ADDIS ABABA UNIVERSITY

ADDIS ABABA INSTITUTE OF TECHNOLOGY

SCHOOL OF GRADUATE STUDIES

Assessing Challenges of EPC Contract delivery system for Railway Projects in Ethiopia

A thesis submitted to the
School of Graduate Studies
In the partial fulfillment of the requirements for Degree of
Master of Science (M.Sc.) in Civil Engineering
(Railway Engineering)

By

Biruk Yemane

Advisor

Wubshet Jekale (Dr.-Ing.)

December 2015

ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY
SCHOOL OF GRADUATE STUDIES

"Assessing Challenges of EPC Contract delivery system for Railway Projects in Ethiopia"

M.Sc. Thesis

By

Biruk Yemane

Approved by Board of Examiners

Wubshet Jekale (Dr.-Ing.)	_____
Advisor	Signature
Fasil Tebeje	_____
Internal Examiner	Signature
Dr. Girmay Kahssay	_____
External Examiner	Signature
_____	_____
Chair Person	Signature

DECLARATION

I, the undersigned, declare that this thesis represents my ideas in my own word and where others ideas or words have been included, I have adequately acknowledged, cited and referenced the original sources. I have also declared that this thesis has not been presented for a degree in any other university.

Name: Biruk Yemane Girma

Signature: _____

Place: Addis Ababa, Ethiopia

Date of Submission: October 05th, 2015 GC

Addis Ababa University
Addis Ababa Institute of Technology,
School of Graduate Studies,
School of Civil & Environmental Engineering
Railway Engineering Center

Title of the Thesis:

"Assessing Challenges of EPC Contract delivery system for Railway Projects in Ethiopia"

Acknowledgements

I would like to express my deep sense of gratitude to my advisor Dr. Ing. Wubshet Jekale, for his inexorable support, guidance, provides me insight & direction from the beginning of this research in all aspects. This thesis would not have been possible without his extended valuable assistance, energizing motivation, excellent advice and also spending his precious time.

I would like to express my appreciation to all questionnaire respondents from contractors, Employer's Representative and Employer staffs who sacrificed their time in filling the questionnaires and all organizations and individuals who provided the necessary materials and support for realization of this thesis. Especial thanks are forwarded particularly to Kassahun, Shalom Ashuro & Neway for their help while collecting data.

I would like to place on record my gratitude to Henon Endale who gave me constant encouragement, without her care and love this thesis would not have been realized.

I am indebted to my family, my classmates and friends who supported me. I am also very much thankful to my work cliques & my Company Afro-Tsion Construction P.L.C. for the positive attitude they have towards education and made me felt like the company asset.

Finally, I humbly thank the almightily GOD, Good Angels and Saints for giving me good health, wellbeing and strength that enabled me to complete this thesis.

Table of contents

Acknowledgements I
List of tables IV
Acronyms V
Abstract VI
1. Introduction 1
1.1. Statement of problem 2
1.2. Research objective 2
2. Literature review 3
2.1. Introduction 3
2.1.1. Delivery system 3
2.1.2. Design build vs. EPC vs. Turnkey 4
2.2. Features of EPC contract delivery system 8
2.2.1. Common feature with other types of delivery systems but with some modifications 9
2.2.1.1. Fixed contract price 9
2.2.1.2. Fixed completion date 10
2.2.1.3. Security/ guarantee from the contractor and/or its parent companies 10
2.2.2. Special features of epc contract delivery system 12
2.2.2.1. Single point responsibility 12
2.2.2.2. Performance specification & performance guarantees 13
2.2.2.3. Caps on liability and design liability on contractor 14
2.2.3. Higher liquidated damages for both delay & performance and longer coverage period 15
2.2.4. Restrictions on the ability of the contractor to claim extensions of time and additional costs due to risk transfer 17
2.3. Challenges of EPC contract delivery system 18
2.3.1. Cost related challenges 18
2.3.2. Time related challenges 25
2.3.3. Quality related challenges 29
2.3.4. Risk 31
3. Research methodology 35
3.1. The study approach 35
3.2. Data sources 36
3.3. Data collection 36
3.3.1. Primary data 36
3.3.2. Secondary data for case study 39
3.4. Data analysis method 40
3.5. Outline of research writing 43

4. Analysis of findings and discussion 45
4.1. General overview 45
4.1.1. Questionnaire response rate 46
4.1.2. Informants profile 47
4.1.3. Interview response rate 48
4.2. Challenges of EPC contract delivery system for railway projects from questionnaire analysis 50
4.2.1. Challenges in terms of probability of occurrence 51
4.2.2. Challenges in terms of impact 58
4.2.2.1. Impacts of cost related challenges 58
4.2.2.2. Impacts of time related challenges 65
4.2.2.3. Impacts of quality related challenges 71
4.3. Risk of EPC contract delivery system for railway projects from questionnaire analysis 77
4.3.1. Risk factors in terms of probability of occurrence 77
4.3.2. Ranking of risk factors in terms of their impact & probability of occurrence 81
4.3.2.1. Cost impact of risk factors 82
4.3.2.2. Time impact of risk factors 88
4.3.2.3. Quality impact of risk factors 94
4.4. Challenges& risk of EPC contract delivery system for railway projects from interviewanalysis 100
4.5. Case study of selected railway projects 105
4.5.1. Addis Ababa Light Rail Project 105
4.5.1.1. Project overview 105
4.5.1.2. Challenges encountered 109
4.5.2. Ethio- Djibouti rail project 1st bid lot (Sebeta-Meiso) 123
4.5.2.1. Project overview 123
4.5.2.2. Challenges encountered 124
4.5.3. Ethio- Djibouti rail project 2nd bid lot (Mieso-Dawanle) 132
4.5.3.1. Project overview 132
4.5.3.2. Challenges encountered 132
5. Conclusion &recommendation 136
5.1. Conclusion 136
5.2. Recommendation 138
Reference 139
Appendix 143
Appendix a: Proposal 143
Appendix b: The Questionnaire 158

LIST OF TABLES

Table 4.1 Questionnaire response rate……47

Table 4.2 Informants Profile……48

Table 4.3 Interview response rate……49

Table 4.4 Probability of Occurrence of Challenge variables on Railway project ……51

Table 4.5 Spearman's rho correlation for Probability of Occurrence of challenge variables……57

Table 4.6 Impact of challenge variables on cost of the project……58

Table 4.7 Spearman's rho correlation for Cost Impact of challenge variables……63

Table 4.8 Impact of challenge variables on Time of the project……65

Table 4.9 Spearman's rho correlation for Time Impact of challenge variables ……70

Table 4.10 Impact of challenge variables on Quality of the project……71

Table 4.11 Spearman's rho correlation for Quality Impact of challenge variables ……76

Table 4.12 Probability of Occurrence of Risk Factors on Railway project ……78

Table 4.13 Spearman's rho correlation for Probability of Occurrence of Risk Factors…80

Table 4.14 Least Combination of probability of Occurrence & Impact on Ranking of Risk Factors ……82

Table 4.15 Impact of Risk Factors on Cost of the project……82

Table 4.16 Ranking of Risk Factors on Cost of the project ……84

Table 4.17 Spearman's rho correlation for Rank of Risk Factors on Cost ……87

Table 4.18 Impact of Risk Factors on Time of the project ……88

Table 4.19 Ranking of Risk Factors on Time of the project ……90

Table 4.20 Spearman's rho correlation for Rank of Risk Factors on Time ……92

Table 4.21 Impact of Risk Factors on Quality ……94

Table 4.22 Ranking of Risk Factors on Quality of the project ……96

Table 4.23 Spearman's rho correlation for Rank of Risk Factors on Quality……98

ACRONYMS

AACRA	Addis Ababa City Roads Authority
AAiT	Addis Ababa Institute of Technology
AALRT	Addis Ababa Light Rail Transit
AAWSA	Addis Ababa Water Sewage Authority
CCECC	China Civil Engineering Construction Corporation
CREC	China Railway Group Limited
DB	Design Build
EEPCO	Ethiopian Electric Power Corporation
EPC	Engineering, Procurement and Construction
ERC	Ethiopia Railway Corporation
ETB	Ethiopian Birr
FEED	Front End Engineering Design
FIDIC	Fédération International Des Ingénieurs Conseils
LRT	Light Rail Transit
MoTaC	FDRE Ministry of Transport and Communications
RFI	Request for Inspections
ROW	Right of Way
SweRoad	Swedish National Road Consulting AB
USD	USA Dollar

Abstract

Launching Mega projects, such as railway projects, has many social, environmental, financial and construction challenges; hence, assessing construction Challenge factors in the new Ethiopian Railway construction industry is sensitive issues. Therefore, carrying out a research in this area will have a paramount importance.

For developing countries like Ethiopia with insufficient financial capacity and inexperience in such Railway projects, Engineering-Procurement and Construction (EPC) Turnkey contract delivery system is pleasant alternative, where a contractor provides design/engineering services, procurement for the facility, construction & commissioning services that also satisfy the lenders requirements for bankability. Even though EPC has many advantages, there are many challenges encountered.

The research was undertaken to assess the challenges of EPC contract delivery system for Railway projects in Ethiopia and to recommend possible remedial measures. Accordingly, intensive literature review was conducted to identify challenge variables from previous findings, through which numerous challenge variables were identified in global and local projects with EPC contract delivery system. Consequently, detail analyses were conducted by collecting relevant data that comprises primary data, through questionnaire & supportive interview, and secondary data using archival records of the three Railway projects undergoing.

The Mean Score of each groups of respondents' response from Employer, Employer's representative, Contractors and skilled professionals in the sector were calculated then Weighted Average of all groups on each variable was calculated to rank them accordingly. Spearman rank correlation coefficients were used to measure the agreement and/or difference in ranking between two groups of respondents on each variable.

The most common Challenge variables identified by this research were insufficiently defined conceptual design & Front End Engineering Design (FEED) by the Employer that leads to Changes in scope of work and variation orders, Failure of the employer to give possession of site & to coordinate utility infrastructure authorities for existing and future planned utilities in the ROW of the project, Incomplete specifications applicable for Railway projects, and Contractor's aim to minimize cost by optimizing quality, aesthetics and design to satisfy the minimum requirement.

Moreover, Construction risk, ROW risk, Design risks of Changes in scope & Variation orders and Market risks of Price escalation &Exchange rate fluctuation have higher

probability of occurrence with highest impact on cost & time. Furthermore, Design not up to standards, unclear scope of work occasionally occurs but has high Quality impact.

Major recommendations include: The Employer should have to build the capacity of his technical & managerial staffs for the preparation of conceptual design or Front End Engineering Design (FEED) and minimize variation orders, well organized and/or well defined Railway standard specification should be prepared, standard contract award system and tender evaluation criteria and well organized master plan should be set that integrates all infrastructures and utilities and clear all obstruction in the Right of Way (ROW) of the proposed before the contract award.

Finally, I believe that this study will contribute a lot for the successful implementation of future Railway projects.

Key words: - Contract delivery System, EPC, Challenge, Risk.

1. Introduction

The Ethiopian Railways Corporation (ERC) was Re-incorporated on 28 November 2007 GC to develop, manage the design, construction, operation and maintenance of both light Rail and Passenger & Freight Rail transportation systems in Ethiopia. In doing so the corporation selects contract delivery system and prepare contract document.

One of the key purposes of any contract is to allocate risks and benefits between the parties to the contract. In the construction context, various project delivery methods have been developed to deal with the different ways, owners, developers, contractors, consultants and public entities view and accept risk. For both the light and heavy rail transits in Ethiopia the implementation strategy is an EPC (Engineering, Procurement and construction) Turnkey contract delivery system.

In EPC contract the funders and Owners expect to get the degree of certainty to time and costs that they require which benefits from an increased amount of the risk of the project being placed on the contractor. However, there is challenge in the implementation of this delivery system, for instance a contractor will attempt to increase the contract price in accordance with the acceptance of increased risk, the cost and time impact of variation is much higher as compared to other delivery systems; in addition, the employer lacks involvement in the design & construction of the project.

Thus, the thesis assesses advantages and challenges of EPC contract delivery system in the Railway projects in Ethiopia tracking Addis-Ababa Light Rail Transit and the two lots of Ethio-Djibouti Railway projects, Sebeta-Mieso & Mieso – Dawanle railway projects through their process of design and construction to conclude about what are the challenges and their associated impact of EPC Contract delivery system.

The evaluation was done stage by stage; in which it starts with Introduction and background information about the topic followed by intensive literature review of previous works. After the detail literature review, detail assessment made based on the questionnaire and interview and case study of archival documents of the case histories of the stipulated projects is conducted finalized with conclusions and recommendations.

1.1. Statement of problem

To my knowledge there was no research done so far that dealt with the challenges of EPC contract as delivery system in Railway Projects in Ethiopia; so that the thesis will become paramount reference for further assessments. Therefore, this research seeks to answer the following question:

> "What are the problems and challenges of EPC contract delivery system in Railway Projects in Ethiopia? What will be the possible remedial measure to tackle those challenges & to handle the risks?"

1.2. Research objective

1.2.1. General Objective

The objective of this research is to assess the challenges of EPC Contract delivery system for Railway projects in Ethiopia.

1.2.2. Specific Objectives

The problem statement for this thesis is approached by developing three data collection methods (Questionnaires, Interviews and Document Analysis) and detail studies on each with an individual objective that contributed to the assessment of challenges of EPC Contract delivery system in Ethiopia. Thus, the specific objectives of the research are:

- To assess the most frequent Challenge variables & risk factors of EPC contract delivery system in railway projects.
- To assess the Challenges of EPC contract delivery system in terms of the Cost impact of the project.
- To assess the Challenges of EPC contract delivery system in terms of the Time impact of the project.
- To assess the Challenges of EPC contract delivery system in terms of the Quality impact of the railway project.
- To assess the Risk factors of EPC contract delivery system& their treatment method.
- To propose possible remedial measures for the challenges assessed.

2. Literature Review

2.1. Introduction

Contract is defined in Civil Code of Ethiopia Proclamation No.165 of 1960 Article 1675 as:-

> *"Contract is an agreement whereby two or more persons as between themselves create, vary or extinguish obligation of proprietary nature."* [1]

Contract is an agreement between two or more entities in which they agree to provide a specific task in exchange for something in return. The key purpose of any contract is to allocate risks and benefits between the parties to the contract. [2]

For successful contract the owner should select appropriate contract delivery methods and contract strategy/ Contract type. To achieve the specific project goals, however, the delivery system must be compatible with the owner's contracting methodology and procurement process, Since Project delivery process merely establishes the roles and relationships among the key members of the project team. [3]

2.1.1. Delivery System

A project delivery system defines the structure of the relationships of the parties, the roles and responsibilities of the parties, and the general sequence of activities by which all of the procedures and components of designing and building a project are organized and put together in an agreement that can results in a completed project. It has been evolved to deal with the many ways in which contracting parties wish to allocate their risk, from the general contract to the development of alternative financing and procurement methods. [2, 4]

Project delivery systems refers to the system that owner use organizing and financing design, construction, operation and maintenance which facilitate the delivery of service or good.[4]There are several project delivery methods in the construction sector; Such as traditional /Design-Bid-Build/, Construction management as own agent, Construction

Manager "At-Risk", Design Build, Engineering procurement and construction (EPC) and others.

Consequently, selection of the project delivery system is one of the most important decisions affecting the success of a project, and is therefore a decision which should be made very early in the process. [4]This decision has become more difficult in recent years as several alternative delivery methods have been developed to address potential weaknesses in the traditional design-bid-build scenario. Proponents of particular alternative methods advocate or promise improvements over the traditional system in terms of project schedule and cost control, and the number of disputes. [5]

2.1.2. Design Build vs. EPC vs. Turnkey

Commonalities of Design Build, EPC (Engineering, Procure & Construct) & Turnkey

The terms Design-Build, EPC (Engineering, Procure & Construct) and Turnkey are used to describe a project delivery approach in which the owner outlines the output requirement of the project and then hires a contractor with total responsibility for detail engineering design, construction and coordination of all the project work. [6]

Design-build, EPC & Turnkey are a project delivery systems involving a single contract between the project owner and a design-build/EPC contractor/Turnkey contractor covering both the design and construction of a project. The design-builder/EPC/Turnkey contractor performs design, construction engineering, and construction according to design parameters, performance criteria, and other requirements established by the agency or client. [2, 5, 6, 7]

The underlying concepts of the design-build/EPC/Turnkey construction project delivery method are:-

- *Simplification of contract and Risk Allocation:* To simplify the construction contracting process by consolidating the design and construction responsibilities for a project into a single contract. Since Owners seeking ways to reduce the time cycle for design and construction, this in turn reduced the risk and effect of

economic inflation on project budgets and financing. Thus, the owner only deals with one entity for both design and construction and for warranty claims. [4, 5, 6 7, 8, 9]

Design-Build, EPC and Turnkey Projects are often packaged as a single mega-project requiring a long development period. Then as an industry, the owners try to control risk contractually, with nonnegotiable terms, and through lump sum pricing. [12]

From a risk-allocation point of view, unlike traditional projects where professional indemnity/design risk remains with the consultant, the owner benefits by being able to off-load the design risk as well as the on-time, on-budget and performance requirements to a single entity. Under this structure the design-builder will be held liable for an overall failure of the design as well as the defects in construction. [2, 10, 11]

- *Partnership:* Design-Build/EPC/Turnkey allows for a close working relationship between the design and the construction team providing more opportunity for creative solutions to design and construction problems. [9]The results of partnership have been very positive and even more essential in long-term contracts, so that any differences, expectations, biases, and quality issues can be mutually discussed in an open forum.[4, 12]

  A partnership is created between the designer and the builder or a venture is formed in which one hires the other, mainly either Contractor led or Designer led. Together, they bid to handle all the work. [13, 14]

  While the other delivery systems often give rise to disputes among various project participants, with the owner acting as referee (or ultimately required to identify who is guilty), in DB many of these disputes between project professionals internalized in DB/EPC teams, which may not affect the owner. Owners also sought solutions to the increasing cost of disputes and delays resulting from what were perceived as adversarial relationships that developed with de-centralized design and construction processes. [2, 5, 7, 8, 15]

EPC contract is attractive to the owners, because it suggests that costly disputes and recourse difficulties when something goes wrong will not be increased by arguments within the supply chain as to who may be at fault.[16]The contractually-established clear lines of responsibility eliminate many disputes of design liability between the owner and the designer. This allows the designer to concentrate more on solving the problem than on determining who is to blame. Thus, this partnership enhances designers designing ability and improving the constructability of his designs. [14]

- *Faster Track of project progress:* Design-build/EPC provides crucial time-saving measures clearly a benefit for any project. Design-build/EPC projects are built with "overlap," allowing simultaneous design and construction, thereby reducing the project delivery time by up to one half, without losing time submitting and reworking plans for builders. [4, 9, 15, 17, 18]Another is the minimal requirement for time consuming, government chain-of-command approvals. Design errors or omissions can often be correct on the construction site without costly work stoppage. [14]
- *Predefined Performance specification:* A design-build/EPC contract is usually based on performance specifications often called Statement of Requirements, from which the Design-Builder defines the project to a detailed level. [4, 14, 19]

  In EPC, Clients' prepare and provided preliminary design, including mandatory requirements in clearly understood performance terms, in a Request for Proposal (RFP) to prospective bidders' before bidding. The client identifies the project's desired end result, and defines clearly the scope of work and the requirements of the technical proposals. [20, 21]It should include a reference number and date, award procedures and evaluation criteria, a clear statement of work, a detailed set of design parameters, and specific equipment required. The performance specification should identify the project goals. ideas for future expansion, and a realistic budget range. To insure they are providing a complete specification. [14]

Difference of Design Build, EPC & Turnkey

The major difference between Design-Build and EPC (Engineering, Procurement & Construction) is their application and procurement mode. Apart from Design build, EPC contract delivery is used for the construction of large scale projects with higher amount of financed infrastructures and energy projects.[2, 22,23]EPC Contracts tend to deal with issues with greater sophistication than other types of construction contract delivery systems. It is a type of contract typical of industrial plant construction sector, comprising the provision of engineering services, procurement of materials and construction. [22, 24]

Design-Build or EPC delivery system with Lump Sum contracting, which is also called Fixed Price: when an owner contracts with a single entity to sets up all necessary premises & equipment and perform a whole scope of work in exchange for an agreed lump sum payment for the specified services, is defined as Turnkey contract delivery system. [5, 12, 13, 20, 25] In addition, a turnkey contractor agrees to identify the appropriate construction site, finance the project, obtain regulatory permits, operate and maintain appropriate facilities for a period to determine if various systems are working properly, and train the owner's maintenance team. [14]Turnkey contracting is sometimes also referred to as 'Lump Sum Turnkey' or 'LSTK', with responsibilities allocated to the contractor to deliver the project on time and to a required performance level, in return for payment of a fixed price. [16] However FIDIC silver book uses the terms EPC and Turnkey interchangeably, meaning the same thing. [10]

2.2. Features of EPC contract delivery system

In the introductory note of FIDIC Silver Book 1st edition of 1999 it was stated that EPC contract is suitably applied where a higher degree of certainty of final price & time required and where the Contractor takes total responsibility for the design and execution of the project, with little involvement of the Employer. [26]

Apart from Design build, EPC contract delivery is used for the construction of large scale projects with higher amount of financed infrastructures and energy projects.[2, 22]EPC is poised for a major growth due to growth driven by power, water, roads & highways, oil & gas, and railway sectors.[34] Since Railway construction incorporates many advanced technologies, which incorporate complex Civil, Electrical and Electro-Mechanical activities, require higher finance, the requirement for the contractor is to prove the reliability and performance; Hence, many employers prefer EPC Contract type. [2, 16]

Under EPC contract the contractor is required to engineer, procure and construct the required works and complete facility then to hand over the keys to the owner, who need only turn a key to start operating the facility. In addition to delivering a complete facility, the contractor must deliver that facility for a guaranteed price by a guaranteed date and it must perform to the specified level. [2, 16]

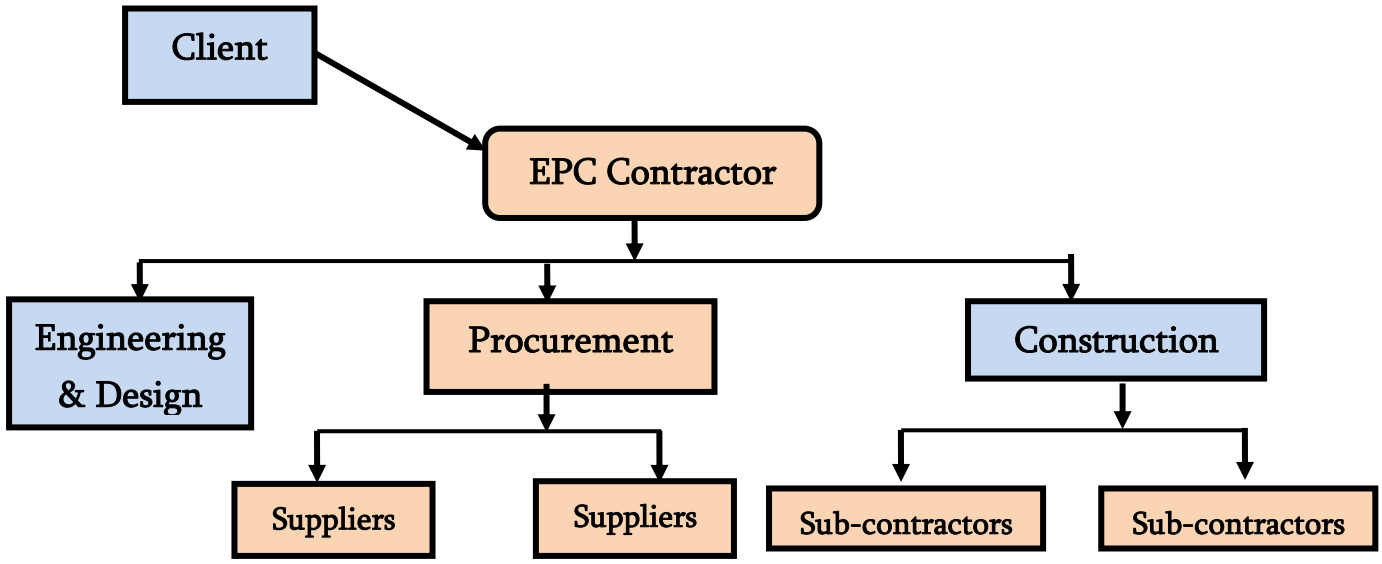


Fig 1.1.EPC Contract General Organogram

2.2.1. Common feature with other types of delivery systems but with some modifications

The main objective of a project is defined in terms of key clauses for time, cost and quality.[16,22,24,28] In the same way as other types of contracts an EPC contract can provide A fixed contract price[2,4,22,23,24], A fixed completion date [2,4,22,23,24,29],Security, Bank guarantee & advance payment guarantee[2,19,23,24], with some modifications in their application and character.[3]

2.2.1.1. Fixed Contract Price

EPC contract is suitably applied where a higher degree of certainty of final contract price & time required and where the Contractor takes total responsibility for the design and execution of the project, with little or no involvement of the Employer. [19, 26]

FIDIC Silver Book clause 4 sub-clause 4.11 'Sufficiency of contract price' states:-

> *"The Contractor shall be deemed to have satisfied himself as to the correctness and Sufficiency of the sufficiency of the Contract Price. Unless otherwise stated in the Contract, the Contract Price covers all the Contractor's obligations under the Contract (including those under Provisional Sums, if any) and all things necessary for the proper design, execution and completion of the Works and the remedying of any defects."*[10]

Since EPC contract gives single point of responsibility for EPC contractor for the design and construction with fixed cost within fixed time, the contractor usually has a limited ability to claim additional money, which is limited to circumstances where the owner himself has delayed the contractor progress or has ordered variations to the works; Therefore, EPC is designed to satisfy the lender's requirements for bankability. [2, 22, 23, 24]

2.2.1.2. Fixed completion date

Since the EPC contractor is responsible for both engineering design, procurement and construction and agreed to complete the whole work and provide the key for the owner, the probability of asking extension of time is limited unless special circumstances like force majeure, variation order or enhancement on the employers requirement required by the client occurs. [23] Therefore, the project has more certainty in the completion up on the dated agreed upon. [2, 4, 22, 23, 24]

The client perceived that design-bid-build approach will take considerable time until the project is completed; therefore, changes the project implementation strategy from the conventional approach to a new approach seeking way to reduce the time cycle for design and construction through an EPC Turnkey contract. [8, 21, 29]

when time is the ultimate factor, it is estimated that the full delivery model can potentially save years in project completion (depending upon complexity and other issues), because many stages of design, environmental statements, approvals, pre-planning aspects, procurement and construction phases overlap & can be accomplished simultaneously, there by minimize the project delivery time or completed prior to the actual construction phase. [9, 12, 18]

2.2.1.3. Security/ Guarantee from the contractor and/or its parent companies

In a world of financial fragility, everyone is interested in project financial security. Owners of mega projects long have exacted security for performance of contract obligations. Security is standard for the contractor to provide performance security to protect the project owner if the contractor does not comply with its obligations under the EPC contract. It is recommended for the design builder/EPC contractor to have an agreement with the design professional, supported by the design professional's errors and omissions insurance. [8, 19, 24]

The security takes a number of forms and expected to post some combination of bank guarantee, letter of credit, payment bond such as Advance Guarantee if advance payment

is made, Retention i.e. withholding a percentage stated in particular condition from each payment, to ensure completion of the work to the desired performance level and insurance for a variety of hazards. [19, 24]

Typically, the EPC Contractor is expected to a parent company guarantee – this is a guarantee from the ultimate parent (or other suitably related entity) of the Contractor which provides that it will perform the Contractor's obligations if design failure, Construction defect & performance deficiency exists & the Contractor fails to perform as per the contract. [19]

2.2.2. Special Features of EPC Contract delivery system

Apart from other contracts EPC contract has special unique features single point responsibility [2,4,22,23,24],Performance specification &Performance guarantees [2,4,8,12,19,22,23,24], Caps on liability including Design liability [6,8,11,19], higher liquidated damage for delay with longer Defects liability period [2,8,20,21],&Limitation on the ability of contractors to claim extension of time and additional cost due to design error & subsequent variations [2,4,19,22,23,24].

2.2.2.1. Single Point Responsibility

EPC Contract provides single point of responsibility, and single point of communication. The unique attribute of EPC is that a single entity has total financial and legal responsibility for all design, Engineering, Procurement, construction, Commissioning & testing. Therefore, a contractor is obliged to deliver a complete facility to a client who need only turn a key to start operating the facility. [5, 6, 8, 24]In addition to delivering a complete facility, the contractor must deliver that facility for a guaranteed price by a guaranteed date and it must perform to the specified level; if any problem occurs the owner looks to & communicate with one party - the EPC contractor. [8, 18]

EPC entity may be a single organization with both architectural/ designer/ Engineer and construction staffs, or a construction organization that hires or affiliates with an architect/Engineer or vice-versa as part of an EPC team. Therefore, the architect/designer is part of the EPC entity and not the agent of the owner. [13, 24]

EPC contractors comprising the consortium have been required to accept joint and several responsibility and liability for the entire contract. EPC contractor solvency and credit risk is, therefore, shifted onto the EPC contract consortium. Although the EPC contractor consortium will have internal arrangements of coordination & integration of their respective work task, responsibility and liability among its members, each member of the consortium takes solvency and credit risk on its joint venture partners. [23, 30]

Since EPC overlap & allowing simultaneous design and construction, which is in single entity, it thereby reducing the project delivery time and suggests that costly disputes and recourse difficulties when something goes wrong will not be increased by arguments within the supply chain as to who may be at fault; Thus, under an EPC contract, if there is a design issue, a workmanship issue, or a time issue, then the dispute is simply between the Owner and the EPC contractor and that can be resolved in a single forum. Therefore, EPC contract is attractive of the owners with large scale projects. [4, 5, 16, 18, 31]

2.2.2.2. Performance Specification & Performance Guarantees

An EPC Contract is usually based on performance specifications, whereby the Owner is able to clearly and explicitly state his expectations often called Statement of Requirements, from which the EPC contractor/Design Builder defines the project to a detailed level; however, it does not dictate how they must be met.[4, 24] In EPC projects, as the contractor is practically responsible for the entire project, it is feasible both by agreement and by default, for the EPC contractor to warrant the performance of the entire project. It is the potential default responsibility which requires the EPC agreement be drafted carefully to allocate risk and responsibility for performance warranties. [8]

It is of critical importance in such projects not only for the project to be delivered within time and cost constraints but also to be delivered so that it is capable of meeting its designed production and output levels. Lenders' security is dependent largely on the ability of the completed facility to operate and generate revenue, whether power, chemicals, processed metals or road toll revenue. [16] This is clearly specified in General Conditions of the FIDIC Silver Book clause 8.2: the 'Time for Completion' of the works includes not only completing and taking over of the work' but also 'achieving the passing of the Tests on Completion'.[10]

For most EPC facilities, the hallmark is a set of performance criteria for measuring the EPC Contractor's performance. These criteria usually focus on capacity of the facility, its efficiency in operation, and its quality of output. Obviously, there are several very carefully defined criteria to measure performance at the time the mega project is tested

and turned over for operation. These performance criteria, be they measures of output, input, or both, are the heart of the typical EPC agreement's measurements of success or failure. These standards may include liquidated damages for failure to achieve the contractual goals. [12, 19]

The Turnkey contract also usually contains a Guarantee of Performance Clause (PGs) stating that, if Contractor does not provide complete compliance with the specifications by the completion date identified in the contract, not only the whole work but also the technology used, the Contractor must provide cash in the form of Performance Liquidated Damages. Also, there may be provision for Performance related Liquidated Damages (PLD) to compensate the Employer for any shortfall of performance guarantees in the designed output or efficiency of the facility. [11, 23, 24]

PLDs (Performance related Liquidated Damages) must also be a genuine pre-estimate of the loss and damage that the project company will suffer over the life of the project if the final product does not achieve the specified performance guarantees. It is determined by reference to the time the contract was signed, usually a net present value (NPV) (less expense) calculation of the revenue forgone over the life of the project. [24]

2.2.2.3. Caps on liability and Design Liability on Contractor

Turnkey contracts place the design and construction duties in the same hands. They also place primary liability on the contractor for any defect in the design, construction or performance of the works. Therefore, as a general proposition, where a defect arises in the works, the employer need not prove to what extent resultant damage was caused by faulty design or by faulty construction. [11, 19]

Under Clause 5.1 of FIDIC silver book "General Design Obligations" the liability of design failure is the contractors' responsibility, since it states:-

> *'The Contractor shall be deemed to have scrutinized, prior to the Base Date, the Employer's Requirements (including design criteria and calculations, if any). The Contractor shall be responsible for the design of*

the Works and for the accuracy for such Employer's Requirements (including design criteria and calculations), except as stated below.

The Employer shall not be responsible for any error, inaccuracy or omission of any kind in the Employer's Requirements as originally included in the Contract and shall not be deemed to have given any representation of accuracy or completeness of any data or information, except as stated below. Any data or information received by the Contractor, from the Employer or otherwise, shall not relieve the Contractor from his responsibility for the design and execution of the Works.' [10]

Therefore, the client is not responsible any fault resulting from design failures both in the whole part of single entity component of the project. The EPC Contractor is also liable for latent defects, which usually are for a longer duration than the defect liability period, since the EPC contractor has done the designing by himself and take design risk/ professional indemnity. [23]

The design-builder's liability for design problems can be returned to the usual "appropriate levels of skill and care standard by including risk-shifting provisions in the design-build agreement, or using industry standard contract documents which allow responsibilities and risk to be allocated along more traditional lines. It is essential for these limitations of liability and remedies be stated expressly in the design-build contract. [6, 8]

2.2.3. Higher Liquidated damages for both delay & performance And Longer coverage period

Completion risk is undertaken by EPC contractor as it remains liable to pay liquidated damage for delay in case of any time overruns. Since In most cases the repayment for project financed loans commences after the completion of the construction project or the commercial operation of the project has commenced, any delay expose the project company penalties there under apart from delaying the loan repayment process and also

increase the interest during the construction period. Hence it is necessary to ensure that there are no time overruns for the project. Likewise any unaccounted for cost overrun make the project unviable and affect the ability of the project to serve the debt. [6] This is because an EPC Contract is designed to satisfy the lenders requirements for bankability by the repayment of loan from the revenue to be generated by the project itself. [6, 22, 23, 24]

According to the Clause 8.7 'delay damages' of General Conditions of the FIDIC Silver Book: If the Contractor fails to comply with Time for Completion, the Contractor shall subject to Employer's Claims and pay delay damages to the Employer for this default. These delay damages shall be the sum stated in the Particular Conditions, which shall be paid for every day which shall elapse between the relevant Time for Completion and the date stated in the Taking-Over Certificate. And under clause 12.4 'failure to pass test after completion' sub clause 12.4 (b) & 12.4 (c) the relevant sum payable as non-performance damages for this failure is stated (or its method of calculation is defined) in the Contract, and the Contractor pays this relevant sum to the Employer during the Defects Notification Period. [10]

Delivery time of project deliverables (such as technical information, drawing or equipment's) has direct effect on project time and has side effect on project cost and performance. For this reason it is necessary to consider penalties or liquidated damages for any delay in delivery time. [22]

Defect liability period may extend subject to an overall performance period. EPC contractor would be liable for latent defects, which usually are for longer duration than the usual defect liability period of 12 month, since the EPC contractor has done designing of the project by itself and liable for Professional Indemnity. [23]

2.2.4. Restrictions on the ability of the contractor to claim extensions of time and additional costs due to Risk transfer

Since EPC contract gives single point of responsibility for EPC contractor for the design and construction with fixed cost within fixed time, the contractor has limited access for extension in the completion schedule and additional compensation. [6, 22, 24]

The idea that turnkey contracting provides the owner (and its lenders) with single-point responsibility is attractive, because it suggests that costly disputes and recourse difficulties when something goes wrong will not be increased by arguments within the supply chain as to who may be at fault.[16, 23]

2.3. Challenges of EPC contract delivery system

Even though EPC contract delivery system has the above listed advantage and paramount features there are challenges encountered under EPC turnkey contract delivery systems.

The objective of a project is mainly defined in terms of time, cost and quality specification often referred to as the iron triangle or the triple constraints. [15] Therefore, those critical constraints and risk are the challenges on EPC contract.

2.3.1. Cost related challenges

There are many reasons stated by many researchers for the cost related challenges on EPC Contract delivery systems.

- Under the turnkey or EPC contract, the employer benefits from an increased amount of the risk of the project being placed on the contractor. However, the contractor will have to factor into its price the cost of absorbing those risks they may suffer and increases the contract price. [22, 32]

  In the introductory note of FIDIC Silver Book 1st edition of 1999 it was stated that Employers on such turnkey projects are willing to pay more - sometimes considerably more - for their project if they can be more certain that the agreed final price will not be exceeded. Among such projects can be found many projects financed by private funds, where the lenders require greater certainty about a project's costs. Consequently to obtain increased certainty of the final price, clearly the Contractor will rightly increase his tender price to account for such extra risks. [6, 26]
- From the nature of the contract Design professionals have contractual incentives to perform their services in a manner to achieve the EPC contractor team's goals, which are not always in the owner's best interests. The design professional may have a disincentive to call the owner's attention to difficulties with the construction work. Also, the design professional may value such factors as cost and construction logistics over other design or technical criteria of importance to the owner, such as life-cycle performance. [8, 14] Total Cost for the owner is not only

the cost for the design &construction, rather includes cost for operation, maintenance/ service life cost. To undertake a project Whole Life Cost assessment, it is essential to establish all first costs and all future costs recurring over the asset life.[33]

- First costs include actual asset costs and all the costs associated with installing and handing over the completed project.
- Future costs include all costs associated with operating and maintaining the asset over its anticipated service life. These include energy costs, planned servicing and maintenance costs, component replacement costs together with any costs for regularly replaced consumables. [33]

- Insufficiently defined conceptual design, employer's requirement and Front End Engineering Design (FEED) by the owner leads to change orders and cost overruns since the EPC contractor may underestimate its bid and cost and time requirement to perform the actual work. Then the EPC contractor miss the scope of the work, did not provide sufficient contingency in its quantity estimate, or find that the design has to be modified to a great extent than it planned; then the EPC contractor submits numerous change orders to attempt to recover for these problems leads to delay and increased cost/cost overrun. Owners often consider design problems are not compensable, thus the modification that the EPC contractor makes to the design documents are the result of this design development of the client. However, the EPC contractor may view the difference between the conceptual design, which is part of the agreement, conflicts or inaccuracies the owner is responsible and which require increase cost and time to resolve.[4, 5,27, 34,]
- Unforeseen ground conditions are another cause of cost related challenge for higher project/contract price. [6, 16]The FIDIC Silver Book outlines that the owner provides information to tendering contractors; it is the contractor who is responsible for verifying as well as interpreting that data. There is no warranty by the owner as to the sufficiency or completeness of the information provided.

Under the FIDIC Silver Book, the risk of adverse ground conditions is intended to be allocated to the contractor. Clause 4.12(b) and (c) provides a catch-all statement to the effect that the contractor accepts responsibility for having foreseen all difficulties and costs, even those which are not foreseeable: 'The Contract Price shall not be adjusted to take account of any unforeseen difficulties or costs.' Thus, unforeseen ground condition may impact the certainty as to outturn of the contract price and time for completion. [10, 16]

- A lack of Design-Build/EPC tender evaluation criteria & award standard is another drawback that can have cost impact. Contractors can be reluctant to bid for a project when they are unfamiliar with the criteria used in the selection process, especially when the cost of preparing an EPC proposal can be so high and large start-up cost with the high risk of bidding. When the owner does receive enough proposals to satisfy public competition statutes, selecting the contractor who is both the lowest bidder and highest qualified can be a very subjective process, since either highest qualified design cannot be lower price and vice versa. [4, 14] Since the projects covered in this research are awarded by invitation & negotiation terms; thus, the lack of EPC contract tender evaluation has no cost impact.

  Even though, some Owner compensates unsuccessful proponents for their proposal submissions at a predetermined amount (honorarium), which covers only part of the proposal preparation cost but the design ideas and innovations remain the property of the proponent, EPC contractors are reluctant to invest the time and money to bid a project when they perceive the awardees being subjectively determined based on some mysterious evaluation criteria. [4, 5, 14] Thus, there are relatively few engineering and construction companies that can and are willing to enter into EPC Contracts. The scarcity of EPC Contractors can also result in relatively high contract prices. This will dramatically increase the contract price. [14, 22]However, no honorarium cost for railway projects studied in this research, which was awarded by invitation.

- Inaccurate cost estimates by the contractor due to inadequate FEED definition resulting in huge cost overrun when scope definition becomes better defined.

  When owners prematurely send their FEED package to EPC contractors seeking lump sum bids, the decisions of the EPC bidders can be either of the following:

  - Highly qualified EPC firm either decline to bid, leaving the owner without confidence that its project can successfully proceed, will submit bids including large contingency which make the project uneconomical, or will recommend the owner convert its contract basis from lump sum to reimbursable to reduce contractor risk, but reduce owners' confidence as to the true capital cost of the project. [19, 30, 34]
  - Lower contractors who are eager to enter a new market will submit lump sum bids. If they are successful in tendering, problems with FEED document will eventually be identified and large change orders, cost overruns, and delays will result during the execution of the project. If the owner refuses to accept the requested change orders, the contractor may default rather than risk financial ruin.[19, 30, 34]

- Ambiguity of the contract document, leading to dispute over the procedures for progress measurement and reporting technical specification requirements, cost and schedule control and change order management. For example, a lump sum contract will be submitting less detailed actual budget and man-hour breakdowns as part of its progress reporting than it would under a cost reimbursable contract. The level of support from the contractor that will be required for pay application will be different for lump sum contract than it will be for reimbursable contract. [34]
- Insufficient number of experienced owner staffing cause delay and cost overrun on the project as:

  - Insufficient number of experienced personnel in Owners organization to manage the technical aspect of a project, leading to delay in review of design & Procurement packages, and late response to Request of

Inspections (RFI) from the contractor, and management team, in managing cause delay and subsequent cost overrun over the project. [23]

- Owners do not have sufficient number of experienced qualified and experienced management team to manage change orders, extension of time and financial claims from the EPC contractors. As a result, the contract administration and the relationship of the contract entities suffer. [27, 34]

- Insufficient management of multiple prime contractor design and construction interference, leading to design changes, delays and cost overruns.

  Owners often place responsibility on multiple contractors to coordinate and integrate their design and construction work to avoid interfaces and delays. While such contractual language is commonly used, one contractor cannot require another contractor to do anything which may alter its design or method of construction performance. If such consequences occur, the affected contractor(s) will seek recovery from the owner for its time and cost impacts of such coordination and integration, and any changes that result from ambiguous design and/or construction responsibility that are assigned to the various contractors. [34]

  Besides no multiple contractors for each railway projects studied, no cost impact as a result of insufficient management of multiple contractors. However, due to the interaction with the road project the impact of other Contractors, that has contractual relation with other employers, has negative impact on the projects investigated.

- Inadequate documentation to support positions and resolve issues that develop during the execution/honeymoon period/ of the project or retrospectively when large claims develop at the end of the project. Contractors often attempt to submit minimal information during the project with which an owner can evaluate the contractors' schedule progress, labor utilization, cost expenditures, and labor productivity. Issues and problems affecting cost and schedule invariably arise, and contractor may attempt to cast blame for those issues and problems on the owner, and prepare request for time extension and associated cost. However, without a

complete historical record and documentation from the contractor's file, the owner may not have all of the facts. Nevertheless, the contractor claim has no effect and rejected for no supporting document; thus the contractor may face profit loss and even financial problems, equivalent to the issue and the problem.[27, 34]

- Multiple change orders are provided during the project or remain unresolved until the end of the project, leading to large s cumulative impact claims for recovery of lost productivity cost. Contractors may sign off on early change orders without including extra cost for productivity loss and cumulative impact from multiple changes. However, after numerous changes have occurred, contractors who were lax on recognizing the potential for such costs will notify the owner that they reserve their right to submit a cumulative impact claim to recover additional cost beyond the costs that were previously agreed in prior change orders. Owners resist this and dispute may occur which do not get resolved until after the project is completed, and often in the courtroom or arbitration hearing. [21, 27, 34]
- Late land acquisition issues, clearing of ROW are a major cause of delay in start & completion project. This issue leads to an extension of time and cost compensation for the contractor, due to the failure of the employer. The compensation in EPC contract is much larger as compared to other delivery systems. Thus, the client may suffer huge financial loss: who have a fixed amount budget for the project. [22, 27, 34]
- Owner's weak coordination & integration with, local government authorities, utility infrastructure authorities, and other for the existing utilities and their future plans that may affect required ROW and leads to design change on EPC contractor. The consequence of those effects leads to delay, change orders, cost overrun & request for recovery of lost productivity.[22, 27, 34]
- Non availability of skilled manpower capable of executing complex project and biases premature estimate of required labor to complete the work activities required to complete the project incur additional cost over the EPC contractor.

- Especially for remotely located projects and for projects run by foreign companies, the camp needed to house the construction direct and indirect labor required to build may be underestimate. If the manpower required increase significantly after the camp size was established, then more construction man-hour will be required leading to an additional camp construction and hostels or working longer hours and/or multiple shift to perform the work, or delaying the completion of the project.[27]
- Excess labor requirement estimation can leads to additional loss of productivity and increased cost as a result of overcrowding, trade stacking, dilution of supervision, and acceleration measures attempt to maintain the completion date. [27]

- Rising of material price/ material escalation is another cause of cost overrun. Even though, price escalation factors are included in the contract, it may be unrealistic to cover. [23, 25, 27]
- Change in foreign currency exchange rate is another cause of cost overrun especially for mega projects with new advanced technological requirement the contractors must purchase those equipment form international market. [23, 25, 27, 35]

The major risk identified for Construction projects in Ethiopia with EPC Contract delivery system is Construction Risk such as Completion with Cost overrun especially that cannot be contractually covered by the EPC Contractor or due to the failure of the employer. [35]

As a result of those above reasons EPC contract experience cost related challenges both the contractor, who may suffer uncertainty of the unforeseen ground condition at tendering stage to fix rate if the actual ground condition deviate adversely from they expected incurs additional cost, the client, who may suffers excessive contract price while using other contract delivery method.

2.3.2. Time related challenges

- Shortage of Skilled manpower leads to delay in the EPC contracts as:
  - Shortage of skilled manpower in the contractor capable of executing complex projects, delay in sourcing critical equipment and reliance on imports and luck of advanced project management practice are the major causes of time overruns. [5, 27, 34]
  - Shortage of skilled technical experts in the client is a critical deficiency of skilled manpower that leads to both cost overrun as variation and time delay. Since the contractor delay and disruption claims often arise because the owner does not respond in a timely manner to documents submitted by the contractor for owner review and approval, to RFI's (Request for inspections) requiring clear response and direction.[5, 27, 34]

    Guide to the Use of FIDIC Conditions for Design-Build and Turnkey Contracts seriously describes that "EPC may also encourage economies, not only in terms of price, but at the expense of quality. Therefore, it is considered essential that the Employer has (or procures) expert technical services, in order to ensure that his requirements are elaborated in the tender documents and are achieved in practice. If expertise is unavailable, problems may arise, particularly in respect of the need for variations." this variation leads to Extension of time in the project. [36]
- Inadequate baseline schedule development and updating by the contractor and no sufficient and reliable integrated master project schedule developed by owners.

  If the schedule does not adequately define the period of performance for all scope requirements, activity duration does not coincides with man-hour determined by the contractor's bid estimate, contains logical errors and excessive constraint the baseline schedule will be flawed and critical path be uncertain. Therefore, the schedule is not useful to measure and evaluate the contractor's progress and also inadequate baseline schedule & revised schedule will not provide a valid basis for

determining if critical path delay occurred or not, which may or may not entitle the contractor to an extension of time and compensable delay.

If the owner also does not develop master project schedule or inadequate schedule prepared, it provides false critical path of the whole project. It's difficult to recognize where, when the delay occurred and who's the cause of the delay. If the activity interfaces between various contractors are not properly identified, delays by one may not properly shown resulting impact on other contractors. [34]

For receiving a guaranteed price and a guaranteed completion date, the project company cedes most of the day-to-day control over the construction. Therefore, project companies have limited ability to intervene when problems occur during construction which will progressively alters the guaranteed completion date. [5, 22]

Even though EPC has a fixed completion date, the general condition of contract for EPC turnkey, Silver Book of FIDIC, allows provision for 'Extension of Time' clause 8.4. In addition, other event giving rise to potential extension of time entitlement under clause 8.4 (b) stated "a cause of delay giving an entitlement to extension of time under a Sub-Clause of these Conditions …"[10] Accordingly, under FIDIC Silver Book, the extension of time provision do not expressly require the contractor to take steps to avoid or mitigate the cause of delay, nor do they seek to make entitlement to any such extension conditional upon taking such steps with an exception for force majeure. For owners seeking a turnkey solution, it is likely that they will want the extension of time provisions under the FIDIC Silver Book to be strengthened considerably and clarified to gather in all those conditions which might give rise to an entitlement. Such clarity allows the events to be more closely managed and delays to be avoided, or at least mitigated. [16]

FIDIC has provision under Clause 8.3 'Programme': "The Contractor shall submit a time programme to the Employer within 28 days after the Commencement

Date. The Contractor shall also submit a revised programme whenever the previous programme is inconsistent with actual progress or with the Contractor's obligations." [10]

This provision give rise to the potential for confusion, as the programme may be updated for actual progress which represents a position of default (due to culpable delay on the part of the contractor). This makes it difficult to assess the impact on the Time for Completion, which may not have changed if there had been no events giving rise to an entitlement to extend. [16, 27]

- Owners do not develop a sufficient and reliable integrated master project schedule that results from pulling together the work activities from multiple prime contractors. In adequately prepared contractor schedules, if integrated "as-is" into an overall master project schedule, may provide false calculations of the overall critical path of the entire project. And if the activity interface between various contractors is not properly identified, delay by one contractor may not properly show the resulting impact to the other contractors. Therefore, delays may go unrecognized and mitigation options are diminished until correction of the master project schedule is made. [34]
- In adequate documentation to support positions and resolve issues that develop during the execution/grace period/ of the project or retrospectively when large claims develop at the end of the project. Contractors often attempt to submit minimal information during the project with which an owner can evaluate the contractors' schedule progress, labor utilization, cost expenditures, and labor productivity. Issues and problems affecting cost and schedule invariably arise, and contractor may attempt to cast blame for those issues and problems on the owner, and prepare request for time extension and change in scope. However, without a complete historical record and documentation from the contractor's file, the owner may not have all of the facts. Daily reports, inspection reports, and RFI's prepared by the EPC contractor and its sub-contractors, often tell a different story as to the real cause of the problems and their effect on the project performance.

Also, this documentation could reveal concurrent delays for which the EPC contractor is responsible and which could mitigate the owner's responsibility for the extension of time and cost of certain issues and problems. [34]

- Ambiguity of the contract document, leading to dispute over the procedures for progress measurement and reporting technical specification requirements, cost and schedule control and change order management. For example, a lump sum contract will be submitting less detailed actual budget and man-hour breakdowns as part of its progress reporting than it would under a cost reimbursable contract. The basis for calculating the progress and percent completion amount needs to be defined. The owner must also decide what it will do to verify the contractor's progress and percent completion submittals. The contractor's actual labor productivity may not be visible from the data it submits to the owner under lump sum contract; therefore, actual man-hour may not correlate well to percent complete. Problems also occur when the bid package does not define the supporting schedule delay calculation and documentation; the contractor is required to submit to justify a time extension. [34]
- Late land acquisition issues, Clearing of ROW are a major cause of delay in start & completion project. This issue leads to dispute & claim between owner and EPC contractor for extension of time, and associated cost. [22, 27, 34]
- Owner's weak coordination & integration with utilities authorities, local government authorities, environmental mitigation requirements, tolling infrastructure, and other project needs that may affect required ROW, may lead to delay beyond the agreed completion date and an extension of time.[22, 27, 34]

2.3.3. Quality related challenges

Every project needs certain resources, skill and knowledge to get to the positive side with regard to cost, time and quality. [28] Meeting the required quality and customer's need is achieved through Quality Management system. Quality Management system includes Quality Policy, which is created by quality experts and fully accepted by top management, Quality Objective that consists of specific objective and time frame for completing them, Quality assurance is the formal activities and managerial processes that attempt to ensure that products and services meet the required quality level. Quality control is a collective term for activities and techniques, within the process, that are intended to create specific quality characteristics. Such activities include continually monitoring processes, identifying and eliminating problem causes, use of statistical process control to reduce the variability and to increase the efficiency of the process. [25]

- The overall design and construction supervision role of the Employer's Engineer is absent from the turnkey contract. The quality assurance, quality management and quality control are all in the contractor's hand. The employer's advisers find their involvement limited primarily to the tender process and supervision of the contractor's work whereas the contractor takes responsibility for the design of the works. Since, the general philosophy of a Turnkey contract, as far as the Employer is concerned, could be described as "Eyes on, Hands off", the employer loss his day-to-day control of the project. [11]

  Guide to the Use of FIDIC Conditions for Design-Build and Turnkey Contracts seriously describes that "EPC may also encourage economies, not only in terms of price, but at the expense of quality. Therefore, it is considered essential that the Employer has (or procures) expert technical services, in order to ensure that his requirements are elaborated in the tender documents and are achieved in practice. If expertise is unavailable, problems may arise, particularly in respect of the need for variations." this variation leads to Extension of time in the project. [36]

Since the client is looking for the final output the overall supervision role of the Owner is absent from the EPC Contract. The EPC model generally contemplates less day-to-day intervention. Therefore, the EPC contractor may be tempted to design the project satisfying the minimum compliant standard to cut his costs and save time. [32]

- For most EPC facilities, the hallmark is a set of performance criteria for measuring the EPC Contractor's performance. These criteria usually focus on capacity of the facility, its efficiency in operation, and its quality of output. These performance criteria, be they measures of output, input, or both, are the heart of the typical EPC agreement's measurements of success or failure. These standards may include liquidated damages for failure to achieve the contractual goals, or "buy-downs" to allow the Contractor to pay for, rather than repair or replace, defective key components. [12, 19] Thus, the standard of performance is partly commercial (the performance criteria that the end product must achieve) and partly professional/commercial (the design methodology and the means of construction and provision of equipment and material). A project therefore might meet all standards for engineering and construction, but still fall short of the performance measures embedded in the contract, resulting in major financial penalties. Likewise, a project might operate at contractually required levels of performance, but suffer numerous defects in construction or design, requiring repair or redesign under the agreement's warranty provisions. [26]
- It is vitally important that great care is taken in selecting the contractor and in ensuring the contractor has sufficient knowledge and expertise to execute the works. Given the significant monetary value of EPC Contracts, and the potential adverse consequences if problems occur during construction, the lowest price should not be the only factor used when selecting contractors; since *"The bitterness of low quality remains long after the sweetness of low price is forgotten."*[22]

2.3.4. Risk

Every project has specific purpose, objective and unique nature with uncertainties. Those uncertainties are more complex and difficult to predict and could result in risk.

Risk is defined as a measure of the probability and consequence of not achieving a defined project goal. Risk constitutes a lack of knowledge of future events. Typically, future events (or outcomes) that are favorable are called opportunities, whereas unfavorable events are called risks. Risk has two primary components for a given event, including a probability of occurrence and its subsequent impact. [25]

General Conditions of contract and Particular(specific) conditions of contract states risk that can cause dispute parties, and allocate them to the parties accordingly who can best manage it; the underlying principle in allocating risk is that the party assuming the risk should be able to best evaluate, control, bear the cost of, and benefit from its assumption. Unless it's properly and clearly identified, analyzed and treated, severely affect and disrupt the progress of the project. Therefore, risk management system should be implemented starting from the project inception and tendering stage of the project. [35, 37, 38]

The extent to which risk is allocated to the contractor under turnkey arrangements will depend upon a range of other factors, including the availability and strengths of guarantees from the project's sponsors. Where a sponsor will not provide any, or only a limited form of, completion guarantee to lenders, this obviously increases the need to allocate completion risk away from the sponsor. In these circumstances, the obvious candidate for the risk, given that it will be in the best position to manage it, will be the turnkey contractor. [13, 16, 39]

The effects of risk includes increased cost, delays to completion, reduced performance, Non-compliance with applicable laws & regulations and the contract, and/or with internal policy & regulations, Suspension and/or cancellation. So, it is therefore necessary for uncertainty and risk to be identified, managed and reduced. This is achieved through Risk management. [25, 35, 40]

Risk management is a logical, systematic, continuous and process oriented approach that includes planning for risk assessing (identifying and analyzing) risk issues, developing risk handling strategies, and monitoring risks to determine how they have changed. [25, 35, 39, 40]

Previous EPC contracts for the construction of hydropower projects in Ethiopia do not have formal Risk management system. However, the risk identification methods used are past experience from related works, group discussion, checklist, assumption analysis and structured review, are consistent with internationally acknowledged practice. [35]

There are different processes adopted in risk management involving risk: planning, assessment (identification and analysis), handling, and monitoring. [25, 38]

Risks identified from the research conducted on EPC contracts implemented in Ethiopia are:

- ✓ Construction risk includes non-completion, delayed completion, completion with cost overrun and completion with performance deficiency.
- ✓ Technological risk while using outdated, improper, not tested and poor life time technology
- ✓ Financial risk attributable to delay excessive conditions
- ✓ Right of way (ROW) related risks where dislocation and resettlement take considerable time to handover the site the EPC contractors.
- ✓ Planning risk as a result of delayed fabrication, factory test, trainings, operation and maintenance manual
- ✓ Project Management risk owing to lack of knowledge, skill & qualification, and lack of motivation.
- ✓ Traffic management and public safety particularly in Addis Ababa LRT project.

- ✓ Market risk as a result of escalation and exchange rate fluctuation
- ✓ Customs clearance related risk which cause Demurrage & other cost with time delay on the project.
- ✓ Transport related risk where insufficient bridge and culvert capacity and incapable pavement roads with insufficient curve radius for the transportation of heavy generator and transmission equipment. As encountered in Beles Hydropower project. [35]

  Advancement in modular construction techniques for resource projects continue for projects involving significant overland transportation to site. These are likely to test the known capabilities of current road transport and associated infrastructure. [41]
- ✓ Underground risk associating geological, thermal, hydrological events, tunnel collapse
- ✓ Extreme hydrological risk by extreme flood and shortage of rain, esp. on hydropower projects.

Risk identification process carried out at the early stage of the project during feasibility, tender, contract negotiation, and design phase. [34]

Risk analysis is main part of risk management to gather enough information about the risk issues to judge the likelihood of occurrence and cost, schedule, and technical consequences and ranking accordingly if the risk occurs. [25] Even though risk analysis is a key part, only Qualitative Risk analysis is undertaken using sensitivity analysis and expected monetary value analysis in the feasibility is applied, no quantitative analysis using either software or risk management tools & Techniques applied in EPC contracts in Ethiopia. [35]

Risk handling includes specific methods and techniques to deal with known risks, identifies who is responsible for the risk issue, and provides an estimate of the cost

and schedule associated with reducing the risk, if any. There are different types of handling mechanisms such as risk retention, risk transfer, risk split/ divide, risk reduction, risk avoidance, and risk spreading. [25, 40]

Among those risk handling mechanisms risk transfer, risk reduction and risk postpone are employed widely for EPC contracts in Ethiopia; risk transfer method prepared proactively such as planting provisional and contingency sum, insurance & bonds, construction method statement, safety plan, quality assurance system and environmental management plan. [35]

The project owner or employer will look to the EPC contractor as the single point of contact for all facets of the project. Indeed, in a sense, some of this risk never leaves the owner. Accordingly Clause 19 of the FIDIC Silver Book (Force majeure) leaves the door open for that risk to migrate back to the owner. [16]

The appetite for EPC contractors accepting project and contractual risks fluctuates with supply and demand in the market. [30] With the EPC contract come many new risks that are often severe due to the complex nature and high cost frequently associated with this type of project. But in situations where time is essence and completion of project is priority, efforts are equally taken by all stakeholders in the interest of project. [39]

3. Research Methodology

This chapter discusses the methodological approach of the thesis that entails the research approach and the limitations considered coupled with data collection methods and how the analysis was made.

Based on the problem statement, first an intensive review of literatures on the subject was undertaken. An intensive literature review of the existing literature represents an integral part of the study. The review identified how EPC turnkey contract delivery system defined, what are the similarity & difference of Design-Build, EPC & Turnkey major, what are the common & special features of EPC contract delivery system with and from other delivery systems respectively, how they explain the advantage of EPC and what are the challenges of EPC contract delivery system in the construction sector; especially, on Mega projects and railway projects? Research studies in the world have confirmed that EPC turnkey has numerous advantages in construction sectors but have faced some challenges with respect to cost, time, quality and risk.

This chapter consists of four parts: Introduction/ The study approach, data Source, data Collection and the data analysis method.

3.1. The study approach

The strategy adopted for this study is exploratory and descriptive. Since it was initiated to identify practical problems and tries to find the presence and causes of challenges in the construction of railway projects in Ethiopia it is Exploratory. It is also descriptive because it tries to describe the impact of challenges encountered in terms of cost, time and quality.

This research is basically of a mixed research type where both qualitative and quantitative methods are employed. A qualitative research is a subjective assessment of a problem and takes the form of an opinion, view, perception and/or attitude towards objectives. Whereas Quantitative research is objective measurement of the problem, that investigates facts and tries to establish relationships using statistical tools.

3.2. Data Sources

From the result found from the literature review on the challenge variables & risk factors of EPC contact delivery system detail data was collected.

The samples were drawn from the client, Ethiopian Railway Corporation, Consulting firms/ Employer's Representative as defined in FIDIC Silver Book, and EPC Contractors involved in Railway project and relevant & skilled professionals in the construction sectors. Those elements were selected since they are the major stakeholders in the sector. No restriction in gender, age, religion but the respondents must be experts or occupying technical and managerial position in their organization.

3.3. Data Collection

From the result found from the literature review on the challenges of EPC contact delivery system detail analysis were conducted by collecting relevant data. The data collection part comprises primary data, which directly collected for this particular research, and secondary data, using archival records and data collected and/or analyzed by others.

3.3.1. Primary data

- Questioner

The data will be collected via printed and electronic Semi-structured questionnaires, which was developed to investigate the major challenges of EPC contract, from the aforementioned client, consulting firms, contractors and relevant professional individuals. The electronic questionnaire is used to address the farthest respondents, who are engaged in Ethio-Djibouti railway project, and media of communication used was via e-mail.

The first page was a covering letter with information about the research project, contents of the questionnaire, how the responses would be utilized and confidentiality of the information & data provided. The second part was the questionnaire. The questionnaire shown in the Appendix consists of four main sections as enumerated from Section 1 to Section 4, the questionnaire comprises of four parts:

Section 1:-Intended to determine the type of organization the respondent involved in, the respondents experience in the construction industry which would help in giving weight to the respondents answer.

Section 2:- Assessment of the Challenges of EPC Contract delivery system adopted for railway Projects in Ethiopia.

Section 2.1:- After the variables of challenges of EPC contract delivery are identified from intensive literature review, Based on their experience the respondents are requested to rank the probability of occurrence and its impact on cost, time and quality.

The answers for the structured part of the questionnaire are based on Likert's-scale, which the Likert scale's invention is attributed to Rensis Likert (1931), who described this technique for the assessment of attitudes towards each inquiry. The reasons for adopting this simple scale are:

- To provide simplicity for the respondent to answer, and
- To make evaluation of collected data easier

The Likert scale of five ordinal measures the agreement towards each statement (from 1 to 5) as shown in the following sections.

The respondents were asked to rank the Probability of occurrences of these challenge variables based on the following choices.

1- *Not at all* = 0% probability to happen
2- *Unlikely* = 0% - 25%
3- *Likely* = 26% - 50%
4- *Almost certain* = 51% - 99%
5- *Certain* = 100% probability to happen

After identifying the probability of occurrence of the challenge variables respondents were asked about the impacts of each challenge variables on the main

objective of a project in terms of Cost, Time, and Quality based on the following choices.

1- No significance
2- Minor significance
3- Average significance
4- High significance
5- Extreme significance

Section 2.2:- Assessment of Risk in the Railway projects undertaken using EPC Contract delivery system is conducted after the identification of risks in mega project implemented with EPC contract delivery method.

The respondents were asked to rank both the frequency (Probability of occurrence) and Severity (Impact) on cost, time and quality using 5-point Likert's scale (from 1-5).Respondents were also requested to propose possible measures/ Method of management used for each risk sources, and their response were analyzed using descriptive statistics including percentages.

Section 3:-Finally, open ended question provided, which was intended to collect the overall challenge encountered in Railway projects in respondent's professional view, other than those factors included in the previous sections. This was mainly targeting to incorporate the shortcomings of the research questions and variable in the subsequent interview and case study investigation.

Section 4:- An open ended question provided to explore the weakness and limitation of the research objective, research questions, and to collect feedback from the respondent that provides professional understanding for future researches.

- Interview

The collection of data through unstructured interview be conducted for two reasons; if there is disparity of response on the questionnaire results from the widely acknowledge practice and logically expected result is the first reason; while the second is to address those professionals /technical staff engaged in the construction site.

The questions prepared for interview are based on the questionnaire forwarded to the respondents; therefore based on this objective the interview was divided in to four sections.

The first section is used to determine the sources of Challenges & risk factors in Railway Projects in Ethiopia with EPC contract delivery system, the Second part of the interview is intended to determine the Impact of the Challenge variable & risk factors on the projects. The third section of the interview question determines method of mitigation measure used so far to tackle the challenges and risk factors, either to avoid and/or decrease the impact or to reduce the probability of occurrence of Risk factors.

3.3.2. Secondary data for Case study

The second step in data collection of the research was to conduct case study analysis on two already lunched railway projects, which are Addis Ababa Light Rail Transit (AALRT Project) and Addis Ababa-Djibouti Railway project. The main objectives of the case studies were to find out the major challenges encountered from archival records and document review. Case studies are the preferred strategy when, how or why questions are being posed. [42]

The case study will be conducted by observation and document analysis. The document analyzed were contract documents, conditions of contract, special provisions, specifications, minutes of meetings, Progress report, change orders and variation orders, payment certificates, relevant correspondences between the client, Employer's representative and EPC Contractor, relevant RFI (Request for Inspections), publications, newsletters on the above projects with regard to the specific objective of the research.

3.4. Data Analysis Method

After all the data were collected the data were refined, classified and analyzed quantitatively and qualitatively. The analysis methods implemented are both descriptive and inferential statistics. For the analysis, IBM SPSS (Statistical Package for the Social Sciences) version 20 statistical analyses and data management software package was used.

In the analysis, for section 2.1 & Section 2.2 of the questionnaire 'Mean Score' method was adopted, in section 2.1 mean score is implemented to assess both the probability of occurrence of challenge variables and their impact on cost, time & quality. While in section 2.2 the mean score is applied to analyze the Probability of occurrence of risks and their impact in terms of cost, time quality.

As discussed earlier Likert's scale of five ordinal measures of agreement towards each statement (1, 2, 3, 4& 5) is used to calculate the mean score for each factor that is used to determine the relative ranking.

The software calculate the mean score (MS) of probability of occurrence and associated impact for each variables of challenges & risk by using the following formula;

$$MS = \frac{\sum(f * s)}{N} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots eq.(1)$$

Where: - MS = Mean Score

f = Frequency of responses for each score

s =Scores given to each factor (from 1 to 5)

N =Total number of responses concerning each factor

Conceptually, risk for each event can be defined as a function of likelihood and impact; that is, [25]

$$risk = f(Likelyhood, impact) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots eq.(2)$$

Thus, in the analysis of section 2.2 of the questionnaire, the cumulative of the mean score of these two (i.e. frequency of occurrence of Risk sources and their associated impact on cost, time & quality) was calculated to determine the overall ranking based on the two criteria. Accordingly, for overall ranking of the risk factors on each of main objective of the project in terms of cost, time & quality the above equation (eq. (2)) modified as follows for cost, time and quality respectively:

$$CMS_c = MS_o \times MS_{i,c} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots eq.(3)$$

$$CMS_t = MS_o \times MS_{i,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots eq.(4)$$

$$CMS_q = MS_o \times MS_{i,q} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots eq.(5)$$

Where: - CMSc = Cumulative Mean Score of risk for impact on *cost*

CMSt = Cumulative Mean Score of risk for impact on *time*

CMSq = Cumulative Mean Score of risk for impact on *quality*

MSo = Mean Score of Probability of occurrence

$MS_{i,c}$= Mean Score of impact on *cost*

$MS_{i,t}$= Mean Score of impact on *time*

$MS_{i,q}$ = Mean Score of impact on *quality*

Using the analysis software, SPSS, the sample Spearman rank correlation coefficient r_s were calculated to measure the population correlation coefficient ρ. It is intended to measure the agreement or difference in ranking between two groups of respondents, for single variable of challenge and source of risk, while ignoring the ranking of the other party.

The ranking correlation coefficient ranges from -1 to +1. A correlation coefficient of 1 indicates a perfect linear correlation i.e. good or strong correlations while -1 indicates negative correlation implying high ranking in one group is associated with low ranking on the other. Correlation coefficient value near to zero indicates little or no correlation. [43]

The formula used for the calculation of spearman correlation coefficient r_s is:-

$$r_s = 1 - \frac{6}{n(n^2-1)} \sum_{i=1}^{n} {d_i}^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots eq.(6)$$

Where: -r_s = Spearman's rank correlation coefficient

d = the difference between ranks given by two parties for each variables

n = number of pairs of values in the data set

3.5. Outline of Research Writing

The research contains five chapters that discuss the background of the research, methodology & process of the research, Result of Finding and Conclusion & recommendation based on the specific objective of the research.

The first Chapter explains the background of the research and spells out what the research intends to achieve both general & specific objectives. The second chapter deals with the finding of challenge variables & risk factors from intensive literature review. This chapter provides a general understanding of previous studies and findings related to the research area, in construction projects with EPC contract delivery system especially on Railway Projects. The third Chapter discusses the methods that are used for the research and it highlights the source of data & data collection methods that the research employed. It also outlines the method of analysis to arrive at the required goal. This chapter is followed by the analysis of finding and discussion of the results obtained from the study in the Fourth Chapter of this research. The last chapter draws conclusion of the research and provides some recommendations for improvement in the sector & provide insight similar future research areas.

The following figure (Fig. 3.1) shows the organization and structure of the research paper.

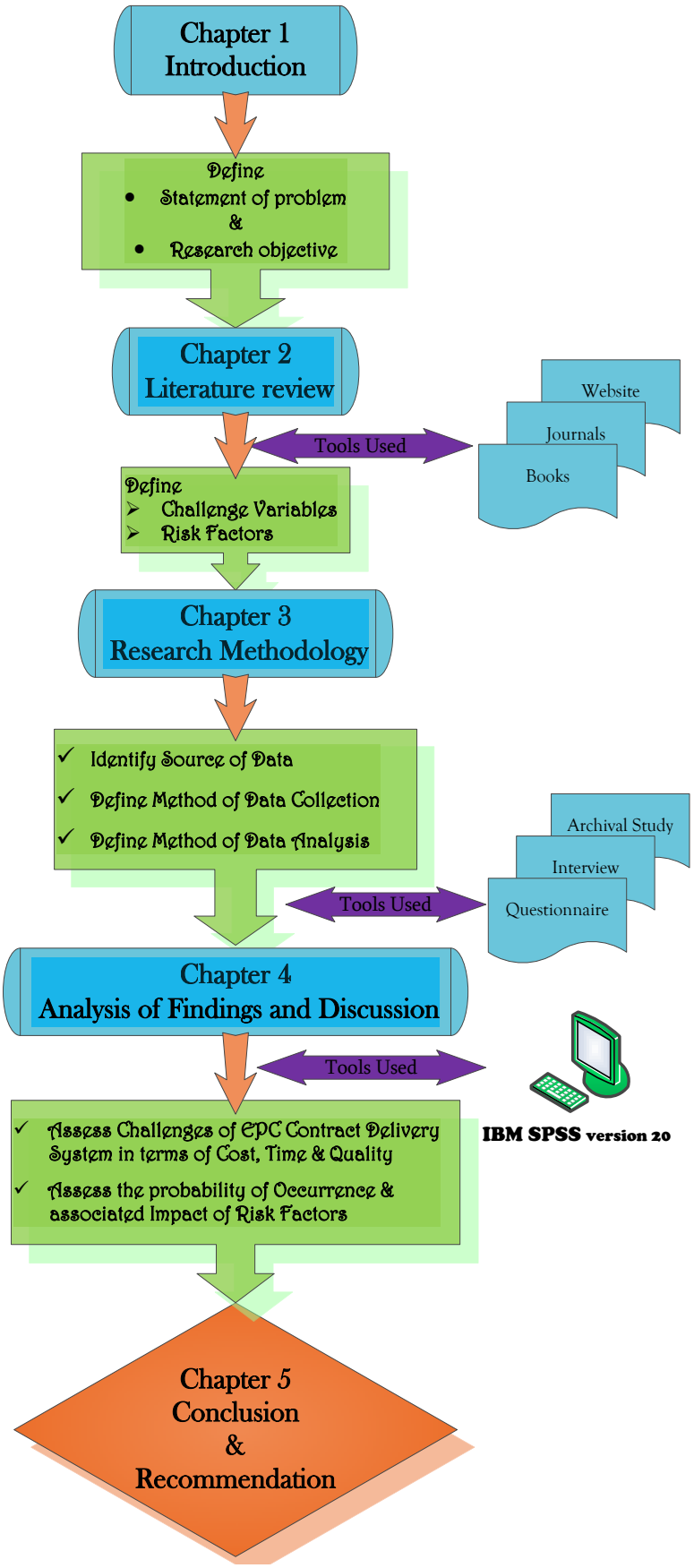


Fig 3.1. The research writing outline

4. Analysis of Findings and Discussion

4.1. General Overview

This Chapter deals with the analysis of the data collected from the questionnaire survey, interview and case study of archival documents used to identify & investigate the cause of challenges of EPC contract delivery system and their impact on cost, time, quality and to identify the source of risk and method of measurement used for railway projects in Ethiopia.

The procedure used in analyzing the results was aimed at establishing the relative importance of the various challenge factors responsible for cost related challenge, time related challenge & quality related challenges and also to investigating the rank of the various risk factors in terms their probability of occurrence & their associated impact on project objectives.

The questionnaire gave each respondent an opportunity to identify the probability of occurrence of challenges encountered and source of risks by giving the response "Not at all", "Unlikely", "Likely", "Almost Certain" & "Certain" and to rate their associated impact on cost, time and quality in terms of "No Significance", "Minor", "Average", "High" & "Extreme".

For each variables of challenge, the percentages of respondents' response were ranked for analysis purpose. On the basis of the ranking of the variables by the various groups, it was possible to identify the most important challenge factors& source of risk that has higher impact on cost, time and quality in Railway projects with EPC contract delivery system in Ethiopia. Furthermore interviews were conducted to supplement& validate the answers obtained from questioner.

The archival study carried out to obtain actual data from the source documents which included the contract documents, bankable feasibility study, Conceptual design, supplementary agreements, variation orders, progress reports, correspondence letters, payment certificates, and technical reports to have appropriate facts on cost, time &

quality in the project. However, since the projects are undergoing the respondents were unwilling, by the instruction from the higher government officials, to provide the appropriate documentation for full analysis of challenge & risk identification.

4.1.1. Questionnaire response rate

Detailed questionnaires were designed, as described in detail in chapter 3 and attached in the annex of this document, and distributed for the assessment of challenges of EPC contract delivery system in Railway projects in Ethiopia, for this purpose the questionnaires were distributed to major stakeholders in the construction industry; these are Employers, Employer's representatives, Contractors and Skilled professionals in the construction sector.

For the preparation of inclusive analysis on challenges of EPC contract delivery system for Railway project undertaken in Ethiopia, a total of 25 questionnaires were distributed to Employers, Employer's representatives, Contractors and Skilled professionals, the number of the samples taken are based on the availability of technical & managerial staff engaged in the railway projects studied. Out of the 25 distributed questionnaires, 20 questionnaires were filled and returned. This yields a response rate of 80%. Before starting the analysis, the returned questionnaire was checked for their applicability & reliability and out of the 20 questionnaires 18 were found to be relevant& reliable for data analysis process with a valid response rate of 72%.Theinvalid responses castoff on the basis of incomplete information based on the respondents' response on the information they have about EPC Contract delivery system, while they respond to the first question of section 2 of the questionnaire.

Table 4.1 below shows the number of questionnaires distributed to Employers, Employer's representatives, Contractors& Skilled professionals and the number of questionnaires returned from these stakeholders including their percentage response rate.

Respondent category	Questioner Issued	Questioner Returned	Response Rate	Valid response	
	No.	No.	(%)	No.	(%)
Employer	12	10	83%	9	75%
Employer's Representative	5	4	80%	4	80%
Contractor	5	4	80%	3	60%
Skilled Professional in the Construction Sector	3	2	67%	2	67%
Total	**25**	**20**	**80%**	**18**	**72%**

Table 4.1 Questionnaire response rate

4.1.2. Informants Profile

The key informants targeted for this research were professionals from the Employer, Employer's Representative, contractors involved in Railway projects and relevant skilled professionals in the construction sector. No restrictions in gender, age and religion but the respondents were limited to be experts or occupying technical and managerial position in their organization. Accordingly, 25 key Informants were selected to fill the questionnaire; However, as discussed in Section 4.1.1 and Shown in table 4.1 only 18 of them provide valid response. Therefore, the profile of those valid Informants is shown in Table 4.2 below.

Seven of the total valid respondents, 18 in number, have Bachelor of Science Degree and the rest 11 respondents have Master of Science Degree in different Specialization fields of Civil Engineering & Construction Management. Three respondents have work experience from 0 to 5 Years, Five respondents involved in the construction sector from 6 to 10 years, seven respondents have work experience between 10 and 15 years, and the rest three respondents have more than 15 years' experience.

Type of Organization * Educational Status * Work experience Cross tabulation					
Work experience			Educational Status		Total
			Bachelor of Science	Master of Science	
0-5 Years	Type of Organization	Client		3	3
		Total		**3**	**3**
6-10 Years	Type of Organization	Client	0	2	2
		Main Contractor	1	1	2
		Employer Representative	0	1	1
		Total	**1**	**4**	**5**
11-15 Years	Type of Organization	Client	3	0	3
		Main Contractor	1	0	1
		Skilled Professional	0	1	1
		Employer Representative	0	2	2
		Total	**4**	**3**	**7**
>15 Years	Type of Organization	Client	1	0	1
		Skilled Professional	0	1	1
		Employer Representative	1	0	1
		Total	**2**	**1**	**3**
Total	Type of Organization	Client	4	5	9
		Main Contractor	2	1	3
		Skilled Professional	0	2	2
		Employer Representative	1	3	4
		Total	**7**	**11**	**18**

Table 4.2Informants Profile

4.1.3. Interview response rate

Out of the twenty respondents who participated in the questionnaire survey who returned the questionnaire Seven (7) of them were willing to provide the required information for the interview questions. There are various reasons for non-willingness of the respondents for interview; however, most has replied that the main reason was they are too busy due to involvement in different routine activities. Besides, All Contractors'

staffs were not willing for interview due the command from the Employer not to undertake any interview either to researcher or media.

Respondent category	Questioner Returned		No of willing respondents for Interview	
	No.	(%)	No.	(%)
Employer	10	50%	5	50%
Employer's Representative	4	20%	1	25%
Contractor	4	20%	0	0%
Professional in the Construction Sector	2	10%	1	50%
Total	**20**		**7**	**35%**

Table 4.3Interview response rate

Thus, the response rate of willing interviewee out of the total questionnaire respondents is 35% therefore the analysis was conducted based on this interview, questionnaire and archival reports.

4.2. Challenges of EPC Contract Delivery System for Railway projects from Questionnaire Analysis

Analysis of the data collected through the research questionnaire has addressed the research specific objectives. For the purpose of relating the research specific objectives with the analysis and also for the ease of presentation, the results and discussions are presented in two major themes. Section 4.2.1 presents the probability of occurrence of challenge variables in Railway projects covered in this Thesis, which are undertaken now with EPC Contract delivery system, Section 4.2.2 presents the impact of challenge variables on the three project objectives: cost, time & quality.

Moreover, Section 4.3 presents the findings and discussions made on the analysis of risk on the three project objectives, which are cost, time & quality. It presents the research findings with respect to the probability of occurrence of source of risk and their impact on the major three project objectives: cost, time and quality. Finally, Rank the Risk factors combining probability of occurrence and impact of Risk factors on each objective: cost, time & quality.

The sources of challenges from the questionnaire survey are identified based on respondents' response on each variables of challenge on project objectives: cost, time and quality. Since the sources of challenges identified by the different researchers, as indicated in the chapter 2 (literature review part) of this thesis, might not be causes of challenges for the Railway projects undertaken in Ethiopian, it is important to ask the respondents for their agreement on each particular variables of source of challenges, then this is accompanied by identification of causes of cost overrun based on their occurrence. For example, Inappropriate/ inexperienced contractor related causes challenge occur less frequently but their impact on cost, time & quality, if they happen, is maximum and increase the of cost the project substantially, prolong the project period and cannot achieve the required performance level. Hence identifying the rate of occurrence alone cannot help in identifying the critical source of challenges that are more prevalent for Railway projects in Ethiopian with EPC contract delivery system.

To clearly identify the most common source of Challenges it is important first to identify the impact of challenges in each project objectives: cost, time & quality, for Railway projects in Ethiopian adopted with EPC contract, and then identify their rate of occurrence and finally their overall challenge or severity on each of main objectives of the project, which includes cost, time and quality.

4.2.1. Challenges in terms of Probability of Occurrence

The most likely and frequent Challenge sources were assessed from the questionnaire respondents and results are given in Table 4.4 below. From 56 challenge sources of EPC contract delivery system rate of occurrences which has a mean score of greater than or equal to 3 (MS $\geq$ 3) are considered as important because there is at least a probability of 50% chance for the existence from likely to occur(likert scale 3) to Certain (likert scale 5). The table shows the probability of occurrence of challenge variables in the Railway projects in Ethiopia with EPC Contract delivery based on the mean scores (MS) of the four respondent groups, Employers, Employer's Representative, Contractors and Skilled professionals in the sector.

Rank	Source of Challenges	MS of Employer	MS of Employer Representative	MS of Contractor	MS of Skilled Professionals	Weighted Average on Probability of Occurrence
1	No final detail design drawing available before the construction starts before final	4.56	4.75	4.67	5.00	4.74
2	Higher cost to accept transfer of Risk	4.33	4.50	4.67	5.00	4.63
3	Insufficiently defined conceptual design and Front End Engineering Design (FEED) by the owner	4.56	4.50	4.67	4.50	4.56
4	Lack of end user/owner involvement in due course of the design and project execution	4.33	4.50	4.67	4.50	4.50
5	Additions and/or enhancement required by clients or end users	4.33	4.50	4.33	4.50	4.42

6	Failure of the employer to give land acquisition/possession of the site/ free from ROW obstruction in accordance with the terms of the contract	4.22	4.25	4.33	4.50	4.33
7	Additional costs due to variations works	4.22	4.25	4.33	4.50	4.33
8	Unclear specifications or changes to specification	4.44	4.25	4.00	4.00	4.17
9	Design that satisfy the Minimum requirement	4.13	4.25	4.00	4.00	4.09
10	Insufficient number of experienced personnel in Owners organization to manage the technical aspect of a project, in review of design & Procurement packages, response to Request of Inspections (RFI).	3.78	4.00	4.33	4.00	4.03
11	Failure of the employer to coordinate utility infrastructure authorities for existing and future planned utilities in ROW of the project in accordance with the terms of the contract	3.78	4.00	4.00	4.00	3.94
12	Insufficient number of experienced qualified and experienced management team to manage change orders, extension of time and financial claims.	4.00	3.75	4.00	4.00	3.94
13	Inflation or increase in the cost of construction materials	4.00	3.75	4.00	4.00	3.94
14	No standard tender evaluation criteria	3.67	3.67	3.67	4.00	3.75
15	Change in foreign exchange rate (for imported materials)	3.78	3.75	3.67	3.50	3.67
16	Insufficient geotechnical investigation	3.67	3.75	3.67	3.50	3.65
17	Higher front end cost/ Higher Preliminary design & Owner's requirement preparation cost at the Bidding stage	3.71	3.33	3.67	3.50	3.55
18	Ambiguities or discrepancies of documents	3.67	3.50	3.33	3.50	3.50

19	Contractors aim to reduction of cost by optimizing quality, aesthetics, high level finishing	3.44	3.50	3.33	3.50	3.44
20	Delayed Payment	3.33	3.25	3.67	3.50	3.44
21	Supplementary/additional agreement	3.44	3.25	3.33	3.50	3.38
22	Encountering of not foreseeable physical obstructions and conditions	3.38	3.25	3.33	3.50	3.36
23	No standard/ quality control mechanism to track the quality/close follow up of the project by the owner prior to handing over	3.22	3.25	3.33	3.00	3.20
24	Changes in Plans and drawings	3.11	3.25	3.00	3.00	3.09
25	Cost associated with test of samples not provided in the contract	3.14	3.50	2.67	3.00	3.08
26	Higher design cost at the Bidding stage	3.25	3.00	3.00	3.00	3.06
27	Designer not acting in the Best Interest of the owner	3.11	3.00	3.00	3.00	3.03
28	No sufficient and reliable integrated master project schedule that results from pulling together the work activities from multiple prime contractors.	3.00	3.00	3.00	3.00	3.00
29	No contractual responsibility of Owner's Representative	3.14	2.75	3.00	3.00	2.97
30	Lack of base line planning and coordination or less emphasis to planning	2.89	2.75	3.00	3.00	2.91
31	Design error resulted from technical error, inadequate survey data, poor specification, on-conformance/to the minimum requirement of the spec.	3.00	2.75	2.67	3.00	2.85
32	Many Change orders and/or lack of control on excessive change orders	2.67	2.75	2.67	3.00	2.77

33	Fluctuations in the cost of labor and/or material or any other matter affecting the cost of the execution of the works and subsequent legislation that affect the project	2.78	2.50	2.67	2.50	2.61
34	Failure of the employer to integrate government authorities, environmental mitigation requirements.	2.56	2.50	2.67	2.50	2.56
35	Insufficient management of multiple prime contractor design and construction interference	2.56	2.50	2.33	2.50	2.47
36	Inadequate documentation or minimal information during the project history on contractors' schedule progress, labor utilization, cost expenditures, and labor productivity.	2.56	2.50	2.33	2.50	2.47
37	No or insufficient environmental protection policy	2.44	2.50	2.33	2.50	2.44
38	Insufficient quality management practice by the contractor	2.44	2.50	2.33	2.50	2.44
39	Inability of owner to track the project progress for payment certification	2.44	2.50	2.33	2.50	2.44
40	Inaccurate quantity estimate or excess quantity during construction	2.56	2.33	2.33	2.50	2.43
41	Insufficient Environmental protection manual and weak implementation policy	2.22	2.25	2.00	2.50	2.24
42	Mistakes during construction or defective work or Wrong construction methodology	2.33	2.25	2.00	2.00	2.15
43	Difficulties in obtaining construction materials in the local market	2.11	2.00	2.00	2.00	2.03
44	Failure to identify problems and institute necessary and timely design and programming changes	2.33	1.75	2.00	2.00	2.02

45	Executive bureaucracy in the client's organization	2.00	2.00	1.67	2.00	1.92
46	Funding problems or client's shortage of finance or delayed payments to contractors	1.89	1.75	2.00	1.50	1.78
47	Higher Compensation/ Honorarium cost for unsuccessful proponents for their proposal/bid submission	1.75	1.67	1.67	1.50	1.65
48	Acceleration required by the owner (shortening of contract time)	1.56	1.75	1.33	1.50	1.53
49	Increase in tax/change in government fiscal/monetary policies	1.67	1.50	1.33	1.50	1.50
50	Inappropriate/inexperienced contractor	1.67	1.50	1.00	1.50	1.42
51	Loss or damage due to excepted risks or employers risk	1.67	1.50	1.00	1.00	1.29
52	Cost under estimation	1.33	1.33	1.00	1.00	1.17
53	Contractors bankruptcy	1.33	1.25	1.00	1.00	1.15
54	Suspension of work ordered by the Owner/ Owner Representative	1.44	1.00	1.00	1.00	1.11
55	Fossils or discovery of things of geological or archeological interest	1.33	1.00	1.00	1.00	1.08
56	Costs due to special risks which very often include outbreak of war, projectile, missile, hostilities, contamination and other risk	1.33	1.00	1.00	1.00	1.08

Table 4.4 Probability of Occurrence of Challenge variables on Railway project.

From the table 4.4 above, we can examine that no final detail design drawing available before the construction starts, Higher cost to accept transfer of Risk, Insufficiently defined conceptual design and Front End Engineering Design (FEED) by the owner, Lack of end user/owner involvement in due course of the design and project execution, Additions and/or enhancement required by clients, Additional costs due to variations works, Failure of the employer to give land acquisition/possession of the site/ free from

ROW obstruction, Unclear specifications or changes to specification, Design that satisfy the Minimum requirement, Insufficient number of experienced personnel in Owners organization to manage the technical aspect of a project, in review of design & Procurement packages, response to Request of Inspections (RFI) and Failure of the employer to coordinate utility infrastructure authorities for existing and future planned utilities in ROW has higher probability of occurrence in the Railway projects undergoing in Ethiopia with EPC contract delivery system. Most of the challenges frequently occurred are due to the nature of the contract delivery system and inexperience of the stakeholders for such huge railway projects.

Spearman's Rank Correlation

One of the requirement of this thesis is to investigate whether there is agreement or not on the attitudes of stakeholders towards the challenges of EPC contract delivery system in railway Projects in terms of cost, time and quality. Hence in this section respondents' response were tested for correlation using Spearman rank correlation coefficients, to see if there is difference in ranking between two groups of respondents; these are Employer versus Employer's Representative, Employer versus Contractors, Employer versus Skilled Professionals, Employer's Representative versus Contractors, Employer's Representative versus Skilled Professionals, and Skilled Professionals versus Contractors on the variables of Impacts of Challenges and their rate of occurrence.

Spearman's rho Correlations for Probability of Occurrence of Challenge Variables						
			MS of Employer	MS of Employer Representative	MS of Contractor	MS of Skilled Professionals
Spearman's rho	MS of Employer	Correlation Coefficient	1.000	.987**	.986**	.985**
		Sig. (2-tailed)		.000	.000	.000
		N	56	56	56	56
	MS of Employer Representative	Correlation Coefficient	.987**	1.000	.981**	.984**
		Sig. (2-tailed)	.000		.000	.000
		N	56	56	56	56
	MS of Contractor	Correlation Coefficient	.986**	.981**	1.000	.987**
		Sig. (2-tailed)	.000	.000		.000
		N	56	56	56	56
	MS of Skilled Professionals	Correlation Coefficient	.985**	.984**	.987**	1.000
		Sig. (2-tailed)	.000	.000	.000	
		N	56	56	56	56
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 4.5 Spearman's rho correlation for Probability of Occurrence of challenge variables.

From the above Table 4.5, it can be concluded that there is strong correlation between the attitudes of the respondents in all the four groups. This means that most of the respondents have the same perception on frequency of the occurrences of variables of challenges. Thus, we can conclude that there is a very good agreement between four groups of respondents in ranking of frequency of occurrence of challenge variables with the least significant level of 98% and the highest degree of agreement 98.7% between Employer &Employer's Representative and Contractor & Skilled Professionals.

4.2.2. Challenges in terms of Impact

To identify the factors that are critical in causing challenges; regardless of the chance of occurrence the significance of the factor independently has to be assessed with respect to its Impact, when it happens during tendering, procuring, construction and handover phase. Thus, Section 4.2.2.1 below presents the first theme which is linked with challenge parameters that has an impact on cost. Accordingly, Section 4.2.2.2 and 4.2.2.3 aspires to present the second and third challenge themes, time and quality respectively, which are related to research specific objective.

4.2.2.1. Impacts of Cost Related Challenges

The factors which are chosen by the respondents to be causes of cost related challenges in the Railway projects in Ethiopian with EPC Contract delivery are identified from the returned questionnaires based on the mean scores (MS) of the four groups of respondents, Employers, Employer's Representative, Contractors and Skilled professionals in the sector for each variables challenges. In this research variables of challenges which have a mean score of greater than 3 (more than "average") are taken as causes of cost related challenges; since a mean score of less than 3 means the respondents do not agree that the variable will be a cause of cost challenge. Table 4.6below shows the impact of challenge variables on cost of the project for Railway Project in Ethiopia with EPC contract delivery system.

Rank	Source of Challenges	MS of Employer	MS of Employer Representative	MS of Contractor	MS of Skilled Professionals	Weighted Average of Cost Impact
1	Supplementary/additional agreement	4.44	4.50	5.00	5.00	4.74
2	Additions and/or enhancement required by clients or end users	4.33	4.50	5.00	5.00	4.71
3	Additional costs due to variations works	4.33	4.25	5.00	5.00	4.65
4	Inappropriate/inexperienced contractor	4.33	4.50	4.67	5.00	4.63
5	Insufficiently defined conceptual design and Front End Engineering Design (FEED) by the owner	4.44	4.50	4.67	4.50	4.53

6	Unclear specifications or changes to specification	4.43	4.50	4.67	4.50	4.52
7	Delayed Payment	4.33	4.50	4.67	4.50	4.50
8	Change in foreign exchange rate (for imported materials)	4.33	4.25	4.67	4.50	4.44
9	Inflation or increase in the cost of construction materials	4.22	4.25	4.67	4.50	4.41
10	No standard tender evaluation criteria	4.22	4.50	4.33	4.50	4.39
11	Ambiguities or discrepancies of documents	4.38	4.25	4.33	4.50	4.36
12	Higher cost to accept transfer of Risk	4.33	4.25	4.33	4.50	4.35
13	Fluctuations in the cost of labor and/or material or any other matter affecting the cost of the execution of the works and subsequent legislation that affect the project	4.00	4.00	4.00	4.00	4.00
14	Many Change orders and/or lack of control on excessive change orders	3.89	4.00	4.00	4.00	3.97
15	Higher front end cost/ Higher Preliminary design & Owner's requirement preparation cost at the Bidding stage	3.88	4.00	4.00	4.00	3.97
16	Contractors bankruptcy	4.00	3.75	4.00	4.00	3.94
17	No sufficient and reliable integrated master project schedule that results from pulling together the work activities from multiple prime contractors.	3.86	3.75	4.00	4.00	3.90
18	Changes in Plans and drawings	3.44	3.50	3.67	4.00	3.65
19	Failure of the employer to give land acquisition/possession of the site/ free from ROW obstruction in accordance with the terms of the contract	3.67	3.75	3.67	3.50	3.65
20	Inaccurate quantity estimate or excess quantity during construction	3.67	3.67	3.67	3.50	3.63
21	Design error resulted from technical error, inadequate survey data, poor specification, on-conformance/to the minimum requirement of the spec.	3.67	3.50	3.67	3.50	3.58
22	Lack of end user/owner involvement in due course of the design and project execution	3.56	3.50	3.67	3.50	3.56

23	Contractors aim to reduction of cost by optimizing quality, aesthetics, high level finishing	3.44	3.50	3.67	3.50	3.53
24	Insufficient number of experienced qualified and experienced management team to manage change orders, extension of time and financial claims.	3.44	3.50	3.33	3.50	3.44
25	Insufficient number of experienced personnel in Owners organization to manage the technical aspect of a project, in review of design & Procurement packages, response to Request of Inspections (RFI).	3.44	3.50	3.33	3.50	3.44
26	Higher design cost at the Bidding stage	3.43	3.33	3.33	3.50	3.40
27	Cost under estimation	3.13	3.33	3.33	3.00	3.20
28	Designer not acting in the Best Interest of the owner	3.22	3.00	3.33	3.00	3.14
29	Mistakes during construction or defective work or Wrong construction methodology	3.22	3.00	3.00	3.00	3.06
30	Insufficient geotechnical investigation	3.11	3.00	3.00	3.00	3.03
31	Failure to identify problems and institute necessary and timely design and programming changes	3.11	3.00	3.00	3.00	3.03
32	Difficulties in obtaining construction materials in the local market	3.11	3.00	3.00	3.00	3.03
33	Insufficient management of multiple prime contractor design and construction interference	3.00	3.00	3.00	3.00	3.00
34	Funding problems or client's shortage of finance or delayed payments to contractors	3.00	3.00	3.00	3.00	3.00
35	Failure of the employer to coordinate utility infrastructure authorities for existing and future planned utilities in ROW of the project in accordance with the terms of the contract	3.00	3.00	3.00	3.00	3.00
36	Acceleration required by the owner (shortening of contract time)	2.89	2.75	2.67	3.00	2.83
37	Encountering of not foreseeable physical obstructions and conditions	2.67	2.50	3.00	3.00	2.79

38	Design that satisfy the Minimum requirement	2.75	2.75	2.67	2.50	2.67
39	Cost associated with test of samples not provided in the contract	2.57	2.75	2.67	2.50	2.62
40	Insufficient Environmental protection manual and weak implementation policy	2.78	2.25	2.33	3.00	2.59
41	Increase in tax/change in government fiscal/monetary policies	2.67	2.50	2.67	2.50	2.58
42	Failure of the employer to integrate government authorities, environmental mitigation requirements.	2.67	2.50	2.67	2.50	2.58
43	Loss or damage due to excepted risks or employers risk	2.63	2.50	2.67	2.50	2.57
44	No contractual responsibility of Owner's Representative	2.57	2.50	2.67	2.50	2.56
45	No final detail design drawing available before the construction starts before final	2.56	2.50	2.67	2.50	2.56
46	Lack of base line planning and coordination or less emphasis to planning	2.56	2.50	2.67	2.50	2.56
47	Insufficient quality management practice by the contractor	2.56	2.50	2.33	2.50	2.47
48	Inadequate documentation or minimal information during the project history on contractors' schedule progress, labor utilization, cost expenditures, and labor productivity.	2.33	2.50	2.33	2.50	2.42
49	Inability of owner to track the project progress for payment certification	2.22	2.25	2.33	2.00	2.20
50	Suspension of work ordered by the Owner/ Owner Representative	2.11	2.00	2.00	2.00	2.03
51	No standard/ quality control mechanism to track the quality/close follow up of the project by the owner prior to handing over	2.11	2.00	2.00	2.00	2.03
52	Higher Compensation/ Honorarium cost for unsuccessful proponents for their proposal/bid submission	2.00	2.00	2.00	2.00	2.00
53	No or insufficient environmental protection policy	1.67	1.75	1.67	1.50	1.65

54	Executive bureaucracy in the client's organization	1.56	1.50	1.67	1.50	1.56
55	Fossils or discovery of things of geological or archeological interest	1.33	1.50	1.33	1.50	1.42
56	Costs due to special risks which very often include outbreak of war, projectile, missile, hostilities, contamination and other risk	1.33	1.50	1.33	1.50	1.42

Table 4.6 Impact of challenge variables on cost of the project.

As we can see from the table 4.6 above, the major cost related challenge of EPC contract delivery system for railway projects in Ethiopia are Supplementary agreement, Additions and/or enhancement required by the client, Inappropriate/ inexperienced contractor, Insufficiently defined Employers requirement/Conceptual design and Front End Engineering Design (FEED) by owner, Unclear Specification or changes to specification, Higher cost to accept transfer of Risk, Delayed Payment, Change in foreign exchange rate, Inflation or increase in the cost of construction material, No standard tender evaluation criteria, Ambiguity or discrepancies of documents, fluctuation in labor and/or material, etc. Which are in agreement with literature review. Moreover, Failure of the employer to give land acquisition/possession of the site/ free from ROW obstruction and to coordinate utility infrastructure authorities for existing and future planned utilities in ROW of the project has major cost impact on Railway projects in Ethiopia.

Due to the inexperience of the Employer, Ethiopian Railway Corporation, in railway projects and the projects studied in this research are considered their opening projects Insufficiently defined conceptual design, Insufficient number of experienced personnel in Owners organization to manage the technical aspect of a project, in review of design & Procurement packages, response to Request of Inspections (RFI) has high cost challenges.

Even though it is considered in EPC contract delivery the risk of adverse ground conditions is intended to be allocated to the contractor, which is the owner provides information on ground conditions to tendering contractors and it is the contractor who is responsible for verifying as well as interpreting that data; There is no warranty by the owner as to the sufficiency or completeness of the information provided, the owner

assurance on the risk of unforeseeable dissipates. Thus, it revert to the more traditional test of foreseeability so that the risk of the unforeseeable remains with the owner. A further variant on this is to take the existence of ground condition reports and all the surveys and to use these to extrapolate assumed conditions. If variances are found in practice from the assumed conditions which affect time or cost, their impact is allocated back to the owner rather than transferred to the contractor. Therefore, unforeseen ground condition and utility are considered to have higher cost impact on the Railway projects.

In the contrary to the literature review, Higher Compensation/ Honorarium cost for unsuccessful proponents for their proposal/bid submission and Cost associated with test of samples not provided in the contract has lower cost impact since there is no compensation/ Honorarium cost for unsuccessful tenderers and the cost of test of samples are assigned to the contractor in the studied Ethiopian railway projects.

Spearman's Rank Correlation

Spearman's rho Correlations for Cost Impact						
			MS of Employer	MS of Employer Representative	MS of Contractor	MS of Skilled Professionals
Spearman's rho	MS of Employer	Correlation Coefficient	1.000	.982**	.981**	.979**
		Sig. (2-tailed)		.000	.000	.000
		N	56	56	56	56
	MS of Employer Representative	Correlation Coefficient	.982**	1.000	.983**	.972**
		Sig. (2-tailed)	.000		.000	.000
		N	56	56	56	56
	MS of Contractor	Correlation Coefficient	.981**	.983**	1.000	.979**
		Sig. (2-tailed)	.000	.000		.000
		N	56	56	56	56
	MS of Skilled Professionals	Correlation Coefficient	.979**	.972**	.979**	1.000
		Sig. (2-tailed)	.000	.000	.000	
		N	56	56	56	56
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 4.7Spearman's rho correlation for Cost Impact of challenge variables.

Spearman's rank correlation coefficient is used to demonstrate whether there is the agreement or disagreement among each pair of parties. As can be inferred from the above results, there is a very good agreement between four groups of respondents in ranking these challenge impacts. The highest degree of agreement 98.3% correlation is between Employer's Representative and Contractors.

4.2.2.2. Impacts of Time Related Challenges

As it was applied for cost related challenges: Causes of Time related challenges in the Railway projects in Ethiopian with EPC Contract delivery are identified from the valid questionnaires based on the mean scores (MS) of the four groups of respondents, Employers, Employer's Representative, Contractors and Skilled professionals in the sector for each variables challenges. Variables of challenges which have a mean score of greater than 3 (more than "average") are taken as causes of Time related challenges; since a mean score below 3 means the respondents do not agree that the variable will be a cause of Time related challenge. The impact of Time related challenge variables on the Railway project are shown in Table 4.8 below.

Rank	Source of Challenges	MS of Employer	MS of Employer Representative	MS of Contractor	MS of Skilled Professionals	Weighted Average of Time Impact
1	Failure of the employer to give land acquisition/possession of the site/ free from ROW obstruction in accordance with the terms of the contract	4.56	4.50	4.67	4.50	4.56
2	Insufficiently defined conceptual design and Front End Engineering Design (FEED) by the owner	4.44	4.50	4.67	4.50	4.53
3	Additions and/or enhancement required by clients or end users	4.44	4.50	4.33	4.50	4.44
4	Unclear specifications or changes to specification	4.43	4.50	4.33	4.50	4.44
5	No sufficient and reliable integrated master project schedule that results from pulling together the work activities from multiple prime contractors.	4.14	4.00	4.33	4.00	4.12
6	Failure of the employer to coordinate utility infrastructure authorities for existing and future planned utilities in ROW of the project in accordance with the terms of the contract	4.11	4.00	4.33	4.00	4.11

7	Insufficient number of experienced personnel in Owners organization to manage the technical aspect of a project, in review of design & Procurement packages, response to Request of Inspections (RFI).	4.00	4.00	4.00	4.00	4.00
8	Inappropriate/inexperienced contractor	4.00	4.00	4.00	4.00	4.00
9	Lack of base line planning and coordination or less emphasis to planning	3.89	4.00	4.00	4.00	3.97
10	Changes in Plans and drawings	3.89	4.00	4.00	4.00	3.97
11	Insufficient number of experienced qualified and experienced management team to manage change orders, extension of time and financial claims.	3.67	3.50	3.67	3.50	3.58
12	Contractors bankruptcy	3.63	3.50	3.67	3.50	3.57
13	Failure to identify problems and institute necessary and timely design and programming changes	3.56	3.50	3.67	3.50	3.56
14	Ambiguities or discrepancies of documents	3.56	3.50	3.67	3.50	3.56
15	Delayed Payment	3.50	3.50	3.67	3.50	3.54
16	Supplementary/additional agreement	3.44	3.50	3.67	3.50	3.53
17	Failure of the employer to integrate government authorities, environmental mitigation requirements.	3.44	3.50	3.67	3.50	3.53
18	Funding problems or client's shortage of finance or delayed payments to contractors	3.50	3.50	3.33	3.50	3.46
19	Insufficient geotechnical investigation	3.44	3.50	3.33	3.50	3.44
20	Mistakes during construction or defective work or Wrong construction methodology	3.38	3.50	3.33	3.50	3.43
21	No standard tender evaluation criteria	3.38	3.33	3.33	3.50	3.39
22	Acceleration required by the owner (shortening of contract time)	3.22	3.25	3.33	3.00	3.20

23	Encountering of not foreseeable physical obstructions and conditions	3.11	3.25	3.33	3.00	3.17
24	Suspension of work ordered by the Owner/ Owner Representative	3.22	3.25	3.00	3.00	3.12
25	Many Change orders and/or lack of control on excessive change orders	3.11	3.25	3.00	3.00	3.09
26	Insufficient management of multiple prime contractor design and construction interference	3.00	3.00	3.33	3.00	3.08
27	No final detail design drawing available before the construction starts before final	3.00	3.00	3.00	3.00	3.00
28	Inflation or increase in the cost of construction materials	3.00	3.00	3.00	3.00	3.00
29	Designer not acting in the Best Interest of the owner	3.00	3.00	3.00	3.00	3.00
30	Inadequate documentation or minimal information during the project history on contractors' schedule progress, labor utilization, cost expenditures, and labor productivity.	2.89	3.00	3.00	3.00	2.97
31	No contractual responsibility of Owner's Representative	2.88	2.75	3.00	3.00	2.91
32	Design that satisfy the Minimum requirement	2.75	2.75	3.00	3.00	2.88
33	Additional costs due to variations works	2.89	2.50	2.67	3.00	2.76
34	Executive bureaucracy in the client's organization	2.78	2.50	2.67	2.50	2.61
35	Fossils or discovery of things of geological or archeological interest	2.44	2.75	2.67	2.50	2.59
36	Lack of end user/owner involvement in due course of the design and project execution	2.67	2.50	2.67	2.50	2.58
37	Difficulties in obtaining construction materials in the local market	2.67	2.50	2.67	2.50	2.58
38	No standard/ quality control mechanism to track the quality/close follow up of the project by the owner prior to handing over	2.56	2.50	2.67	2.50	2.56

39	Design error resulted from technical error, inadequate survey data, poor specification, on-conformance/to the minimum requirement of the spec.	2.56	2.50	2.33	2.50	2.47
40	Inability of owner to track the project progress for payment certification	2.44	2.50	2.33	2.50	2.44
41	Fluctuations in the cost of labor and/or material or any other matter affecting the cost of the execution of the works and subsequent legislation that affect the project	2.44	2.50	2.33	2.50	2.44
42	Costs due to special risks which very often include outbreak of war, projectile, missile, hostilities, contamination and other risk	2.33	2.25	2.33	2.50	2.35
43	Insufficient quality management practice by the contractor	2.11	2.00	2.00	2.00	2.03
44	Insufficient Environmental protection manual and weak implementation policy	2.11	2.00	2.00	2.00	2.03
45	Contractors aim to reduction of cost by optimizing quality, aesthetics, high level finishing	2.11	2.00	2.00	2.00	2.03
46	No or insufficient environmental protection policy	2.00	2.00	2.00	2.00	2.00
47	Inaccurate quantity estimate or excess quantity during construction	2.00	2.00	2.00	2.00	2.00
48	Change in foreign exchange rate (for imported materials)	1.89	2.00	2.00	2.00	1.97
49	Higher cost to accept transfer of Risk	2.00	1.75	2.00	2.00	1.94
50	Cost associated with test of samples not provided in the contract	1.75	1.75	1.67	1.50	1.67
51	Cost under estimation	1.56	1.67	1.67	1.50	1.60
52	Increase in tax/change in government fiscal/monetary policies	1.67	1.50	1.67	1.50	1.58
53	Loss or damage due to excepted risks or employers risk	1.44	1.50	1.33	1.50	1.44

54	Higher front end cost/ Higher Preliminary design & Owner's requirement preparation cost at the Bidding stage	1.56	1.67	1.00	1.50	1.43
55	Higher design cost at the Bidding stage	1.44	1.33	1.33	1.50	1.40
56	Higher Compensation/ Honorarium cost for unsuccessful proponents for their proposal/bid submission	1.00	1.00	1.00	1.00	1.00

Table 4.8 Impact of challenge variables on Time of the project.

Most of the major Time related challenge of EPC contract delivery system for railway projects in Ethiopia shown in the table 4.8 above agrees with the findings from literature review. Those that has highest Time related challenge are Failure of the employer to give land acquisition/possession of the site/ free from ROW obstruction, insufficiently defined conceptual design and Front End Engineering Design (FEED) by the owner, Additions and/or enhancement required by clients, Unclear specifications or changes to specification, No sufficient and reliable integrated master project schedule for multiple contractors, Failure of the employer to coordinate utility infrastructure authorities for existing and future planned utilities, and Insufficient number of experienced personnel in Owners organization to manage the technical aspect of a project, in review of design & Procurement packages, response to Request of Inspections (RFI).

Moreover, Changes in Plans and drawings, Lack of base line planning and coordination or less emphasis to planning, insufficient number of experienced qualified and experienced management team to manage change orders, extension of time and financial claims, Ambiguities or discrepancies of documents, Delayed Payment, Insufficient geotechnical investigation has high Impact on the Time of the projects.

Spearman's Rank Correlation

Spearman's rho Correlations for Time Impact						
			MS of Employer	MS of Employer Representative	MS of Contractor	MS of Skilled Professionals
Spearman's rho	MS of Employer	Correlation Coefficient	1.000	.989**	.988**	.987**
		Sig. (2-tailed)		.000	.000	.000
		N	56	56	56	56
	MS of Employer Representative	Correlation Coefficient	.989**	1.000	.987**	.989**
		Sig. (2-tailed)	.000		.000	.000
		N	56	56	56	56
	MS of Contractor	Correlation Coefficient	.988**	.987**	1.000	.985**
		Sig. (2-tailed)	.000	.000		.000
		N	56	56	56	56
	MS of Skilled Professionals	Correlation Coefficient	.987**	.989**	.985**	1.000
		Sig. (2-tailed)	.000	.000	.000	
		N	56	56	56	56
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 4.9 Spearman's rho correlation for Time Impact of challenge variables.

To validate whether there is the agreement or disagreement among each pair of respondent groups using Spearman's rank correlation coefficient we can infer that there is a very good agreement between four groups of respondents in ranking these challenge impacts. The highest degree of agreement 98.9% correlation is between Employer and Employer's Representative and between Employer's Representative and Skilled Professionals.

4.2.2.3. Impacts of Quality Related Challenges

Causes of Quality related challenges in the Railway projects with EPC Contract delivery in Ethiopian are also identified based on the mean scores (MS) of the four respondent groups, Employers, Employer's Representative, Contractors and Skilled professionals in the sector for each challenge variables. Challenge variables which has a mean score of greater than 3 (more than "average") are taken as causes of Quality related challenges; since a mean score below 3 means the respondents do not agree that the variable will be a cause of Quality related challenge. Quality related impact of challenge variables on the Railway project are shown in Table 4.10.

Rank	Source of Challenges	MS of Employer	MS of Employer Representative	MS of Contractor	MS of Skilled Professionals	Weighted Average of Quality Impact
1	Inappropriate/inexperienced contractor	4.33	4.50	4.33	4.50	4.42
2	Insufficiently defined conceptual design and Front End Engineering Design (FEED) by the owner	4.00	4.00	4.33	4.00	4.08
3	Unclear specifications or changes to specification	4.00	4.00	4.00	4.00	4.00
4	No standard/ quality control mechanism to track the quality/close follow up of the project by the owner prior to handing over	3.89	4.00	3.67	4.00	3.89
5	Mistakes during construction or defective work or Wrong construction methodology	3.78	4.00	3.67	4.00	3.86
6	Contractors aim to reduction of cost by optimizing quality, aesthetics, high level finishing	3.78	4.00	3.67	4.00	3.86
7	Designer not acting in the Best Interest of the owner	3.89	3.75	3.67	4.00	3.83
8	Design error resulted from technical error, inadequate survey data, poor specification, on-conformance/to the minimum requirement of the spec.	3.56	3.75	3.67	3.50	3.62

9	No final detail design drawing available before the construction starts before final	3.56	3.50	3.67	3.50	3.56
10	Ambiguities or discrepancies of documents	3.56	3.50	3.67	3.50	3.56
11	Design that satisfy the Minimum requirement	3.50	3.50	3.67	3.50	3.54
12	Insufficient quality management practice by the contractor	3.44	3.50	3.67	3.50	3.53
13	Lack of end user/owner involvement in due course of the design and project execution	3.33	3.50	3.33	3.50	3.42
14	Insufficient number of experienced personnel in Owners organization to manage the technical aspect of a project, in review of design & Procurement packages, response to Request of Inspections (RFI).	3.33	3.50	3.33	3.50	3.42
15	No contractual responsibility of Owner's Representative	3.25	3.00	3.00	3.00	3.06
16	No or insufficient environmental protection policy	3.11	3.00	3.00	3.00	3.03
17	Insufficient Environmental protection manual and weak implementation policy	3.11	3.00	3.00	3.00	3.03
18	Failure to identify problems and institute necessary and timely design and programming changes	2.89	3.00	3.00	3.00	2.97
19	Cost associated with test of samples not provided in the contract	3.00	3.00	2.67	3.00	2.92
20	Contractors bankruptcy	2.88	2.75	3.00	3.00	2.91
21	Insufficient geotechnical investigation	3.00	2.75	2.67	3.00	2.85
22	Insufficient number of experienced qualified and experienced management team to manage change orders, extension of time and financial claims.	2.67	2.50	2.67	2.50	2.58
23	Encountering of not foreseeable physical obstructions and conditions	2.63	2.50	2.67	2.50	2.57
24	Lack of base line planning and coordination or less emphasis to planning	2.56	2.50	2.67	2.50	2.56

25	Changes in Plans and drawings	2.44	2.50	2.33	2.50	2.44
26	No standard tender evaluation criteria	2.43	2.33	2.33	2.50	2.40
27	Difficulties in obtaining construction materials in the local market	2.00	2.00	2.00	2.00	2.00
28	Inadequate documentation or minimal information during the project history on contractors' schedule progress, labor utilization, cost expenditures, and labor productivity.	2.11	2.00	1.67	2.00	1.94
29	Higher cost to accept transfer of Risk	1.89	2.00	1.67	2.00	1.89
30	Additions and/or enhancement required by clients or end users	1.89	1.75	1.67	1.50	1.70
31	Inflation or increase in the cost of construction materials	1.67	1.75	1.67	1.50	1.65
32	Failure of the employer to integrate government authorities, environmental mitigation requirements.	1.89	1.50	1.67	1.50	1.64
33	Cost under estimation	1.67	1.67	1.67	1.50	1.63
34	Insufficient management of multiple prime contractor design and construction interference	1.78	1.50	1.67	1.50	1.61
35	Failure of the employer to give land acquisition/possession of the site/ free from ROW obstruction in accordance with the terms of the contract	1.78	1.50	1.67	1.50	1.61
36	Failure of the employer to coordinate utility infrastructure authorities for existing and future planned utilities in ROW of the project in accordance with the terms of the contract	1.78	1.50	1.67	1.50	1.61
37	Fluctuations in the cost of labor and/or material or any other matter affecting the cost of the execution of the works and subsequent legislation that affect the project	1.67	1.50	1.67	1.50	1.58
38	Change in foreign exchange rate (for imported materials)	1.67	1.50	1.67	1.50	1.58
39	Increase in tax/change in government fiscal/monetary	1.44	1.50	1.67	1.50	1.53

	policies					
40	Many Change orders and/or lack of control on excessive change orders	1.89	1.25	1.33	1.50	1.49
41	Inaccurate quantity estimate or excess quantity during construction	1.44	1.67	1.33	1.50	1.49
42	No sufficient and reliable integrated master project schedule that results from pulling together the work activities from multiple prime contractors.	1.56	1.50	1.33	1.50	1.47
43	Inability of owner to track the project progress for payment certification	1.44	1.25	1.33	1.50	1.38
44	Funding problems or client's shortage of finance or delayed payments to contractors	1.33	1.25	1.33	1.00	1.23
45	Supplementary/additional agreement	1.22	1.25	1.33	1.00	1.20
46	Additional costs due to variations works	1.22	1.25	1.33	1.00	1.20
47	Acceleration required by the owner (shortening of contract time)	1.11	1.25	1.33	1.00	1.17
48	Executive bureaucracy in the client's organization	1.33	1.00	1.33	1.00	1.17
49	Suspension of work ordered by the Owner/ Owner Representative	1.22	1.00	1.33	1.00	1.14
50	Loss or damage due to excepted risks or employers risk	1.22	1.00	1.33	1.00	1.14
51	Higher front end cost/ Higher Preliminary design & Owner's requirement preparation cost at the Bidding stage	1.22	1.33	1.00	1.00	1.14
52	Delayed Payment	1.11	1.25	1.00	1.00	1.09
53	Higher Compensation/ Honorarium cost for unsuccessful proponents for their proposal/bid submission	1.11	1.00	1.00	1.00	1.03
54	Higher design cost at the Bidding stage	1.00	1.00	1.00	1.00	1.00
55	Fossils or discovery of things of geological or archeological interest	1.00	1.00	1.00	1.00	1.00

56	Costs due to special risks which very often include outbreak of war, projectile, missile, hostilities, contamination and other risk	1.00	1.00	1.00	1.00	1.00

Table 4.10 Impact of challenge variables on Quality of the project.

The major Quality related challenge of EPC contract delivery system for railway projects in Ethiopia shown in the table 4.10 above are Inappropriate/inexperienced contractor, Insufficiently defined conceptual design and Front End Engineering Design (FEED) by the owner, Unclear specifications or changes to specification, No standard/ quality control mechanism to track the quality/close follow up of the project, Mistakes during construction or defective work or Wrong construction methodology, Contractors aim to reduction of cost by optimizing quality, aesthetics, high level finishing, Designer not acting in the Best Interest of the owner, No final detail design drawing available before the construction starts before final, and Design that satisfy the Minimum requirement.

In Ethiopian construction industry unlike to other countries No or insufficient environmental protection policy, protection manual and weak implementation policy are not considered as higher quality impact in Railway projects undertaken.

Most quality challenges are due to the nature of the Contract type that the Employer has no room to inspect the quality of the work regularly in day-to-day basis, no final detail design before construction and no reference to the Employer's Representative to review, comment and inspect the work, the designer does not act in the best interest of the owner thus designs to satisfy the minimum requirement and aims to reduce cost by optimizing quality, aesthetics, not using high level finishing.

Spearman's Rank Correlation

Spearman's rho Correlations for Quality Impact						
			MS of Employer	MS of Employer Representative	MS of Contractor	MS of Skilled Professionals
Spearman's rho	MS of Employer	Correlation Coefficient	1.000	.970**	.976**	.983**
		Sig. (2-tailed)		.000	.000	.000
		N	56	56	56	56
	MS of Employer Representative	Correlation Coefficient	.970**	1.000	.967**	.981**
		Sig. (2-tailed)	.000		.000	.000
		N	56	56	56	56
	MS of Contractor	Correlation Coefficient	.976**	.967**	1.000	.970**
		Sig. (2-tailed)	.000	.000		.000
		N	56	56	56	56
	MS of Skilled Professionals	Correlation Coefficient	.983**	.981**	.970**	1.000
		Sig. (2-tailed)	.000	.000	.000	
		N	56	56	56	56
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 4.11 Spearman's rho correlation for Quality Impact of challenge variables.

Spearman's rank correlation coefficient used to validate the agreement or disagreement of responses among each pair of respondent groups. Thus, we can deduce that there is a very good agreement between four groups of respondents in ranking these challenge impacts with the highest degree of agreement 98.3% correlation between Employer and Skilled Professionals.

4.3. Risk of EPC contract delivery System for Railway Projects from Questionnaire Analysis

This section deals with the analysis of the information on Risk of EPC contract delivery system on Railway Projects in Ethiopia gathered from the questionnaire survey including identification of rate of occurrences and impacts of risk factors on cost, time and Quality of the project.

Thus, in the Ranking of Risk factors, the cumulative of the mean score of these two (i.e. frequency of occurrence of Risk factors and their associated impact on each of cost, time & quality) was calculated. Accordingly, overall ranking of the risk factors were calculated using equation eq.3, eq.4 & eq.5foreach of major objective of the project in terms of cost, time & quality respectively.

4.3.1. Risk factors in terms of Probability of Occurrence

A list of 43 Risk factors were presented to the respondents to rank and score them according to rate of occurrence and impact on cost, time & quality on Likert scale of 1 to 5. The mean scores (MS) for each potential risk factor based on both rate of occurrence and impact.

As shown in the figure 4.1 below, the rating of the probability of occurrence of factors were made as Rare, Occasional, Likely, Frequent, Very Frequent. The most likely and frequent Risk factors were assessed from the questionnaire respondents and results are given in Table 4.12 below. From the 43Risk factors of EPC contract delivery system rate of occurrences which has a mean score of greater than or equal to 3 (MS $\geq$ 3) are considered as important because there is at least 50% probability of existence from likely to occur(Likert scale 3) to Very Frequent (likert scale 5). The table shows the probability of occurrence of risk factors in the Railway projects in Ethiopian with EPC Contract delivery based on the mean scores (MS) of the four respondent groups, Employers, Employer's Representative, Contractors and Skilled professionals in the sector.

Rank	Source of Risk	MS of Prob. of Occurrence by Employer	MS of Prob. of Occurrence By Employer Representative	MS of Prob. of Occurrence by Contractor	MS of Prob. of Occurrence by Skilled Professionals	Weighted Average Probability of Occurrence
1	· Dislocation of existing utilities	4.00	4.25	4.67	4.50	4.35
2	· Evacuation & resettlement of communities, houses & bldg.	3.89	4.00	4.33	4.50	4.18
3	· Price escalation	3.67	4.00	4.33	4.50	4.13
4	· Exchange rate fluctuation	3.67	4.00	4.33	4.50	4.13
5	· Delayed Completion	4.00	4.00	4.00	4.50	4.13
6	· Completion with cost overrun	4.13	4.00	4.00	4.00	4.03
7	· Changes in scope of work/Clients new requirement	3.67	3.50	4.00	3.50	3.67
8	· Incomplete or poor specifications	3.44	3.75	3.67	3.50	3.59
9	· Inadequate geological, geotechnical/hydrological/ hydraulic study	3.56	3.50	3.33	3.50	3.47
10	· Geological & Geotechnical	3.33	3.25	3.67	3.50	3.44
11	· Delayed payment certification & Disbursement	3.33	3.25	3.67	3.50	3.44
12	· Delayed freight transport	3.22	3.33	3.33	3.50	3.35
13	· Lack of coordination/ communication	3.22	3.25	3.33	3.50	3.33
14	· Unidentified utilities	3.13	3.25	3.33	3.00	3.18
15	· Differing site condition	3.00	3.25	3.33	3.00	3.15
16	· Traffic management	3.22	3.00	3.33	3.00	3.14
17	· Access road/ Detour facilitation	3.22	3.00	3.33	3.00	3.14
18	· Hydrological, Hydraulic & Sub-surface	3.22	3.00	3.00	3.00	3.06
19	· Integration problem	3.00	2.75	3.00	3.00	2.94
20	· Liquidated, consequential, and Punitive damages clauses	2.88	2.75	3.00	3.00	2.91
21	· Unclear scope of work & Inaccurate assumptions on technical issues	3.00	2.50	3.00	3.00	2.88
22	· Inadequate project planning	2.56	3.25	2.67	3.00	2.87
23	· Emphasis on meeting schedules & increased production volume (tight schedule)	3.00	2.75	2.67	3.00	2.85
24	· Completion with performance deficiency	2.75	2.75	2.33	2.50	2.58

25	· Ambiguities in contract.	2.78	2.25	2.67	2.50	2.55
26	· Lengthy project development period (change in site conditions due to late bidding)	2.56	2.50	2.33	2.50	2.47
27	· Inappropriate contract award process	2.56	2.50	2.33	2.50	2.47
28	· Inefficient dispute resolution procedures	2.44	2.50	2.33	2.50	2.44
29	· Delayed fabrication, test, training	2.44	2.50	2.33	2.50	2.44
30	· Funding risk	2.33	2.25	2.33	2.50	2.35
31	· Lack of Knowledge, skill & qualification	2.44	2.00	2.00	2.50	2.24
32	· Incomplete/inadequate survey data	2.33	2.00	2.00	2.00	2.08
33	· Lack of motivation & inspiration	2.22	2.00	2.00	2.00	2.06
34	· Labor shortage or strike	1.89	1.50	2.00	2.00	1.85
35	· Inefficient project delivery system	2.00	2.00	1.33	2.00	1.83
36	· Design not up to standards (nonconformance to codes and standards)	1.78	1.50	1.33	2.00	1.65
37	· Demurrage cost	1.89	1.67	1.33	1.50	1.60
38	· Incomplete/inaccurate quantity& Cost estimate	1.89	1.50	1.33	1.50	1.56
39	· Non-completion	1.56	1.50	1.33	1.50	1.47
40	· Lack of experience of the design team	1.33	1.25	1.00	1.50	1.27
41	· Improper, non-tested technology	1.33	1.25	1.00	1.50	1.27
42	· Outdated technology	1.33	1.25	1.00	1.00	1.15
43	· Insolvency/Bankruptcy of participants	1.25	1.25	1.00	1.00	1.13

Table 4.12 Probability of Occurrence of Risk Factors on Railway project.

Results indicated that out of the identified 43 risk factors 6 (14%) factors were rated as Frequent-Very Frequent,12 (28%) as likely-Frequent, majority of the scores lie in the range from Occasional-Likely 15(35%) and 10 (23%) factor was grouped under rare-Occasional.

Thus 18 risk factors (42% of the total identified factors) considered as important, which has at least 50% probability of occurrence.

Unlike literature review, Financial risks Funding risk and Insolvency of Participants has lower probability of occurrence, since the financial source of the projects is in loan from China government directly pay to the EPC contractor.

Spearman's Rank Correlation

In this section respondents' response were tested for correlation using Spearman rank correlation coefficients, to see if there is ranking difference between two groups of respondents; these are Employer, Employer's Representative, Contractors, and Skilled Professionals, on the probability of occurrence of risk factors.

Spearman's rho Correlations for Probability of Occurrence of Risk factors

			MS of Prob. of Occurrence by Employer	MS of Prob. of Occurrence by Employer Representative	MS of Prob. of Occurrence by Contractor	MS of Prob. of Occurrence by Skilled Professionals
Spearman's rho	MS of Prob. of Occurrence by Employer	Correlation Coefficient	1.000	.965**	.979**	.973**
		Sig. (2-tailed)		.000	.000	.000
		N	43	43	43	43
	MS of Prob. of Occurrence by Employer Representative	Correlation Coefficient	.965**	1.000	.967**	.972**
		Sig. (2-tailed)	.000		.000	.000
		N	43	43	43	43
	MS of Prob. of Occurrence by Contractor	Correlation Coefficient	.979**	.967**	1.000	.977**
		Sig. (2-tailed)	.000	.000		.000
		N	43	43	43	43
	MS of Prob. of Occurrence by Skilled Professionals	Correlation Coefficient	.973**	.972**	.977**	1.000
		Sig. (2-tailed)	.000	.000	.000	
		N	43	43	43	43

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

Table 4.13 Spearman's rho correlation for Probability of Occurrence of Risk Factors.

It can be concluded from the Table 4.13above, that there is strong correlation between the attitudes &perception of the respondents in all the four groups on probability of occurrences of Risk factors. Thus, we can conclude that there is a very good agreement between four groups of respondents in ranking of frequency of occurrence of challenge variables with the least significant level of 96.5%.

4.3.2. Ranking of Risk factors in terms of their Impact & Probability of Occurrence

To identify the factors that are source of Risk in Railway projects with EPC Contract delivery system; regardless of the probability of occurrence, the significance of the Risk factor, gathered from intensive literature review, independently has to be assessed with respect to its Impact, when it happens during the implementation of the projects.

The mean scores (MS) for each potential risk factor based on their impact on cost, time & quality were calculated; and their cumulative effect with probability of Occurrence were computed to rank the factors based on overall impact i.e. product of impact and probability of occurrence were be used to rate the risk factor as discussed in section 3.4 of this thesis. For the purpose of this research Fig. 3.1 is used to rank the Risk factors by the combination of probability of occurrence & their severity.

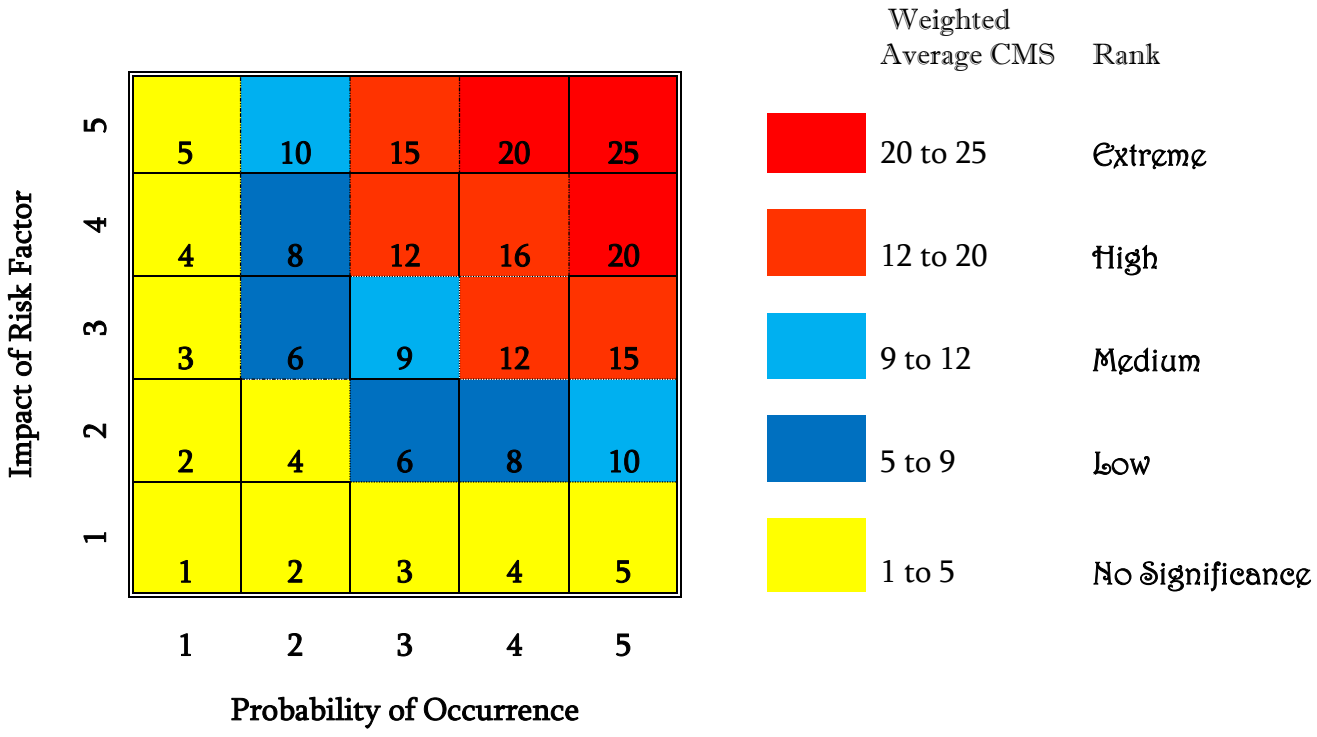


Fig. 4.1 Ranking Grid for Risk Factors.

The ranking values were selected in terms of the value of MS of Probability of Occurrence and their Impact. Such that, The Risk factor categorized under the following principle: with a least combination shown below.

Rank	Value	Option 1		Option 2	
		Prob. Occurrence (Likert Value)	Impact (Likert Value)	Prob. Occurrence (Likert Value)	Impact (Likert Value)
Extreme	20 to 25	Frequent (4)	Extremely High (5)	Very Frequent (5)	High (4)
High	12 to 20	Likely (3)	High (4)	Frequent (4)	Moderate (3)
Medium	9 to 12	Likely (3)	Moderate (3)	Likely (3)	Moderate (3)
Low	5 to 9	Likely (3)	Low (2)	Occasional (2)	Moderate (3)
No Significance	1 to 5	-	Very Low (1)	Rare (1)	-

Table 4.14 Least Combination of probability of Occurrence& Impact on Ranking of Risk Factors.

4.3.2.1. Cost Impact of Risk Factors

The Mean Score (MS) of Informants responses with regard to the Impact of risk factors in cost of Railway Projects with EPC contract delivery system are shown in Table 4.15 below. The table demonstrates the mean scores (MS) of the four groups of respondents, Employers, Employer's Representative, Contractors and Skilled professionals in the sector for each Risk factors derived from literature review.

Rank	Source of Risk	MS of Impact on Cost Employer	MS of Impact on Cost Employer Representative	MS of Impact on Cost Contractor	MS of Impact on Cost Skilled Professionals	Weighted Average of Cost Impact
1	• Completion with cost overrun	4.56	4.50	4.67	4.50	4.56
2	• Non-completion	4.44	4.50	4.67	4.50	4.53
3	• Insolvency/Bankruptcy of participants	4.11	4.00	4.00	4.00	4.03
4	• Price escalation	4.00	4.00	4.00	4.00	4.00
5	• Changes in scope of work/Clients new requirement	3.89	4.00	4.00	4.00	3.97
6	• Funding risk	3.56	3.50	3.67	3.50	3.56
7	• Exchange rate fluctuation	3.56	3.25	3.67	3.50	3.49
8	• Incomplete/inaccurate quantity& Cost estimate	3.22	3.50	3.67	3.50	3.47

9	· Inappropriate contract award process	3.44	3.25	3.33	3.50	3.38
10	· Delayed Completion	3.11	3.00	3.00	3.00	3.03
11	· Evacuation & resettlement of communities, houses & bldg.	2.78	2.75	2.67	2.50	2.67
12	· Inefficient project delivery system	2.67	2.75	2.67	2.50	2.65
13	· Dislocation of existing utilities	2.67	2.75	2.67	2.50	2.65
14	· Completion with performance deficiency	2.67	2.75	2.67	2.50	2.65
15	· Demurrage cost	2.67	2.67	2.67	2.50	2.63
16	· Unclear scope of work & Inaccurate assumptions on technical issues	2.56	2.75	2.67	2.50	2.62
17	· Delayed freight transport	2.56	2.67	2.67	2.50	2.60
18	· Unidentified utilities	2.56	2.50	2.67	2.50	2.56
19	· Lack of experience of the design team	2.56	2.50	2.67	2.50	2.56
20	· Incomplete or poor specifications	2.56	2.50	2.67	2.50	2.56
21	· Hydrological, Hydraulic & Sub-surface	2.56	2.50	2.67	2.50	2.56
22	· Geological & Geotechnical	2.56	2.50	2.67	2.50	2.56
23	· Emphasis on meeting schedules & increased production volume (tight schedule)	2.56	2.50	2.67	2.50	2.56
24	· Delayed payment certification & Disbursement	2.56	2.50	2.67	2.50	2.56
25	· Inadequate geological, geotechnical/hydrological/ hydraulic study	2.44	2.50	2.67	2.50	2.53
26	· Lack of Knowledge, skill & qualification	2.33	2.50	2.33	2.50	2.42
27	· Differing site condition	2.25	2.25	2.67	2.50	2.42
28	· Access road/ Detour facilitation	2.44	2.25	2.33	2.50	2.38
29	· Lengthy project development period (change in site conditions due to late bidding)	2.22	2.25	2.33	2.00	2.20
30	· Inadequate project planning	2.22	2.25	2.33	2.00	2.20
31	· Liquidated, consequential, and Punitive damages clauses	2.33	2.00	2.33	2.00	2.17
32	· Ambiguities in contract.	2.11	2.25	2.00	2.00	2.09
33	· Incomplete/inadequate survey data	2.33	2.00	2.00	2.00	2.08
34	· Outdated technology	2.22	2.00	2.00	2.00	2.06
35	· Improper, non-tested technology	2.22	2.00	2.00	2.00	2.06

36	· Design not up to standards (nonconformance to codes and standards)	2.22	2.00	2.00	2.00	2.06
37	· Lack of coordination/ communication	2.11	2.00	2.00	2.00	2.03
38	· Integration problem	2.00	2.00	2.00	2.00	2.00
39	· Delayed fabrication, test, training	2.00	2.00	2.00	2.00	2.00
40	· Traffic management	1.56	1.50	1.67	1.50	1.56
41	· Labor shortage or strike	1.56	1.50	1.67	1.50	1.56
42	· Inefficient dispute resolution procedures	1.44	1.50	1.33	1.50	1.44
43	· Lack of motivation & inspiration	1.44	1.33	1.33	1.50	1.40

Table 4.15 Impact of Risk Factors on Cost of the project.

Moreover, using equation eq.3 the Cumulative Mean Score of cost (CMS_{cost}) were calculated for each respondent group in conjunction with the associated Mean Score (MS) of Probability of Occurrence of Risk Factors. Accordingly, overall ranking of the risk factors on Cost of the project were ranked by means of the ranking Grid shown above in figure 4.1.

Rank	Source of Risk	CMS_{Cost} Employer	CMS_{Cost} Employer Representative	CMS_{Cost} Contractor	CMS_{Cost} Skilled Professionals	Weighted Average of CMS_{Cost}
1	· Completion with cost overrun	18.79	18.00	18.67	18.00	18.36
2	· Price escalation	14.67	16.00	17.33	18.00	16.50
3	· Changes in scope of work/Clients new requirement	14.26	14.00	16.00	14.00	14.56
4	· Exchange rate fluctuation	13.04	13.00	15.89	15.75	14.42
5	· Delayed Completion	12.44	12.00	12.00	13.50	12.49
6	· Dislocation of existing utilities	10.67	11.69	12.44	11.25	11.51
7	· Evacuation & resettlement of communities, houses & bldg.	10.80	11.00	11.56	11.25	11.15
8	· Incomplete or poor specifications	8.80	9.38	9.78	8.75	9.18
9	· Geological & Geotechnical	8.52	8.13	9.78	8.75	8.79
10	· Delayed payment certification & Disbursement	8.52	8.13	9.78	8.75	8.79

11	· Inadequate geological, geotechnical/hydrological/ hydraulic study	8.69	8.75	8.89	8.75	8.77
12	· Delayed freight transport	8.23	8.89	8.89	8.75	8.69
13	· Funding risk	8.30	7.88	8.56	8.75	8.37
14	· Inappropriate contract award process	8.80	8.13	7.78	8.75	8.36
15	· Unidentified utilities	7.99	8.13	8.89	7.50	8.13
16	· Hydrological, Hydraulic & Sub-surface	8.23	7.50	8.00	7.50	7.81
17	· Differing site condition	6.75	7.31	8.89	7.50	7.61
18	· Unclear scope of work & Inaccurate assumptions on technical issues	7.67	6.88	8.00	7.50	7.51
19	· Access road/ Detour facilitation	7.88	6.75	7.78	7.50	7.48
20	· Emphasis on meeting schedules & increased production volume (tight schedule)	7.67	6.88	7.11	7.50	7.29
21	· Completion with performance deficiency	7.33	7.56	6.22	6.25	6.84
22	· Lack of coordination/ communication	6.80	6.50	6.67	7.00	6.74
23	· Non-completion	6.91	6.75	6.22	6.75	6.66
24	· Inadequate project planning	5.68	7.31	6.22	6.00	6.30
25	· Liquidated, consequential, and Punitive damages clauses	6.71	5.50	7.00	6.00	6.30
26	· Integration problem	6.00	5.50	6.00	6.00	5.88
27	· Lengthy project development period (change in site conditions due to late bidding)	5.68	5.63	5.44	5.00	5.44
28	· Lack of Knowledge, skill & qualification	5.70	5.00	4.67	6.25	5.41
29	· Incomplete/inaccurate quantity& Cost estimate	6.09	5.25	4.89	5.25	5.37
30	· Ambiguities in contract.	5.86	5.06	5.33	5.00	5.32
31	· Traffic management	5.01	4.50	5.56	4.50	4.89
32	· Delayed fabrication, test, training	4.89	5.00	4.67	5.00	4.89
33	· Inefficient project delivery system	5.33	5.50	3.56	5.00	4.85

34	· Insolvency/Bankruptcy of participants	5.14	5.00	4.00	4.00	4.53
35	· Incomplete/inadequate survey data	5.44	4.00	4.00	4.00	4.36
36	· Demurrage cost	5.04	4.44	3.56	3.75	4.20
37	· Inefficient dispute resolution procedures	3.53	3.75	3.11	3.75	3.54
38	· Design not up to standards (nonconformance to codes and standards)	3.95	3.00	2.67	4.00	3.40
39	· Lack of experience of the design team	3.41	3.13	2.67	3.75	3.24
40	· Lack of motivation & inspiration	3.21	2.67	2.67	3.00	2.89
41	· Labor shortage or strike	2.94	2.25	3.33	3.00	2.88
42	· Improper, non-tested technology	2.96	2.50	2.00	3.00	2.62
43	· Outdated technology	2.96	2.50	2.00	2.00	2.37

Table 4.16Ranking of Risk Factors on Cost of the project.

From the result we can scrutinize that, out of the identified 43 risk factors from Literature Review 5factors (12%) were rated as high, 3 factors (7%) categorized under Medium, majority of the factors 22 (51%) lie in the Low severity range and the rest 13 (30%) factor was highlighted as having no significance on the cost of the project.

As we can see from the table 4.16 above Completion with Cost overrun, price escalation, Changes in Scope of work/ Clients new requirement, and delayed completion has high cost related impact on railway projects in Ethiopia with EPC contract delivery system. Thus, Market Risk and Design Risk has higher cost impact in railway project, which is the same as what was inferred from literature review; however, unlike the literature review Construction Risk has cost impact on Railway projects with EPC Contract delivery system in Ethiopia.

Moreover, ROW risks: Failure of the employer to give land acquisition free from ROW obstruction and dislocation of existing utility infrastructure, Financial Risk; Delayed Payment, and Custom Clearance Risk: Delayed Freight Transport has cost impact on

Railway projects in Ethiopia succeeding to the above risks: Market risk, Design Risk & Construction Risk respectively.

Spearman's Rank Correlation

In this section respondents' response were tested for the agreement or disagreement among each pair of respondent groups using Spearman rank correlation coefficients.

Spearman's rho Correlations for Rank of Risk factors on Cost

			CMS_{Cost} Employer	CMS_{Cost} Employer Representative	CMS_{Cost} Contractor	CMS_{Cost} Skilled Professionals
Spearman's rho	CMS_{Cost} Employer	Correlation Coefficient	1.000	.968**	.960**	.982**
		Sig. (2-tailed)		.000	.000	.000
		N	43	43	43	43
	CMS_{Cost} Employer Representative	Correlation Coefficient	.968**	1.000	.964**	.970**
		Sig. (2-tailed)	.000		.000	.000
		N	43	43	43	43
	CMS_{Cost} Contractor	Correlation Coefficient	.960**	.964**	1.000	.971**
		Sig. (2-tailed)	.000	.000		.000
		N	43	43	43	43
	CMS_{Cost} Skilled Professionals	Correlation Coefficient	.982**	.970**	.971**	1.000
		Sig. (2-tailed)	.000	.000	.000	
		N	43	43	43	43

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

Table 4.17 Spearman's rho correlation for Rank of Risk Factors on Cost.

Thus, we can infer that there is a very good agreement between four groups of respondents in ranking these challenge impacts. The highest degree of agreement 98.2% correlation is between Employer and Skilled Professionals and lowest degree of 96.0% between Employer and Contractor.

4.3.2.2. Time Impact of Risk Factors

Table 4.17 below demonstrates the Mean Score (MS) of respondents' responses on Time Impact of risk factors in the three Railway Projects in Ethiopia with EPC contract delivery system, which this thesis studies. The table reveals the mean scores (MS) of the four groups of respondents, Employers, Employer's Representative, Contractors and Skilled professionals in the sector for each risk variables.

Rank	Source of Risk	MS of Impact on Time Employer	MS of Impact on Time Employer Representative	MS of Impact on Time Contractor	MS of Impact on Time Skilled Professionals	Weighted Average of Time Impact
1	· Non-completion	4.67	4.50	4.67	4.50	4.58
2	· Delayed Completion	4.56	4.50	4.67	4.50	4.56
3	· Inadequate project planning	4.44	4.50	4.67	4.50	4.53
4	· Insolvency/Bankruptcy of participants	4.44	4.50	4.33	4.50	4.44
5	· Changes in scope of work/Clients new requirement	4.22	4.00	4.33	4.00	4.14
6	· Funding risk	4.11	4.00	4.00	4.00	4.03
7	· Evacuation & resettlement of communities, houses & bldg.	4.00	4.00	4.00	4.00	4.00
8	· Dislocation of existing utilities	4.00	4.00	4.00	4.00	4.00
9	· Inefficient project delivery system	3.67	3.75	3.67	3.50	3.65
10	· Unclear scope of work & Inaccurate assumptions on technical issues	3.56	3.50	3.67	3.50	3.56
11	· Delayed freight transport	3.44	3.33	3.67	3.50	3.49
12	· Price escalation	3.56	3.50	3.33	3.50	3.47
13	· Inappropriate contract award process	3.44	3.50	3.33	3.50	3.44
14	· Exchange rate fluctuation	3.22	3.00	3.00	3.00	3.06
15	· Delayed fabrication, test, training	3.11	3.00	3.00	3.00	3.03
16	· Lack of coordination/ communication	3.00	3.00	3.00	3.00	3.00
17	· Integration problem	3.00	3.00	3.00	3.00	3.00
18	· Access road/ Detour facilitation	3.00	3.00	2.67	3.00	2.92
19	· Completion with performance deficiency	2.89	2.75	2.67	3.00	2.83
20	· Lack of Knowledge, skill & qualification	2.56	2.50	2.67	2.50	2.56
21	· Incomplete or poor specifications	2.56	2.50	2.67	2.50	2.56

22	· Delayed payment certification & Disbursement	2.56	2.50	2.67	2.50	2.56
23	· Inadequate geological, geotechnical/hydrological/ hydraulic study	2.44	2.50	2.67	2.50	2.53
24	· Lack of experience of the design team	2.56	2.50	2.33	2.50	2.47
25	· Incomplete/inaccurate quantity& Cost estimate	2.44	2.50	2.33	2.50	2.44
26	· Geological & Geotechnical	2.44	2.50	2.33	2.50	2.44
27	· Emphasis on meeting schedules & increased production volume (tight schedule)	2.44	2.50	2.33	2.50	2.44
28	· Ambiguities in contract.	2.44	2.50	2.33	2.50	2.44
29	· Hydrological, Hydraulic & Sub-surface	2.33	2.50	2.33	2.50	2.42
30	· Lengthy project development period (change in site conditions due to late bidding)	2.44	2.25	2.33	2.50	2.38
31	· Unidentified utilities	2.11	2.25	2.33	2.00	2.17
32	· Demurrage cost	2.33	2.33	2.00	2.00	2.17
33	· Traffic management	2.00	2.25	2.33	2.00	2.15
34	· Differing site condition	2.11	2.00	2.33	2.00	2.11
35	· Completion with cost overrun	2.00	2.00	2.33	2.00	2.08
36	· Lack of motivation & inspiration	2.00	1.75	2.00	2.00	1.94
37	· Labor shortage or strike	1.89	1.75	1.67	1.50	1.70
38	· Inefficient dispute resolution procedures	1.56	1.50	1.67	1.50	1.56
39	· Incomplete/inadequate survey data	1.56	1.50	1.33	1.50	1.47
40	· Design not up to standards (nonconformance to codes and standards)	1.22	1.25	1.33	1.00	1.20
41	· Liquidated, consequential, and Punitive damages clauses	1.11	1.25	1.33	1.00	1.17
42	· Outdated technology	1.22	1.25	1.00	1.00	1.12
43	· Improper, non-tested technology	1.11	1.25	1.00	1.00	1.09

Table 4.18 Impact of Risk Factors on Time of the project.

Moreover, using equation eq.4 the Cumulative Mean Score of Time (CMS_{Time}) were calculated for each respondent group in combination with the Time Impact of Risk Factor and Mean Score (MS) of Probability of Occurrence of Risk Factors. Accordingly, using the ranking Grid shown above in figure 4.1 the overall ranking of the risk factors on Time of the project were ranked as shown in the table 4.19 below.

Rank	Source of Risk	CMS_{Time} Employer	CMS_{Time} Employer Representative	CMS_{Time} Contractor	CMS_{Time} Skilled Professionals	Weighted Average of CMS_{Time}
1	· Delayed Completion	18.22	18.00	18.67	20.25	18.78
2	· Dislocation of existing utilities	16.00	17.00	18.67	18.00	17.42
3	· Evacuation & resettlement of communities, houses & bldg.	15.56	16.00	17.33	18.00	16.72
4	· Changes in scope of work/Clients new requirement	15.48	14.00	17.33	14.00	15.20
5	· Price escalation	13.04	14.00	14.44	15.75	14.31
6	· Inadequate project planning	11.36	14.63	12.44	13.50	12.98
7	· Exchange rate fluctuation	11.81	12.00	13.00	13.50	12.58
8	· Delayed freight transport	11.10	11.11	12.22	12.25	11.67
9	· Unclear scope of work & Inaccurate assumptions on technical issues	10.67	8.75	11.00	10.50	10.23
10	· Lack of coordination/ communication	9.67	9.75	10.00	10.50	9.98
11	· Funding risk	9.59	9.00	9.33	10.00	9.48
12	· Incomplete or poor specifications	8.80	9.38	9.78	8.75	9.18
13	· Access road/ Detour facilitation	9.67	9.00	8.89	9.00	9.14
14	· Integration problem	9.00	8.25	9.00	9.00	8.81
15	· Delayed payment certification & Disbursement	8.52	8.13	9.78	8.75	8.79
16	· Inadequate geological, geotechnical/hydrological/ hydraulic study	8.69	8.75	8.89	8.75	8.77
17	· Inappropriate contract award process	8.80	8.75	7.78	8.75	8.52
18	· Completion with cost overrun	8.25	8.00	9.33	8.00	8.40
19	· Geological & Geotechnical	8.15	8.13	8.56	8.75	8.39
20	· Delayed fabrication, test, training	7.60	7.50	7.00	7.50	7.40
21	· Hydrological, Hydraulic & Sub-surface	7.52	7.50	7.00	7.50	7.38
22	· Completion with performance deficiency	7.94	7.56	6.22	7.50	7.31
23	· Emphasis on meeting schedules & increased production volume (tight schedule)	7.33	6.88	6.22	7.50	6.98
24	· Unidentified utilities	6.60	7.31	7.78	6.00	6.92
25	· Non-completion	7.26	6.75	6.22	6.75	6.75
26	· Traffic management	6.44	6.75	7.78	6.00	6.74
27	· Inefficient project delivery system	7.33	7.50	4.89	7.00	6.68
28	· Differing site condition	6.33	6.50	7.78	6.00	6.65

29	• Ambiguities in contract.	6.79	5.63	6.22	6.25	6.22
30	• Lengthy project development period (change in site conditions due to late bidding)	6.25	5.63	5.44	6.25	5.89
31	• Lack of Knowledge, skill & qualification	6.25	5.00	5.33	6.25	5.71
32	• Insolvency/Bankruptcy of participants	5.56	5.63	4.33	4.50	5.00
33	• Lack of motivation & inspiration	4.44	3.50	4.00	4.00	3.99
34	• Incomplete/inaccurate quantity& Cost estimate	4.62	3.75	3.11	3.75	3.81
35	• Inefficient dispute resolution procedures	3.80	3.75	3.89	3.75	3.80
36	• Demurrage cost	4.41	3.89	2.67	3.00	3.49
37	• Liquidated, consequential, and Punitive damages clauses	3.19	3.44	4.00	3.00	3.41
38	• Lack of experience of the design team	3.41	3.13	2.33	3.75	3.15
39	• Labor shortage or strike	3.57	2.63	3.33	3.00	3.13
40	• Incomplete/inadequate survey data	3.63	3.00	2.67	3.00	3.07
41	• Design not up to standards (nonconformance to codes and standards)	2.17	1.88	1.78	2.00	1.96
42	• Improper, non-tested technology	1.48	1.56	1.00	1.50	1.39
43	• Outdated technology	1.63	1.56	1.00	1.00	1.30

Table 4.19 Ranking of Risk Factors on Time of the project.

Out of the total identified 43 risk factors from Literature Review 7factors (16%) were rated as high, 6 factors (14%) categorized under Medium, 11 factors (44%) lie in the Low severity range and the rest 11 (26%) factor was highlighted as having no significance on the Time of the project.

As can be inferred from the table 4.19 above delayed Completion, Failure of the employer to give land acquisition free from ROW obstruction and dislocation of existing utility infrastructure, Changes in Scope of work/ Clients new requirement has high Time related impact on railway projects in Ethiopia with EPC contract delivery system. Thus, ROW risks, Construction Risk and Design Risk has higher cost impact in railway project, similar with what was stated in literature review.

Moreover, Planning Risk; Inadequate project planning & Emphasis on meeting schedules & increased production volume (tight schedule), Project Management Risk: Lack of coordination/ communication, Market risks: Price escalation, Financial Risk; Funding risk, and Custom Clearance Risk: Delayed Freight Transport has Time impact on Railway projects in Ethiopia next to the above risks with highest Time impact.

Spearman's Rank Correlation

One of the purposes of this thesis is to investigate whether there is agreement or not on the attitudes of stakeholders towards the ranking of Risk Factors of EPC contract delivery system in railway Projects. Hence in this section respondents' response were tested for correlation using Spearman rank correlation coefficients, to see if there is difference in ranking between two groups of respondents; these are Employer versus Employer's Representative, Employer versus Contractors, Employer versus Skilled Professionals, Employer's Representative versus Contractors, Employer's Representative versus Skilled Professionals, and Skilled Professionals versus Contractors on the Time Impacts of Risk Factors and their probability of occurrence.

Spearman's rho Correlations for Ranking of Risk factors on Time

			CMS_{Time} Employer	CMS_{Time} Employer Representative	CMS_{Time} Contractor	CMS_{Time} Skilled Professionals
Spearman's rho	CMS_{Time} Employer	Correlation Coefficient	1.000	.988**	.962**	.992**
		Sig. (2-tailed)		.000	.000	.000
		N	43	43	43	43
	CMS_{Time} Employer Representative	Correlation Coefficient	.988**	1.000	.961**	.980**
		Sig. (2-tailed)	.000		.000	.000
		N	43	43	43	43
	CMS_{Time} Contractor	Correlation Coefficient	.962**	.961**	1.000	.956**
		Sig. (2-tailed)	.000	.000		.000
		N	43	43	43	43
	CMS_{Time} Skilled Professionals	Correlation Coefficient	.992**	.980**	.956**	1.000
		Sig. (2-tailed)	.000	.000	.000	
		N	43	43	43	43

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

Table 4.20 Spearman's rho correlation for Rank of Risk Factors on Time.

From the above Table 4.20, we can conclude that there is strong correlation between the attitudes of the respondents in all of the four groups. This means that most of the respondents have the same perception on Ranking of Risk Factors. Thus, we can decide that there is a very good agreement between four groups of respondents in ranking of Risk Factors with respect to their impact on time of the project with the least significant level of 95.6% and the highest degree of agreement 99.2% between Contractor & Skilled Professionals and Employer &Skilled Professionals respectively.

4.3.2.3. Quality Impact of Risk Factors

The Mean Score (MS) of Quality impact of Risk factors for each respondent groups and their weighted average is shown in the Table 4.21 below. The table reveals the mean scores (MS) of the response of four groups of respondents Employers, Employer's Representatives, Contractors and Skilled professionals in the sector on Quality Impact of risk factors in the three Railway Projects in Ethiopia with EPC contract delivery system, which this thesis studies each risk variables.

Rank	Source of Risk	MS of Impact on Quality Employer	MS of Impact on Quality Employer Representative	MS of Impact on Quality Contractor	MS of Impact on Quality Skilled Professionals	Weighted Average of Quality Impact
1	· Completion with performance deficiency	4.25	4.00	4.33	4.00	4.15
2	· Design not up to standards (nonconformance to codes and standards)	4.00	4.00	4.33	4.00	4.08
3	· Improper, non-tested technology	3.89	4.00	4.00	4.00	3.97
4	· Outdated technology	3.56	4.00	4.00	4.00	3.89
5	· Lack of Knowledge, skill & qualification	3.78	3.75	4.00	4.00	3.88
6	· Incomplete or poor specifications	3.67	3.50	3.67	3.50	3.58
7	· Unclear scope of work & Inaccurate assumptions on technical issues	3.56	3.75	3.33	3.50	3.53
8	· Lack of experience of the design team	3.44	3.50	3.67	3.50	3.53
9	· Changes in scope of work/Clients new requirement	3.44	3.50	3.67	3.50	3.53
10	· Inadequate geological, geotechnical/hydrological/ hydraulic study	3.33	3.50	3.67	3.50	3.50
11	· Geological & Geotechnical	3.56	3.50	3.33	3.50	3.47
12	· Inefficient project delivery system	3.11	3.25	4.00	3.50	3.47
13	· Hydrological, Hydraulic & Sub-surface	3.44	3.50	3.33	3.50	3.44
14	· Inappropriate contract award process	3.11	3.00	3.33	3.00	3.11
15	· Non-completion	2.56	2.50	2.67	2.50	2.56
16	· Price escalation	2.78	2.50	2.33	2.50	2.53
17	· Incomplete/inadequate survey data	2.44	2.50	2.67	2.50	2.53
18	· Lack of coordination/ communication	2.67	2.50	2.33	2.50	2.50

19	· Exchange rate fluctuation	2.67	2.50	2.33	2.50	2.50
20	· Funding risk	2.50	2.50	2.33	2.50	2.46
21	· Insolvency/Bankruptcy of participants	2.44	2.25	2.33	2.50	2.38
22	· Delayed fabrication, test, training	2.33	2.25	2.33	2.50	2.35
23	· Emphasis on meeting schedules & increased production volume (tight schedule)	2.22	2.25	2.00	2.00	2.12
24	· Integration problem	2.13	2.25	2.00	2.00	2.09
25	· Inadequate project planning	2.00	2.00	2.33	2.00	2.08
26	· Unidentified utilities	2.00	2.00	2.00	2.00	2.00
27	· Ambiguities in contract.	1.89	2.25	1.67	2.00	1.95
28	· Delayed payment certification & Disbursement	2.00	2.00	1.67	2.00	1.92
29	· Labor shortage or strike	1.89	2.00	1.67	2.00	1.89
30	· Demurrage cost	1.56	1.67	1.67	1.50	1.60
31	· Lack of motivation & inspiration	1.44	1.50	1.67	1.50	1.53
32	· Incomplete/inaccurate quantity& Cost estimate	1.44	1.50	1.67	1.50	1.53
33	· Dislocation of existing utilities	1.67	1.50	1.33	1.50	1.50
34	· Differing site condition	1.56	1.50	1.33	1.50	1.47
35	· Delayed Completion	1.56	1.50	1.33	1.50	1.47
36	· Access road/ Detour facilitation	1.44	1.50	1.33	1.50	1.44
37	· Completion with cost overrun	1.33	1.50	1.33	1.50	1.42
38	· Evacuation & resettlement of communities, houses & bldg.	1.33	1.25	1.00	1.00	1.15
39	· Traffic management	1.11	1.25	1.00	1.00	1.09
40	· Delayed freight transport	1.11	1.00	1.00	1.00	1.03
41	· Liquidated, consequential, and Punitive damages clauses	1.00	1.00	1.00	1.00	1.00
42	· Lengthy project development period (change in site conditions due to late bidding)	1.00	1.00	1.00	1.00	1.00
43	· Inefficient dispute resolution procedures	1.00	1.00	1.00	1.00	1.00

Table 4.21 Impact of Risk Factors on Quality.

Equation eq.5 was used for the calculation of Cumulative Mean Score of Quality ($CMS_{Quality}$) for each respondent group in combination of the Mean Score (MS) of Quality Impact of Risk Factor and Mean Score (MS) of Probability of Occurrence of Risk Factors. Consequently, using the ranking Grid shown in figure 4.1 above the overall ranking of the risk factors on Quality of the project were ranked as shown in the table 4.22 below.

Rank	Source of Risk	$CMS_{Quality}$ Employer	$CMS_{Quality}$ Employer Representative	$CMS_{Quality}$ Contractor	$CMS_{Quality}$ Skilled Professionals	Weighted Average of $CMS_{Quality}$
1	· Changes in scope of work/Clients new requirement	12.63	12.25	14.67	12.25	12.95
2	· Incomplete or poor specifications	12.63	13.13	13.44	12.25	12.86
3	· Inadequate geological, geotechnical/hydrological/ hydraulic study	11.85	12.25	12.22	12.25	12.14
4	· Geological & Geotechnical	11.85	11.38	12.22	12.25	11.92
5	· Completion with performance deficiency	11.69	11.00	10.11	10.00	10.70
6	· Hydrological, Hydraulic & Sub-surface	11.10	10.50	10.00	10.50	10.52
7	· Price escalation	10.19	10.00	10.11	11.25	10.39
8	· Exchange rate fluctuation	9.78	10.00	10.11	11.25	10.28
9	· Unclear scope of work & Inaccurate assumptions on technical issues	10.67	9.38	10.00	10.50	10.14
10	· Lack of Knowledge, skill & qualification	9.23	7.50	8.00	10.00	8.68
11	· Lack of coordination/ communication	8.59	8.13	7.78	8.75	8.31
12	· Inappropriate contract award process	7.95	7.50	7.78	7.50	7.68
13	· Design not up to standards (nonconformance to codes and standards)	7.11	6.00	5.78	8.00	6.72
14	· Delayed payment certification & Disbursement	6.67	6.50	6.11	7.00	6.57
15	· Dislocation of existing utilities	6.67	6.38	6.22	6.75	6.50
16	· Unidentified utilities	6.25	6.50	6.67	6.00	6.35
17	· Inefficient project delivery system	6.22	6.50	5.33	7.00	6.26
18	· Integration problem	6.38	6.19	6.00	6.00	6.14
19	· Delayed Completion	6.22	6.00	5.33	6.75	6.08
20	· Emphasis on meeting schedules & increased production volume (tight schedule)	6.67	6.19	5.33	6.00	6.05
21	· Inadequate project planning	5.11	6.50	6.22	6.00	5.96
22	· Funding risk	5.83	5.63	5.44	6.25	5.79
23	· Delayed fabrication, test, training	5.70	5.63	5.44	6.25	5.76
24	· Completion with cost overrun	5.50	6.00	5.33	6.00	5.71
25	· Incomplete/inadequate survey data	5.70	5.00	5.33	5.00	5.26
26	· Improper, non-tested technology	5.19	5.00	4.00	6.00	5.05
27	· Ambiguities in contract.	5.25	5.06	4.44	5.00	4.94
28	· Evacuation & resettlement of	5.19	5.00	4.33	4.50	4.75

	communities, houses & bldg.					
29	· Differing site condition	4.67	4.88	4.44	4.50	4.62
30	· Access road/ Detour facilitation	4.65	4.50	4.44	4.50	4.52
31	· Lack of experience of the design team	4.59	4.38	3.67	5.25	4.47
32	· Outdated technology	4.74	5.00	4.00	4.00	4.44
33	· Non-completion	3.98	3.75	3.56	3.75	3.76
34	· Labor shortage or strike	3.57	3.00	3.33	4.00	3.48
35	· Delayed freight transport	3.58	3.33	3.33	3.50	3.44
36	· Traffic management	3.58	3.75	3.33	3.00	3.42
37	· Lack of motivation & inspiration	3.21	3.00	3.33	3.00	3.14
38	· Liquidated, consequential, and Punitive damages clauses	2.88	2.75	3.00	3.00	2.91
39	· Insolvency/Bankruptcy of participants	3.06	2.81	2.33	2.50	2.68
40	· Demurrage cost	2.94	2.78	2.22	2.25	2.55
41	· Lengthy project development period (change in site conditions due to late bidding)	2.56	2.50	2.33	2.50	2.47
42	· Inefficient dispute resolution procedures	2.44	2.50	2.33	2.50	2.44
43	· Incomplete/inaccurate quantity& Cost estimate	2.73	2.25	2.22	2.25	2.36

Table 4.22 Ranking of Risk Factors on Quality of the project.

7% of Risk factors derived from intensive literature review, which are 3 in number, found to be ranked as High, Out of the total identified 43 risk factors 6factors (14%) were rated as Medium, 17 factors (40%) categorized under Medium and the rest 17 (40%) factor was highlighted as having no significance on the Quality of the project.

As can be scrutinized from the table 4.22 above Changes in scope of work/Clients new requirement, Incomplete or poor specifications, inadequate geological, geotechnical, hydrological/ hydraulic study has the Highest Impact on the Quality of projects. Hence, Design risk is the major Risk factor with highest impact on the Quality of projects.

Additionally, Underground Risk; Geological & Geotechnical, Hydrological, Hydraulic & Sub-surface, Construction Risk; Completion with performance deficiency, Project Management Risk: Lack of coordination/ communication, Market risks: Price escalation, and Financial Risk; funding risk has Moderate Quality impact on Railway projects in Ethiopia next to the above risks with highest Quality impact.

Spearman's Rank Correlation

One of the specific objectives of this research is to investigate agreements of project participants on ranking of the risk factors. The rank of risk factors based on cumulative value for their occurrences and impacts on Quality as identified by each party are listed in Table 4.12& 4.21 respectively. The ranking based on the cumulative mean score weighted average (illustrated above in table 4.22) cannot indicate the agreement in perception of the parties on risk factors; rather it indicates the overall ranking by all parties. Therefore, the agreement in ranking of the factors between respondents in each category: these are Employer, Employer's Representative, Contractors, and Skilled Professionals need to be tested.

A significance association between the sets of ranks from calculated Spearman's rank correlation coefficients (r_s) is assessed, in order to see whether there is agreement between two groups of respondents in ranking the factors; the level of significance 95% ($\rho = 0.05$) is used. This allows verifying whether there is "agreement" between respondents' response.

Spearman's rho Correlations for Rank of Risk factors on Quality						
			$CMS_{Quality}$ Employer	$CMS_{Quality}$ Employer Representative	$CMS_{Quality}$ Contractor	$CMS_{Quality}$ Skilled Professionals
Spearman's rho	$CMS_{Quality}$ Employer	Correlation Coefficient	1.000	.972**	.966**	.969**
		Sig. (2-tailed)		.000	.000	.000
		N	43	43	43	43
	$CMS_{Quality}$ Employer Representative	Correlation Coefficient	.972**	1.000	.979**	.961**
		Sig. (2-tailed)	.000		.000	.000
		N	43	43	43	43
	$CMS_{Quality}$ Contractor	Correlation Coefficient	.966**	.979**	1.000	.960**
		Sig. (2-tailed)	.000	.000		.000
		N	43	43	43	43
	$CMS_{Quality}$ Skilled Professionals	Correlation Coefficient	.969**	.961**	.960**	1.000
		Sig. (2-tailed)	.000	.000	.000	
		N	43	43	43	43
**. Correlation is significant at the 0.01 level (2-tailed).						

Table 4.23 Spearman's rho correlation for Rank of Risk Factors on Quality.

The least significant level is 96.0% between Contractor & Skilled Professionals, which satisfies the required least significant level (95%); thus, we can clinch that there is a very good agreement between four groups of respondents in ranking of Risk Factors with respect to impact on Quality of the project.

4.4. Challenges& Risk of EPC Contract Delivery System for Railway projects from Interview Analysis

I. Challenge variables of EPC Contract delivery system in railway projects

First the respondents were asked to describe the sources of challenge/problems observed in railway projects so far that has impact in cost, time, quality & risk?

According to the Employer and Employer representative response, the contractors' perspective were not included since they were not willing for an interview due to the reason described on section 4.1.3 of this thesis, the main challenge observed in railway projects with EPC contractor with regards to cost, time, quality & risk include:-

i. Lack of end user/Employers' involvement in due course of the design and project execution even if mistakes during construction & quality problems were observed before the handing of the project.
ii. Additions and/or enhancement required by Employer due to Insufficiently defined conceptual design and Front End Engineering Design (FEED),
iii. No final detail design drawing available before construction which leads to failure of stakeholders to identify problems & timely draw appropriate mitigation measures,
iv. Delay on land acquisition/ hand over free of ROW obstruction,
v. Lack of coordination between Employer & other infrastructure authorities for the integration of existing & future utility infrastructures,
vi. No standard specification for railway construction applicable for our country's scenario: the adopted specification is Chinese standard; thus, design review & approval and follow-up of construction procedure of the project made impossible task due to language barrier and inexperience of employer and Employer's representative in using the specification so far.
vii. Insufficient geotechnical, hydrologic/hydraulic investigation prior to commencement of construction,

viii. Contractor's aim to minimize cost by optimizing quality, optimizing aesthetics or robust finishing material, and design that satisfy the minimum requirement,

ix. Ambiguities or discrepancies of documents,

From the above challenges identified in the interview session challenges itemized in ii, iv, v, vi, vii, ix has cost related impact on the projects. Accordingly item ii, iv, v, vi, vii, ix highly affects the time of the projects. Moreover, challenges stated in i, ii, iii, vi, vii, viii, ix negatively affects the required quality of the project works.

II. Risk factors in railway projects & Method Management Used

The respondents were given 12 risk factors derived from intensive literature in the questionnaire survey. However, in the interview session the respondents are free to describe any risk factors, they consider as source of risk, and categorized them accordingly in the analysis. Moreover, even though the respondents requested to include method of management used to deal with the risk factors, most of the respondents have not included method of managements used. Thus, supplementing the questionnaire survey with interview was coherent method to identify risk treatment method used.

From the feedback gathered from interview the major risk variables encountered are:-

- ROW Risk:

  All the Seven respondents (100% of the respondents) respond delay on land hand over, Lack of the coordination of Employer with Public sector development organizations (Regional government office, City & Sub-city Administration, Land management & administration bodies, Road authorities, service providers (water supply, utility lines Electric & telecom)) to evacuate & resettle communities & houses and dislocate and/or integrate utility lines to make clear ROW (right of way) free from obstruction and hand over has very frequent probability of occurrence in all Railway projects undertaken; this risk factor has high cost and time impact with low quality on the projects.

Method of measure used to manage ROW risk is maintaining good communication with government authorities and close follow up from higher government officials to integrate different public sectors.

- Construction Risk:

  86% of the respondents (6 in number) highlights delayed completion & completion with cost overrun has high probability of occurrence with high impact on cost and time of the project. Four respondents Out of the seven indicated that construction risk has Moderate impact on Quality.

  Risk Sharing through Insurance coverage, performance guarantee coverage & guarantee for advance payment and close follow up of the project by employer is used as Method of measure used to manage construction risks. Moreover, quality control plan, quality assurance manual & environmental mitigation plan is included as contract document to inspect the quality and performance of the project.

- Design Risk:

  All seven respondents describe Changes in scope of work/Clients new requirement& variation orders has higher probability of occurrence with extremely high Impact on Cost & time with moderate to high impact on quality of project.

  Five respondents out of seven (70% of the respondents) identify Incomplete specification has moderate probability of occurrence with average outcome on cost and time of the project and moderate to high impact in quality.

  Five respondents Out of the seven indicated that even though Design not up to standards, unclear scope of work & inaccurate assumptions on technical issues occasionally occurs, it has High impact on Quality.

- Financial Risk

  Except delayed payment other financial risks: funding risk & Insolvency/ Bankruptcy of participants has rare probability of occurrence. However, due to insufficient number of experienced personnel in Employer's & Employers' representative in some projects to manage and approve interim payment certificates of a project, delayed payment has moderate probability of occurrence. Most respondents replied that even though financial risk doesn't occur so far in the project its impact on cost and time, if it happens, is extremely higher.

- Planning Risk

  Inadequate project planning has moderate probability of occurrence with high-extreme impact on project time. However, moderate impact on cost and low to moderate impact on quality.

  Procurement risk: inappropriate contract award process & inefficient project delivery system has low to moderate probability of occurrence. These have moderate to high outcome on project cost, time and quality.

- Custom Clearance Risk:

  Six respondents out of seven (86% of the respondents) indicates Delayed Freight transport has moderate probability of occurrence & Demurrage cost has rare occurrence. The two factors have lower cost & quality outcome but delayed freight transport has moderate to high time impact in the progress of the project.

  The Employer has taken risk mitigation method to deal with demurrage cost by allowing the EPC contractor to import construction items in duty-free. Besides, the employer works closely with Ethiopian Revenue & customs authority to minimize delay in customs clearance and quick delivery at ports.

- Market Risk

  Six respondents' highlights Price escalation &Exchange rate fluctuation has high probability of occurrence with high impact on cost, Moderate to high time impact and low quality impact on the projects.

  Risks Sharing through Price escalation provision for selected major construction items such as rail, cement, rebar and Diesel is used as Method of measure for market risks.

4.5. Case Study of Selected Railway Projects

4.5.1. Addis Ababa Light Rail Project

4.5.1.1. Project Overview

The Government of the Federal Republic of Ethiopia (FDRE) has unleashed the economy by issuing a free market policy in 1992. Following the economic liberation policy, the government has earmarked a huge proportion of the national budget towards improving the infrastructure network of the country. A World Bank financed transport study of Addis Ababa in 2005 identified the East-West and North-South corridors as most appropriate for public mass transport services. It also indicated that choices of different public mass transport system (PMTS) technologies are available. Any decision will depend on a number of parameters such as cost (initial and lifecycle); capacity; reliability; safety; environmental impact, etc. [29]

In line with the study findings and indications, the Ministry of Transport and Communications (MoTaC) of the Federal Democratic Republic of Ethiopia set up a steering committee in early 2007. The duty of the steering committee is to render advisory services to MoTaC in its bid for selecting and implementing the most appropriate PMTS. After hearing expert opinions and deliberating over a number of discussions, PMTS accepted that a Light Rail Transit (LRT) System for the East-West and North-South routes was the most appropriate from the perspectives of capacity, lifecycle cost, environmental friendliness, safety, comfort, attractiveness, accessibility to the physically challenged and to help to resolve the ever increasing transport demand of Addis Ababa.

As a first step towards implementation, the Addis Ababa City Roads Authority (AACRA) was given the task of preparing a Request for Proposals (RFP) for the detailed study of the East-West and North-South corridors. Accordingly, AACRA opened LRT project desk and prepared a RFP for each corridor. The terms of reference (TOR) prepared by AACRA require an integrated road and LRT study for both corridors. RFP prepared by AACRA was sent to pre-selected consulting firms in January 2008. It was later perceived by the government of Ethiopia that the conventional design-bid-build approach will take

considerable time until the project gets completed. This perception has led to changing the project implementation strategy from the conventional approach to a new approach through an EPC Turnkey contract.

Following the strategy shift from the conventional design-bid-build to EPC Turnkey contracting strategy, the government has established Ethiopian Railway Corporation (ERC) on November 28th 2007 GC by Regulation Number 141/2007 of the Council of Ministers of FDRE and transferred the Addis Ababa LRT project to the Ethiopian Railways Corporation (ERC). In early April 2008, ERC prepared EPC Turnkey tender document to pre-selected contractors and contractor-consultant consortiums including those invited by AACRA. Some three tenderers returned proposals. From these two of them did not comply with the tender requirements which led to the rejection of their proposals. The remaining one tenderer quoted a price too high to bear. Subsequently, the tender was rejected and a new line of implementation is underway.

Soon after the rejection of the EPC Turnkey Tender, ERC has set up a pool of in-house professionals assisted by foreign expatriates for the preparation of bankable feasibility report.

The Addis Ababa E-W & N-S (phase I) Light Rail Transit Project, with Total length of 34.25 km (North-South line 16.9 km & East-West line 17.35 km with 2.7 Km common track)was awarded to China Railway Group Limited (CREC) by the Ethiopian Railway Corporation with the total project cost of USD 475,000,000 (Four hundred seventy five million USD) of which the 85% of the cost will be funded by the Export Import Bank of China (EXIM Bank) of China and the 15% will be in Ethiopian Birr to be paid as down payment. The contract agreement was signed on 3rd of September 2009.The turnkey project has a completion time of 3 years (1095 calendar days), having commencement date of January 31st 2012 and a completion date of January 30th 2015, and defects liability period of one year. Basic Contract data is shown in the table below:-

Project Name	EPC/Turnkey Contract for Addis Ababa E-W & N-S (Phase I) Light Rail Transit Project.
Employer	Ethiopian Railway Corporation
Contractor	CHINA RAILWAY GROUP LIMITED (CREC).
Employer's Representative	Swedish National Road Consulting AB(SweRoad) in Association with Hifab International
Date of Contract Signature for the main Contract	September 3rd 2009
Contract Funded by	The Federal Government of Ethiopia. Through Loan and own budget.
Contract No.	ET/ERC/CREC/0901
Currencies and proportion of payment	85% USD and 15% ETB
Commencement Date of Works Contract	January 31st 2012 as per the Notice to Commence issued by the Employer.
Type of Contract	EPC Turnkey project
Original Contract Price	The contract price is 475,000,000.00 USD from the contract price, 85% amounting to USD 403,750,000 is secured from the EXPORT IMPORT BANK OF CHINA through the Preferential Buyer's Credit and 15% amounting to USD 71,250,000 as Employer's contribution which shall be payable in ETB as down payment with exchange rate applicable to the base date.
Contract Base date	June 3, 2009
Performance Guarantee Amount	10% of the Contract Amount.
Expiry Date of the Performance Guarantee	-
Contract Completion Time	36 months (1095 calendar days)
Original Completion date	30/01/2015 as per addendum No. 2 dated 14th October 2010.
Contract Railway Length	31.743 km(17.4km EW and 16.9km NS /2.627Km shared section/)
Amount of Liquidated Damage	0.05% of the contract price as delay damages in respect of the whole of the works or any section thereof, payable (per calendar day) in the proportions of currencies in which the contract price is payable.
Limit of Liquidated Damage	10 (ten) per cent of the contract price stated in the Contract Agreement.

Defects Notification Period	The Defects Notification Period shall be for duration of 365 Calendar days, subject to any Extension of time in the Contract.
Date of site Handover	January 31st 2012
Retention Money	5(five) per cent of Interim Payment Certificate, up to a maximum of 5(five) percent of the contract price less Provisional Sums. Retention money may be replaced by unconditional Bank guarantee
Maximum Amount of Advance Payment	15% of Contract Price in ETB plus 10% of contract price in USD up on receiving an equivalent Bank Guarantee.
Expiry Date of Advance Guarantee	-
Start and complete Repayment of Advance Payment	Repayments shall commence no later than when 30% of the total value of Works valued in accordance with Sub– Clause 14.3 or sub clause 14.4 as applicable; and repayments shall be complete no later than when 80% of the total value of Works.
Settlement of Disputes	The Appointing Authority shall be: Singapore International Arbitration Centre

Supervision Contract detail

Supervision is Funded by	Government of Ethiopia (Ethiopian Railway Corporation).
Employer's Representative	Swedish National Road Consulting AB (SweRoad) in Association with Hifab International
Date Agreement Signed	May 23rd 2012
Commencement date	June 6th 2012
Original Contract Price for the Construction Supervision Phase)	USD 4,246,974 and ETB 25,600,000.00

4.5.1.2. Challenges Encountered

- **No Design Standard**

Since there was no design standard for railway works in Ethiopia the contract forced to adopt China design Standard as specified in the particular condition of the contract clause 5.4 "Technical standards and regulations", which states "*Generally, the project shall be designed, constructed and tested by the relevant codes and standards of the People's Republic of China*." Besides, the Chines standard adopted is not fully applicable for Light Rails. Moreover, even though has per particular condition of Contract Clause 1.4 the language of the Contract is English, the design standard adopted was in Chines language. Thus, the Employer and Employer's representatives review and approval of any design document and construction procedure of the project made impossible task to approve payment certificates of the constructed work as per the contract and standard since it could only be accomplished based on the standards the EPC contractor submitted.

As a result, the Contractor provides particular standards in line with the design drawing that satisfies the minimum requirement and the designer's or the Contractor's interest not the Best interest of the Employer.

To illustrate this, the Employer's representative has requested the contractor to conduct California Bearing Ratio (CBR) & Atterberg limits for borrow materials; however, the contractor conduct only grain size analysis, proctor density (compaction) and moisture content tests and said that the tests carried out on the borrow materials are according to the Chinese standard for railway projects and. This will contradict with the internationally accepted material quality verification test from Geotechnical Knowledge. Thus, it's too difficult to prove the quality of the works such that difficult to prove the ground has sufficient bearing capacity.

- **Incomplete or Insufficient Employer's requirement**

The employer's requirement, that is supposed to be reviewed and finalized before the commencement of the project, it takes too long for more than 13 months that counts from commencement date of the project, January 31, 2012 GC, to the finalization of Employer's requirement made as part of the contract document, March 21st 2013 GC. *during the process* This was mainly due to the fact that as it was agreed by the Employer & the contractor in the contract negotiation meeting held in China Railway Group limited office from August 27th 2009 GC to September 1st 2009 GC and the minute made part of the contract document, in section 7 of the minute of meeting the contractor has requested more time to read the Employer's Requirement Document in detail. The Employer and Contractor after discussion agreed that the Contractor to Review, Comment and come up with justifications and recommendations for any rectification before the Commencement Date. If the Contractor does not react accordingly, the Employer's Requirement document is deemed accepted. However, after so many communications and discussion the contractor forwarded his recommendations and justification on November 16th, 2012 GC with letter Ref. No. ET/ERC/LRT/2012-260. The Employer's Representative has reviewed the original Employer's requirement along with the Contractor's recommendation and have found acceptable and need to be revise the Employer's requirement. After the tripartite meeting between Employer, Employer Representative and the contractor the Employer's requirement has been revised and finalized, so that the document be signed and made part of the contract documents on March 21st, 2013 GC. As a result of the late revision of the Employer's requirement, The Contractor however is insisting in retaining his comments and changes made instead of comments forwarded prior to the approval of Revised Employer's requirement to adhere to the original requirements. Consequently, the following variations and time delays has been encountered on the progress of the project.

- ✓ The employer (ERC) has instructed the contractor final recommendation of Junction location St. Urael Church, St. Sealite-Mehiret Church, Last Roundabout, Anwar Mosque Junction, Autobes-Tera Junction &Gotera Interchange (Both ends of the

Interchange); from which Anwar Mosque Junction & Autobes-Tera Junction were not included in the Conceptual Design. Thus, the Contractor has forwarded a Cost Breakdown Proposal of **27,243,188.50** USD variation & Time Extension, quoting clause 13 & 8.4 respectively, for the extension of Overpass Bridge #1(Anwar Mosque), Additional new Bridge#1 & Station(at Autobes-Tera). The Contractor further requested a Supplementary agreement as a pre-condition to implement changes.

However, the Employer & Employer's Representative responded stating that the total number of elevated stations of the LRT proposed in the Conceptual Design and the actually designed proposed to be constructed by the Contractor are found the same (9) and contractual, as stated in the Conceptual Design Chapter1 "General Conditions" and Sub-chapter 1.4.3 "Route", which states "As the topographical documents are not complete, plan and profile design could not be very integrated. In the next phase, a better route scheme will be made, including the setting of underground line, ground line, and elevated line, on the basis of detailed topographic data…." Consequently, the Route should conform to the requirements of Master Plan of the City. Further, ERC strongly instructed CREC to precede the construction without delay and according to updated/adjusted Addis Ababa City Master Plan. Thus, reject the forwarded time extension and additional cost.

- ✓ On the contrary, ERC (the Employer) have requested for credit due to the omitted tunnel. As per the conceptual design the Contractor has proposed 900m long tunnel with approximately 2.5m cover at Gottera Interchange with Underground station; however, the scope of placement of the actual LRT with ERC confirmation is 922m at grade and two crossing bridges with total length of 699m. Accordingly, the Employer with letter Ref. No. LRT/BO125/13 requested credit of **10,946,735.30** USD to the replaced tunnel by bridge No.5 and No.6, but the contractor castoff the credit requested by letter Ref.No. ET/SR/LRT/2013-029 with detail cost breakdown that shows the elevated proposal cost will result in an increment of 7,220,681.00USD. Therefore neither credit request nor cost claim were substantiated.

As a result of insufficiently defined conceptual design and Front End Engineering Design (FEED) by the owner leads to change orders, cost overruns, unnecessary delay in the project and it becomes a cause for conflict.

- **Incomplete & Late revision of Master work Schedule**

As stipulated in the contract, the Contractor is required to submit the Master Schedule of the project within 28 days after commencement of work. Though the Commencement date of the project is January 31st, 2012 GC, the Contractor was able to submit this schedule lately only on July 2012 GC. The major shortcomings of the Contractor's Master Work Schedule submitted master schedule include total absence of Construction Work Methodology, no submission of BOQ, absence of estimated volumes of works and a forecast of cash flow, lack of information with regard to deployment of resources such as equipment and manpower for each individual activities and sub activities. Thus, Employer and Employer's Representative could not follow up & monitor the progress of the project.

After inclusion of some requirements such as Construction Method statements for ditch work, subgrade works, underground & manual digging holes and still lacking information on work volume, equipment allocation and forecasted cash flow, with the comment from the Employer's representative, Master Work Schedule has been signed by the three parties on November27th, 2012 GC.

The Contractor has presented a revised work schedule in line with AACRA's road construction plan and as per the Employer's instruction to catch up with the delay the Revised Master Work Schedule has been signed by the three parties on April 16th, 2013 GC.

As indicated in all Employer's Representative monthly progress reports starting from August 2012 GC, late enclosure of some requirements, none inclusion of some relevant requirements and information on the revised master schedules, failure of the contractor

for revision of the Master schedule on time hampers the exact evaluation of project progress by the Employer's representative. Thus, it was difficult to track where, why and by whom delay occurs in the project progress.

- **Failure of Employer to give land acquisition free ROW**

As per Sub Clause 2.1 of the General Conditions of the Contract, the Employer shall give the Contractor right of access to and possession of all the site parts of the project, within the time (or conditions) stated in the Particular Conditions. The right and possession may not be exclusive to the Contractor. If, under the Contract, the Employer is required to give (to the Contractor) possession of any foundation, structure, plant or means of access, the Employer shall do so in the time and manner stated in the Employer's Requirements. However, the Employer may withhold any such right or possession until the Performance Security has been received.

Sub Clause 2.1 of the Particular Condition of the contract also states that "The Employer is responsible for clearing and exploration cost of any utilities (underground, above ground or at the surface) and buildings within the Right of Way. The time for access to the site can be as per the Contractor's Work Schedule and stage by stage."

Though, the Particular Conditions of the Contract presume submittal of Contractor's Work Schedule for handing over of sites from time to time, As stated above the original master schedule with relevant land use schedule which was signed between the three parties that is contractor (CREC), Employer Representative (SWE Road) and Employer (ERC) on November 27th, 2012 GC was revised on April 16th, 2013 GC.

The Contractor has forwarded his "Time Extension & Financial Consequences" proposal with letter Ref.No. ET/ERC/LRT /2013-276 dated June 18th 2013 GC including damage breakdowns for the land hand over delay in regard to the Schedule signed on November 27th, 2012. The Time extension and financial amount claimed was 184 days and 3,502,619.9 USD, respectively. Consequently, the Employer's Representative responded for non-acceptance of the contractor's claim with letter Ref.No. LRT /BO160/13 dated

July 2nd, 2013 GC that the land use schedule dated November 2012 GC, attached in the original Master Schedule cannot be ground for any claim, as it was updated in April 2013 GC with newly submitted land use schedule of the same Project Completion Time (Jan. 2015).

The contractor with his many repetitive letters has notified the Employer that he has not received land as per the agreed schedule. He has also requested to handover the site by clearing all obstructions that can affect the construction progress, such as: Water pipe at E-W line, houses at Entrance/Exit of Elevated Stations of EW15,EW17, EW20, NS21, NS22, NS27, culvert, Bridges & underpass works by AACRA, Overhead power cable of EEPCO.

But even with the updated schedule the owner unable to handover the land use with their mileage the main causes for delay of land acquisition was delay of work such as underpass and overpass with ACCRA, delay on relocation water main lines, pipes and culverts, delay on relocation of utility lines, delay on land handover of Kality depot due to vehicles not being removed, based on this issues of claims initiated by the contractor has forwarded his claim report on the prolonged Total Working duration, due to Employer's (ERC's) delayed handing over ROW, external Power Supply integration & Newly added Works. With his letter Ref.No. ET/ERC/LRT /2014-689 dated December 15th, 2014 GC the contractor has stated Clause 1.13, Clause 2.1, Clause 8.4 and Clause 20 for substantiation of his claim request for a total of 137 days Contract time Extension. The Employer Representative's evaluation analysis on the actual Work volume that had been affected by the claimed delay has forwarded a letter of recommendation to the Employer with Ref.No. LRT /BO1190/15 dated January 13th, 2015, that grants 120 Calendar days as an aggregate Time Extension for EPC/Turnkey Contractor. Even though, the Employer Representative evaluate 120 days the Employer extend the Project completion period only by 60 Calendar days beyond January 31st, 2015 which yields the new set completion date of April 2nd, 2015 GC with letter Ref. No. 2.14/1279/15/2015 dated January 30th, 2015 GC.

Further the Employer on his letter to The Employer's representative with Ref. No. dated has approved the Employer Representative's previous 120 calendar day time Extension. Instructed to issue to the EPC Contractor to extend the Project completion period by 60 Calendar days (beyond April 2nd, 2015 GC) and that the Project Completion Date shall be May 30th, 2015.

- **Failure of Employer to Coordinate utility infrastructure authorities**

➢ Prior to the completion of sub-grade work of the LRT and re-work of sub-grade has to be avoided by starting the implementation of required location of Utility lines. As the three of the Utility Companies (AAWSA, EEPCO & Telecom) has submitted their design in October, 2012 GC, Accordingly, the final list of chainage and types of the Standard Utility Crossings under LRT of future use, agreed by contractor (CREC), Employer (ERC) and other respective Utility Companies on January 16th, 2013 GC. Moreover, Referring to the previous correspondences, Employer's representative (SweRoad) forwarded an instruction of installation with attachment of additional Sewer Line from AAWSA, at East of CMC Roundabout and also a requirement of EEPCO's PVC pipe upgrade from 110mm to 160mm dated April 12th, 2013 GC. After so many modifications on location of utility & discussions the Employer's representative (SweRoad) forwarded with letter Ref.No. LRT/BO159/13 dated June 28th, 2013 GC to the contractor (CREC), an attachment of the final list of chainage and types of the Standard Utility Crossings under LRT of future use, agreed by CREC, ERC and other respective Utility Companies. Even though, the contractor (CREC) forwarded the design for Standard Utility Crossings under LRT, along with a work quantity and design plan for Employer's approval with letter Ref.No. ET/ERC/LRT/2013-313 dated July 08th, 2013 GC, The Employer's Representative responded officially with Ref.No. LRT/BO176/13 dated July 13th 2013 GC that the Contractor has to submit cost break down of the required Utility Crossings for Material & labor costs in local currency (ETB) along with relevant Bill of Quantities for the work to be performed. Accordingly, the contractor has forwarded an amount of **65,569,597** ETB for the construction of newly added work for the future standard

utility crossing. However, the Employer and Employer representative estimates the newly added work only cost **38,122,674** ETB and no final cost amount agreed by the two parties yet.

Thus the process of coordination of utility authority takes too long time thus the progress of the project was affected and incurs additional cost.

- Permanent External power Integration work is executed by Ethiopian Electric Power (EEP). EEP has been executing Addis Ababa LRT GIS Substation Project consists of design, manufacture, test, supply, erection and commissioning (including civil works) of 230/15 kV Torhayloch GIS Substation, 132/15 kV Minilik GIS substation, 132/15 kV Kaliti GIS substation, 132/15 kV Ayat GIS substation&15 kV AIS Substations at AA-LRT Corridors. However, EPC Contractor has instructed by the Employer's representative to execute new Additional trench work for external power cable with work order issued by Ref. No. LRT/BO 1443/15 Ref. No. LRT/BO 1447/15 dated May 06th,2015 GC. Thus the Contractor has requested an extension of Time referring clause 8.4which amounts 1month for Ground section and 2month for Elevated section trench works.

- **Variation Orders by the Employer request**
  - Employer (ERC) had sent an instruction letter to Contractor (CREC) regarding the final recommendation on the critical Pending Junctions with their mileage, based on their meeting held on July 14th, 2012 GC. The Junctions at Anwar Mosque Junction (for the extension of Overpass Bridge #1) and Autobes-Tera Junction (Additional new Bridge #1 & Station) were Variation Orders. Since those junctions were not included in the conceptual design of the project, the employer instructed the contractor for those variation orders to comply with the new master plan and to avoid the traffic conflict and congestion respectively. Thus, the Contractor has forwarded a 27,243,188.50 USD cost Breakdown Proposal quoting clause 13 & Time Extension referring clause 8.4 of the Special provision the contract document and requested for supplementary agreement. However, the cost and associated time extension claims were rejected by the Employer referring that the total number of

elevated stations of the LRT proposed in the Conceptual Design and the actually designed proposed to be constructed by the Contractor are found the same (9) and referring chapter 1 &sub-chapter 1.4.3 of the conceptual design as discussed above in detail.

- With work order issued by Employer's representative letter Ref. No. LRT/BO 1443/15 and Ref. No. LRT/BO 1447/15 dated May 06th, 2015 GC the contractor were instructed an additional variation work of new Additional trench work for external power cable for Permanent External power Integration work. Based on the unit price set in the Employer's letter Ref. No. 2.17/1548/2014 the Contractor has submitted its quotation which amounts 50 million ETB and construction scheme through letter Ref. No. ET/ERC/LRT/2014-527. Furthermore, the Contractor has requested an extension of Time referring clause 8.4 which amounts 1month for Ground section and 2month for Elevated section additional trench works.
- Attaching the basic requirements of Automatic Train Protection System (ATP) and scope of work for ATP, The Employer's Representative (SweRoad) forwarded a recommendation to be evaluated and clarified by the Contractor (CREC) with letter Ref.No. LRT/BO170/13 dated July 15th, 2013 GC. Hence, The Contractor, CREC, replied with his letter Ref.No. ET/ERC/LRT/2013-360 dated August 7th, 2013 that the addition of this system may result in an increment of 50,000,000 USD & 6 months' time extension. After so many negotiations and correspondences the contractor, CREC, resubmitted his revised Cost Breakdown with letter Ref.No.ET/ERC/LRT/2014-262 dated May 20th, 2014 GC, indicating the total cost to be 36,000,011.38 USD, and 4 additional month extension of time as his final quotation and requested the approval of same and signing of the new contract for the newly added IATP system. However, the Employer's Representative forwarded to Employer, ERC, of his points of discussion on negotiation of cost reduction and recommends a total amount to be **19,052,000.00** USD for the newly added Intermittent Automatic Train Protection System (IATP).

- As per the Conceptual design for N-S & E-W line of LRT chapter 15, the ticketing system combined method of fare collection and manual fare collection is planned. In section 15.1.1 & 15.2.1 of the chapter "Principles for Design" & "Ticket Mode and Operation Management Mode" specifies The fare collection depends on onboard card readers and hand-held onboard card readers. Thus, the contractor claims 3month extension of time for the delay on the approval of onboard ticketing system, for the shipment & installation. However, the Employer's Representative not accepted the claim for the on-board ticketing system referring previous repetitive instructions to change the On-Board Ticket system by Off-Board Ticketing system with letter Ref.No. LRT/BOT1440/15 and LRT/BOT1488/15 dated April 30th, 2015 GC and May 21st, 2015 GC respectively. Thus, due to the variation/additional work the contractor requested with letter Ref.No. ET/ERC/LRT/ 2015-240 dated May 29th, 2015 GC an additional 8 month extension of time for the provision of off-Board ticketing system. Hence, the Employer's representative with letter Ref.No. LRT/BO1515/15 dated June 2nd, 2015 GC has granted 126 days considering short term plan that includes time required to build Ticket office & start paper ticket sell right away. But long term ticketing plan to completely networked to Addis Ababa LRT system might take a minimum of 4 month beyond the short term ticketing plan.

- **Insufficient Geological Investigation**

On late December 2013, after a year from commencement date, after permanent construction for the Bridge has been started underground Sewage pipe line of AACRA, at Bridge # 5 N-S (YCK12+284), existing river (continuous & 29.36+26+24m) at Bridge # 4 N-S (YCK9+644) has been detected and the contractor requested the employer to relocate the same, unless relocate by himself and request for cost and extension of time as per Sub-clause 1.13, 2.1 & 20 of the Contract. Hence, the contractor forwards their claim with their letter Ref.No. ET/ERC/LRT /2013-249 consisted of cost breakdown attachment, which added up a total amount of **153,255.00**USD payments. However, the employer has refused and replied that, the contractor's lack of proper Geotechnical

investigation prior to the start of permanent work and this sewage line relocation claims were rejected on the two locations.

Moreover, the contractor informed the employer of his observation of underground Sewage culvert, but it was clarified as water line, with sectional size of 1.8mX2.4m in a stretch YDK9+209-YDK9+554(about 393m) of Bridge #2 (E-W line, Meskel Square). Requested the employer to remove or relocate the same, which otherwise shall be relocated by CREC and expense incurred being paid by the employer. Furthermore, the contractor with his letter Ref.No. ET/ERC/LRT/2014-060 dated January 24th, 2014GC has requested a total amount of **27,332.00** USD for the demolition and relocation at Station YDK17+915 - YDK18+165 and YDK5+867 of North-South line.

Nevertheless, the employer replied that, it's contractor's failure of detection of existing utilities during survey & design stage and inform the employer will not accept to pay any cost due to lack of thorough Geological investigation, as required by the EPC Contract.

- **Insufficient Hydrological and Hydraulic design & poor construction**

As per the finding on "Addis Ababa LRT Flood Incident Investigation Report and Mitigation Options", the new LRT drainage system is poor which conveys runoff from the LRT ballast surface into the AACRA road storm drainage system was also blocked by debris. It was also noted that the position of the weep hole which is designed to drain the ballast is not up to the international standard which contributed to the flooding of the track. [44]

Dr. Manaye on his report identified critical flood prone areas along the LRT route and their main cause: the design philosophy of the Contractor is to discharge the runoff from the LRT ballast surface into the existing AACRA storm drainage system. Thus, it is strongly recommended that the capacity of the exiting road storm drainage systems to be checked supported by hydrological and hydraulic modeling to ensure that enough storage is available to accept additional flows from the LRT network. The location of

outfall structures should also be assessed to make sure that no backwater effect is created at the outfall during flooding. However, no detail hydrologic and hydraulic analysis conducted and it's observed that the Road drainage system has capacity problems (under designed storm drainage systems). The pipes that are used to carry floodwaters along roads do not have the capacity for the quantity of water they carry. Some roads have also have design problems (size and location). [44]

Therefore, the newly constructed have flooding problem such as in the LRT line at Station 21+892 (Meri Area), 20+000 (CMC Roundabout), 19+200 (Ayma International Hotel opposite to the CMC compound), 18+400 (civil service college), 17+100 (Sehalite Mihiret church Roundabout), 16+700 (Gurd Shola),and Gotera Interchange and around global hotel. The current drainage design arrangement is to construct a ramp between the road and the LRT network above the observed flood level. However, this design arrangement will cause the water to pond on the road surface and cause traffic disruption which is not acceptable for rail user. [44]

For site observation on January 30th, 2015 GC at the tunnel section of N-S LRT section and from the captured picture and shown below it's observed that there is heavy seepage and water flow inside to the tunnel section. This leakage risk has happened due to poor material quality, method of construction & workmanship from the Contractor. This problem were minted and discussed in meeting No.22 dated February 1st, 2013 GC by the three parties, Employer, Employer's Representative and Contractor, prior to the construction of tunnel wall but not substantial action had been taken. Thus, due to poor workmanship & insufficient hydrologic design by the designer, not in the best interest of the owner aim in designing to the minimum requirement to reduce cost on the contractor, the project suffer significant quality challenges.

Fig.4.2 Water Flow inside the Tunnel of Addis Ababa LRT before remedial measure taken

- **No Integrated Master project schedule that results from pulling together the work activities from multiple contractors**

➢ In the EW line of LRT project at chainage YCK14+500 (Megenagna) Junction the underpass work shall be constructed by AACRA contractor in priority of the construction of LRT works. Due to delay of AACRA contractor the land acquisition free from ROW was delayed, such that the progress of the project has been hindered.

In addition, due to delayed construction of culvert by AACRA contractor on the EW line at station YDK13+045 & YDK14+030 the Right of Access to site as per Clause 2.1 of the Particular condition of the contract. Moreover, the Bridge work executed by AACRA Contractor on NS line at Station NS YDK11+380 affect the EPC contractor's overhead network installation and cause unnecessary delay on the contractor's progress.

AACRA is carrying out the construction of roads at junctions, such as, Lideta, Mexico, Urael, Hayahulet and Megenagna Junctions through Contractors. The construction of these roads is slow and the LRT Contractor has not possessed section of these areas and handover the site timely. Following this, the LRT Contractor (CREC) vides his letter Ref. No. ET/ERC/LRT/2014-018dated January 06th, 2014 GC has submitted his intent to claim on delay for land use hand over in the above mentioned sites as per the previously agreed land handing over schedule.

➢ Due to the delay of the construction Awash bank, which LRT's EW20 overpass bridge at Lideta is connected, the EPC contractor cannot carry out Elevator & Escalator works.

➢ Due to the delayed permanent External Power Integration work by Ethiopian Electric Power (EEP) the joint commissioning and single system testing of all the systems delayed. The contractor declares, delayed permanent External Power Integration work is the major problem encountered in the finishing phase of the project, that joint commissioning and single system testing of all equipment and rolling stock necessitate the availability of permanent external power supply which is severely retarded and restrict the realization of total project schedule.

4.5.2. Ethio- Djibouti Rail Project 1st Bid Lot (Sebeta-Meiso)

4.5.2.1. Project Overview

The Technical Advisory Group set up in early 2007 by Ministry of Transport and Communications (MoTaC) of the Federal Democratic Republic of Ethiopia. The duty of the Technical Advisory Group is to render advisory services to MoTaC in its bid for selecting and implementing the most appropriate different public mass transport system (PMTS) technologies.

The Technical Advisory Group explicitly justified introduction of railway system across Ethiopia as primary national mass transport system on following grounds: Geographical necessities, Alternative means of transport, output in transportation system, Operating Costs, Saving in travel Time, Employment generation, Increase in demand, Social benefits. As a result, the Technical Advisory Group has identified 14 railway projects in three groups, from those identified railway projects the Existing Addis Ababa – DireDawa-Djibouti link is considered to be the first priority as it has already developed huge corridor traffic and hence is not included in the analysis. Hence, Addis-Ababa-Djibouti project is included in the 1st phase 1st route of National Railway Network of Ethiopia. [45]

The Addis-Ababa-Djibouti project (Addis Ababa-Mojo-Awash-Dire Dawa-Dewele-Djibouti railway project) has a total length of 752.25 Km from Sebeta to Negad. The project has two EPC contract bid lot. From this the 1st bid lot is Sebeta- Meiso project with total length of 329.145km from which Sebeta- Adama is double truck section with a length of 115Km, while Adama-Meiso is single truck with a length of 214.145km.

The 1st bid lot project was awarded to China Railway Group Limited (CREC) by the Ethiopian Railway Corporation with the total project cost of USD 1.841 Billion of which the 85% of the cost will be funded by the Export Import Bank of China (EXIM Bank) of China and the 15% will be in Ethiopian Birr to be paid as down payment. The turnkey project has a completion time of 42months and one year of defects liability period.

4.5.2.2. Challenges Encountered

- **Incomplete or Insufficient Employer's requirement**

In the EPC contract there is only 7crossings and under clause 24 of Minute of Meeting on EPC Contract negotiation other places other than the 7 un-level crossings as set out in the contract shall be level-crossing; however, the actual required crossings are 10. Thus, the contractor (CREC) has justified the issue to the Employer (ERC) in the meeting held from September 25th 2009 GC to September 27th 2009 GC and the Employer has agreed the un-level crossing for 10 crossings at DK3+053.4, DK12+115, DK13+133, D1K40+566, D1K53+428, DK99+650, D1K126+895, D1K154+268, D1K163+958.75 & DK325+575. In addition, the Employer (ERC) with letter Ref.No. 2.17/1192/13 instructed to increase pedestrian passageways, which are beyond the EPC contract of scenery 7 un-level crossing. Accordingly, the contractor (CREC) has requested for price coat for the additional work; however, the Employer has not negotiated the price issue yet that the contractor has claim for the affected execution of the project.

The Employer with letter Ref.No. 2.2/1281/2014 dated August 27th, 2014 GC with the subject "final locations of traction substations" explicitly instructed to change the location of Mojo traction substation that was not included in the original contract document and the primary power supply voltage of Sebeta Traction Substation is 230KV; however, the primary power supply set out in the contractor's (CREC's) final evaluation report is 132KV, it has constituted change order to design. This change order teat varies from the original Employer's front end engineering design/ conceptual design leads to claim for change order by the contractor.

- **Variation Orders by the Employer request**

- The employer requires and instructed the Contractor to change Meiso station building to two-floor station building; therefore, the contractor (CREC) submits additional cost and extension of time for the newly instructed variation works. In addition, put precondition that the construction will start after getting the written approval of the Employer for the cost and time.
- The employer (ERC) instruct the contractor (CREC) with letter Ref. No. 2.17/359/15/2014 for the construction of Detour roads at DK154 & DK163 that is not included in the contract. Thus, the contractor has completed the construction of the detours and requests an amount of USD 316,258 additional cost. Moreover, upon the employers instruction temporary passage way at DK154+200, where a road diversion will be built upon completion of tract laying, Permanent diversion set to other locations at DK163+958.75 and DK93+660.37 as per the employers request Ref.No. 2.17/2362/14. Though the contractor requests additional cost for those additional orders the parties doesn't agree the specific amount yet.
- The employer (ERC) requested the Contractor (CREC) to build and furnish laboratory around Contractor's (CREC's) Lebu Camp. This instruction considered as additional variation work by the two parties.
- The contractor claims the Employer for the variation of location of Metehara Traction substation, in the same manner as Mojo Traction Substation,with letter Ref.No. ET/ERC/NR/20114-925 dated October 06th, 2014 GC.

- **No final standard prior to the commencement of the project**

The employer requested CIECC to evaluate the standard of the project. In accordance with CIECC Final evaluation report submitted by the Employer (ERC) to the Contractor (CREC) in the end of 2012 GC, thus, some technical standards and construction scale were changed accordingly. Therefore, the contractor had to revise all of the working drawings completed and approved by September 2012 GC and the design for station were suspended. The revision of the under-the-track working drawings was finalized on the

end of March 2013 GC. Thus, it jeopardized the progress of the project particularly on under-the-track works on bridges, culverts, and Frame Bridges.

- **Failure of Employer to give land acquisition free ROW**

As per Sub Clause 2.1 of the FIDIC General Conditions of the Contract for EPC contract, the Employer shall give the Contractor right of access to and possession of all the site parts of the project, within the time (or conditions) stated in the Particular Conditions. The right and possession may not be exclusive to the Contractor. If, under the Contract, the Employer is required to give (to the Contractor) possession of any foundation, structure, plant or means of access, the Employer shall do so in the time and manner stated in the Employer's Requirements.

Sub Clause 2.1 of the Particular Condition of the contract also states that "The Employer is responsible for clearing and expropriation cost of any utilities (underground, above ground or at the surface) and buildings within the Right of Way. The time for access to the site can be as per the Contractor's Work Schedule and stage by stage."

In Ethiopian context, as per Article 40.3 of the Constitution of FDRE and The land proclamation 31/1975 of rural land and 47/1975 of urban land state that land is the common property of the state/ public and cannot be subjected to sale or other means of exchange. Moreover, ownership of land vested in the state and the people dwellers have only have use rights over land. [46] Article 44.2 of the constitution also indicate that interventions of public good that cause displacement of people or adversely affect the livelihood of the local population shall give right to commensurate monetary or other means of compensation including relocation (resettlement) with adequate state assistance. Article 7(72) of proclamation 4/1975 states that the Government shall pay fair compensation for property found on the land. [46, 47, 48, 49]

However, as per proclamation No. 55/1993 article 5.2 (k) states that government project shall use, free of charge, land and such other resources and quarry substances for the purpose of construction of highway/railway, camp, storage of equipment and other

required services, provided, however, that it shall pay compensation in accordance with law for properties on the land it uses. [50]

Accordingly, the railway project is government financed and owned project; thus, it's supposed the employer (ERC) to compensate only the property on the land not for the land itself. Therefore, the compensation amount is not so much expensive. However, the land acquisition task takes too long by the owner that leads time extension and associated cost compensation on the projects.

Hence, the contractor claims for extension of time with his letter Ref.No. ET/ERC/NR/2013-735 dated October 11th, 2013 GC for late granting of Right of Access to Site by the Employer.

- **Delayed Payment**

From the beginning of the project the major cause of claim by the contractor in the project is delayed payment. Contractor's request for delayed payment claim begins on August 23rd, 2012 GC with letter Ref.No. ET/ERC/NR/2012-167 for the delayed 2nd advance payment in this claim the contractor claims for extension time and additional payment. In addition withlettersRef.No.ET/ERC/NR/2013-733 dated October 11th, 2013 GC,ET/ERC/NR/2013-760 dated November 20th, 2013 GC and ET/ERC/NR/2013-868 dated May 29th, 2014 GC the contractor claims for extension of time and additional cost due delay in the 2nd installment of Advance payment,

As a result of delayed payment the contractor has forwarded many notices of claims. Accordingly, with contractors' letter Ref. No. ET/ERC/NR/2013-647 dated June 14th, 2013 GC for delayed IPC#1, letters Ref.No. ET/ERC/NR/2013-662 & ET/ERC/NR/2013-733 dated June 27th, 2013 GC for delayed IPC#4the contractor has forwarded notice of claims.

The contractor has submitted claim substantiation for delayed payment from IPC#1 to IPC#5 with letter Ref.No. ET/ERC/NR/2013-761 dated November 20th, 2013 GC, for delayed payment IPC#6 with letter Ref.No. ET/ERC/NR/2013-784 dated December 27th, 2013 GC.

- **Inappropriate method of Construction & Inappropriate material used**

The contractor has utilized inappropriate material for sub-grade and embankment construction. As described in "Sebeta-Adama-Meiso Railways Project Site Visit Report and Recommended Mitigation Works" report prepared by Design Review Steering committee of ERC, there are a lot of quality problems need site investigation and mitigation measures.

From the stated problems, inappropriate filling material such as River stones, Over-sized particles, Volcanic ashes, Fine/sediment/ materials are used (as subgrade material). The material utilized didn't fulfill the standard requirement of the project; besides, as per Chinese Class II Railway Standard, the maximum particle size should not be greater than 150mm for Group A and 200mm for Group B and C the fill material used is more than the requirement.[51]

But As per chine's class II Railway Standard, volcanic ashes are grouped as "D" which is inappropriate to use it as filling material without physical or chemical improvement. However, the EPC contractor has not blended with materials having cohesive property and utilized the parent volcanic ash material as filling material. [51]

The contractor failed to maintain the minimum layer thickness, Optimum moisture content & type of machinery required for compaction; thus, it is impossible to get the required strength by compaction. [51]

- **Insufficient Hydrological and Hydraulic design & poor construction**

There are no drainage ditches & berms provided in some locations with high embankment depth; even the provided ditch has dimensional errors as compared to the standard requirement and poor construction quality.

From the observation of Design Review Steering committee all the natural channels have been relocated in order to shorten the length of the culvert crossing the railway alignment such as at Station DK38+540, D1K+430- D1K+540,D1K30+752, D1K9+503-

DK10+700, which is not recommended where severe or abrupt changes in channel alignment are required upstream or downstream of the culvert. Culverts are usually constricting the natural channel and increase the flow velocity over that in the natural watercourse. Except when the culverts flow full, the highest velocity occurs near the outlet and this is the point where most erosion damage is likely to occur. Most of Upstream of the culverts in the project, as a result of the acceleration of the flow, as it leaves the natural channel and enters the culvert. If the flow emerging from a culvert has a sufficiently high velocity and the channel is erodible, the jet will scour a hole in the bed immediately downstream and back eddies will erode the stream banks to form a circular elongated scour hole. [51]

They also investigate that a standard culvert design (slab culvert) approach has been adopted by the contractor for all sites culvert required sections without undertaking detail site investigation to determine the location, alignment, size and foundation type. The culverts at Station D1K46+600,D1K 55+000,DK130+050, culvert at GPS location of E: 0536351 N:0948011&E: 0538143N: 0949142 are incorrectly oriented and the culvert invert level is buried below the natural ground. Culvert Inlet and out let structure at Station D1K44+620, D1K71+282,D1K106+365,D1K105+914-942 & at DK99+760 are very narrow and constrictive to flow. Likewise, Culvert at D1K50+860,DK123+100 &DK91+530is buried deep into the ground compared to the surrounding ground levels. [51]

Most outlet structures were damaged due to insufficient hydraulic and hydrological design such as at Station Culverts at D1K104+560, D1K104+993, D1K105+690.

Fig 4.3 Damaged outlet structure

Fig 4.4 incorrectly oriented Culvert Structure

Fig 4.5 buried culvert invert level deep into the ground compared to the surrounding ground levels.

The above 3 Photos taken from Sebeta-Adama-Meiso Railways Project Site Visit Report and Recommended Mitigation Works [51]

Moreover, Structure at GPS location of E: 0509135 N: 0960121 is partially submerged by water and it is not properly oriented and The Bridge at GPS location coordinate of E: 0508793N: 0960639 has wrong direction of orientation.[51]Accordingly, most of drainage structures are failing prematurely before they start the required operation. [51]

- **Insufficient Geotechnical Investigation**

The EPC contractor failed to undertake detail geotechnical investigation for structures. The Design Review Steering committee in site investigation report explores some locations with geotechnical problems. Foundation of Culvert at Station D1K 11+005 is black cotton soil and the ground is prone to erosion. Erosion protection measures should be provided both at upstream and downstream section of the structure. The inlet and outlet work construction method is poor and must be revised.

4.5.3. Ethio- Djibouti Rail Project 2nd Bid Lot (Mieso-Dawanle)

4.5.3.1. Project Overview

The First Phase-first route identified by Technical Advisory Group set by Ministry of Transport and Communications (MoTaC) of the Federal Democratic Republic of Ethiopia was Addis Ababa – DireDawa-Djibouti link. The second Lot of this route is from Mieso – Dawanle Railway Project. The line starts from the end of Mieso sections, heading to the east, via Mulu, Afdem, Bike,Gota, Erer, and Hurso, to Dire-Dawa and turns to the north before reaching Arawa, runs from Adigala, to Lasarat, Aysha, Dawanle and the border between Ethiopia and Djibouti, with a total length of about 339.1 Km.

The 2nd bid lot of Ethio-Djibouti project was awarded to China Civil Engineering Construction Corporation (CCECC) by the Ethiopian Railway Corporation with the total project cost of USD 1.1974 Billion of which the 77.69% of the cost will be funded by the Export Import Bank of China (EXIM Bank) of China and the rest 22.31% will be in Ethiopian Birr to be paid as down payment. The contract agreement was signed on16th of December 2011. The turnkey project has a completion time of 42 months plus 10 month grace period, having commencement date of April 12th, 2012 GC and defects liability period of one year.

4.5.3.2. Challenges Encountered

- **Incomplete or Insufficient Employer's requirement**

The EPC Contractor (CCECC)with letter Ref.No. CCECC.MDRP-DD-2015-013 dated February26th, 2015GC has requested Clarification about the external power supply configuration and system integration. Such that, not clearly specified in the Conceptual design by the Employer (ERC).

In addition, the EPC Contractor (CCECC)has forwarded his letter with Ref.No. CCECC.MDRP-DD-2015-070 dated June 13th, 2015 GC regarding the design scheme of the traction substation, it is suggested that a discussion meeting about the external power supply for the traction substation.

Moreover, the Contractor (CCECC)has forward his request for clarification and suggestion to be made on passenger and freight electronic ticketing system with Ref.No. CCECC.MDRP-DD-2015-072 dated June 9th, 2015GC. Insufficiently defined employer's Requirement on the issues of ticketing system is the major problems encountered by of all EPC Contractors in Railway projects.

- **No Design Standard**

Since there was no design standard for railway works in Ethiopia the contract forced to adopt China design Standard as specified in the particular condition of the contract "Technical standards and regulations", which states "*Generally, the project shall be designed, constructed and tested by the relevant codes and standards of the People's Republic of China*.".

There is no technical standard document prepared by Ethiopian Railway Corporation for Railway construction, operation & maintenance projects, the technical standard of Mieso – Dewanle Railway project is "Chinese Railway Class II". Moreover, even though as per particular condition of Contract the language of the Contract is English, the design standard adopted was in Chinese language.

As a result, the Chinese Contractor provides particular standards in line with the design drawing that satisfies the minimum requirement and the designer's or the Contractor's interest not the Best interest of the Employer.

To illustrate this, the Employer's representative has requested the contractor to conduct California Bearing Ratio (CBR) &Atterberg limits for borrow materials; however, the contractor conduct only grain size analysis, proctor density (compaction) and moisture content tests and said that the tests carried out on the borrow materials are according to the Chinese standard for railway projects and. This will contradict with the internationally accepted material quality verification test from Geotechnical Knowledge. Thus, it's too difficult to prove the quality of the works.

- **Failure of Employer to give land acquisition free ROW**

As per Sub Clause 2.1 of the FIDIC General Conditions of the Contract for EPC contract, the Employer shall give the Contractor right of access to and possession of all the site parts of the project, within the time (or conditions) stated in the Particular Conditions. The right and possession may not be exclusive to the Contractor. If, under the Contract, the Employer is required to give (to the Contractor) possession of any foundation, structure, plant or means of access, the Employer shall do so in the time and manner stated in the Employer's Requirements.

Sub Clause 2.1 of the Particular Condition of the contract also states that "The Employer is responsible for clearing and expropriation cost of any utilities (underground, above ground or at the surface) and buildings within the Right of Way. The time for access to the site can be as per the Contractor's Work Schedule and stage by stage."

Accordingly, the railway project is government financed and owned project; thus, it's supposed the employer (ERC) to compensate only the property on the land not for the land itself. Therefore, the compensation amount is not so much expensive. However, the land acquisition task takes too long by the owner that leads time extension and associated cost compensation on the projects.

Even though commencement date of the project was on April 12th, 2012 GC, the Employer didn't provide full possession of site free from ROW obstruction to the EPC Contractor for enormous period of time. Thus, the Contractor (CCECC) has forwarded his request for possession of site to the Employer (ERC) for the section at DK1+450 which involved two different nations. Besides, the Employer (ERC) failed to provide possession of site paying compensation for the farm lands which lies on the railway line at DK80+024-80+094, DK80+024-DK79+994; thus, the contractor suggest the Employer to pay compensation for the farmers with letter Ref.No. CCECC.MDRP-ED-2015-17.

Likewise, the Contractor (CCECC) informed the employer the entry of the Siphon at DK80+024 which needs clearing of 8 meters of farm land and the construction of ditch at

DK80-85 was interrupted by the ROW obstruction with his letter Ref.No. CCECC.MDRP-ED-2015-17.

The contractor (CCECC) had officially informed the Employer (ERC) on February 26th, 2015 GC he is not able to undertake the work for communication fiber optic repeaters of the whole line due to the land acquisition problem, where there is farm land, at station DK82+900 & DK123+700.

5. Conclusion &Recommendation

The aim of this research, as mentioned in section 1.2 of this thesis, is to assess the challenges of EPC contract delivery system for Railway Projects in Ethiopia, thereby contributing for future efficient progress of the new Railway construction industry.

This chapter presents the conclusion of findings and recommendations made to address the objectives of the study. Therefore, the following conclusions, at section 5.1, and recommendation, at section 5.2 below, are drawn based on the analysis finding of the data collected from the questionnaire, supportive interview and case study of archival documents. The data, questionnaire, interview analysis and the case study analysis, used to identify & investigate the cause of challenges of EPC contract delivery system and their impact on cost, time, and quality and to identify & rank the source of risk and method of measurement used for railway projects in Ethiopia have presented the same finding.

5.1. Conclusion

This section deals with the conclusion made based on the finding of the analysis in terms of probability of occurrence of Challenge variables & risk factors and their associated impact on cost, time & quality of railway projects.

Insufficiently defined Employer's requirement/conceptual design/Front End Engineering Design (FEED) by the Employer, Clients new requirement or variation orders, Failure of the employer to give possession of the site free from ROW obstruction & Failure to coordinate utility infrastructure authorities for existing and future planned utilities are the most frequently occurred challenge variables. These have highest cost & Time impact in studied Railway Projects with EPC contract.

No final detail drawing before construction, Incomplete or poor specifications applicable for Railway projects & Design that satisfy the Minimum requirement are also frequently occurred challenges having higher quality impact.

Construction risk, ROW risks & Design risks of Changes in scope of work, Clients new requirement & variation orders have higher probability of occurrence with extremely higher impact on cost & time but moderate-to-high outcome on quality of project.

Market risk: Price escalation & Exchange rate fluctuation has high probability of occurrence with high impact on cost, Moderate to high time impact and low quality impact on the projects. In addition, Design not up to standards, unclear scope of work & inaccurate assumptions on technical issues occasionally occurs but its impact on Quality is high.

Financial risks: delayed payment has moderate occurrence with higher cost and time impact. Besides, inadequate project planning & Delayed Freight transport has moderate occurrence with high-to-extreme and moderate-to-high time impact respectively.

Different risk treatment methods implemented to deal with different identified risk factors. Risk mitigation/ Risk reduction method used in the contract document to deal with demurrage cost, as the Employer cover all taxes of goods for permanent works, spare parts & Tires of Contractor's equipment. Moreover, quality control plan, quality assurance manual & environmental mitigation plan is included in contract document to proactively reduce the probability of occurrence of risk factors that has an impact on quality and performance of the project.

Risks Sharing through Price escalation provision/ adjustment for changes in costs for selected major construction items such as cement, Diesel, Rail, Structural Steel, Reinforcement steel and Cables is used as Method of measure for market risks. Risk Transfer through Insurance coverage for insurable risks, performance guarantee coverage for the appropriate performance of the work as per the contract & advance payment guarantee for the release of advance payment and retention for the assurance of quality of work is used as a Method of risk treatment in Railway projects in Ethiopia. Close follow up from higher government officials used to integrate different public sectors and maintaining good communication to manage ROW risk.

5.2. Recommendation

Based on the findings of the research, the following improvements were recommended to the stakeholders of Railway construction projects in Ethiopia to tackle the challenges identified.

1. The Employer should have to build the capacity of his technical & managerial staffs that are responsible for the preparation of conceptual design or Front End Engineering Design (FEED).

   The conceptual design should proactively include all detail requirements and minimize and/or remove variation orders and premature enhancement requirements.
2. The Employer, Skilled professionals & concerned stakeholders should prepare well-organized and/or well-defined Railway standard specification for Ethiopia.
3. There should be standard contract award system and tender evaluation criteria by the Employer to attract more bidders with advanced capacity and capability.
4. The Employer should have to clear all obstruction in the Right of Way (ROW) of the proposed project before the contract award, and handover the site to the EPC contractor on time as specified in the contract.
5. There should be well organized master plan that integrates well all infrastructures and utilities. Moreover, there should be coordination and communication between Ethiopian Railway Corporation and other public agencies & Utility authorities.
6. Owner should have qualified inspectors to control contractor's inspection while equipment's are manufacturing as well materials parallel to third party inspector. Owner must have inspection plan for critical equipment.
7. Owners should consider a review of the quality of Contractor's baseline schedule and periodic schedule updates by a forensic schedule delay analyst to determine if problem exist.

Reference

1. Civil Code of The Emperor of Ethiopia (1960); Proclamation No. 165 of 1960, Berhanenna Selam Printing Press of H.I.M. Haile Selassie I, Addis Ababa.

2. Jody Becker and Tim Murphy, "Alternative Construction Delivery Methods".

3. Loulakis, M. (1999), "Design-build: Does it guarantee project success?" (Construction Risk.com), Vol.1, No.8.

4. British Colombia Construction Association (July 09th 2012), "Recommended Guidelines for the selection of A construction Project Delivery method".

5. Advancing Professional Construction & Project management worldwide (2012), "Owner guide to Project delivery methods", the construction management Association of America.

6. Mike Beehler, Burns & McDonnell (Oct.2003), "Method of delivering major projects", Engineering, Construction, Environmental and consulting Solution.

7. Joint committee of The American Institute of Architects & The Associated General Contractors of America (2011), "Primer on Project Delivery", Second Edition, The American Institute of Architects & The Associated General Contractors of America.

8. Richard P. Goldberg (1999), "Design-Build project Delivery-Challenges for the Surety", American Institute of Architects& CSI.

9. D. Bruce Gleig(2005), "Project Delivery Systems", Clark Wilson LLP.

10. The FIDIC 1999, condition of contract for EPC/Turnkey Projects, 1st edition, Lausanne, Switzerland.

11. The Byron Partnership (March 2009), Turnkey Contracts simply explained.

12. PekkaPakkala (2002), Innovative Project delivery Methods for Infrastructure: An International Perspective, Finnish Road Enterprise, Helsinki, Finland.

13. Patricia Galloway (2009);"Design-Build/EPC Contractor's Heightened Risk-Changes in a Changing World", Journal of Legal Affairs and Dispute Resolution In Engineering and Construction.

14. Mark Howard Hovatter (1993); "A study of Design-Build Construction and its placer in public Contracts", University of Florida.

15. The American Institute of Architects Minnesota, "Understanding Project Delivery for the Design and Construction of Public Buildings", A society of The American Institute of Architects.

16. Jonathan Hosie (November 2007), "Turnkey contracting under the FIDIC Silver Book: What do owners want? What do they get?", Mayer Brown, London.

17. Marwa A. El Wardani (May 2004), "Comparing Procurement Methods for Design-Build Projects", Computer Integrated Construction Research Program, Department of Architectural Engineering, the Pennsylvania State University.

18. Michael De Chiara, and Thomas O'Neill, Zetlin& De Chiara LLP, "Public Project Design-Build In New York, Mann Report, New york.

19. Charles M. Sink (2009), "Mega Project Construction Contracts: An Owner's Perspective, 21B", Farella Braun + Martel LLP, San Francisco, California.

20. TiinaKoppinen&PerttiLahdenperä(2004), "The current and future performance of road project delivery methods",VTT Publications Prima Oy, Helsinki

21. James David Fernane (August 2011), "Comparison of design-build and design-bid-build", University of Nevada, Las Vegas.

22. KouroshAbbasi, "How can EPC contract facilitate and being benefited for project stakeholders", 6th International Project Management Conference, STPC, Iran

23. Pranjal Bora, November 2009, "Bankability and structuring of EPC Contracts", EPC World.

24. DLA Piper (2011); "EPC Contracts in the Power Sector", Asia Pacific Projects Update.

25. Harold Kerzner (2003); PROJECT MANAGEMENT, A Systems Approach to Planning, Scheduling, and Controlling, John Wiley & Sons, Inc., New Jersey.

26. The FIDIC 1999; "Introductory Note to the FIDIC 1999", Lausanne, Switzerland.

27. SandeepMenezes, 2012, "Enhancing EPC Efficiency", Project Vendor, India.

28. Lucky MahlatseBaloyi (2013), "Project Manager's Degree of Technical Knowledge in Projects", University of Johannesburg, (MPH Dissertation), South Africa.

29. Ethiopian Railway Corporation (2009), "Addis Ababa Light Rail Transit (LRT) System, Bankable feasibility", Addis Ababa.

30. Vinson and Elkins (2013); "Appetite for Risk in Emerging marker EPCs", International Construction Newsletter.

31. Phil Loots and Nick Henchie (November 2007), "Worlds Apart: EPC and EPCM Contracts: Risk issues and allocation", Mayer Brown, London.

32. http://professionalprojectmanagement.blogspot.com/2010/07/contract-clauses-in-epc-contract-case.htmlaccessed on November 08th, 2014GC.

33. The European Federation of Engineering Consultancy Association (EFEC) & FIDIC (May 2001), "Project Financing Sustainable Solution: Re-Assessing the Priorities Adding Value through Innovation,The European Federation of Engineering Consultancy Association (EFEC) & FIDIC.

34. Richard J. Long (2015); "Typical Problems Leading to Delay, Cost Overruns, and Claims on Process Plant and Offshore Oil & Gas Projects", Long International, Inc.

35. AlemayehuGessesse (2014); "Risk Management of EPC Turnkey Construction projects in Ethiopia", Journal of Ethiopian Association of Civil Engineers Vol.7-No 5, 23-30.

36. The FIDIC 1999,"Guidance for the preparation of Particular Conditions", Lausanne, Switzerland.

37. Uher T. and Toakley A. (1999); "Risk Management in the conceptual phase of project", International Journal of Project Management Vol. 17-No 3, Elsevier Science Ltd. And IMPA.

38. Rahul Bali and Prof M.R Apte (2014),"Risk Management in EPC Contract-Risk Identification", IOSR Journal of Mechanical and Civil Engineering Vol.11-Issue 1-Ver.IV 07-12.

39. John Walewski and G. Edward Gibson (2003); "International Project Risk Assessment: Methods, Procedures, and Critical factors", Center Construction Industry Studies Report No.31, The University of Texas, Austin.

40. Wubishet J. Mengesha, (2008); "Risk Management for Construction Projects", Journal of Ethiopian Association of Civil Engineers Vol.4-No 4.

41. Allianz Global Corporate & Specialty (2013); "Fourth Generation Modular Construction Marine Insurance Challenges: A technical report", Munich, Germany.

42. Robert K. Yin. (1984), Case study research- Design and Method, Volume 5- 3rd edition, Saga Publication International Education and professional Publisher Thousand Oaks. London. New Delhi.

43. G. Jay Kerns(2010); "Introduction to Probabilityand Statistics Using R: First Edition".

44. DrManayeEwunetu (July 2014), "Addis Ababa Light Railway Transit System (LRT) 10th July Gotera Area Flood Incident Investigation Report and Mitigation Options", LRT Localized Flood Investigation Report and Mitigation Options for Ethiopia Railway Corporation(ERC), Addis Ababa, Ethiopia.

45. http://www.erc.gov.et/index.php/projects/national-railway-network-of-ethiopianrne.htmlaccessed on June 12th, 2015GC.

46. Ethiopia – Constitution

47. Proclamation No. 31/1975, Federal Negarit Gazeta of the FDRE, BerhanennaSelam Printing Enterprise, Addis Ababa, Ethiopia.

48. Proclamation No. 47/1975, Federal Negarit Gazeta of the FDRE, BerhanennaSelam Printing Enterprise, Addis Ababa, Ethiopia.

49. Proclamation No. 4/1975, Federal Negarit Gazeta of the FDRE, Berhanenna Selam Printing Enterprise,Addis Ababa, Ethiopia.

50. Proclamation No. 55/1993, Federal Negarit Gazeta of the FDRE, Berhanenna Selam Printing Enterprise,Addis Ababa, Ethiopia.

51. Design Review String Committee ERC (May 2014), "Sebeta-Adama-Meiso Railways Project Site Visit Report and Recommended Mitigation Works", Ethiopia.

Appendix

Appendix A: Proposal

ADDIS ABABAINSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL & ENVIRONMENTAL ENGINEERING

A thesis proposal submitted to the School of Civil & Environmental Engineering in the partial fulfillment of the degree of Master of Science in Railway Civil Engineering

Assessing Challenges of EPC Contract delivery system for Railway Projects in Ethiopia

By

BirukYemane

Advisor

WubshetJekale (Dr.-Ing.)

September 2014

Contents

ABSTRACT VI
INTRODUCTION 1
STATEMENT OF PROBLEM……..……2
RESEARCH OBJECTIVE 2
LITERATURE REVIEW 3
RESEARCH METHODOLOGY 35
WORK PLAN..... 8
BUDGET 9
APPROVAL FORM 1560
REFERENCE 1231

Abstract

Engineering-Procurement and Construction (EPC) Turnkey contract delivery system is where a contractor provides design/engineering services and procurement services for a facility and construction & commissioning services. EPC contract delivery system in Ethiopia was adopted for mega projects such as Hydropower projects, Highway & Buildings. Those projects have faced challenges in due course of the project.

The thesis will be conducted to assess the challenge of Engineering-Procurement and Construction (EPC) Turnkey contract delivery system in Railway projects in Ethiopia. This is to provide a useful supplement to the knowledge of the EPC turnkey contract delivery system.

Accordingly, the assessment will be conducted on advantage, disadvantages and challenges of EPC contract delivery system in the Railway projects. The assessment will be conducted by collection and analyzing relevant data from the concerned stakeholders with questionnaires, interviews and Case study on the two railway projects, Addis Ababa Light rail transit and Addis Ababa- Djibouti railway projects.

The thesis will identify the challenges of EPC turnkey contract delivery system in terms of cost, time, quality, and risk. After the detail evaluation valuable recommendation will be drawn for the other railway projects in Ethiopia and Addis Ababa.

Introduction

The Ethiopian Railways Corporation (ERC) was Re-incorporated on 28 November 2007 to develop manage the design, construction, operation and maintenance of both light and heavy rail transportation systems in Ethiopia. In doing so the corporation should select contract delivery system and prepare contract document.

One of the key purposes of any contract is to allocate risks and benefits between the parties to the contract. In the construction context, various project delivery methods have been developed to deal with the different ways, owners, developers, contractors, consultants and public entities view and accept risk. For both the light and heavy rail transits in Ethiopia the implementation strategy is an EPC (Engineering, Procurement and construction) Turnkey contract delivery system.

In EPC contract the funders and Owners expect to get the degree of certainty as to time and costs that they require which benefits from an increased amount of the risk of the project being placed on the contractor. However, depending upon market forces, a contractor will attempt to increase the contract price in accordance with the increase in risk. And also the employer loss control over the design & construction.

The thesis assesses pros & cons and challenges of EPC contract delivery system in the Railway projects in Ethiopia.

The evaluation will be done stage by stage; in which it starts with Introduction and background information about the topic followed by detail literature review of previous works. After that the detail literature review assessment of the case histories of the stipulated projects be conducted finalized with conclusions and recommendations.

The thesis includes tracking Addis-Ababa Light Rail Transit and Ethio-Djibouti Railway projects through their process of design and construction and provides recommendations about what will be the impact if EPC Contract delivery be used on future projects.

The result of the thesis will be helpful in giving the detail information on the impacts of the delivery system assessed for clients, funders and contractor involved in the construction of Railway construction.

Statement of problem

To my knowledge there was no research done so far that dealt with the challenges of EPC contract as delivery system in Railway Projects in Ethiopia; so that the thesis will become milling stone for further assessments. Therefore, this research seeks to answer the following question:

"What are the problems and challenges of EPC contract delivery system in Railway Projects in Ethiopia? What will be the possible remedial measure?"

Research objective

General Objective

The objective of this research is to assess the challenges of EPC Contract delivery system for Railway projects in Ethiopia.

Specific Objectives

The problem statement for this thesis is approached by developing three data collection methods (Questionnaires, Interviews and Document Analysis) and detail studies on each with an individual objective that contributed to the assessment of challenges of EPC Contract delivery system in Ethiopia.

- To assess the Challenges of EPC contract delivery system in terms of
  - ✓ Cost
  - ✓ Time
  - ✓ Quality
  - ✓ Risk
- To propose possible remedial measures for the challenges assessed.

Literature Review

The key purpose of any contract is to allocate risks and benefits between the parties to the contract. Project delivery methods have evolved to deal with the many ways in which contracting parties wish to allocate their risk, from the general contract to the development of alternative financing and procurement methods.[1]

Project delivery systems refers to the system that owner use organizing and financing design, construction, operation and maintenance which facilitate the delivery of service or good [4]

There are several project delivery methods in the construction sector. Regarding this Engineering, procurement and construction (EPC) contracts are structured very similarly to the turnkey design-build contract by which the contractor bears the risk of integrating the performance of all package contractors, including designers. EPC contracts are commonly used in the construction of larger-scale project-financed infrastructure and energy projects.[1]

EPC Contracts tend to deal with issues with greater sophistication than other types of construction contracts. An EPC can provide for A single point of responsibility, A fixed contract price, A fixed completion date, Performance guarantees, Caps on liability, Security, A bank guarantee, advance payment guarantee, Defects liability or liquidated damage for both delay and performance, restriction on the ability of contractors to claim extension of time and additional cost.[3]Those characteristics of the delivery system made more efficient for large scale projects.

A feature of the turnkey approach to contracting, including revenue-generating facilities, is the requirement for the contractor to prove the reliability and performance of the plant and equipment. It is of critical importance in such projects not only for the project to be delivered within time and cost constraints but also to be delivered so that it is capable of meeting its designed production and output levels. [2] According to the General Conditions of the FIDIC Silver Book: the 'Time for Completion' of the works includes not simply '…completed taking over of the work'but also 'achieving the passing of the Tests on Completion'.

Since In most cases the repayment for project financed loans commences after the completion of the construction project or the commercial operation of the project has commenced, any delay expose the project company penalties there under apart from delaying the loan repayment process and also increase the interest during the construction period. Hence it is necessary to ensure that there are no time overruns for the project. Likewise any unaccounted for cost overrun make the project unviable and

affect the ability of the project to serve the debt. [6] This is because an EPC Contract is designed to satisfy the lenders requirements for bank ability.

Even though EPC contract delivery system has advantage there are disadvantages or challenger encountered under EPC turnkey contract delivery systems.

- Cost:-

  Under the turnkey or EPC contract the employer benefits from an increased amount of the risk of the project being placed on the contractor. The contractor increases the contract price to accommodate the increase in risk they may suffer. Another consequence of the risk allocation is the fact that there are relatively few engineering and construction companies that can and are willing to enter into EPC Contracts. [3] This will dramatically increase the contract price.

  Unforeseen ground conditions are another cause for higher project/contract price. The FIDIC Silver Book states that the owner provides information to tendering contractors; it is the contractor who is responsible for verifying as well as interpreting that data. There is no warranty by the owner as to the sufficiency or completeness of the information provided. Under the FIDIC Silver Book, the risk of adverse ground conditions is intended to be allocated to the contractor. Clause 4.12(b) and (c) provides a catch-all statement to the effect that the contractor accepts responsibility for having foreseen all difficulties and costs, even those which are not foreseeable: 'The Contract Price shall not be adjusted to take account of any unforeseen difficulties or costs.'

- Time

  Shortage of skilled manpower capable of executing complex projects, delay in sourcing critical equipment and reliance on imports and luck of advanced project management practice are the major causes of time overruns. [8]

  For receiving a guaranteed price and a guaranteed completion date, the project company cedes most of the day-to-day control over the construction. Therefore, project companies have limited ability to intervene when problems occur during construction which will progressively alters the guaranteed completion date.[3]

- Quality

  Since the client is looking for the final output the overall supervision role of the Owner is absent from the EPC Contract. The EPC model generally contemplates less day-to-day intervention. Therefore, the EPC contractor may be tempted to under-design the project and will aim for minimum compliant standard to cut his costs and save on time.[9]

- Risk

  The project owner or employer will look to the EPC contractor as the single point of contact for all facets of the project. Indeed, in a sense, much of this risk never leaves the owner. Accordingly Clause 19 of the FIDIC Silver Book (Force majeure) leaves the door open for that risk to migrate back to the owner. [2]

  With the EPC contract come many new risks that are often severe due to the complex nature and high cost frequently associated with this type of project. But in situations where time is essence and completion of project is priority, efforts are equally taken by all stakeholders in the interest of project.

Research Methodology

The methodology employed in the research consists of four parts:

1) Literature review

An intensive literature review of the existing literature represents an integral part of the study. The review identified how the author defined EPC turnkey contract delivery system, explain the advantage, disadvantage and challenges of EPC contract delivery system.

Numerous research studies have confirmed that EPC turnkey has numerous advantages but has some disadvantage with respect to cost, time, quality and risk.

2) Data Sources

From the result found from the literature review on the disadvantage and challenges of EPC contact delivery system detail data will be collected.

The samples will be drawn from the client Ethiopian Railway Corporation, Consulting firms and Contractors involved in Railway project and relevant professionals in the construction sectors. Those elements were selected they are the major stakeholders in the sector No restriction in gender, religion but the respondents must be experts or occupying technical and managerial position in their organization.

3) Data Collection

From the result found from the literature review on the disadvantage and challenges of EPC contact delivery system detail analysis will be conducted by collecting data

- ✓ Primary data
  - Questioner

The data will be collected through questionnaires, which will be developed to investigate the major challenges and advantages of EPC contract delivery, from the aforementioned client, consulting firms, contractors and relevant professional individuals.

  - Interview

The collection of data through interview of those professionals engaged in the construction site.

- ✓ Secondary data for Case study

The second step in data collection of the research was to conduct case study analyses the two already lunched railway projects, which are Addis Ababa Light Rail Transit and Addis Ababa-Djibouti Railway project. The main objectives of the case studies were to find out the major challenges encountered. Case studies are "the preferred strategy when how or why questions are being posed. [7]

The case study will be conducted by observation and document analysis. The document analyzed will be contract documents, specifications, relevant correspondences between the client, Client representative and EPC Contractor, publications, newsletters on the above projects with regard to challenges in the projects

4) Data Analysis

After all the data were collected the data will be refined classified and analyzed quantitatively and qualitatively. The analysis output will be the challenges encountered in EPC Contract delivery system in the railway projects.

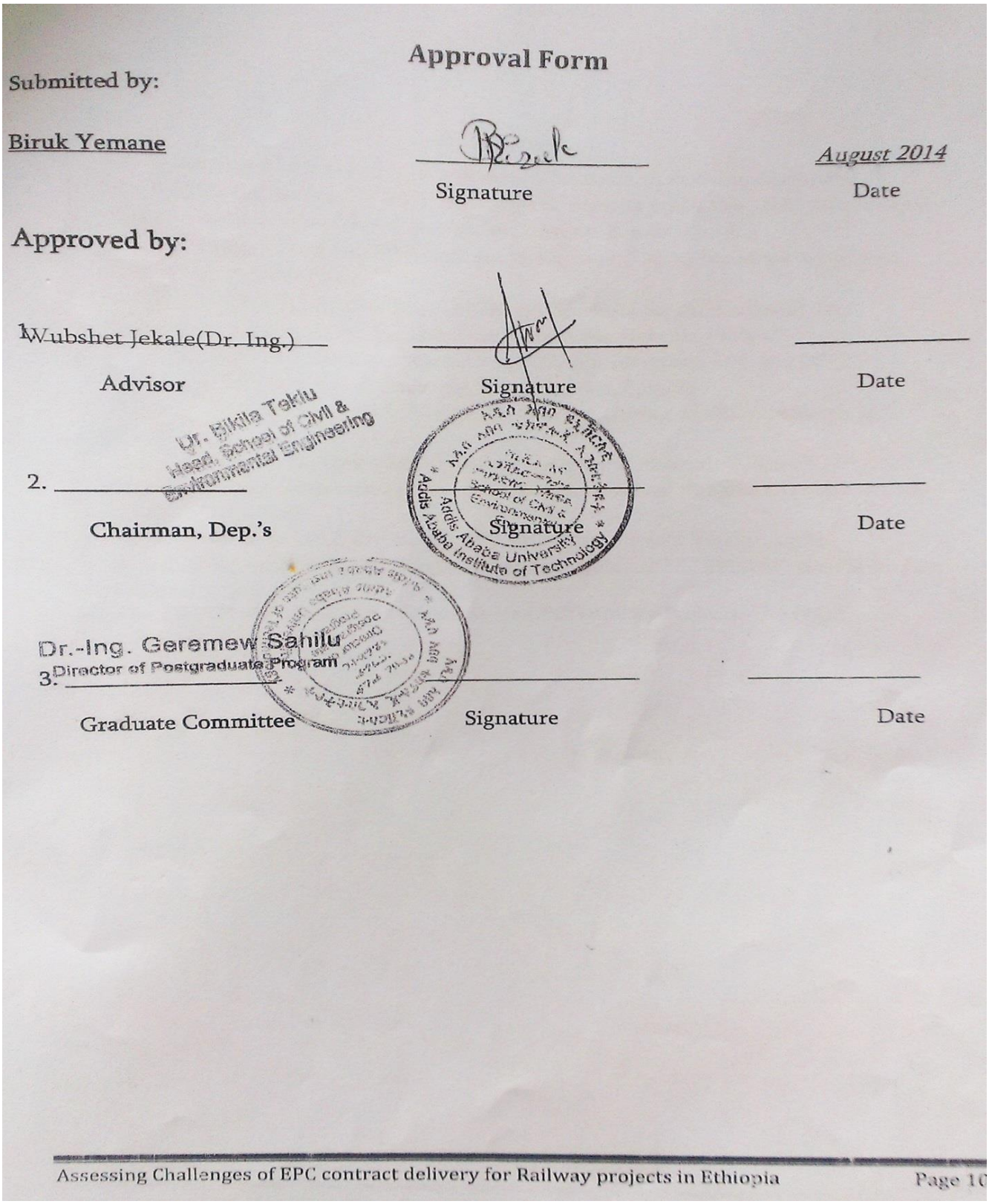
Work Plan

Activity	September				October				November				December			
	W-1	W-2	W-3	W-4	W-1	W-2	W-3	W-4	W-1	W-2	W-3	W-4	W-1	W-2	W-3	W-4
Literature Review	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Detail Literature Review	■	■	■	■												
Data collection																
Questionnaire			■	■	■	■										
Interview					■	■	■	■								
Case study					■	■	■	■								
Data Analysis									■	■	■					
Report writing												■	■	■		
Edition, Submission															■	■

Budget

Activities	Reason	Amount (ETB)
Stationaries	Documentation, printing and Duplication	2000
Documents	Purchasing of Books, Journals,	3500
Transport	Allowance for Transport (To the projects and to the colleague)	3000
Others	Stationary items, flash discs, internet service ….	2000
Total		10,500

Approval Form



Approval Form

Submitted by:

Biruk Yemane — Signature — August 2014 — Date

Approved by:

1. Wubshet Jekale(Dr. Ing.) — Advisor — Signature — Date

Dr. Bikila Teklu
Head, School of Civil & Environmental Engineering

2. _____ — Chairman, Dep.'s — Signature — Date

Addis Ababa University
Addis Ababa Institute of Technology
School of Civil & Environmental

Dr.-Ing. Geremew Sahilu
Director of Postgraduate Program

3. _____ — Graduate Committee — Signature — Date

Assessing Challenges of EPC contract delivery for Railway projects in Ethiopia Page 10

Reference

52. Jody Becker and Tim Murphy, Alternative Construction Delivery Methods.
53. Jonathan Hosie, November 2007, Turnkey contracting under the FIDIC Silver Book: What do owners want? What do they get?, Mayer Brown, London
54. KouroshAbbasi, How can EPC contract facilitate and being benefited for project stakeholders", STPC, Iran
55. Pakkala, P.2002. Innovative Project delivery Methods for Infrastructure: An International Perspective, Finnish Road Enterprise, Helsinki Finland.
56. Phil Loots and Nick Henchie November 2007, Worlds Apart: EPC and EPCM Contracts: Risk issues and allocation,Mayer Brown, London
57. Pranjal Bora November 2009, Bankability and structuring of EPC Contracts, EPC World.
58. Robert K. Yin. 1984, Case study research- Design and Method, Volume 5- 3rd edition, Saga Publication International Education and professionalPublisher Thousand Oaks. London. New Delhi
59. SandeepMenezes 2012, Enhancing EPC Efficiency, Project Vendor, India.
60. http://professionalprojectmanagement.blogspot.com/2010/07/contract-clauses-in-epc-contract-case.html
61. The FIDIC 1999, condition of contract for EPC/Turnkey Projects, 1st edition, Lausanne, Switzerland.

Appendix B: The Questionnaire

Questionnaire

This questionnaire is prepared for a thesis in partial fulfillment of degree of Masters in Railway Civil Engineering. The main objective of the research is to investigate/assess the Challenges of EPC(Engineering Procurement & Construction) Delivery system for Railway Projects in Ethiopia.

Regarding confidentiality, any data or information provided in this survey, is solely used for Academic purpose of the research under consideration and all specific interviewee and company information will be kept confidential at all times.
If you have questions or seek clarifications, please contact me on address below.
I thank you in advance, for your invaluable cooperation.

I thank you in advance for your invaluable cooperation and willingness to fill the questionnaires & returning them back on time.

With Best Regards,

BirukYemane

Post Graduate Student, Railway Civil Engineering
Addis Ababa University,
Addis Ababa Institute of Technology,
School of Civil & Environmental Engineering
Tel: *0913 09 66 34*
E-mail:-birukyemane@hotmail.com
Addis Ababa

Section 1: Company and respondent profile

1.1.Company Name (optional):_____

1.2.Type of your organization (Please indicate with "√" when appropriate)

Project Owner/Client_____ Consultant/Employer representative_____

Main Contractor_____ Sub-Contractor_____

Government official_____

Others (please specify) _____

1.3.Nationality

Ethiopian_____ Foreigner_____

1.4.How long have you worked in Ethiopian Construction sector?

0 – 5 years_____ 6 – 10 years_____
11 – 15 years_____ More than 15 years_____

1.5.Educational status?

BSc_____ MSc_____ PhD_____
Others; please specify_____

1.6.Related experience:

Estimating (_____years) Design (_____years);
Construction (_____years) Supervision (_____Years)
Contract Administration (_____years) Management (_____years)

Section 2: Challenges on EPC Contract delivery

2.1. Do you have information about EPC (Engineering, Procurement and Construction) Contract Delivery system?

Yes_____ No_____

The terms EPC (Engineering, Procure & Construction) is used to describe a project delivery approach in which the owner defines the project and then hires a contractor involving a single contract between the project owner and an EPC/Turnkey contractor with total responsibility for detail engineering design, procurement, construction and coordination of all the project work according to design parameters, performance criteria, and other requirements established by the agency or client.

Cost, Time & Quality challenges on EPC Contract delivery

2.2. Based on your experience, would you please rank the following causes of challenges in terms of probability of occurrence and severity of impact on time, cost, &quality? You can add, if any.

I.No	Sources of Challenges	Probability of occurrence					Impact														
							Cost					Time					Quality				
		Not at all	Unlikely	Likely	Almost Certain	Certain	No Significance	Minor	Average	High	Extreme	No Significance	Minor	Average	High	Extreme	No Significance	Minor	Average	High	Extreme
	Tendering & Awarding Stage																				
1	No standard tender evaluation criteria																				
2	Higher Compensation/ Honorarium cost for unsuccessful proponents for their proposal/bid submission																				
3	Higher front end cost/ Higher Preliminary design & Owner's requirement preparation cost at the Bidding stage																				
4	Higher design cost at the Bidding stage																				
	Inappropriate document																				
5	Insufficiently defined conceptual design and Front End Engineering Design (FEED) by the owner																				
6	Ambiguities or discrepancies of documents																				
7	Unclear specifications or changes to specification																				
8	Cost associated with test of samples not provided in the contract																				
	Contractors failure																				
9	Inappropriate/inexperienced contractor																				
10	Mistakes during construction or defective work or Wrong construction methodology																				
11	Design error resulted from technical error, inadequate survey data, poor specification, on-conformance/to the minimum requirement of the spec.																				
12	Design that satisfy the Minimum requirement																				
13	No final detail design drawing available before the construction starts before final																				
14	Inaccurate quantity estimate or excess quantity during construction																				
15	Cost under estimation																				

I.No	Sources of Challenges	Probability of occurrence					Impact														
							Cost					Time					Quality				
		Not at all	Unlikely	Likely	Almost Certain	Certain	No Significance	Minor	Average	High	Extreme	No Significance	Minor	Average	High	Extreme	No Significance	Minor	Average	High	Extreme
16	Lack of base line planning and coordination or less emphasis to planning																				
17	Failure to identify problems and institute necessary and timely design and programming changes																				
18	Insufficient geotechnical investigation																				
19	Encountering of not foreseeable physical obstructions and conditions																				
20	Contractors bankruptcy																				
21	Inadequate documentation or minimal information during the project history on contractors' schedule progress, labor utilization, cost expenditures, and labor productivity.																				
22	Higher cost to accept transfer of Risk																				
23	Insufficient quality management practice by the contractor																				
24	Insufficient Environmental protection manual and weak implementation policy																				
25	Contractors aim to reduction of cost by optimizing quality, aesthetics, high level finishing																				
	Employer Failure																				
26	Designer not acting in the Best Interest of the owner																				
27	No contractual responsibility of Owner's Representative																				
28	Lack of end user/owner involvement in due course of the design and project execution																				
29	Failure of the employer to give land acquisition/possession of the site/ free from ROW obstruction in accordance with the terms of the contract																				

I.No	Sources of Challenges	Probability of occurrence					Impact																	
							Cost					Time					Quality							
		Not at all	Unlikely	Likely	Almost Certain	Certain	No Significance	Minor	Average	High	Extreme	No Significance	Minor	Average	High	Extreme	No Significance	Minor	Average	High	Extreme			
30	Failure of the employer to coordinate utility infrastructure authorities for existing and future planned utilities in ROW of the project in accordance with the terms of the contract																							
31	Failure of the employer to integrate government authorities, environmental mitigation requirements.																							
32	No sufficient and reliable integrated master project schedule that results from pulling together the work activities from multiple prime contractors.																							
33	Funding problems or client's shortage of finance or delayed payments to contractors																							
34	Executive bureaucracy in the client's organization																							
35	Loss or damage due to excepted risks or employers risk																							
36	Insufficient number of experienced personnel in Owners organization to manage the technical aspect of a project, in review of design & Procurement packages, response to Request of Inspections (RFI).																							
37	Insufficient number of experienced qualified and experienced management team to manage change orders, extension of time and financial claims.																							
38	No standard/ quality control mechanism to track the quality/close follow up of the project by the owner prior to handing over																							
39	No or insufficient environmental protection policy																							
40	Inability of owner to track the project progress for payment certification																							

I.No	Sources of Challenges	Probability of occurrence					Impact														
							Cost					Time					Quality				
		Not at all	Unlikely	Likely	Almost Certain	Certain	No Significance	Minor	Average	High	Extreme	No Significance	Minor	Average	High	Extreme	No Significance	Minor	Average	High	Extreme
	Market																				
41	Inflation or increase in the cost of construction materials																				
42	Fluctuations in the cost of labor and/or material or any other matter affecting the cost of the execution of the works and subsequent legislation that affect the project																				
43	Change in foreign exchange rate (for imported materials)																				
44	Increase in tax/change in government fiscal/monetary policies																				
45	Difficulties in obtaining construction materials in the local market																				
46	Delayed Payment																				
47	Insufficient management of multiple prime contractor design and construction interference																				
	Variation & Change order																				
48	Additions and/or enhancement required by clients or end users																				
49	Supplementary/additional agreement																				
50	Acceleration required by the owner (shortening of contract time)																				
51	Suspension of work ordered by the Owner/ Owner Representative																				
52	Many Change orders and/or lack of control on excessive change orders																				
53	Changes in Plans and drawings																				
54	Additional costs due to variations works																				
	Other issues																				
55	Costs due to special risks which very often include outbreak of war, projectile, missile, hostilities, contamination and other risk																				
56	Fossils or discovery of things of geological or archeological interest																				
	Add if Any																				

Risk on EPC Contract delivery

Many literatures defined risk as a measure of the probability and consequence of not achieving a defined project goal. Risk constitutes a lack of knowledge of future events, which are unfavorable events. Risk has two primary components for a given event, including a probability of occurrence and its subsequent impact.

Risk management is a logical, systematic, continuous and process oriented approach that includes planning for risk assessing (identifying and analyzing) risk issues, developing risk handling strategies, and monitoring risks to determine how they have changed. The following questions are, therefore, intended to assess the current practice of Risk management practice of Railway construction projects undertaking now.

2.3. From your experience in the sector, what are the sources of risks in railway constructionprojects undertaking now? Identify from the list and rank them in order of probability of occurrence and severity of impact? And state the method of measurement used to handle. You can add, if any.

Source	Probability of Occurrence					Impact															Method of management used
						Cost					Time					Quality					
	Rare	Occasional	Likely	Frequent	Very Frequent	Very Low	Low	Moderate	High	Extremely High	Very Low	Low	Moderate	High	Extremely High	Very Low	Low	Moderate	High	Extremely High	
Planning and selection risks																					
· Inadequate project planning																					
· Inefficient project delivery system																					
· Inappropriate contract award process																					
· Delayed fabrication, test, training																					
· Emphasis on meeting schedules & increased production volume (tight schedule)																					
· etc.																					
Design risks																					
· Changes in scope of work/Clients new requirement																					
· Unclear scope of work & Inaccurate assumptions on technical issues																					
· Incomplete/inadequate survey data																					
· Inadequate geological, geotechnical/hydrological/ hydraulic study																					
· Incomplete or poor specifications																					
· Design not up to standards (nonconformance to codes and standards)																					
· Incomplete/inaccurate quantity& Cost estimate																					
· Lengthy project development period (change in site conditions due to late bidding)																					
· Lack of experience of the design team																					
Financial risks																					
· Funding risk																					
· Delayed payment certification & Disbursement																					
· Insolvency/Bankruptcy of participants																					
· etc.																					
Contractual risks																					
· Ambiguities in contract.																					
· Liquidated, consequential, and Punitive damages clauses																					
· etc.																					

Source	Probability of Occurrence					Impact															Method of management used
						Cost					Time					Quality					
	Rare	Occasional	Likely	Frequent	Very Frequent	Very Low	Low	Moderate	High	Extremely High	Very Low	Low	Moderate	High	Extremely High	Very Low	Low	Moderate	High	Extremely High	
ROW risks																					
• Dislocation of existing utilities																					
• Evacuation & resettlement of communities, houses & bldg.																					
Construction risks																					
• Non-completion																					
• Delayed Completion																					
• Completion with performance deficiency																					
• Completion with cost overrun																					
• Integration problem																					
• Differing site condition																					
• Unidentified utilities&etc.																					
Project management risks																					
• Lack of Knowledge, skill & qualification																					
• Lack of coordination/ communication																					
• Lack of motivation & inspiration																					
• Inefficient dispute resolution procedures																					
• etc.																					
Market risks																					
• Price escalation																					
• Exchange rate fluctuation																					
• Labor shortage or strike etc.																					
Underground risks																					
• Geological & Geotechnical																					
• Hydrological, Hydraulic & Sub-surface																					
Technological risks																					
• Outdated technology																					
• Improper, non-tested technology																					
Transport & Traffic management risks																					
• Traffic management																					
• Access road/ Detour facilitation																					
Customs Clearance risks																					
• Demurrage cost																					
• Delayed freight transport																					

Section 3: Overall comments

Do you have any comment on the challenges of EPC contract delivery system adopted for railway projects in Ethiopia?

_____
_____
_____
_____
_____

Section 4: General comment on the research

_____
_____
_____
_____
_____

Would you like an electronic copy of the study? Yes _____ No_____
May you be contacted to discuss your replies further? Yes _____ No_____

If you replied 'Yes' to any of the above questions, please complete the following:
Name (Optional):_____
E-mail:_____
Tel. No: _____

I sincerely appreciate your timely response and cooperation.

Thank you,