Bills, materials, detailed cost estimates ➢ Tender advertisement

2.17: Basic Cost Elements of Consultant

2.16.1: Direct Salary

Direct salary is defined include, but are not limited to:

Medical Insurance (health, dental, vision), Social Security Insurance pension Plan, unemployment insurance, survivors benefits and workers compensations as an engineer's total income, which is inclusive of bonuses and profit sharing. This amount will vary by their title, experience, and area of expertise.

2.16.2: Fringe Benefits

These benefits are separate from the direct salary. Other names for them are "employee benefits, perks and benefits in kind (British English). Categories that fall under this heading

2.16.3: Overhead

These are costs, exclusive of direct salary and fringe benefits, required for the organization to function. Overhead is commonly given in terms of the ratio of indirect costs to the direct labor cost. It may also be further classified into two categories, functional and administrative overhead.

2.16.3.1: Functional Overhead

These are the "indirect support costs that are attributable to a specific transportation program, but which cannot be practically assigned to a particular project. Categories that fall under this heading include, but are not limited to: Program management, training costs, and supervisory costs, other than project management costs rent, equipment and office support

2.16.3.2: Administrative Overhead

These are the administration costs and those costs incurred by other agencies or department which provide support services. Categories that fall under this heading include, but are not limited to: Human resources, executive management, Legal support, accounting, and procurement

It has been suggested that using labor-hours as an estimating tool could cause a misrepresentation of the total work performed Sturts et al (2005). Due to the advancement in available technology and computer aided design the labor-hours can be significantly reduced but the value of the design could be increased Sturts et al (2005). This was also suggested by Carr and Beyor (2005) where they found that the design fees are not keeping up with the inflation of Construction prices. Another study Gransberg et al (2007) found that if the design fee of a project is too low, it can lead to major cost growth in the construction process due to incomplete construction documents. The issue of under-estimating the reasonable cost of the necessary design effort must be considered when using past project data to estimate direct hours and make adjustments if necessary.

CHAPTER -THREE

3. Research Methodology

3.1: Introduction:

This chapter dealt with the research design and methodology of the study. It includes research design, source of data, data collection instrument, sampling techniques and methods of data analysis.

3.2: Research Strategy:

To conduct the research work, a survey approach was used to collect/ gather information from targeted people. The techniques used to collect primary data were through desk study and standardized questionnaires. Desk study was conducted to examine and assess the trend of design cost in the cases ERA DBB road projects. For the purpose of the research work, a sample of 89 selected design service projects were taken and examined. These Samples were taken from projects signed in the last consecutive years 2004EC to 2007 EC. Whereas, the structured an standardized questionnaires were distributed to targeted or focused groups (client and consulting firms) working in the road sector industry. Besides the desk study and questionnaire survey work, literature review was also conducted in parallel.

Literature review was conducted starting from the choice and approval of research topic up to the completion or finalization of research work. During the literature review, publications, reports, different professional journals, books, standard contracts guidelines and specifications, previous researches were examined. Literature review was helpful in the following aspects:

- In identifying the impact or effect of design cost on design and project performance in global context
- In assessing factors influencing/ affecting design cost
- In questionnaires and research design
- In formulation of conceptual framework of the study and
- In analyzing data contextualization of findings.

3.3: Research Design

The research was conducted through exploratory and descriptive types of research design. Identifying and examining factors affecting design cost, design performance and then the impact of design cost on design and the performance of DBB road project was assessed by taking the case of Ethiopian Roads Authority. The research was also observational or desk study which focused on reviewing consultants design cost or design fees for design service rendered and assessed salary of key staffs working under the design firm.

3.4: Data Collection Method and Sampling Techniques

The study covered case studies of DBB road projects implemented under ERA. In the research process, non-probability sampling specifically purposive sampling technique was used for data collection from professionals engaged in the project to identify major factors affecting design cost, design and project performance. To assess the impact of less design cost on the performance of DBB road project, questioner was prepared and distributed to the focused or targeted groups working in the stakeholders such as in the consulting firms, and client.

Among the targeted people, 15 questionnaires to 15 design consulting firms and 15 questionnaires were distributed to professionals engaged and working under (ERA) in the procurement, design management and contract administration and implementation directorates.

The Data was collected through a closed ended questioner in order to specifically address the already identified factors in different studies. In questioner, five-point Likertscale rating ranging from strongly disagree (1) to strongly agree (5) was used. Furthermore, to explore and get in depth information regarding the subject matter, in the data collection process, personal interviews was planned however; due to the emergence of corona virus pandemic it was inconvenient to conduct interviews.

The reason why questioner method is used for data collection was:

1. It takes less time to fill up a questioner. It is also a common way of collecting information. Besides it is considered to be the most appropriate method to collect data for this study.
2. Respondents will have adequate time to give well thought out answers.
3. The data gathered through questioner is easy to analyze

The questionnaires were prepared in four sections as shown below:

Section I: Background information which targeted at obtaining general information of the respondents and their organization such as; general and specific experience of the respondents, their position within the organization, type of projects embarked on by their organization.

Section II: Is about identification of factors affecting design cost of highway projects. Based on the identified factors the impact of such factors was assessed. The impact of design cost on performance of project Cost, Quality and Time. In this section the impact of design fee on aforementioned triple project constraints (cost, quality and time) was explored in three project phases: in procurement process phase, design process phase and construction process phase. The effect of those previously identified factors on literatures affecting design cost and project performance was examined.

Section III: Dealt with questions related to factors affecting Design performance and as well as the impact of the design performance on the performance of the construction project. The impact of design performance/ design out on the performance of the construction project was assessed.

Section IV: The forth section entertained questions related to design and procurement.

3.5: Research Conceptual Framework

3.5.2: Conceptual framework of the thesis work

In order to conduct the thesis, a conceptual framework has been formulated depicting relationships among variables such as (Independent, intervening or mediating, and dependent variables) as shown in figure3.1and figure 3.2 below:

Relationship among design cost, Design performance and Construction/Project Performance using mediation moderation effects

3.5.1.1: Mediation Effect:

- Path-c shows the direct impact of design cost on project performance

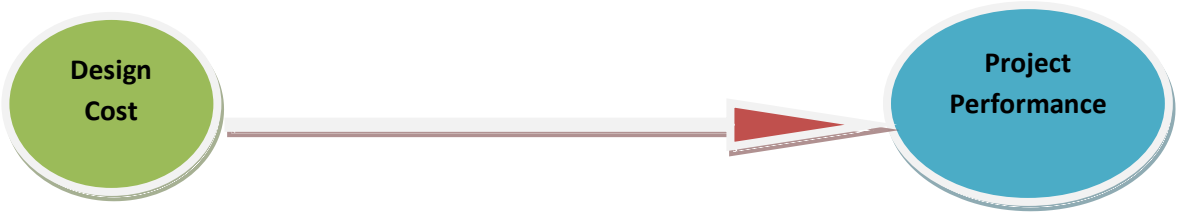


Figure 3.1: Model: Without Mediator

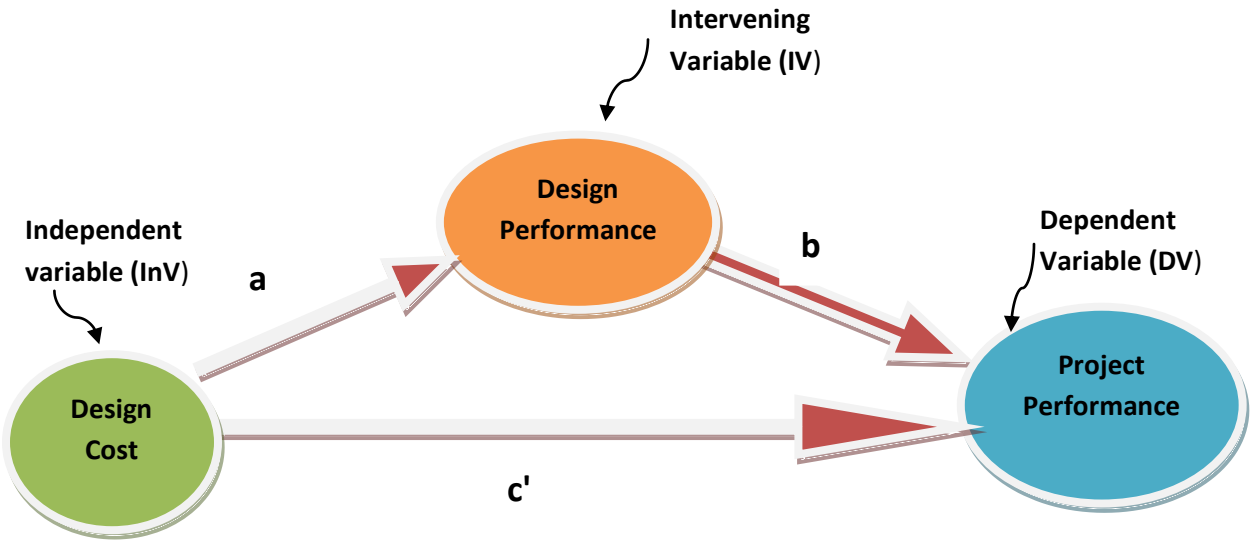
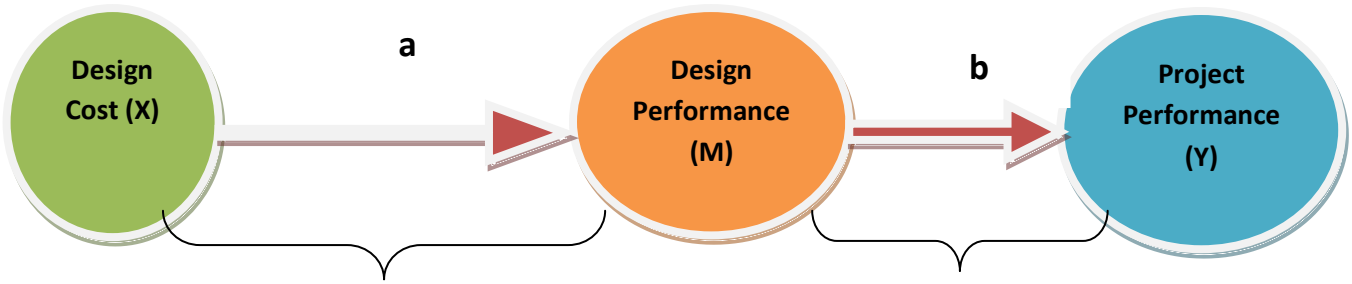
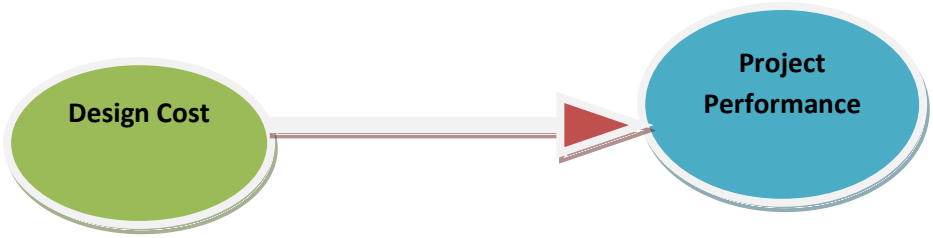


Figure 3 .2: Mediator Model



Path-a Path-b



Path-c

The required analysis is:

a Path-c:biviriate regression predicting Dependent Variable(Project performance) from the Independent Variable (Design cost)

b Path - a **:**biviriate regression predicting Mediator(Design performance) from Independent Variable(Design cost)

c Path-b and c' :multiple regression predicting dependent variable (Project Performance) from Mediator(Design performance) and Independent Variable (Design cost)

Mediation Equations using regression analysis the effect of independent and intervening variables on dependent variable (project performance) can be computed as follow:

Path-c, Direct effect, $Y=i1+C*X+\mu1$----------Eq.(1)

$Y=i2+C'*X+ b*M * c+\mu2$--------Eq.(2)

Where, X=Independent variable

Y= Outcome variable/Dependent variable

M= Mediating Variable and i1,i2 and i3 are intercepts in each equation, and

μ1μ2 and μ3 are residuals

A. In Eq.(1) the coefficient C represents the total effect that X(Design cost) can have on Y (outcome variable or project performance)

B. In Eq.(2) the parameter C^' denotes the relationship b/n X and Y controlling for M, representing the direct effect-the effect of X on Y that is adjusted for M, the parameter b denotes the relation between M and Y adjusted for X

C. In Eq.(3) the coefficient 'a' denotes the relation between X and M. Complete mediation is the case where the total effect is completely explained by the mediator, that is, there is no direct effect. In this case, the total effect is equal to the mediated effect (i.e., c = ab). Partial mediation is the case where the relation between the independent and the outcome variable is not completely accounted for by the mediating variable. There are alternative estimators of the mediated effect including difference in coefficients and product of coefficients, which are based on the regression equations.

3.5.1.2: Moderation Effect:

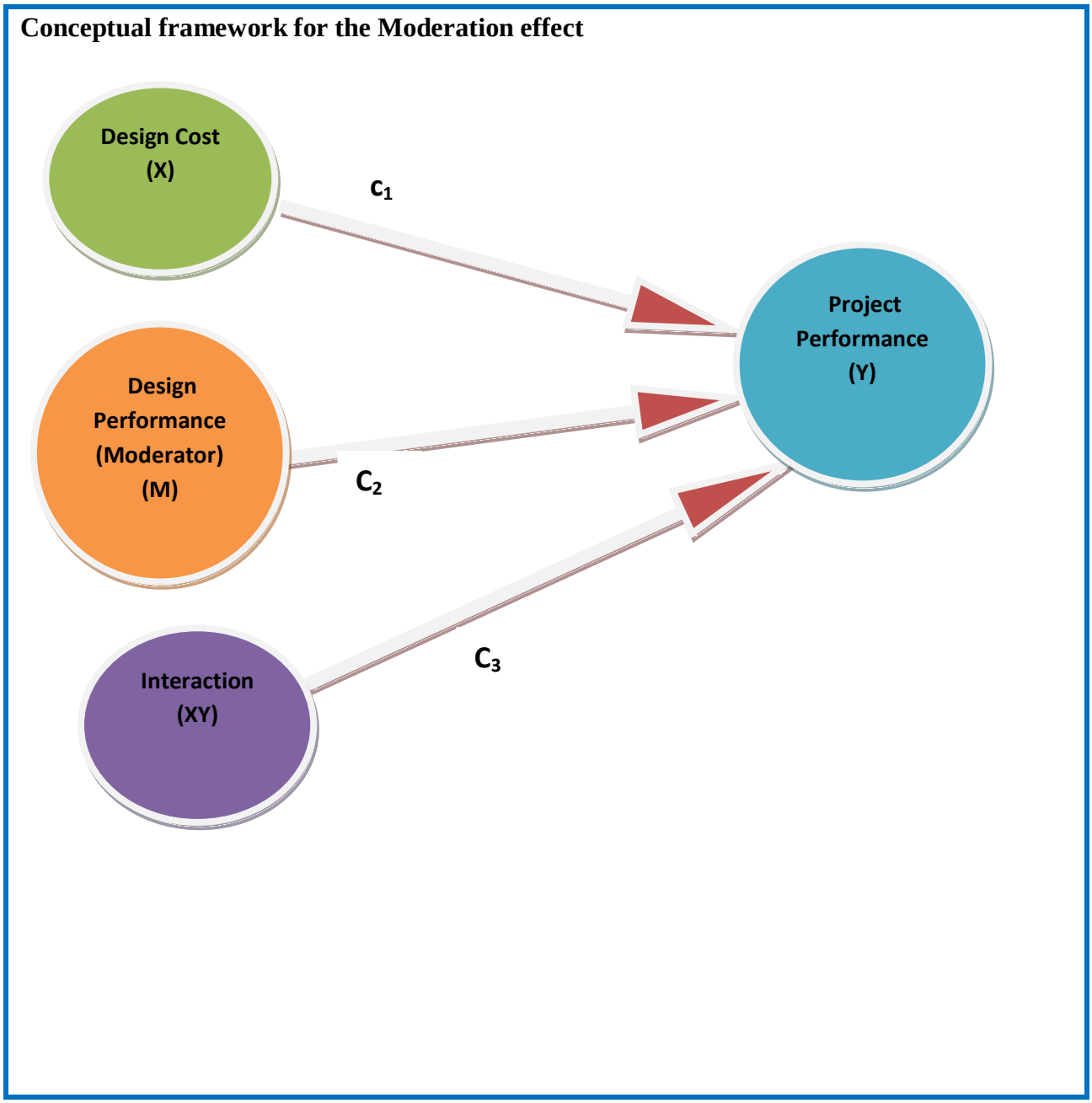


Figure 3.3: Model for moderator

Moderation Regression Equations

$Y=i_1+C_1X+C_2Z+C_3XZ+\mu_1$-----Eq.(4)

Where Y= the dependent variable,

X = the independent variable,

Z = the moderator variable, and

XZ =the interaction of the moderator and the independent variable; μ_1 is a residual, and c_1, c_2, and c_3 represent the relation between the dependent variable and the independent variable, moderator variable, and moderator by independent variable interaction, respectively. The moderating variable XZ is the product of X and Z where X and Z are often centered (centered means that the average is subtracted from each observed value of the variable). If the XZ interaction is statistically significant, the source of the significant interaction is often explored by examining conditional effects with contrasts and plots

3.6: Correlation of Variables:

3.6.1: Correlation among Design cost, design performance and project performance

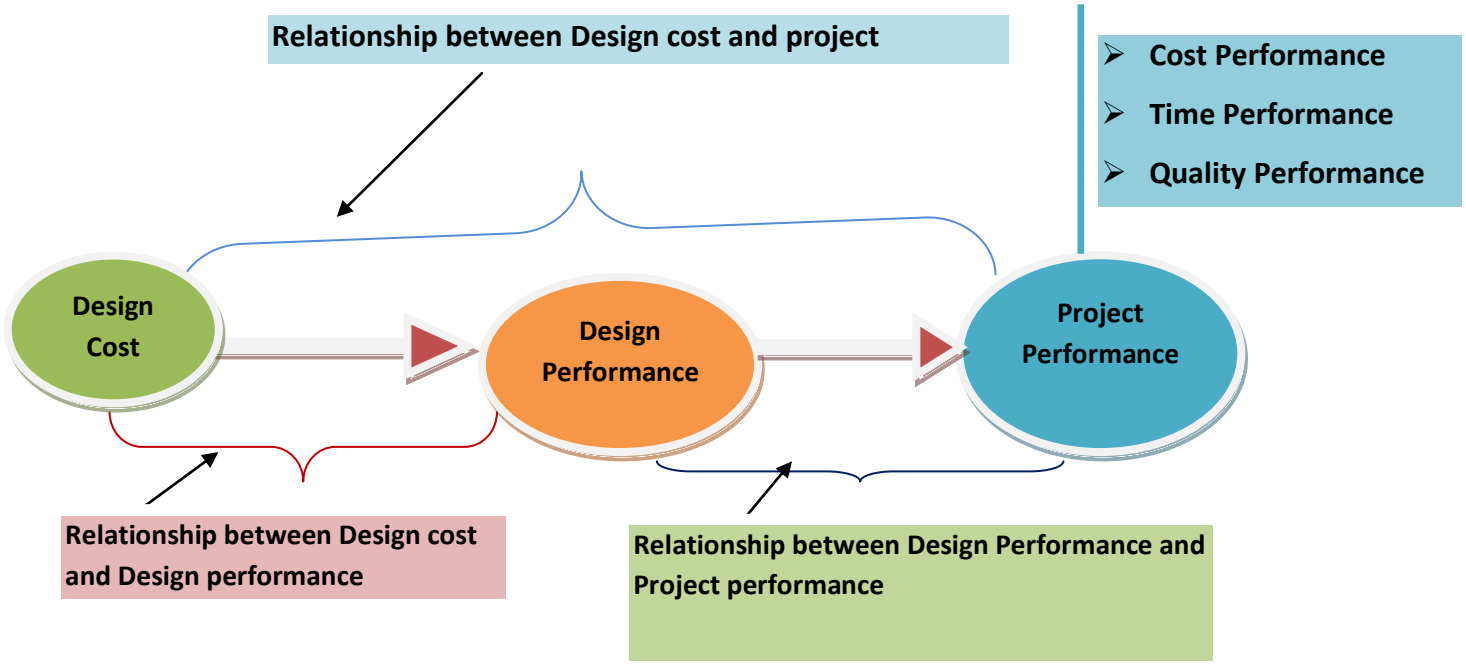


Figure 3.4: Relationship between Design cost, design performance and project performance

CHAPTER -FOUR

4. ANALYSIS AND DISCUSSIONS

4.1. Profile of respondents and questionnaires response rate

Using purposive sampling techniques, to get information data, a total of 30 questionnaires were prepared and distributed to client and consulting firms. Among the total number of 30 questionnaires, 15 distributed to the client (ERA's) design management directorate, contract administration and procurement directorate's teams. Whereas, the remaining 15 questionnaires are distributed to local consulting firms working on federal roads projects and whose head office is at Addis Ababa city. From 15 questionnaires distributed to the client (ERA), 14 or (93.33%) are responded and out of 15 distributed

Questionnaires to the local consultants**,** 10 or (66.67%) have been responded.

Table 4.1: Summary of Respondents

I/No	Respondents	Total Questionnaires Distributed		Total Questionnaires Responded	
		Quantity	%	Quantity	%
1	Client(ERA)	15	50	14	58.33
2	Consultants	15	50	10	41.67
Total		30	100	24	100

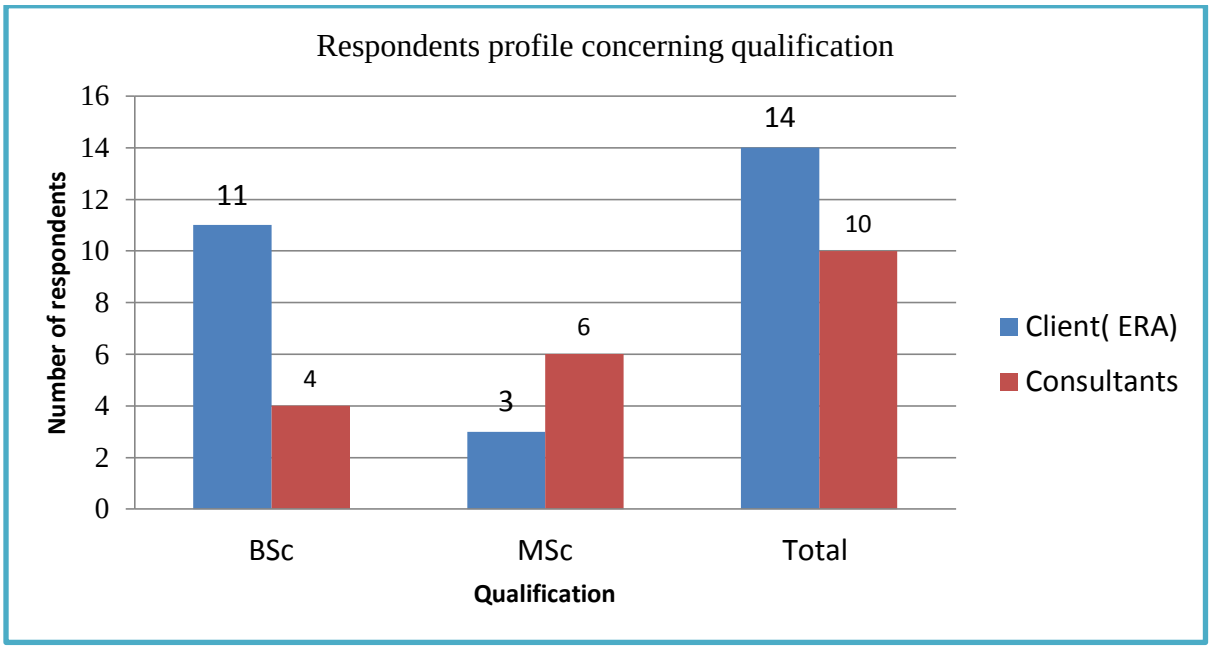


Figure 4.1: Summary of respondents profile concerning qualification:

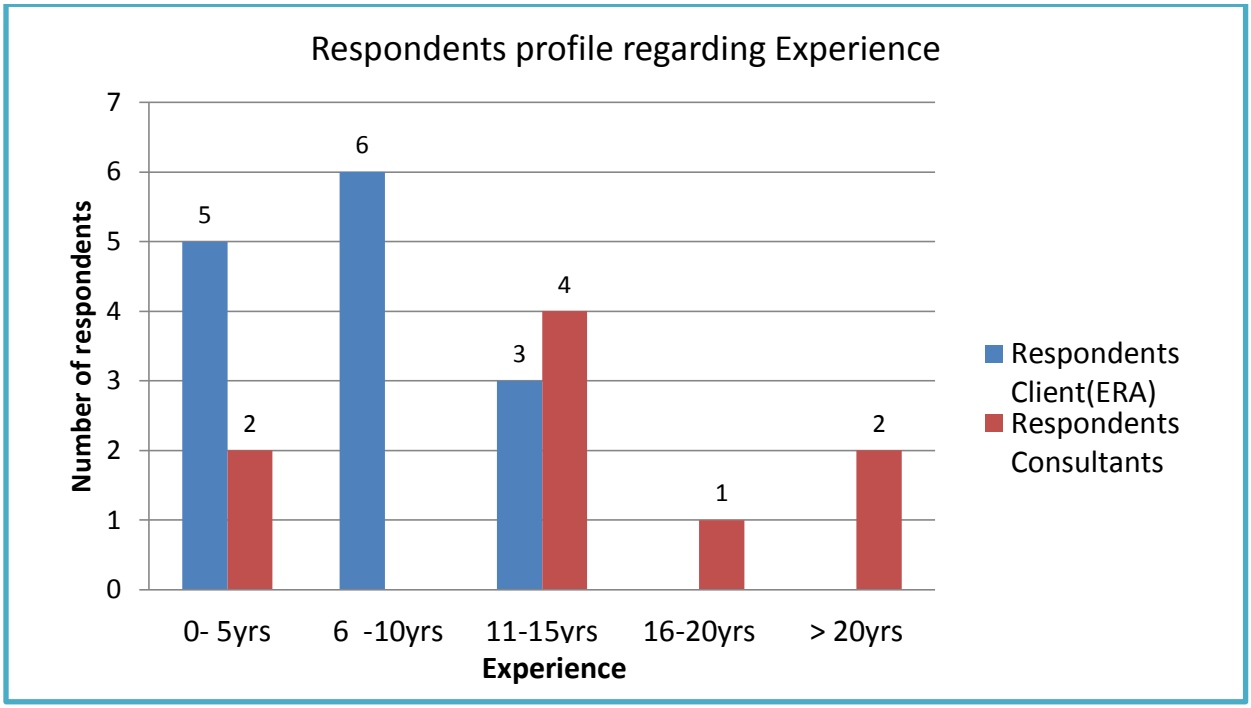


Figure 4.2: Summary of respondents profile concerning experience:

4.2. Quantitative Analysis

According to Saunders, Lewis, & Thornhill,(2015),there are several tools and methods available to execute quantitative analysis, such as tables, graphs, and statistics. And accordingly, depending on the collected/ gathered data, the aforementioned tools and methods has been used in the analysis of the research work. In the case of the statistical tool, Statistical Package for Social Sciences (SPSS) has been used in analysis to arrive at the outputs descriptive and frequency.

In addition to the SPSS, tables and graphs have been used to depict the out of the analysis as it is simple and convenient way to understand.

4.3. Pearson Correlation

Pearson correlation is a measure of the strength and direction of association that exists between two or variables. This measurement can be used to understand whether there is an association between design cost and design performance, between design cost and project performance and also between design and project performance. The correlation of the variables could be positive or negative. The correlation coefficient can range in value from -1 to +1. The larger the absolute value of the coefficient, the stronger the relationship between the variables

Table-4.2: Summary of the results of the analysis carried out for identified factors showing Whether the respondents agree or not with identified factors

Factor	Response Rating in percentage					
	Strongly Agree (%)	Agree (%)	Neither agree Nor disagree (%)	Disagree (%)	Strongly Disagree (%)	Total percentage
Q4	40.82	48.98	6.12	4.08	0	100
Q7	34.88	41.86	13.95	6.98	2.33	100
Q9	27.03	27.03	16.22	29.73	0	100
Q10	47.37	33.68	12.63	6.32	0	100
Q13	41.67	54.7	0	4.17	0	100
Q16	22.73	63.64	10.23	2.27	1.14	100

Legend:

- ✓ Q4= for design project of low fees, consulting engineers give less consideration to design alternative and to checking and reviewing of documents. How far do you agree with this statement?
- ✓ Q7=. How far do you agree that the existence of minimum design fee regulation is necessary to organize professional practice in the country?
- ✓ Q9 =How far do you agree with the statement as a 'result of low design fee the design firm shortens the required time for the design process in order to maintain profit?
- ✓ Q10= How far do you agree with the statement that 'most of the private offices pay small salaries for their engineers in order to maximize profit on one hand and compete with the low design fees in the market on the other hand?
- ✓ Q13= Capacity building of designers in construction operations and involving construction expertise in the design process can reduce the project cost and time?'
- ✓ Q16='Having a direct estimate of expected fee and a reliable contingency gives an agency a starting point for negotiations with design consultants, and it will also allow them allocate funds to more efficiently through the program.' How far do you agree with such statement?

Different previously conducted studies indicated that low fees can influence the commitment of the firm or organization to fully address the requirements stipulated in the contract agreement. And to know to what extent do respondents agree with such statement 'whenever the fees for design projects gets less that the design firms give less consideration for design alternatives and checking and reviewing documents' a questionnaire was prepared and distributed. Then, the distributed questionnaires was collected and analyzed using five scale Linkert rating from strongly agree (value=5), to strongly disagree with (value=1) through SPSS tool. The result of the analysis revealed that the majority of the respondents agree with the statement i.e. 48.98% of the respondents agreed that as a result of low fees the design firms give less consideration for design alternatives and checking & reviewing the document while 40.82% of the respondents strongly agreed with the statement.

To know whether the existence of minimum design fee regulation is important or not for an organization as a country, a question how far does you agree with such statement was delivered to the respondents. As indicated in the study, 41.86% agreed and 34.88% gave a response that they strongly agree the existence of minimum design fees regulation is so important.

Respondents were asked whether they agree or disagree with the statement 'as the result of low design fees that design firms shorten the required time for the design process in order to maintain profit.' Their response indicated that 27.03% agreed and 27.03% strongly agreed. But on the contrast, 29.73% of the respondents disagreed and 16.22% gave their response that they neither agreed nor disagreed with the statement.

To ascertain whether private organizations or firms tend to compete with low design fees on market on one hand, and tend to pay small salaries for their employee/ engineers to maintain profit on the other hand, respondents were requested to give their opinions. The results of the study indicated that among the respondents 47.37% strongly agreed and 33.68% agreed with the statement whereas, 12.63% neither agreed nor disagreed and 6.32% disagreed.

Generally, based on the results obtained, the study indicated that the majority of the respondents above 80%agreed with the statement that private firms compete with low design fees on one hand in the market and pay small salary for their engineers to maintain their profit on the other hand.

Capacity building is one the most important means of upgrading skills and acquisition of knowledge through training and practice. Regarding this, respondents were asked how far capacity building of designers in construction operations and involving construction expertise in the design process can reduce project cost and time. Depending on the results of the analysis, the study revealed that 54.17% of the respondents agreed and 41.67% strongly agreed with the statement. Among all respondents, only 4.17% disagreed. As a whole, from the finding, about95% of the respondents agreed with statement that capacity building of designers and involving construction expertise in the design process is important to reduce project cost and time.

In order to know how far having direct estimate of expected fee and reliable contingency gives a starting point for negotiations with design consultants, can allow them to more efficiently allocate funds, respondents were asked how far they agree with such a statement.

The results of the analysis indicated that 63.64% of the respondents agreed and 22.73% strongly agreed with the statement. Meanwhile, 10.23% neither agreed nor disagreed and 1.14% strongly disagreed.

To assess the impact of identified factors affecting design cost of highway projects, a questionnaire was distributed to respondents. The questionnaire comprised of impact rating scale i.e.(‘Very high’ designated with value =5), (High impact designated by value=4),(Moderate impact' with value=3), ('very low impact' with value=2)and (‘has no impact' with value=1).Then Relative Impact Index (RII)of each factor was computed using Equation (1)

$$RII = \frac{\sum_1^5 W}{A * N}$$ ----------Eq. (1)

Where:

$\sum_1^5 W$ = Summation of weight age given by each respondents which is the summation of (Rating *Frequency)

A= the highest rating if we take 1 to 5 the highest is 5

N= Total number of samples

As shown Table-4.3: Results of the analysis revealed that among ten (10) identified factors affecting design cost of highway projects, Project complexity, Number of Bridge and Type of Project ranked first to third position consecutively to impact design cost of highway project. Whereas, project length, Geography and Project cost ranked forth to six position to have impact on design cost.

Table-4.3: Project related factors affecting design cost

Project Related Factors (PRF)	RII	RANK
Complexity	0.883	1
No. of bridge	0.783	2
Project type	0.775	3
Project length	0.767	4
Geographic	0.758	5
Project cost	0.733	6
No. of lane	0.633	7
Highway classification	0.608	8
No. of plan sheets/ deliverables	0.600	9
National or environmental policy	0.558	10

Contract and procurement have their own effect on the design cost of highway projects. And to assess its impact on design cost of highway projects, questionnaires were distributed to respondents to rate and identify which factor will impact design cost. Using the Relative Impact Rating, the analysis was carried out. The result of the analysis revealed, among contract and procurement related four identified factors affecting design cost, type of Contract, procurement method and procurement policy ranked first to third position consecutively to impact design cost. Procurement type is ranked in the last position i.e. fourth position as shown in Table-4.4:

Table-4.4: Procurement and contract related factors affecting design cost

Contract &Procurement Related factors (CPRF)	RII	RANK
Type of contract	0.675	1
Procurement method	0.617	2
Procurement policy	0.608	3
Procurement Type	0.558	4

Another factors affecting design cost of highway project is Market condition related factors. Related to this condition, inflation rate, currency devaluation and stability of market condition ranked first to third positions to impact design cost of highway. Number of competitors was also another factor among market related factors impacting design cost which is ranked in the fourth position. A result of the analysis is indicated in Table-4.5.

Table-4.5: Market Condition Related Factors affecting design cost

Market Condition Related Factors (MCRF)	RII	RANK
Inflation rate	0.817	1
Currency devaluation	0.775	2
Stability of market condition	0.750	3
Number of competitors	0.725	4

Availability of qualified and competent consulting firms has a critical role in the achievement of the project objectives. The analysis was carried out to assess the impact of the identified factors on the design cost. And the result revealed that among five identified factors, designers' level of experience, availability of all fields of specialization in project team and commitment of the firm to compete on fairground ranked first to third position consecutively. Meanwhile loss of design effort and bid rigging ranked in the fourth and fifth position. Table-4.6 depicts the result of the analysis.

Table-4.6: Consultant Related Factors affecting design cost

Consultant Related Factors (CRF)	RII	RANK
Designers experience level	0.858	1
Availability of all fields of specialization in project team	0.833	2
Commitment of the firm to compete on fair ground	0.808	3
Loss of design effort	0.775	4
Bid rigging	0.767	5

For design service or construction operation activity, clients undergo selection process to hire competent and qualified consultants or contractors. Selection of competent and qualified consultants can be made through different methods such as on least cost base, quality based, performance and value based. Among the identified factors, to assess which methods of selection will highly impact or influence design cost of highway projects, respondents were requested to give their response. Based on the response provided by the respondents, as depicted in Table-4.7 the result of the analysis indicated that Least Cost Based selection can impact design cost of highway projects to an extent of very high with a rank of first position. Whereas quality based, performance and value based selection methods ranked second o third and fourth position consecutively.

Table-4.7: Method of Consultant Selection factors affecting design cost

Factors Related to Method of Consultant Selection(FRTCS)	RII	RANK
Least Cost Based	0.792	1
Quality Based	0.758	2
Performance Based	0.700	3
Value Based	0.667	4

Concerning Client, six factors were identified to impact design cost of highway project. Among these factors, insufficient design time ranked first whereas, clients' requirement on quality and scope of work both ranked in the second position while term of reference and unwillingness of client to pay design commensurate ranked in the fourth and fifth position. Client's financial situation and budget ranked in the six positions.

Table-4.8: Client Related Factors affecting design cost

Client Related Factors (CRF)	RII	RANK
Insufficient Design Time	0.783	1
Client's requirement on quality	0.758	2
Scope of work	0.758	2
Term of Reference	0.742	4
Un willingness of client to pay design commensurate	0.667	5
Client's financial situation and budget	0.633	6

Project delivery method is one of the factors identified in the study to impact design cost. Even though there are different delivery methods, Design- Bid- Build which is usually considered as the traditional has been used for many years even if it had its own limitations relative to the design build delivery methods. To identify which factors have significant impact on design cost, the analysis was computed using Relative Impact Index. And the results of the analysis indicated that DBB delivery method impact design cost to an extent of high level with a rank of first than DB and other delivery methods. The analysis is depicted in Table -4.9:

Table-4.9: Project Delivery methods related affecting design cost

Factors related to Project Delivery methods(FRTPDM)	RII	RANK
DBB	0.725	1
DB	0.708	2
Others	0.358	3

Average Relative Impact Index (RII) of factors affecting design cost

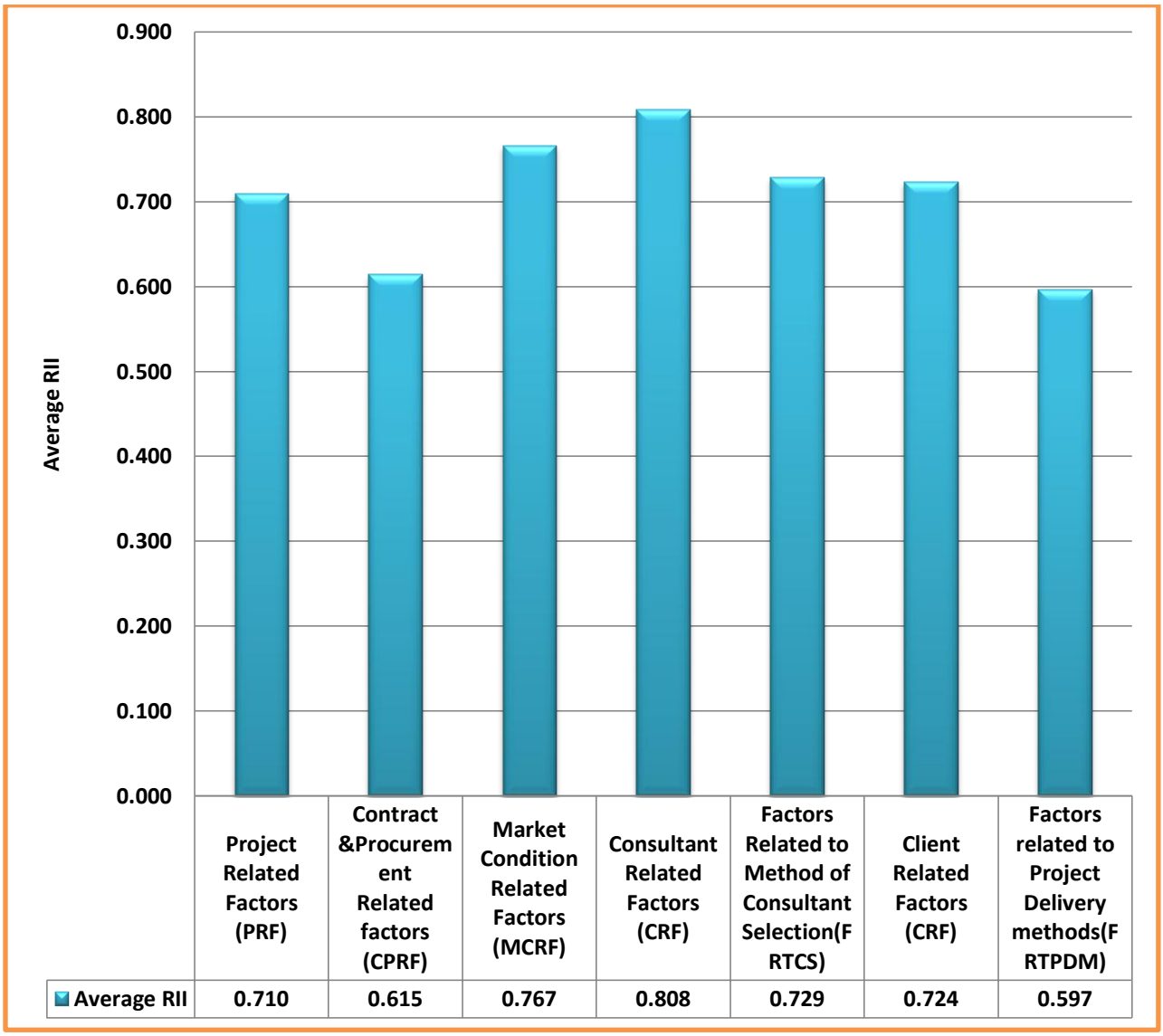


Figure 4.3: Summary of factors affecting design cost of highway projects

To identify which factor will impact most design cost, average value of Relative Index of each factor was computed. Based the computation, among the main factors affecting design cost, consultant related factors, market condition related and consultant selection related factors ranked first to third position to impact design cost of highway projects.

Design Performance Related Questions

It is obvious that design performance has significant effect on the performance of the project. Design performance itself can be affected by other input variables. Nine input factors affecting the performance of design were identified by the study. To evaluate the relative impact of each input factor on the performance of design, questionnaires were distributed to be filled by the respondents. Then, the returned response rate was analyzed using RII. The result of the analysis revealed that among the identified factors, overall quality of design firm, and complexity of project condition to highly impact design performance ranking first to second position. Overall size of the design firm and complexity of the function both ranked third position. Table-4.10: Input variables affecting design performance

Input variables Affecting Performance of design	RII	RANK
Level of scope definition	0.675	9
Size of design contract	0.683	8
Continuity of man-hour commitment for the project	0.692	7
Level of competition in the market	0.717	6
Complexity of the design process	0.733	5
Complexity of the project function	0.758	3
Overall size of design firm	0.758	3
Complexity of project conditions(type of problem, Magnitude of problem, and No. of problems)	0.767	2
Overall quality of design firm	0.833	1

The impact design code and standards design quality was assessed by this study. Results of the study revealed that among all respondents 31.58 % believed that it could impact to an extent of very high, 59.95% of the respondents answered that it could impact design quality to high level.

Only 9.47 % of the respondents gave their response that the impact would be low. In general, the majority of the respondents believed design code and standards to have high to very high level of impact on the quality of the design.

Table-4.11**:** Impact of design code and standards on design quality

Q# 4. What is the impact of design code and standards on design quality?	
Rating	Percentage
Very High	31.58
High	58.95
Low	9.47
Very Low	0.00
Has no effect impact	0.00

In the achievement of quality design out, the commitment of the design firm takes major role. Instead of carrying out proper design task, by deploying important key staffs, to save time and cost some consulting firms tend to Copy and modify from previously work. To ascertain how far such a statement is true, respondents were asked to give response. As shown in Table - 4.12. The study indicated that among the respondents, 53.19% rated the impact to be very high, 29.79% rated it to be high. And 12.77% rated to have an average impact. However, only 4.26% of the respondents rated its impact to be low.

Table-4.12**:** Impact of copying and modifying design from previous work on design quality

Rating	Percentage
Very High	53.19
High	29.79
Average	12.77
Low	4.26
Has no effect/impact	0.00

The study was conducted to assess the impact of identified factors, such as reduced design fees, minimum design time and client's unrealistic expectation and inability to properly define project objectives, on the quality of design. The relative impact index of reduced design fees was higher than that of minimum design time and client's unrealistic expectation with RII value of 0.842. Meanwhile the RII value of minimum design time, and client's unrealistic expectation were 0.825 and 0.775 consecutively. It revealed that among the three factors affecting design quality, reduced design fees ranked first to influence or impact design quality whereas, minimum design time and clients' unrealistic expectation and inability to properly define project objectives are ranked second to third position consecutively.

Using SPSS data analysis tool, to predict the impact of design errors & omissions on the performance of construction project, a descriptive analysis was used. The result of the analysis indicated mean value of 4.52 which was greater than 4 and less than 5. The impact rating values assigned for the level of 'High impact' ='4' and for 'very high'='5'. The obtained result of the analysis found to be between 4 and 5 nearer to 5. So, it revealed that design errors& omission could impact the performance of the construction project to a level of very high.

Design change is one of design performance related factors affecting the performance of the construction projects. Similar to that of design errors and omissions the result of the analysis depicted mean value of 4.52 which was nearer to 5. Based on the assigned rating given to predict the rate of impact, ratings with mean value '5' were considered to have very high impact.

Therefore, the study indicated that design change was also one of the factors which could impact the performance of the project to a very high level.

BOQ is a base on which the amount of project cost and duration is predicted. It plays vital role especially for government funded projects for the purpose of allocating sufficient budget to run projects. Contrary to its importance, inaccurate BOQ is one of the factors affecting the performance of the project. The impact of such factor was assessed through SPSS tool, by descriptive analysis. The results of the analysis indicated a mean value of 4.43 which was between 4 i.e. ' high' and 5' Very High.' So, the study indicated that inaccurate Bill of Quantities could highly impact the performance of the construction project.

Availability of detailed drawings, especially during the construction phase of the project is very important, due to the fact that, the actual construction operation will be undertaken based on it. To evaluate or ascertain how is the impact of absence of detailed drawings on construction project performance, from respondents (design and construction professionals) point of view, question how do you rate the impact of such statement was provide to them .Based their reply, the analysis of the study indicated the impact of absence of detailed drawing on performance of the project with a mean value 3.91. This was nearer to value 4. Therefore, it indicated that it could highly, impact the construction project performance.

The impact of absence of up to date standards and specifications on performance of construction project was also assessed. The result of the analysis similar to that of the impact of absence of detailed drawings indicated a mean value of 3.91 which was nearer to value' 4'.So, since the assigned rating with value 4 was designated to be high, the impact of absence of up to date standard and specification also would highly impact the performance of the construction project.

Generally, among five identified design performance related factors affecting performance of construction projects, it revealed that design errors& omissions, and design change could impact the performance of construction to a very high level. Whereas, inaccurate BOQ, absence of detailed drawings, and up to date standards and specification could highly impact the performance of construction projects.

Table-4.13**:** Summary of design performance related factors affecting project performance

		Impact of design errors and omissions on performance of construction projects	Impact of design change on performance of construction projects	Impact of inaccurate BOQ on the performance of construction projects	Impact of absence of detail drawings on performance of construction projects	Impact of absence up-to-date standards and specifications on performance of construction projects?
N	Valid	23	23	23	23	23
	Missing	1	1	1	1	1
Mean		4.52	4.52	4.43	3.91	3.91
Std. Error of Mean		.124	.124	.152	.177	.188
Mode		5	5	5	4	4
Std. Deviation		.593	.593	.728	.848	.900
Variance		.352	.352	.530	.719	

The impact of design cost on the triple project performance measures, such as on quality, time and cost was assessed. As shown in Table 4.18, the mean values of each project constraint or project measure was found to be 4.42, 4.00 and 4.15 consecutively. By rounding the value of each measure to the nearest whole number the mean value of all would be 4.00 i.e. 'high'. Therefore, the study revealed that reduced design fees, could highly impact quality, time and cost of the project. Table 4.14 shows the results of the analysis.

Table 4.14: Summary of impact of reduced design fees on performance of triple project constraints, quality, time and cost

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Quality	19	3	5	4.42	.139	.607
Time	17	1	5	4.00	.243	1.000
Cost	20	1	5	4.15	.233	1.040
Valid N (list wise)	17					

To evaluate the impact bidding low with an intention of doing less than in the requirement on project performance, questionnaires were prepared and distributed to respondents. Then, based on their reply, the analysis was carried out. The result of the analysis has shown a mean value of 4.25. And depending on the results of the study, it indicated that bidding low with intention to do less than the in the requirement would also highly impact the performance of the project.

Table 4.15: Mean value of bidding with the intention of doing less than the requirement

N	Valid	24
	Missing	0
Mean		4.25
Std. Error of Mean		.150
Mode		4
Std. Deviation		.737

Based on the analysis carried out, the impact of design cost or design fees, with mea value 4.42 and as a result of low fees if the consultant produce simple design to minimize the commitment of the resource to a design task with mean value of 4.38 could highly impact the performance of the project. Whereas, with organizations offering reduced design fees in order just to win and increase competitive pressure with a mean value 4.63 approaching 5 the performance of the project would be impacted to a level of very high.

Table 4.16 Descriptive Statistics Showing summary of factors affecting project performance

	N	Minimum	Maximum	Mean	Std. Deviation
Q # 1.	24	3	5	4.42	.654
Q # 6.	24	3	5	4.38	.647
Q # 11.	24	4	5	4.63	.495
Valid N (list wise)	24				

Legend:

Q #1= How do you rate the impact of design cost/design fee on performance of DBB road project?

Q#6= For projects with low fees, consulting engineers produce simple design to minimize the commitment of the resources to a design task. So, what do you think will be the impact of this statement on project performance?

Q#11=What is the influence of fees on quality of project performance with the statement 'organizations offering reduced fees in order just to win and this increased competitive pressure will lead to decline in professional standard's, resulting in poor project performance.

Rounding the mean values of each factor to the nearest whole number, among nine identified factors eight factors i.e. lack of qualified consultants staff, insufficient and missing input information, tight design schedule or inaccurate time estimate and Reduced design fees, lack of sufficient time for design review, lack of data integration across design discipline, absence of high cost experienced design team and unwillingness of client to pay fees commensurate with design of high quality service found to highly impact project performance in terms of cost. Allocation of a staff to more than one project in the same time would have average or moderate impact. The mean value of the identified factors in terms its impact on project performance measure time was between 3.83 and 4.42. If these numbers rounded to its nearest whole number it would be 4.00 signifying high impact.

So, the study indicated that all the identified factors could highly impact project performance in terms of time. Again the impact of mean values of all identified factors was found between 3.72 and 4.42 whose nearest whole number would be 4.00. Therefore, the impact of all factors in terms of project performance measure quality found to be high.

Table 4.17: Summary of factors affecting triple project performance measures

I/No	Factors	Impact		
		on cost	on time	on quality
1	Lack of qualified consultants staff	4.45	4.42	4.33
2	Insufficient and missing input information	4.18	4.42	3.85
3	Tight design schedule or inaccurate time estimate	4.08	4.4	4.45
4	Reduced design fees	4	4.15	4.42
5	Lack of sufficient time for design review	3.75	4.32	4.22
6	Lack of data integration across design discipline	3.67	3.89	4.17
7	Absence of high cost experienced design team	3.59	3.83	3.85
8	Unwillingness of client to pay fees commensurate with design of high quality service	3.5	3.95	3.72
9	Allocation of a staff to more than one project in the same time	3.43	3.86	3.95

Correlation of variables:

To evaluate correlations among variables such as:

A. Impact of Reduced Design fee or design cost on design quality
B. Impact of design errors and omissions on the performance of construction projects
C. Impact of inaccurate BOQ on the performance of construction projects
D. Impact of design change on the performance of construction projects and
E. Impact of absence of detail drawings on the performance of construction projects

Correlation analysis has been carried out, and the results of the analysis indicated that, there positive correlations among these variables.

Table 4.18: Summary of Descriptive Statistics showing mean values of factors

Factors	N	Mean of each
Q # 1. How do you rate the impact of design cost/design fee on performance of DBB road project?	24	4.42
Q # 2. How do you rate impact of design errors and omissions on the performance of construction projects?	23	4.52
Q # 2. How do you rate impact of design change on the performance of construction projects?	23	4.52
Q # 2. How do you rate impact of inaccurate BOQ on the performance of construction projects?	23	4.43
Q # 2. How do you rate impact of absence of detail drawings on the performance of construction projects?	23	3.91
Q # 2. How do you rate impact of absence up to date standards and specifications on the performance of construction projects?	23	3.91
Q # 8. As a result of reduced design fees/ design cost; 'Design firms tend to limit type of staff available, the extent of supervision & training, and increase use of junior inexperienced staff to carry out the design	24	3.96

function.' Consequently, these lead t		
Q # 8. As a result of reduced design fees/ design cost; 'Design firms tend to limit type of staff available, the extent of supervision & training, and increase use of junior inexperienced staff to carry out the design function.' Consequently, these lead t	24	4.42
Q # 8. As a result of reduced design fees/ design cost; 'Design firms tend to limit type of staff available, the extent of supervision & training, and increase use of junior inexperienced staff to carry out the design function.' Consequently, these lead t	24	4.29
Q #3. How do you rate the impact of reduced design fees on performance of triple project constraints; cost?	20	4.15
Q #3. How do you rate the impact of reduced design fees on performance of triple project constraints; quality?	19	4.42
Q # 6. For projects with low fees, consulting engineers produce simple design to minimize the commitment of the resources to a design task. So, what do you think will be the impact of this statement on project performance?	24	4.38
Q #5. For design projects with low fees, consulting engineers bid low with intention of doing less than in the requirement, and making up fees with claims and variations. How do you rate its effect on project performance?	24	4.25
Q # 11. What is the influence of fees on quality of project performance with the statement 'organizations offering reduced fees in order just to win and this increased competitive pressure will lead to decline in professional standard's, resulting in poor	24	4.63
Q # 2 Impact of Reduced Design fee or design cost on design quality	24	4.21
Valid N (list wise)	19	

Table 4.19: Summary of average mean value for variables i.e. design cost, design performance and project performance

I/N	Mean score values of Impact of design cost on project performance	Mean Scores values of Impact of design cost on design performance	Mean Score Values of Impact of Design performance on project performance
1	3.96	4.1	4.52
2	4.29	4.42	4.52
3	4.42	4.25	4.43
4	4.42	4.29	3.91
5	4	4.63	3.91
Average	4.22	4.34	4.26

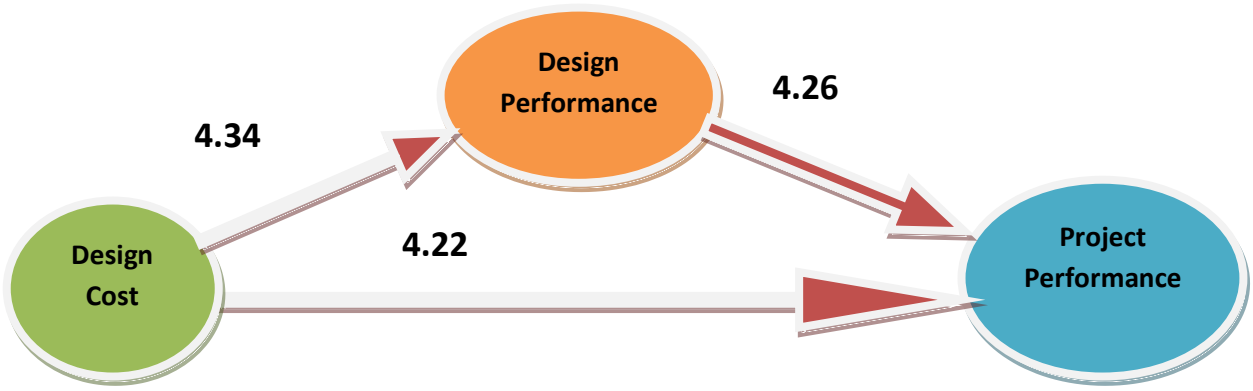


Figure 4.4: Mean Values of impact of design cost, on design and performance and impact of design performance on project performance

The analysis was conducted using questionnaire survey data, and it indicated that design cost cans highly impact design and project performance. The impact of design on project performance was relatively higher than the impact of design cost. The study was also indicated that the impact of design cost is relatively higher on design performance than on project performance.

Regression Analysis

Table 4.20: Summary of regression out put

Regression Statistics						
Multiple R	0.373636631					
R Square	0.139604332					
Adjusted R Square	-0.290593502					
Standard Error	0.372923859					
Observations	4					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	1	0.04513059	0.045	0.324	0.626	
Residual	2	0.27814441	0.139			
Total	3	0.323275				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	7.344	5.535	1.327	0.316	-16.472	31.160
4.1	-0.717	1.258	-0.570	0.626	-6.129	4.696
RESIDUAL OUTPUT						
Observation	*Predicted 4.52*	*Residuals*	*Standard Residuals*			
1	4.176375533	0.343624467	1.129			
2	4.298204836	0.131795164	0.433			
3	4.269539118	0.359539118	-1.181			
4	4.025880512	0.115880512	-0.381			
The effect of design performance on project performance using Regression model						
➢ As F calculated is less than F critical at 5% level of significance, it shows that the model is not significant.						

The F-test of overall significance indicates whether the linear regression model provides better fit to the data than a model that contains no independent variable (design performance). The predictor variable explains changes in the response (dependent variable) which is project performance. Here the result of the analysis indicated that how project performance and design performance are associated.

Bhorat et al, (2017) taking sources: ILO Global Wage database, World Bank WDI has summarized monthly minimum and mean wage of Sub-Saharan Africa as below: Table 1. Monthly Average Minimum Wage Estimates: Sub-Saharan Africa

Table 4.21: Low income countries Monthly Minimum and mean wage

Country Minimum wage (US$ PPP) Mean wage (US$ PPP) Kaitz ratio				
A	Low-income economies	Minimum wage (US$ PPP)	Mean wage (US$ PPP)	Kaitz ratio
1	Burkina Faso	138	210	0.66
2	Burundi	26	256	0.1
3	Chad	239	371	64
4	Congo, Dem. Rep	68	53	1.27
5	Ethiopia	77	175	0.44
6	Madagascar	128	183	0.7
7	Malawi	49	368	0.13
8	Tanzania	148	624	0.24
9	Uganda	65	464	0.1
10	Group mean	104	300	0.46
11	Group median	77	256	0.44

Group mean value for monthly wage for low income countries was found to be 300 US $. Among the listed out 11(eleven) countries, three countries namely: Congo, Dem. Rep, Ethiopia and Madagascar scored monthly mean wage of even below 200US $.Two countries (Burkina Faso, and Burundi) has registered monthly wage between 200 and 300. The remaining four countries namely; Chad, Malawi, Tanzania and Uganda had monthly mean wage of above the group mean wage (300 US $). However, Bhorat et al, (2017) did not indicate what the mean wage would be in the subsequent or succeeding times.

Table 4.22: Lower-middle-income countries Monthly Minimum and Mean Wage

B	Lower-middle-income economies	Minimum wage (US$ PPP)	Mean wage (US$ PPP)	Kaitz ratio
1	Congo, Rep.	145	526	0.28
2	Ghana	128	469	27
3	Kenya	331	979	0.34
4	Lesotho	242	377	0.64
5	Senegal	148	983	0.15
6	Swaziland	94	815	0.12
7	Zambia	98	252	0.39
8	Group mean	169	629	0.31
9	Group median	145	526	0.28

The group mean monthly wage of the lower-middle income countries was computed to be 629US $. It is twice the group mean wage value for low income countries having 300 US $. Among seven low middle income countries, the mean monthly wage of Zambia was the least one with value (252) which is even below low income counties group mean monthly wage. Three countries; Kenya, Senegal and Swaziland scored a higher monthly mean wage greater than group mean value.

Table 4.23: Upper-Middle-Income Countries Monthly Minimum and Mean Wage

C	Upper-middle-income economies	Minimum wage (US$ PPP)	Mean wage (US$ PPP)	Kaitz ratio
1	Algeria	531	1003	0.53
2	Botswana	148	1287	0.12
3	Gabon	418	2356	0.18
4	Mauritius	218	1424	0.15
5	South Africa	517	1251	0.41
6	Group mean	366	1464	0.28
7	Group median	418	1287	0.18
8	Total SSA mean	188	687	0.37

Based on desk study conducted to find and assess the trend of design fees paid for the design service, DBB design road projects signed since 2004 to 2007 EC was considered. Accordingly, average design fees per kilometer for the under mentioned projected have been computed as shown below:

Case Study -1 Concerned about surveying and analyzing the trend of design cost of DBB road projects of Ethiopian federal roads, for the time periods 2004 to 2007 EC or (2011-2014GC)

Average Design Fees or Design cost per kilometer in (ETB)

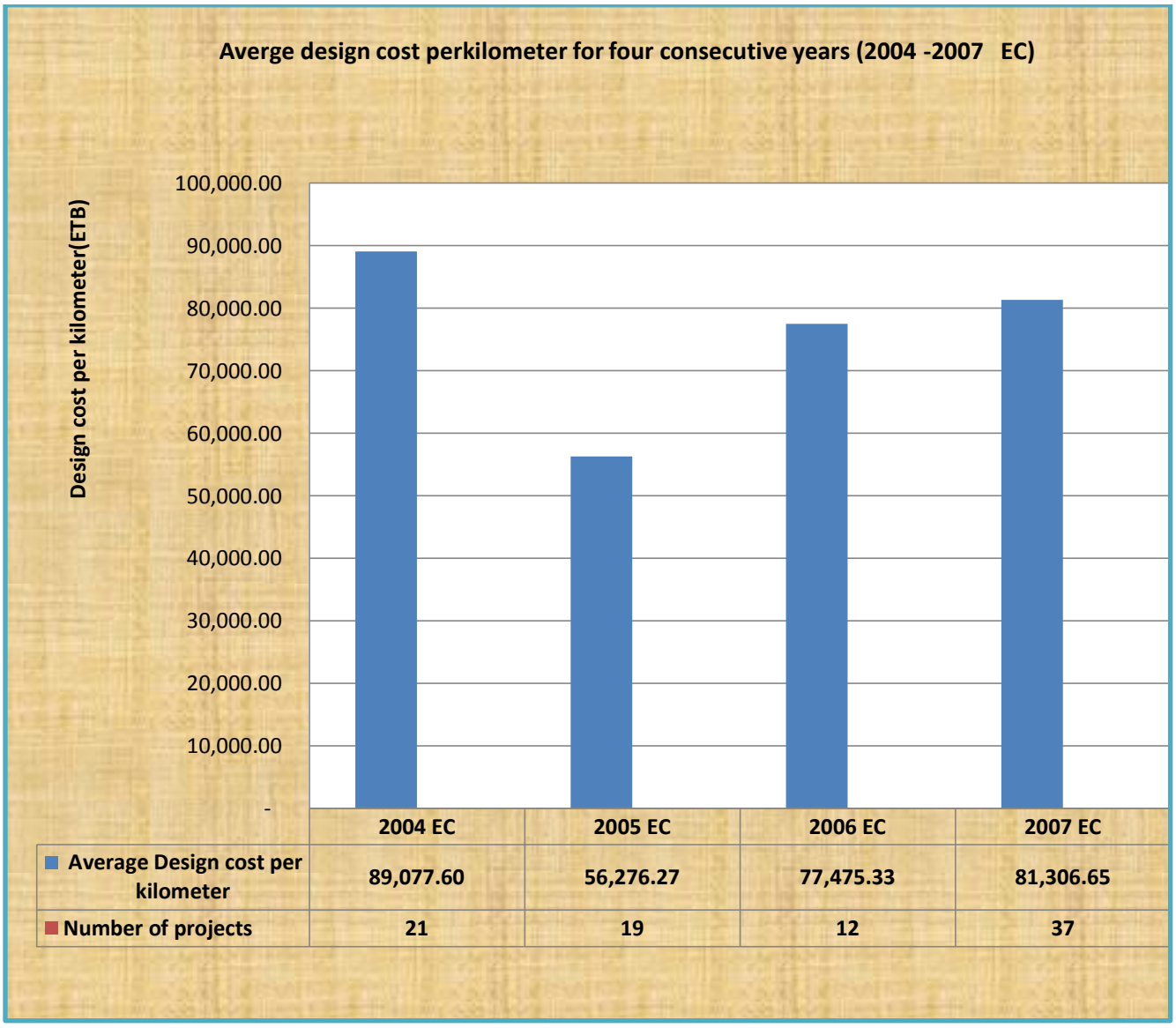


Figure 4.5: Average Design Fees or Design cost per kilometer in (ETB)

The analysis, indicated that average design cost per kilometer for 2005EC, gets declined relative to 2004 and 2006EC. However, during the subsequent periods, it has shown a significant increment.

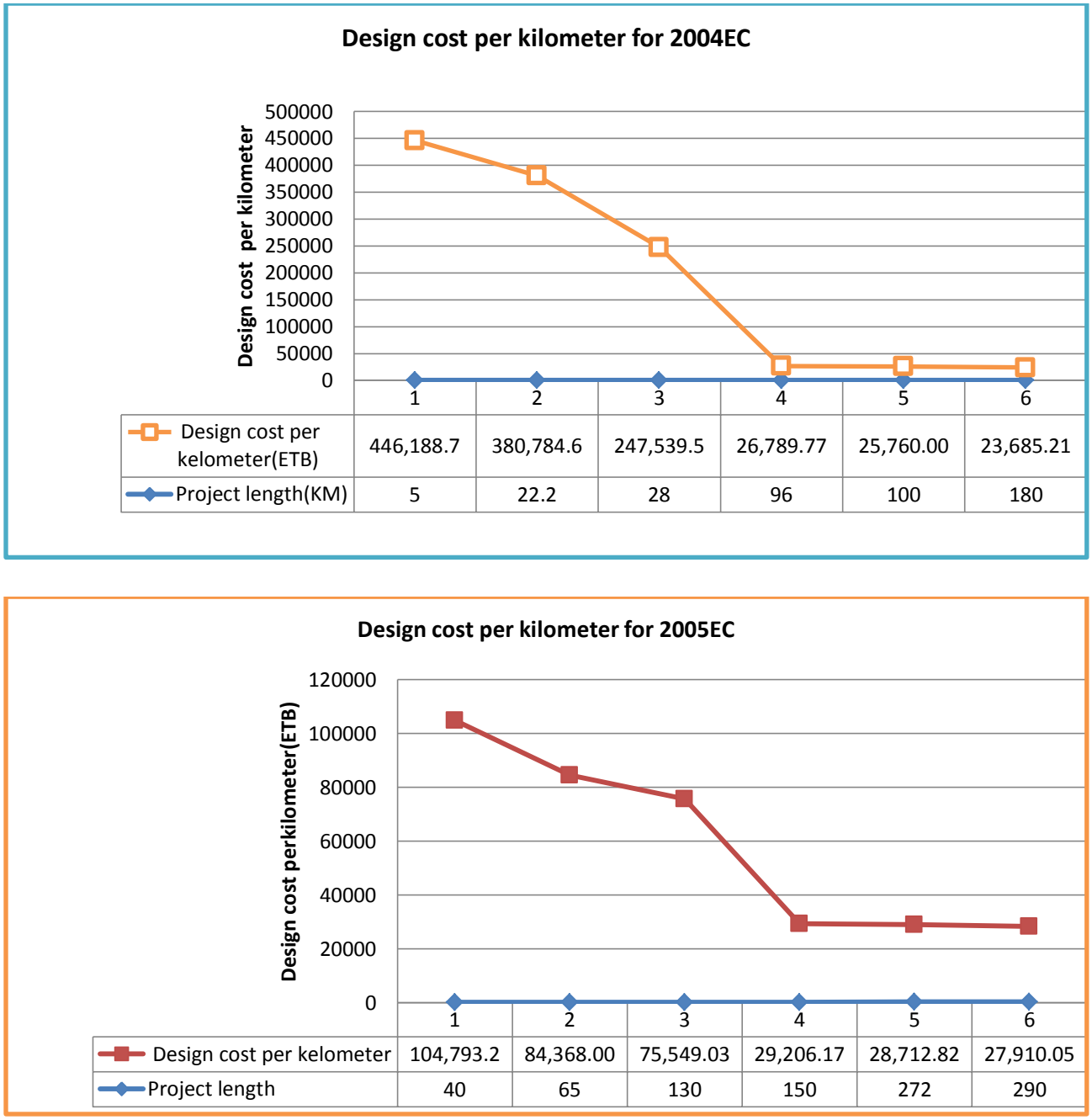
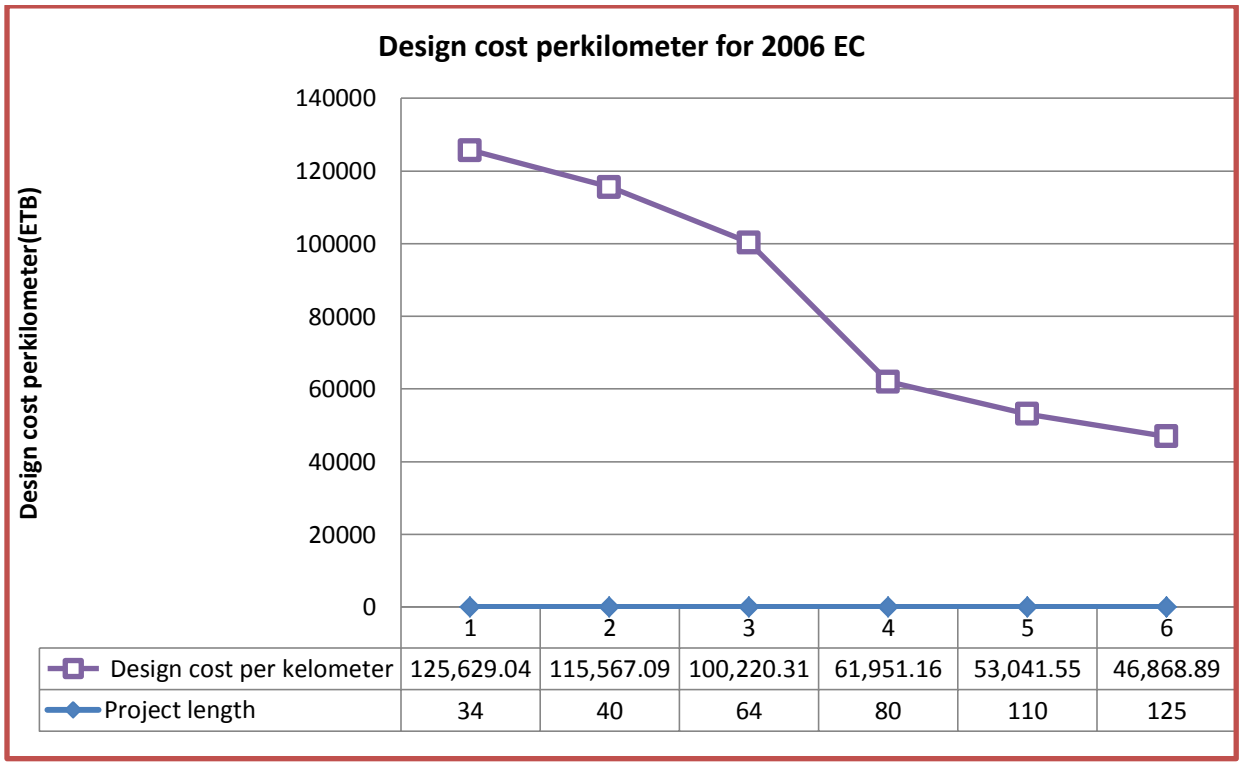


Figure 4.6: Design cost per kilometer versus Project length for 2004 and 2005EC



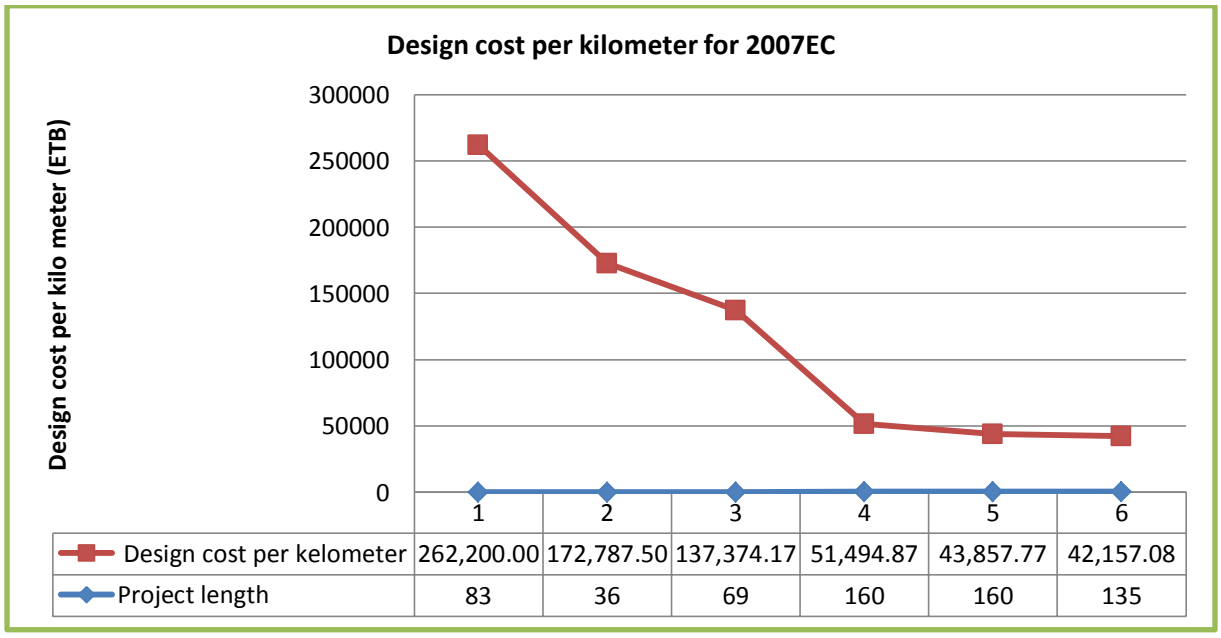


Figure 4.7: Design cost per kilometer versus Project length for 2006 and 2007EC

- The analysis depicted that as project length increase the design cost decrease

To know the trend of design fees versus Project length, the study has been conducted taking ERA design service projects signed in the last four consecutive years from 2012-2014GC.The study revealed that as project length (kilo meter coverage) increases the design cost or design service substantially gets decreased. It indicated that design cost or design fees have an inverse relationship with project length.

Case study-2: In case study two the performance of five DBB road projects assessed as depicted in Table (4.24).

Table 4.24: Performance of DBB federal road projects

I/N	Project Name	Project length (km)	Design cost per kilometer (ETB)	Original Contract Amount (ETB) In millions (1000,000)	Total Executed Amount(ETB) Up to April, 2020 In millions (1000,000)	Original Completion Date	Final Completion date	Work executed to date up to April, 2020	Total time Elapsed
1	Melkasa-Sodere-Nuraera-Metehara	96	26,789.77	1,203.129	387.304	22/06/20	31/12/20	13.58 %	850 days or 77.55%
2	Arbareketi-Gelemso-Mechera	57.5	26,760.00	1,052.379	509.944	1/05/20	-	51.28%	95.5%
3	Daye-Chiri-Nansebo	65	84,368.00	1,330.389	1,682.275 (Revised Amount)	26/09/20	-	34.34%	86.39%
4	Iteya-Robe-Seru	130	75,549.03	1,324.234	442.00 (executed to date)	6/11/20			Up to June ,2020 76.26%
5	Chereti-Gorobeksa-Gordamole	290	27,910.05	1,300.354	923.440 (Executed To date)	25/4/20	Plus 83 days	84.45%	Extension of 83 days

Taking, five road projects as case study, results obtained, revealed that the performance of all projects delayed or behind schedule.

- For Melkasa-Sodere-Nuraera-Metehara Road project: The performance of the project accomplishment is too late with a to date total executed work of 13.58% whereas, estimated total project time elapsed to date up to April,2020 is 77.55%. Here, it is obvious that with the remaining 22.45% time, that the project work could not be finalized and tends to time delay and cost overrun. On the other hand, related to this project the allocated design service cost is too low relative to total project cost. And this can signify that low design cost can impact project performance as indicated in literatures.

- The performance of Arbareketi-Gelemso-Mechera road Project is also lagging behind the allotted project completion time, with a total elapsed time of 95.5% and with a to date work accomplishment of 51.28%. The remaining contract time (0.05%), is not sufficient for the accomplishment of the rest 48.72% project work. So, it revealed that the project get delayed and because of this entitled for an extra time or time extension. For this road project, the design cost is also too less comparative to the project cost.

- Daye-Chiri-Nansebo road project, up to end of April, 2020 with 86.39% of elapsed time accomplished 34.34% project work. It is impossible to be dead sure that the project will be completed on schedule with the remaining 23.61% time.

- Fiscal accomplishment of Iteya-Robe-Seru road project up to end of June, 2020, is 76.26% with a remaining 4 months completion date (November, 6/2020). With this time interval, it is difficult to estimate that the remaining project work will be completed on time, with the coming rainy season.

- For Chereti-Gorobeksa-Gordamole road project the allotted original completion date was 25/40/20. During that period, its fiscal accomplishment was 84.45%. Due to nonperformance or failure of the project to be finalized as per the contract time,

It was entitled for an extension period of 83 (Eighty three days). The amount of Design cost per kilometer for this project is too less relative to other design projects.

This case study was conducted to observe and indicate the relationship between Design cost and project performances to assess the impact of low design cost.

Table 4.25: Percentage of Design service cost of highway projects relative to its construction cost

I/N	Project Name	Design Cost (ETB)	Project cost(ETB) in millions (1000,000)	Percentage of design cost relative to project cost
1	Melkasa-Sodere-Nuraera-Metehara	2,571,817.45	1,203.129	0.21%
2	Arbareketi-Gelemso-Mechera	2,576,000.00	1,052.379	0.245%
3	Daye-Chiri-Nansebo	5,483,919.90	1,330.389	0.41%
4	Iteya-Robe-Seru	9,821,373.75	1,324.234	0.74%
5	Chereti-Gorobeksa-Gordamole	8,093,914.42	1,300.354	0.62%

As depicted in the summary, the design service cost of highway projects relative to its construction cost is very low even below 1% total construction project cost. However, its amount is too few, it has significant impact on the performance of the project, due to the fact that time delay, and cost overrun can be even beyond the design cost as a result of nonperformance of the design problem. And for the nonperformance of the design, design cost has a significant impact as indicated in literatures.

So, the procuring entity in the selection process of competent and qualified design consultants, should take in to account, the impact of design fees on the performance of design. Because relying on least cost competitive bidding method does not guarantee project requirement outcome. Due to the reason of some consulting firm bid with the intention to do below the requirement.

1. Average Monthly salary paid for Key staffs working under consultants /Design Firm taking the case of design road Projects of Ethiopian Roads Authority. It is computed taking the number of projects in that particular period in to account.

Table 4.26: Monthly Salary of key staffs working under design firm Average rate (ETB/month)

Position of the key staffs on the project	Period in Ethiopian Calendar (EC)						
	2006	2007	2008	2010	2011	2012	Average
Project Team Leader	22,809.00	23,165.00	22,000.00	24,514.29	31,000.00	34,316.67	26,300.83
Material Engineer	21,465.20	19,045.00	20,000.00	19,700.00	26,666.67	30,540.58	22,902.91
Structural Engineer	22,410.00	18,460.00	30,000.00	21,128.57	26,666.67	30,540.58	24,867.64
Geotechnical Engineer	24,410.00	18,500.00	18,000.00	26,128.57	26,666.67	30,540.58	24,040.97
Highway Engineer	13,510.00	7,500.00	20,000.00	20,414.29	21,666.67	30,540.58	18,938.59
Hydraulic Engineer	21,963.80	19,088.00	28,000.00	25,700.00	28,333.33	32,017.50	25,850.44
CAD Engineer	15,500.00	13,355.00	10,000.00	12,585.71	19,333.33	12,500.00	13,879.01
Quantity Surveyor	6,000.00	6,100.00	10,000.00	13,414.29	12,333.33	12,500.00	10,057.94
Senior Surveyor	18,900.00	13,205.00	12,000.00	15,014.29	16,333.33	19,974.58	15,904.53
Transport Economist	27,000.00	21,319.00	30,000.00	24,414.29	31,666.67	16,666.67	25,177.77
Environmentalist	21,563.80	20,450.00	30,000.00	29,985.71	30,000.00	26,872.08	26,478.60
Sociologist	22,800.00	20,161.00	28,000.00	24,842.86	30,000.00	16,666.67	23,745.09
Contract Engineer	21,700.00	17,145.00	18,000.00	19,414.29	21,666.67	30,540.58	21,411.09

Adapted from: ERA (Design Management Directorate)

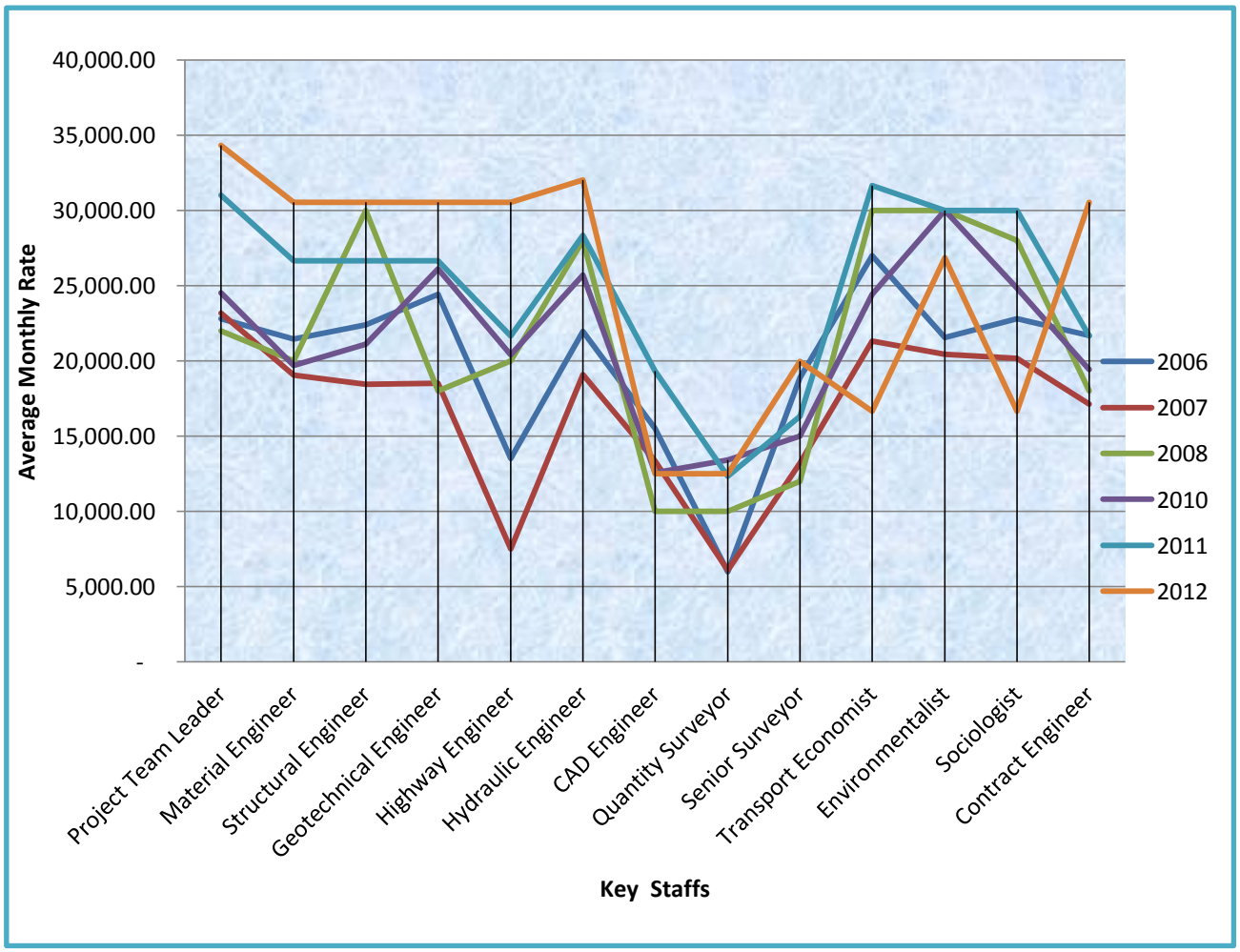


Figure 4.8: Salary trend of key staffs at different time interval (2006 to 2012EC)

The results shown on the graph depicts that, salary for some professionals(Engineering professionals) indicated substantial increment for the periods 2011 and 2012 EC. For other non-engineering professionals the monthly salary is substantially decreased.

Computed Average Monthly Salary of Design firms' key professional staffs involved in design tasks of federal road projects for the time intervals (2006-20012EC).

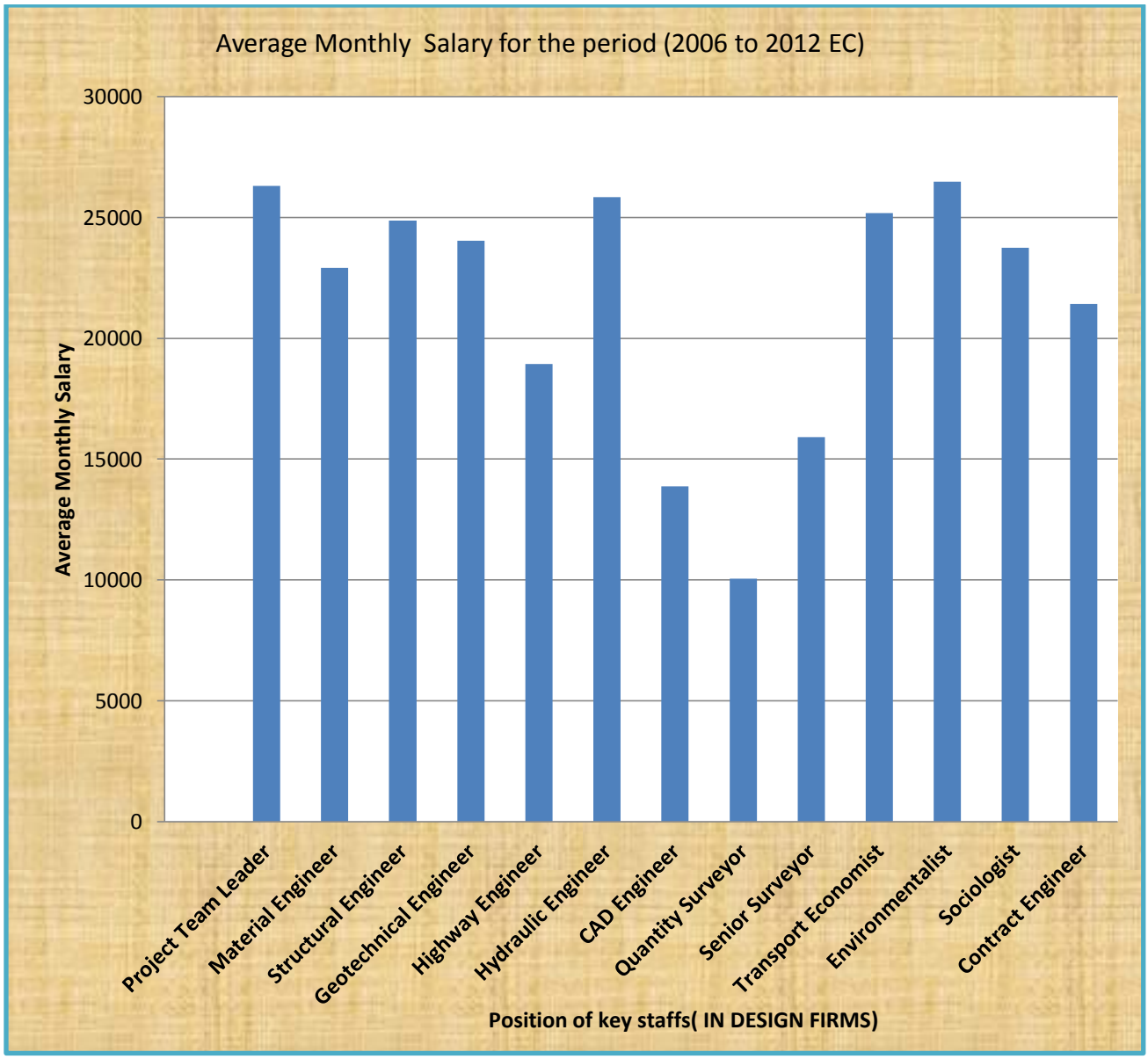


Figure 4.9: Average Monthly Salary of key staffs for the period of (2006-2012EC)

CHAPTER -FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

The main objective of the study was to assess the impact of design cost / design fee on design and project performance taking the case of Ethiopian Federal DBB Roads project and identifying and assessing factors affecting design cost of highway projects.

5.1. CONCLUSIONS

Based on the analysis carried out, the following conclusions have been drawn and recommendations were forwarded.

1. One of the main objectives of the study was to identify factors affecting design cost of DBB road projects. Accordingly, seven main factors to be the cause to impact design cost of highway projects have been identified by the study. These factors have been identified in relation to: Project, consultant, client, contract and procurement, methods of consultant selection, Project delivery method, and market condition. Among these, consultant related, market condition and method of consultant related factors are ranked first to third position to highly impact design cost of highway projects.
2. The study was also aimed to assess the impact of design cost on design and project performance of DBB road projects. It revealed that design cost affects or impact both design as well as project performance to a level of very high.
3. The impact of design performance on project performance has been assessed and design related factors affecting design performance was also identified. The study indicated that design perforce can highly affect project performance. Regarding factors affecting design performance, ten input factors affecting design performance have been identified. Among these factors affecting design performance, overall quality of design firm and complexity of project condition (type of problem, and magnitude of problem) ranked first to second position consecutively to highly impact design performance.

Meanwhile both overall sizes of design firm and complexity of project function are ranked in the third position consecutively to impact design performance of highway projects.

4. In the study to assess what techniques have been used in other countries for design cost estimations, different literatures have been reviewed? As revealed in the literatures, one of the methods used to fix design cost is using percentage of construction cost. Here while fixing design cost, two factors namely, complexity of the project and the amount of project cost are taken in to account. When the complexity of the project is high, the percentage of design cost will also get increased. But depending on the amount of project cost the amount design cost varies. As the amount of project cost increases the percentage design cost for that particular project tends to decrease. The minimum percentage design fee amount for highway project of average complexity range between 3.6 to 4.3 % and for above average complexity 5.2 to 5.8 %. However, in the case of Ethiopian federal roads DBB design service projects the percentage of design cost of the relative to its construction or project cost is below 1% construction cost as revealed in this study taking Eighty nine DBB road projects as case study.

5.2. RECOMMENDATIONS

1. Recognizing the impact /influence of design cost on design and project performance, client should devise method of consultant selection with due consideration of scope and complexity of the project in to account. As reveal in the study, the amount of design cost relative to construction cost is very minimal even below 1% of construction cost. However it is minimum, it has consequential effect on the performance design as well as on performance of project. So, the client should give due consideration and pay design firms design commensurate equitable with the services delivered.

2. Design is one of the critical issues which can serve the contracting parties or stakeholders involved in the undertaking of the work assignment. It is a base up on which project cost and time estimate is determined. The performance of the project outcome will also depend on the performance of the design product. Due to non-performance of the design, most projects encounter problems such as, delay, and cost overruns. The effect of design problems should not be undermined, and should be given due attention by concerned bodies. For the achievement of common objectives, involvement of clients and Consultants at early design stage is very important. Client specially, ERA, should strengthen design management department through training, capacity building and implementing up to date design performance measures. The design firms should also capacitate their staff through provision of intensive training, and hiring competent qualified professionals for undertaking of the design task. Should not hire highly skilled and qualified professionals only for the sake of winning the bid.

3. Based on the conditions of the project, capacity and preference required, there are different types of project delivery methods. Among such delivery methods, DBB is a traditional and commonly used delivery method by many organizations. Most design service projects of ERA's road projects also delivered through DBB delivery system. This delivery method as its own pros and cons.

The draw backs of this delivery system are due the sequential, and lengthy contracting procedures, unless the design task is fully completed, it difficult for the client to make contract with contractors and for the contractors to start the construction activity in the soonest time.

4. Availability of experienced and qualified design professionals is so significant in the achievement of the required design services. To have such professional firms, the clients usually, undergo different types of selection and recruitment process. The selection process could be Quality & least Cost Based, Least Cost based, Value Based and Performance Based. For instance, ERA uses quality and least cost method with 80% technical and 20% financial weightage. However, the percentage of technical evaluation is larger relative to financial evaluation, it does not guarantee, the achievement of the required final product, due to the fact that some design firms may compete just to win with CV's of highly qualified and experienced professionals. Whereas in the meantime, the actual design task is carried out by inexperienced junior Engineers.

References

1. Adnan E. and Mohamed A.(2017).'Factors Contributing to Rework and their Impact on Construction Projects Performance '.International Journal of Sustainable Construction Engineering & Technology (ISSN: 2180-3242) Vol 8, No 1, 2017

2. Adnan.E and Mohamed A.(2017) ' Factors Contributing to Rework and their Impact on Construction Projects Performance'International Journal of Sustainable Construction Engineering & Technology (ISSN: 2180-3242) Vol 8, No 1, 2017

3. AftabHameed(2012**).** 'Time and Cost Perfomance in Costruction Projects in Southern and Cenrtal Regions of PenisularMalaysia'International Journal of Advances in Applied Sciences (IJAAS) Vol.1, No.1, March 2012, pp. 45~52 ISSN: 2252-8814

4. Alhaji A. et.al (2017) 'Causes *of Low-Skilled Workers' Performance in Construction Projects'* in construction industry in Nigeria. *Journal of Path of Science. 2017. Vol. 3, No 6*

5. Anderson, S., Molenaar, K., and Schexnayder, C. (2006). "Final Report for NCHRP Report 574: Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction." NCHRP Web-Only Document 98, Transportation Research Board, <http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w98.pdf> (July 7, 2008)

6. Anderson, S., Molenaar, K., and Schexnayder, C. (2007). Guidance for Cost Estimation and Management for Highway Projects during Planning, Programming, and Preconstruction, NCHRP Report 574, Transportation Research Board, Washington, D. C.

7. Anderson, S., Molenaar, K., and Schexnayder, C. (2007). *Guidance for Cost Estimation and Management for Highway Projects during Planning, Program*

8. Andi, S. & Minato, T. (2003) 'Design Documents Quality in the Japanese Construction Industry: Factors Influencing and Impacts on Construction Process'. International Journal of Project Management, 21 (7), 537-546.

9. Arditi, D., Elhassan, A., and Toklu, Y. (2002). "Constructability Analysis in the Design Firm." Journal of Construction Engineering and Management, 128(2), 117 126.

10. Bresnen, M. & Marshall, N. (2000a) 'Partnering in Construction: A Critical Review of Issues,Problems and Dilemmas'. Construction Management and Economics, 18 (2), 229-237.

11. Bresnen, M. & Marshall, N. (2000c) 'Building Partnerships: Case Studies of Client-Contractor Collaboration in the UK Construction Industry'. Construction Management and Economics, 18 (7), 819-832.

12. Brown, D., Ashleigh, M., Riley, M. & Shaw, R. (2001) 'New Project Procurement Process'.Journal of Management in Engineering, 17 (4), 192-201.

13. Bubshait, A., Al-Said, F., and Abolnour, M. (1998). "Design fee versus design deficiency." J. Archit. Eng., 10.1061/(ASCE)1076-0431(1998) 4:2(44), 44–46.

14. Burati, J.L. and Farrington, J.J. (1987), Costs of Quality Deviations in Design and Construction, CII Source Document No. 29, The Construction Industry Institute, Austin, USA.

15. Burati, J.L., Farrington, J.J. and Ledbetter, W.B., 1992, "Causes of quality deviations in design and construction", *Journal of Construction Engineering and Management,* Vol. 118, No. 1, pp 34-49.

16. Burati, J.L., J.J. Farrington, and W.B. Ledbetter (1992). "Causes of quality deviations in design and construction," J. of Constr. Engrg. And Mgmt, ASCE, 118(1), 34-36.

17. Carr, P., and Beyor, P. (2005). "Design fees, the state of the profession, and a time for corrective action." J. Manage. Eng.J. Manage. Eng., 10.1061/(ASCE)0742-597X(2005)21:3(110), 110–117.

18. CIDA, 1995 “Measuring up or muddling through: Best practice in the Australian nonresidential construction industry, Construction Industry Development Agency and Master Builders, Australia, Sydney, Australia, pp 59-63.Co., Washington, D.C.

19. Dawit B. (2018) 'Impacts of Value Engineering related practices in Ethiopian federalroad ',A Thesis submitted to in partial fulfillment of the requirements for the Degree of Master of Science in Civil Engineering (Construction Technology and Management Stream) Addis Ababa Institute of Technology ,Addis Ababa university School of Civil and Environmental Engineering, Addis Ababa, Ethiopia.

20. DeFraites, A.A. Jr. (1989), Fee Versus Quality, Journal of Professional Issues in Engineering, Vol. 115, No.2, pp 125-128.

21. Dell'lsolla, A. J. (1998). Value engineering: Practical Applications ...for Design, Construction, Maintenance and Operation, 1997, R.S.Means,

22. Dosumu& Aigbavboa.2018 "An assessment of the causes, cost effects and solutions to design-error-induced variations on selected building projects" in Nigeria.

23. ERA Road Sector Development Program 21 years Performance assessment report(2019)

24. Eradius E. and David A. (2013). "Effect of Inadequate Design on Cost and Time Overrun of Road Construction Projects" in Tanzania, KICEM Journal of Construction Engineering and Project Management Online ISSN 2233-9582

25. Eriksson, P. E., & Westerberg, M. (2011). Effects of cooperative procurement procedures on construction project performance: A conceptual framework. International Journal of Project Management, 29(2), 197-208.

26. Faridi, A. & El-Sayegh, S. (2006) 'Significant Factors Causing Delay in the UAE Construction Industry'. Construction Management and Economics, 24 (11), 1167-1176.

27. GetachewTsegaye(2009)," Design Risk Management in Ethiopian Federal Road projects"

28. GetuTilahun, (2014), "Application of web based construction communication" in Ethiopian Federal Road Projects. Master of science thesis ,AAiT, Addis Ababa University school of civil and Environmental Engineering.

29. Gransberg, D. D., Lopez Del Puerto, Carla, Humphrey, D. (2007). "Relating Cost Growth from the Initial Estimate to Design Fee for Transportation Projects." *Journal of Construction Engineering and Management*, American Society of Civil Engineers, Reston, VA. 133(6), 404-408

30. Horner, R.M.W. and Zakieh, R. 1998, "Improving construction productivity – apractical demonstration for a process based approach", *Internal publication*, Construction Management Research Unit, University of Dundee.

31. Hoxley, M. (2000). "Are competitive fee tendering and construction professional service quality mutually exclusive?" Constr. Manage. Econ., 18(5), 599–605

32. Hromada, E. Construction of Traffic Infrastructures: Causes of Low Effectiveness. Procedia Engineering. 85 (2014) pp. 251-259. Improving practice Office for Professional Liability Research, Victor O. Schinner and

33. Josephson, P. E. and Hammerlund, Y. 1996, "Costs of quality defects in the 90's",*Report 49*, Building Economics and Construction Management, Chalmers University of Technology, pp 125.

34. KamyarKabirifar and Mohammad Mojtahedi (2019) *"The impact of Engineering, Procurement and Construction (EPC) Phases on Project Performance"*: A Case of Large-scale Residential Construction Project. Journal of buildings 2019. Faculty of Built Environment, University of New South Wales; Sydney 2052, Australia; m.mojtahedi@unsw.edu.au

35. Koskela, L., 1999, "Management of production in construction: a theoretical view", *Proceedings of the 7th International Group for Lean Construction Conference*, University of Berkeley, California, USA.

36. Ling, F. (2004). "Consultancy fees: Dichotomy between A/E's need to maximize profit and employers' need to minimize cost." J. Prof. Issues Eng. Educ. Pract., 10.1061/(ASCE)1052-3928(2004)130:2(120),120–123.

37. Love, P. and Edwards, D. 2004b. Forensic project management: The underlying causes of rework in construction projects. Civil Engineering & Environmental Systems, Vol. 21, pp. 207-228.

38. Lowry, N. (1996), Government Procurement of Capital Works and Competition Policy – Their Effect on the Quantity Surveying Profession and Ramifications for the Community, Research Report, Australian Institute of Quantity Surveyors: Queensland Chapter, Australia

39. Lukuman O. et.al, 'Design Factors Influencing Quality of Builing Projects in Nigeria: Consultants' perception .The Australian Journal of Construction Economics and Building [Vol 3. No 21)

40. Machowski F. and Dale, 1995, "The application of quality costing to engineering changes", *International Journal of Materials and Product Technology*, Vol. 10, No. 3, pp 378-388.

41. MaranVleems(2018),'Measuring project performance: a method of project comparison' Open University of the Netherlands, faculty of Management, Science & Technology Master of science thesis,AAiT, Addis Ababa University school of civil and Environmental Engineering.

42. McSkimming, J., B. Peck, B. Hoy, and S. Carr (2005). "The quality of design documents: what can the cm do?" CMAA forum on quality of design documents, May, 2005.http://cmaanet.org/user_images/forum.quality_of_design_documents_-_mcskimming.pdf,(January 5, 2013).

43. Morgen, E.T. (1986). Claims by the federal government against its A/E – Guidelines for

44. Morgen, E.T. (1986). Claims by the federal government against its A/E – Guidelines for improving practice. Office for Professional Liability Research, Victor O. Schinner and Co., Washington, D.C.

45. Morris, J., Rogerson, J., Jared, G., 1999, "A tool for modelling the briefing and design decision making processes in construction", *School of Industrial and ManufacturingScience*, Cranfield University, Cranfield, UK. *National Cooperative Highway Research Program (NCHRP.1999) Draft guide book for highway contracting for innovation: The role of procurement and Contracting Approach in facilitating the implementation of Research Findings. Transportation Research Board, National Research Council, Washington,DC.*

46. NirajanMani(2011) 'Impact of design cost on performance of DBB project' Thesis paper.

47. Olawale, Y., and Sun M. (2010). "Cost and time control of construction projects: Inhibiting factors and mitigating measures in practice." Construction Management and Economics, 28 (5), 509 – 526.

48. PN.Okonkwo and J.Wium(2018) 'Impact of discounted professional fees on the risk exposure of civil and structural engineering service consultants' in South Africa. Journal of the South African Institution of civil engineering, Volume 60 No.1/ March 2018.

49. Rafiq Muhammad Choudhry et al.(2017). 'Causes of discrepancies between design and construction' in the Pakistan construction industry. Journal of Construction in Developing Countries, 22(2): 1–18.

50. Rafiq Muhammad Choudhry, HamzaFarooq Gabriel, Mustafa Kamal Khan and Salman Azhar. (2017).'Causes of discrepancies between design and construction' in the Pakistan construction industry. Journal of Construction in Developing Countries, 22(2): 1–18. https://doi.org/10.21315/jcdc2017.22.2.1

51. RenataSchneiderovaHeralova,(2016) 'Possibility of Using Value Engineering in Highway Projects' Czech Technical University in Prague, Faculty of Civil Engineering, Thakurova 7, 166 29 Prague, Czech Republic

52. Report of National Bank of Ethiopia(2018/19)

53. SchneiderováHeralová, R.: Highway Projects: Prices in Public Bids. Procedia Engineering. 2015, vol. 2015, no. 123, p. 496-503.

54. Shady Khalil Abdalaziz (2009)'Factors Affecting the Quality of Design and Contractual Documents' in Gaza Strip. A Thesis Submitted in Partial Fulfillment of Requirements for the Degree of Master in Construction Management.

55. Song, L., Mohamed, Y., &AbouRizk, S. M. (2009). Early contractor involvement in design and its impact on construction schedule performance. Journal of Management in Engineering, 25(1), 12-20.

56. Stroe, G. S. (2013). Structural analysis of engineering consulting and design industry. Management & Marketing, 8(1), 41.

57. Sturts, C.S. and F.H Griffis, Pricing Engineering Services, American Society of Civil Engineers, Journal of Management in Engineering. Vol. 21 Issue 2, 2005, pp. 56–62.

58. Tilley and Barton (2000) *'Cost cutting leads to poor value*' commonwealth scientific research organization Australia.

59. Tilley, P.A. (1998), Design and Documentation Deficiency and its Impact on Steel Construction, Steel Construction – Journal of the Australian Institute of Steel Construction, Vol. 32, No. 1, pp 2-13.

60. 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.

APPENDICES

APPENDIX 1: QUESTIONNAIRES

Dear Respondent,

It is obvious that construction industry plays a significant role for the development of a country in general and for the nations in particular. In view of this importance, as a country, the government of Ethiopia allocates a huge amount of money for the expansion and execution of many infrastructural projects in all states of the country. Among the infrastructures road sector development is one of the major contributor for the sustainable economic development. However the Authority's (ERA's) effort is encouraging, in upgrading and expansion of new road network coverage, due to some factors there are problems associated with non-performance of project execution and most projects undergo time and cost overruns, with quality of substandard.

Performance of construction projects can be influenced by design performance i.e. effectiveness, efficiency, constructability and innovation of design. Non-performance of design i.e. design errors omissions, design change, poor design output, which can be caused due to **Design Cost/ Design fees** can hinder the progress of project.

Prudent expenditures during design to improve design decisions can return significant initial and follow-on cost and quality improvement. Although, the performance of project are measured during the construction phase, as revealed in some literatures, the planning and design phase accounts for 80 to 90% of the impact on project quality and cost.

So, the purpose of this questionnaire is to acquire information in order to conduct a thesis project entitled ***Impact of Design Cost on Design and Project performance of DDB road project***.

As the quality of the research output will highly depend on the credibility of input data taken, the information you provide me will have great impact on the outcome of the findings expected, and on conclusions and recommendations to be forwarded.

Therefore, I kindly request your valuable cooperation to timely respond me the provided information data given in the questionnaire survey, and return back the questionnaire paper as soon as possible.

Thank you in advance for your cooperation and honesty in providing me your valuable response

Sincerely yours,

SeyoumAdmasu

Address: syamex21@ yahoo.com or seyoumadmasu1@gmail.com

SECTION I

General Information: Questions Related to Respondents

1. **Question No.1** Respondents general information:

   A. Academic information and experiences of respondent

Positions held so far in the organization/firm	**Qualification**	**Name of Employer**	**Years of experiences in the organization/ firm**	
			General	**Specific**
1.---------- Years of Experience ☐	A) BSc Degree in ----------	----------	----------	----------
2.---------- Years of Experience ☐	B) MSc Degree	----------	----------	----------
3.---------- Years of Experience ☐	in ----------	----------	----------	----------

SECTION II: Questions Related to Design fee/ Design cost

1. How do you rate the impact of design cost/design fee on performance of DBB road project?

Rating	Very high	High	No impact	low	Very low
Response					

2. How much will: reduced design fee, minimum design time, and client's unrealistic expectation and inability to properly define project objectives and requirements influence design quality?

Factor	Rating				
	Very high	high	No impact	low	Very low
Reduced design fee					
Minimum design time					
Clients unrealistic expectation and inability to properly define project objectives					

3. What is the effect of the statement 'As a result of competitive fees, designers produce simpler design to minimize the commitment of resource to task' in addition to this, it will have ----------negative effect on capital costs of construction and operation.

Rating	Very high	High	No effect	low	Very low
Response					

4. For design projects with low fees, consulting engineers give less consideration to design alternative and to checking and reviewing of documents. How far do you agree with this statement?

Rating	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Response					

5. For design projects with low fees, consulting engineers bid low with intention of doing less than in the requirement, and making up fees with claims and variations. How do you rate its effect on project performance?

Rating	Very high	High	No effect	low	Very low
Response					

6. For projects with low fees, consulting engineers produce simple design to minimize the commitment of the resources to a design task. So, what do you think will be the impact of this statement on project performance?

Rating	Very high	High	No impact	low	Very low
Response					

7. How far do you agree that the existence of minimum design fee regulation is necessary to organize professional practice in the country?

Rating	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Response					

8. As a result of reduced design fees/ design cost; 'Design firms tend to limit type of staff available, the extent of supervision & training, and increase use of junior inexperienced staff to carry out the design function.' Consequently, these lead to design errors and rework. So, what is the impact of such statement on performance of project out come during the construction phase?

Factors	Rating				
	Very high	high	No impact	low	Very low
Limiting the type of staff available					
Limiting the extent of supervision and training					
Increasing use of junior inexperienced staff to carry out the design function					
Overloading; assignment of one person to more than one activities at the same time					

9. How far do you agree with the statement as the 'result of low design fee the design firm shortens the required time for the design process to in order to maintain profit?'

Rating	Strongly agree	agree	Neither agree nor disagree	Disagree	Strongly disagree
Response					

10. How far do you agree with the statement that 'most of the private offices pay small salaries for their engineers in order to maximize profit on one hand, and compete with the low design fees in the market on the other hand?'

Rating	Strongly agree	agree	Neither agree nor disagree	Disagree	Strongly disagree
Response					

11. What is the influence of fees on quality of project performance with the statement 'organizations offering reduced fees in order just to win and this increased competitive pressure will lead to decline in professional standard's, resulting in poor service to clients and a decline in the standard's capability of recent graduate and junior staff?'

Rating	Very high	High	No effect	low	Very low
Response					

12. How do you rate the impact of factors affecting Design Cost of highway projects?

Project Related Factor	Impact Rating Very high=5, High=4, Moderate=3, Less impact =2, No impact=1				
	Very high	High	Moderate	Less impact	No impact
➢ Project type					
➢ Project cost					
➢ Project length					
➢ No. of lane					
➢ No. of bridge					
➢ Complexity					
➢ Geographic					
➢ No. of plan sheets/ deliverables					
	Impact Rating Very high=5, High=4, Moderate=3, Less				

Factor	impact =2, No impact=1				
	Very high	**high**	**moderate**	**Less impact**	**No impact**
➢ Highway classification					
➢ National or environmental policy					
Contract &Procurement Related factors					
➢ Type of contract					
➢ Procurement policy					
➢ Procurement method					
➢ Procurement type					
Market condition related factors					
➢ Inflation rate					
➢ Number of competitors					
➢ Stability of market condition					
➢ Currency Devaluation					
Consultant Related factors					
➢ Commitment of the firm to compete on fair ground					
➢ Bid rigging					
➢ Loss of design effort					
➢ Availability of all fields of specialization in project team					
➢ Designers experience level					
Factors related to method of consultant selection					
➢ Quality based					
➢ Least cost based					
➢ Value based					
➢ Performance based					
Client Related factors					
➢ Un willingness of client to pay design commensurate					
➢ Insufficient Design Time					
➢ Term of Reference					
➢ Scope of work					
➢ Client's financial situation and					

budget					
➢ Client's requirement on quality					
Factors related to Project Delivery methods					
➢ DBB					
➢ DB					
➢ Others					

Section III. Questions related to design performance

1. How do you rate the impact of the following input variables as a criterion to influence the performance of design?

I/NO	Input Variable	Impact Rating Very high=5, High=4, Moderate=3, Less impact =2, No impact=1				
		Very high	High	Moderate	Less impact	No impact
1	Overall size of design firm					
2	Overall quality of design firm					
3	Size of design contract					
4	Complexity of the project function					
5	Complexity of the design process					
6	Complexity of project conditions(type of problem, Magnitude of problem, and No. of problems)					
7	Level of scope definition					
8	Continuity of man-hour commitment for the project					
9	Level of competition in the market					

2. How do you rate the impact of design related factors on the performance of construction projects?

I/NO	Design related factor	Impact Rating Very high=5, High=4, Moderate=3, Less impact =2, No impact=1				
		Very High	High	Moderate	Less impact	No impact
1	Design errors and omissions					
2	Design change					
3	Inaccurate BOQ					
4	Absence of detailed drawings					
5	Absence of up-to-date standards and specifications					

3. How do you rate the impact of the following identified factors affecting quality of design and documents on performance of triple project constraints; cost, time and quality?

Factors	Impact on Cost					Impact on Time					Impact on Quality				
	Very high	High	No impact	low	V. low	Very high	high	No impact	low	Very low	Very high	High	No impact	Low	Very low
Insufficient and missing in put information from the client															
Lack of qualified consultants staff															
Insufficient design review with relevant parties															
Lack of time for design review															
Tight design schedule or inaccurate time estimate															

Reduced design fees															
Lack of data integration across design discipline															
Absence of high cost experienced design team															
Allocation of staff to more than one project in the same time															
Unwillingness of clients to pay fees commensurate with the design of high quality services															

Section IV. Questions Related to Design and Procurement

1. How far do you agree with the statement that clients provide insufficient design time for design work without taking the complexity and scope of wok into account?

Rating	Strongly agree	agree	Neither agree nor disagree	Disagree	Strongly disagree
Response					

4. How do you rate the effect of design time on the quality of design output? Among the given choices, Please tick one you think will be the answer.

Rating	Very high	High	average	low	Very low
Response					

5. How do you rate the level of commitment among design professionals to quality improvement?

Rating	V. poor	Poor	average	good	V. good
Response					

2. What is the impact of design code and standards on design quality?

Rating	V. high	High	No impact	low	V. low
Response					

6. For Design Bid Build (DBB) Delivery method whom do you think will be financially liable for the cost of any errors or omissions encountered in construction due to design case?

a) The owner/ client b) The design consultant c) The contractor d) All

Please would you elaborate your answer or give your justification?

_____

_____

_____

3. What is the impact of poor communication among design professionals on project performance?

Rating	Very high	High	average	low	Very low
Response					

4. How do you rate the impact of poor level of commitment to quality improvement among design professionals on performance of project?

Rating	Very high	High	average	low	Very low
Response					

5. What is the effect of inadequate involvement of other professionals and team work during design stage on project performance?

Rating	Very high	High	average	low	Very low
Response					

6. What is the impact of lack of constructability review of design on project performance?

Rating	Very high	High	average	low	Very low
Response					

7. How do you rate the impact of the statement that Some design consultants copy and modify design from previous work to minimize time and cost' has on design quality?

Rating	Very high	High	average	low	Very low
Response					

8. What do you think will be the effect of insufficient and missing input information from the client on quality of design output?

Rating	Very high	High	average	low	Very low
Response					

9. What is impact of lack of qualified consultants' staff on design quality?

Rating	Very high	High	No impact	low	Very low
Response					

10. Capacity building of designers in construction operations and involving construction expertise in the design process can reduce the project cost and time?'

Rating	Strongly agree	agree	Neither agree nor disagree	Disagree	Strongly disagree
Response					

11. What is the effect of weak or absence of quality control system in the design process on construction project performance?

Rating	Very high	High	No effect	low	Very low
Response					

12. 'Having a direct estimate of expected fee and a reliable contingency gives agency a starting point for negotiations with design consultants, and it will also allow them to more efficiently allocate funds through the program.' How far do you agree with such statement?

Rating	Very high	High	No effect	low	Very low
Response					

APPENDIX-2: **Lists of the Respondents Company or organization Name**:

The respondents of the questionnaire are from client (ERA) and from private consulting Engineering firms.

- **Concerning client**, the respondents were professionals (Engineers) working in Ethiopian Roads Authority (ERA), under contract administration and implementation directorate (North region, Eastern, western region directorates) and those working under Design management directorate and Engineering Procurement Directorate.
- **Name of some the respondents private consulting Engineers company/ Firm name:**
  1. Beza Consulting Engineers
  2. Best Consulting Engineers
  3. UNICONE Consulting Engineers
  4. HEC Consulting Engineers
  5. GONDWANA Consulting Engineers
  6. Net Consulting Engineers
  7. TCDE
  8. MH Consulting Engineers
  9. Ethio Enfra Consulting Engineers
  10. Core Consulting Engineers

APPENDIX-3: Case Study -1 Concerned about surveying and showing trends of design cost of DBB road projects of Ethiopian federal roads, for the time periods 2004 to 2007 EC or (2011-2014GC)

Table 4.27: Design Cost of DBB Federal Road Project for 2004E.C (2011 to 2012GC)

I/N	Project Name	Type of service	Type of project	Length in km	Contract Signature date	Design cost (ETB)	Design cost/km
1	Chancho-Derba-Becho	Service	Ditto	28	Aug12/2011	6,931,107.50	247,539.55
2	Gashena - Lalibela - Sekota	Service	Ditto	180	Aug12/2011	4,263,337.50	23,685.21
4	Robe-Gassera - Ginir	Service	Ditto	10	Sepr5/2011	3,951,745.00	32,931.21
5	Awash - Mille Road Overlay	Service	Ditto	295	Nov29/2011	25,342,550.00	85,906.95
6	Nekempt _ Bure	Service	Ditto	44	December26/2011	12,018,499.06	49,256.14
7	Hamusit_ Estie	Service	Ditto	78	January 30/2012	4,200,166.70	53,848.29
8	ArbaReketi _ Gelemso _Mechara	Service	Ditto	100	February13/2012	2,576,000.00	25,760.00
9	Melkasa-Sodere-Nurera - Metahare	Service	Ditto	96	March 8/2012	2,571,817.45	26,789.77
10	Harar - Jarso	Service	Ditto	5	Mar19/2012	2,230,943.65	446,188.73
11	MayTsebri-Dima-FiyelWeha-AbiAdi-Hawzen-FireWeyin Cont3 FiyelWeha- AbiAdi	Service	Ditto	82	Mar 30/12	11,501,702.00	140,264.66
12	Pave town Section Under South Region	Service	Ditto	22.2	Apr 9/2012	8,453,420.00	380,784.68
13	Adiremet - Kulta - Adigoshu	Service	Ditto	73	Apr 22/2012	3,197,698.80	43,804.09
14	Dembidolo - Mugi - Gambela	Service	Ditto	137	Apr 30/2012	4,417,437.50	32,244.07

15	Fincha _ Shambu_Bako	Service	Ditto	103	May 15/201	3,399,285.00	33,002.77
16	Sodo -Sawla	Service	Ditto	135	May 25/2012	4,707,926.00	34,873.53
17	Chida - Sodo	Service	Ditto	165	May 29/2012	5,985,763.23	36,277.35
18	Jihur-Zemro-Degolo-Guguftu	Service	Ditto	140	Jun6/2012	4,988,079.86	35,629.14
19	Asko- Baday- Chalaka	Service	Ditto	65	Jun8/2012	2,887,0750	44,416.54
20	Shek Hussein - Ginir	Service	Ditto	125	Jun12/2012	3,250,475.00	26,003.80
21	Fik - Hamero - Imi Bale	Service	Ditto	190	Jun14/2012	6,565,847.95	34,557.09
AVERAGE							89,077.60
MIN							23,685.21
MAX							446,188.73

Table 4.28: Design Cost of DBB Federal Road Project for 2005E.C (2012 to 2013GC)

Design service projects signed in 2005 EC							
I/N	Project Name	Type of service	Type of project	Length in km	Contract Signature date	Design cost (ETB)	Design cost/km
1	Babile - Fik	Service	Ditto	120	July 25/2012	7,205,325.00	60,044.38
2	Asaita - Afambo	Service	Ditto	50	Aug16/2012	3,776,525.94	75,530.52
3	Morka - Gircha - Chencha	Service	Ditto	64	Aug20/2012	2,971,456.25	46,429.00
4	Chereti-Gorobeksa-Gordamole	Service	Ditto	290	Aug23/2012	8,093,914.42	27,910.05
5	Terecha - Woldehana - Omonada	Service	Ditto	82	Aug31/2012	5,360,888.88	65,376.69
6	Arbaminch -Dilbana-Konso-Woito	Service	Ditto	150	Sep4/2012	4,380,925.00	29,206.17

7	Jijga-Gelesh-Deghemdo-Segeg	Service	Ditto	240	Sep14/2012	12,032,162.50	50,134.01
8	Negele - Filtu	Service	Ditto	127	Sep17/2012	4,366,437.40	34,381.40
9	Negele - Wachile	Service	Ditto	127	Dec14/2012	6,441,410.00	50,719.76
10	Alemketema - Degolo	Service	Ditto	85	Dec21/2012	4,518,874.12	53,163.22
11	Dima - Joba - Omorate	Service	Ditto	272	Dec25/2012	7,809,887.92	28,712.82
12	Guguftu - Tenta	Service	Ditto	120	Dec28/2012	6,239,481.48	51,995.68
13	Tenta - Gashena	Service	Ditto	107	Dec30/2012	6,532,605.00	61,052.38
14	Ginchi - Kachise	Service	Ditto	40	Feb12/2013	4,191,728.13	104,793.20
15	Aykel- Zufan- Angerb	Service	Ditto	100	Feb28/2013	6,247,462.50	62,474.63
16	Korem - Sekota-AbiAdi	Service	Ditto	231	Mar10/2013	11,850,550.00	51,301.08
17	Daye-Chiri-Nansebo	Service	Ditto	65	Apr30/2013	5,483,919.90	84,368.00
18	Iteya- Robe-Seru	Service	Ditto	130	May28/2013	9,821,373.75	75,549.03
19	Mekele-Dengolat-Samre-Finaiwa	Service	Ditto	95	July1/2013	5,330,170.00	56,107.05
	Average						56,276.27
	Minimum						27,910.05
	Maximum						104,793.20

Table 4.29: Design Cost of DBB Federal Road Project for 2006 E.C (2013 to 2014GC)

Design service projects signed in 2006 EC							
I/N	Project Name	Type of service	Type of project	Length in km	Contract Signature date	Design cost (ETB)	Design cost/km
1	Hayk-Bistima-Chifra	Service	Ditto	40	July20/2013	4,622,683.75	115,567.09
2	Ejere-Gundomeskel-Welka	Service	Ditto	64	July31/2013	6,414,100.00	100,220.31
4	Guliso-Chaliya-Dila-Babo-Kondala-Begi	Service	Ditto	115	Sep16/2013	7,451,511.25	64,795.75
5	Jinka-Tolta-Gelila-Laska	Service	Ditto	125	Sep20/2013	5,858,611.23	46,868.89
6	Harar -Kombolcha-Ejersagoro-Fugnanbira	Service	Ditto	90	Feb07/2014	5,973,100.00	66,367.78
7	Guder- Kegna-Delssa-Balami-Gondea	Service	Ditto	80	Feb07/2014	4,956,092.90	61,951.16
8	Kamba-Daramalo	Service	Ditto	34	Mar25/2014	4,271,387.50	125,629.04
9	Burka-Midaga-Tolla-Babile	Service	Ditto	140	Mar31/2014	11,286,675.00	80,619.11
10	Shishinda-Tepi	Service	Ditto	74	May16/2014	5,118,081.22	69,163.26
11	Daye-Girja-Melka-Desta	Service	Ditto	110	Jun30/2014	5,834,571.00	53,041.55
12	Maytemen-Maygaba-Maytsebry	Service	Ditto	110	Jul1/2014	7,736,812.98	70,334.66
Average							77,475.33
MIN							46,868.89
MAX							125,629.04

Table 4.30: Design Cost of DBB Federal Road Project for 2007E.C (2014 - 2015GC)

Design service projects signed in2007 EC							
I/N	Project Name	Type of service	Type of project	Length in km	Contract Signature date	Design cost (ETB)	Design cost/km
1		Service	Ditto	50	Ju18/2014	5,173,965.00	103,479.30
2	Mekaneyesus-Semada Saint	Service	Ditto	160	Jul 22/2014	7,017,242.50	43,857.77
3	Gelego-Tewodros-Ketema	Service	Ditto	90	Jul25/2014	6,130,856.06	68,120.62
4	Ageremariam -Geana-Derba-Nechsar- Arbaminch	Service	Ditto	98	Jul28/2914	4,932,925.00	50,335.97
5	F6Junction_F4 Junction	Service	Ditto	83	Jul29/2014	21,762,600.00	262,200.00
6	DebreBirhan- Deneba	Service	Ditto	86	Jul 30/2014	4,648,760.00	54,055.35
7	AmbaGiorgis- ArbaTsegur-AbiAdi Junction	Service	Ditto	197	Jul 31/2014	11,602,925.00	58,898.10
8	Maji- Kibishi	Service	Ditto	60	Aug 14/2014	5,626,283.00	93,771.38
9	Ali Ethiopia-Degahmdo	Service	Ditto	160	Aug 29/2014	8,239,179.60	51,494.87
10	Alemketema - Jema-Kelela	Service	Ditto	70	Sept 23/2014	7,102,863.45	101,469.48
11	Fik-Segeg-Gerebo- Danan	Service	Ditto	240	Sept 30/2014	11,092,066.25	46,216.94
12	Goro-Kenete-Fincha sugar Factory	Service	Ditto	53	Oct 2/2014	3,176,300.00	59,930.19
13	Rmeti-Burka	Service	Ditto	180	Oct 10/2014	11,120,160.48	61,778.67
14	Raitu - Dikashkisa - Elkere	Service	Ditto	69	Oct 10/2014	9,478,817.50	137,374.17
15	Adola-Desta-Harenfema(Medago)	Service	Ditto	104	Oct 10/2014	6,003,805.00	57,728.89
16	Kelela - Akesta	Service	Ditto	70	Oct 13/2014	4,627,276.81	66,103.95
17	Jiga-Quarit -Arbgebeya-Sekela-Tililli	Service	Ditto	125	Oct 15/2014	9,250,600.00	74,004.80

18	Dodola - Kibremengist	Service	Ditto	180	Dec 25/2014	9,367,838.21	52,043.55
19	Awash-Kulibi- DireDawa	Service	Ditto	312	Dec 26/2014	42,231,450.00	135,357.21
20	Filtu-Dolo-Odo-DoloBaye	Service	Ditto	224	Dec31/2014	10,439,412.50	46,604.52
21	Wukro-Abreha-weatsbha-AbiAdi	Service	Ditto	96	Dec31/2014	8,257,051.75	86,010.96
22	Kurmuk-Sherkole	Service	Ditto	60	Jan 13/2015	5,299,142.50	88,319.04
23	Wukro -Atsbi-Konoba	Service	Ditto	62	Jan 15/2015	5,167,180.00	83,341.61
24	Mesel/Musle-Kora/Kori-Teru	Service	Ditto	210	Jan26/2015	11,056,668.39	52,650.80
25	Tarmaber-Molale-Mehalmeda	Service	Ditto	135	Jan28/2015	5,691,205.84	42,157.08
26	Tepi- Mizan	Service	Ditto	51	Feb31/2015	3,736,847.65	73,271.52
27	Gore-Masha-Tepi	Service	Ditto	140	Mar12/2015	16,111,095.94	115,079.26
28	KetemaNigus-AdiselamMaygaba	Service	Ditto	60	Mar25/2015	5,994,375.00	99,906.25
29	Dela-Chilena-MerawaTsetsera-Alamata	Service	Ditto	125	Mar30/2015	8,516,842.50	68,134.74
30	Denbecha-feresBet-Adet	Service	Ditto	123	Apr 8/2015	7,541,700.00	61,314.63
31	D/Markos-Degotsion-Mota	Service	Ditto	122	Apr 16/2015	6,625,555.85	54,307.83
32	Omo River - Kibishi	Service	Ditto	175	Apr24/2015	13,789,650.00	78,798.00
33	Adiremet-Awra - Dansha	Service	Ditto	60	Apr27/2015	5,098,985.00	84,983.08
34	Adura-Jikawo	Service	Ditto	36	Apr28/2015	6,220,350.00	172,787.50
35	Abobo -Meti	Service	Ditto	150	Apr28/2015	8,645,150.00	57,634.33
36	Rama -ChilaAdidaero-Semema	Service	Ditto	60	Apr29/2015	6,966,355.00	116,105.92
37	Koncho-Kamishi-Soge-Nekmpt	Service	Ditto	235	Apr30/2015	11,448,700.00	48,717.87
AVERAGE							81,306.65
MIN							42,157.08
MAX							262,200.00

Source: Adapted from ERA procurement directorate

Note:Ditto Means-Route Selection &Survey, Feasibility &EIA studies, Detailed Engineering Design, Resettlement Action Plan (RAP) &Tender Document Preparation

APPENDIX-4: **Correlation among variables:**

Reduced Design fee or design cost on design quality, impact of design errors and omissions on the performance of construction projects, impact of inaccurate BOQ on the performance of construction projects, impact of design change on the performance of construction projects, impact of absence of detail drawings on the performance of construction projects and impact of absence up-standards and specifications on the performance of construction projects. Table 4.31: Shows results of correlation analysis among variables.

Table 4.31:

Correlations							
		A	B	C	D	E	F
A	Pearson Correlation	1	.766**	.783**	.766**	.811**	.844**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	24	23	23	23	23	23
B	Pearson Correlation	.766**	1	.925**	1.000**	.817**	.855**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	23	23	23	23	23	23
C	Pearson Correlation	.783**	.925**	1	.925**	.800**	.824**
	Sig. (2-tailed)	.000	.000		.000	.000	.000

	N	23	23	23	23	23	23
D	Pearson Correlation	.766**	1.000**	.925**	1	.817**	.855**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	23	23	23	23	23	23
E	Pearson Correlation	.811**	.817**	.800**	.817**	1	.942**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	23	23	23	23	23	23
F	Pearson Correlation	.844**	.855**	.824**	.855**	.942**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	23	23	23	23	23	23

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

- Correlation analysis was carried out for the combined variables and results of the analysis indicated a positive correlation among the variable

Legend:

A. Impact of Reduced Design fee or design cost on design quality
B. How do you rate impact of design errors and omissions on the performance of construction projects?
C. How do you rate impact of inaccurate BOQ on the performance of construction projects?
D. How do you rate impact of design change on the performance of construction projects?

E. How do you rate impact of absence of detail drawings on the performance of construction projects?

F. How do you rate impact of absence up-standards and specifications on the performance of construction projects?