

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
COLLEGE OF TECHNOLOGY AND BUILT ENVIRONMENT
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING



**ASSESSMENT ON ETHIOPIAN ROADS ADMINISTRATION COST ESTIMATE
VALIDATION SYSTEM AND ITS IMPACT ON THE PROCUREMENT OF ROAD
PROJECTS**

A Thesis submitted to Addis Ababa Institute of Technology School of Civil and Environmental Engineering in partial fulfillment of the requirement for the award of the degree of Master of Science in Civil Engineering (Construction Technology and Management)

By: Biruk Yersaw

Advisor: Abraham Assefa (PhD)

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BY: BIRUK YERSAW

APPROVED BY THE BOARD OF EXAMINERS

<u>Abraham Asfaha</u>	<u>Asfaha</u>	<u>09/29/25</u>
Advisor	Signature	date
<u>Girmay Kahsay</u>	<u>Girmay</u>	<u>30/09/25</u>
External Examiner	Signature	date
<u>Fekadu Melese</u>	<u>Fekadu Melese</u>	<u>1/10/2025</u>
Internal Examiners	Signature	date
<u>Tensay Gebremedhin</u>	<u>Tensay</u>	<u>02/10/25</u>
Chairman	Signature	date

DECLARATION

I hereby declare that this thesis entitled “Assessment on Ethiopian Roads Administration Cost Estimate Validation System and its Impact on the Procurement of Road Projects” is my original work except for citations and quotations; which have been duly acknowledged. I also declare that this study has not been presented for the award of a degree program in any other university.

Biruk Yersaw

Author's Name

Signature

Date

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ABBREVIATIONS

ADB	Asian Development Bank
AFDB	African Development Bank
BOQ	Bill of Quantity
CMS	Construction Management System
CPA	Contract Price Adjustment
CPM	Construction Project Management
CSA	Central Statistics Agency
DB	Design Build
DBB	Design Bid Build
DC	Direct Cost
DDG	Deputy Director General
DMD	Design Management Directorate
ECE	Engineering Cost Estimate
EE	Engineer's Estimate
EPD	Engineering Procurement Directorate
ERA	Ethiopian Roads Administration
ERCC	Ethiopian Road Construction Corporation
ERAMS	Ethiopian Roads Administration Management System
EVS	Estimate Validation System
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Product
GOE	Government of Ethiopia
IC	Indirect Cost
ICB	International Competitive Bidding
IDA	International Development Agency
MOF	Ministry of Finance
NBE	National Bank of Ethiopia
NCB	National Competitive Bidding
OH	Overhead
PDS	Project Delivery System
PE	Project Engineer
PQSM	Performance Quality and System Management

PPPA	Public Procurement and Property Administration
QARISM	Quality Assurance Inspection and Road Safety Management
RBU	Rate Build Up
RAM	Road Asset Management
RRC	Road Research Center
RSDP	Road Sector Development Program
SCC	Special Conditions of Contract
STS	Standard Technical Specification
SPSS	Statistics Package for Social Science
TL	Team Leader
US	United States
WB	World Bank
WBS	Work Breakdown Structure

ABSTRACT

The validation of engineering cost estimates is fundamental to transparent and efficient procurement in public infrastructure. This study examines the key deficiencies and challenges in the review and validation of engineering cost estimates of Ethiopian Roads Administration (ERA) and the impact of the identified gaps on the procurement of road projects. The research employed a mixed-methods design to provide a robust analysis adopting both descriptive and explanatory designs, using a quantitative and qualitative research approach. Primary data were collected through structured questionnaires, semi-structured interviews and focus group discussions from key management personnel directly involved in estimate validation. An in-depth study was conducted on a selected federal road project to assess and evaluate the capacity of the cost estimate validation system (ERAMS) using the collected secondary data such as Consultant's cost estimate, ERAMS validation report and Contractor's offer. Data analysis and presentation including coding, frequency analysis and presentation of questionnaire responses was carried out using relevant tools. Questionnaire data reveals key shortcomings which includes the absence of standardized review checklists and up-to-date guidelines, inadequate documentation practices, and limited traceability in the basis of estimate, with nearly **60%** of respondents expressing dissatisfaction with the existing review and quality control processes. Further, the in-depth study quantified the technical limitations of ERAMS, showing that **56%** of the **159** bill items in the sample project were not validated by the system's rate build-up due to its inability to validate non-standard (custom) items. This validation failure contributed directly to procurement challenges with variances on major individual items exceeding **300%** due to the poor integration with market prices. Hence, discrepancies between consultants estimates and contractors bids remain significant, often due to inconsistencies in assumptions, lack of standardization, and differing approaches to risk assessment. The findings conclude that ERA's current cost validation system is inadequate, creating procurement risks and inefficiencies that needs urgent systemic reform focusing on updating technical guidelines, enhancing the functionality of ERAMS to validate all bill items, standardizing estimation procedures, building institutional capacity through training of dedicated estimation validation units, and improving data-sharing protocols to bridge the gap between estimates and market realities.

Keywords: Cost Estimate Review, ERA, Procurement, Road Projects, Design Consultants, Estimate Validation, ERAMS, Contractor offers

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CHAPTER ONE

1 INTRODUCTION

1.1 Background of the Study

In most African nations, the building industry has grown rapidly in recent years. This is due to the fact that massive infrastructure projects are being carried out in an effort to address the struggling economy by making efficient use of available resources, creating job opportunities, and meeting societal demands. One can use Ethiopia as a standard example for this situation. Large-scale public construction projects are currently crucial to the development goals of the nation. To advance the building industry, the government dedicates a significant portion of its budget to these initiatives (Koshe and Jha, 2016).

The authors Koshe and Jha (2016) also argue that there are still continuing shortcomings in the nation despite this admirable goal and the concentrated efforts undertaken to realize the ambitious Growth and Transformation Plan. It is an undeniable fact that a project is deemed successful when it is finished on time, within budget, to the required quality and to the satisfaction of all stakeholders. However, excellent performance and project completion are not standard practices in the construction business, particularly in developing nations. Cost increases are now a regular issue facing Ethiopia's expanding construction sector on a large scale as a result of the issues the Ethiopian building industry has also been dealing with.

The development of infrastructure is crucial to Ethiopia's economic and social progress because it is a developing nation with low economic income and high rates of unemployment in urban areas. Roads alone account for a greater portion of this industry. In an effort to expand the road network across the nation, the Ethiopian government has been allocating multimillion ETB for road projects. This has been done through the implementation of several federal and regional road construction projects, as well as the creation of successive road sector development programs (RSDP), (ERA, 2024).

Ethiopian Roads Administration is the organization appointed by the government of Ethiopia, which takes the responsibility to design, construct, maintain and administer the Federal roads of the country. The overall mandate of ERA is to regulate, plan and manage the federal road network, which includes construction, maintenance, upgrading and rehabilitation so that it will achieve the overall objective of economic development, growth and poverty reduction.

Clients like ERA delay starting construction until they are positive there will be a return on investment because it is a significant capital expense. If a project is private, this benefit might only be driven by financial concerns; in the case of public enterprises, it could benefit society as a whole, supported by a cost-benefit analysis, (Alemayehu, 2014). This cost-benefit analysis is carried out at the beginning of the design phase. Before moving on to the building stage for the actual work, these stages involve preliminary and detailed cost estimation.

By its very nature, detailed cost assessment necessitates consistency in preparation techniques and close attention to detail. The ability to pay attention to detail and simultaneously see the bigger picture of how construction components interface that is, the capacity to connect design specifications and specifics to real construction processes benefits those who create cost estimates, (Adom, 2015).

Planning and feasibility studies depend on accurate cost assessment of construction projects early in the project's development. In order for construction clients to make an informed choice about the viability of a given project, they need early and precise cost guidance prior to site acquisition and building commitment. However, doing cost estimation in the early stages presents a variety of challenges. Lack of preparatory data, a database of job expenses, proper cost assessment techniques, and the presence of several environmental, political, social, and external uncertainties are major issues, (Alemayehu, 2014).

Due to various institutional constraints, construction cost estimates might be seen from several angles. Despite the wide range of cost estimates that are employed at various stages of a project, estimating techniques can be classified into four main groups: parametric, historical bid-based, cost-based, and risk-based, (Adom, 2015). Numerous specific methods and resources are included in these categories to help the estimator create cost estimates. Recognizing that any particular estimate could contain any mix of the methodologies is crucial.

In this research, the impact of cost estimate validation system on the procurement of road projects has been assessed.

1.2 Problem Statement

Road construction is one of the most important sectors for developing countries as it provides access to energy, irrigation, markets, healthcare, and education centers. Ethiopian Roads Administration (ERA) has been striving for years to meet Ethiopian's urgent infrastructure needs that are the backbones of economic prosperity and sustainable development. ERA, as a public body of the Federal Democratic Republic of Ethiopia for the development and administration of federal highways; outsources the design and construction of road projects to different national and international contracting firms.

In connection, to outsource the design and construction of road projects, ERA through its procurement wing conducts the evaluation process. The key evaluation and qualification criteria for selecting the civil works contractor, such as Annual Construction Turnover, Specific construction experience and liquid asset (cash flow) requirements are related to the estimated cost of projects and hence, evidently the level of effort exhausted in the preparation, checking and approval of the cost estimate and quality of the deliverables would affect the selection of the right contractor in terms of capability and experience.

However, ERA has encountered many difficulties (challenges) regarding cost estimates such as inconsistency of the reporting content (submission) requirements, methodologies, assumptions and considerations for analysis of direct and indirect cost elements, how the inputs and measurement and payment provisions of the project technical specifications and other project specific issues noted in the engineering design reports have been integrated in the cost estimate. Accordingly, gaps have been noted during bid evaluation processes in comparing bid prices of projects from the bidders offer with the corresponding cost estimates prepared at the design stage.

In view of the above, Ethiopian Roads Administration implement a validating system known as Ethiopian Roads Administration Management System (ERAMS) which is a tool mounted on a computer server in ERA Data Centre and accessed through either the Intranet or Internet over a secure website. While using ERAMS, gaps have been observed in updating the unit rates frequently, the browser the system has been using, on standardized and non-standardized (custom) items, regarding unit of measurement and on its user friendliness for the end users.

There are different literatures conducted on cost estimates from the consultants and contractors perspective in the world. However, the researcher could not find researches conducted on

validation of estimates from the client's perspective particularly in Ethiopia and hence, this research is initiated in assessing the reviewing and validating techniques of cost estimates of ERA which is a client that administers federal road projects of Ethiopia that will contribute to the existing body of knowledge.

1.3 The Objective of the Study

1.3.1 General Objective

The general objective of this research is to assess and investigate ERA's cost estimate reviewing and validation system and its impact on the procurement of Federal Road Projects.

1.3.2 Specific Objective

The specific objectives of this study include:

1. To assess and identify the major deficiencies and limitations in reviewing cost estimates provided from Design Consultants hired by ERA before feeding to the system;
2. To assess and evaluate the capacity of ERA's cost estimate validation system (ERAMS) in checking, reviewing and validating cost estimates and
3. To compare and contrast the Design Consultants Cost Estimates validated by ERAMS with the winning contractor offer and recognize its impact on the procurement of road projects

1.4 Research Questions

- What guidelines, manuals and procedures are followed by ERA to review and check the cost estimates submitted from design Consultants before feeding to the system?
- What are the primary required Services, capacity of the Ethiopian Roads Administration Management System (ERAMS) and the deficiencies that hamper the validation system to perform in full capacity?
- What are the impacts of the limitations of the cost estimate reviewing and validation system of ERA on the procurement of road projects?

1.5 Significance of the Study

ERA and Consultants taking part in federal road construction projects would be the main stakeholders who will benefit from the findings of this research, as demonstrated below:

- Since the study attempts to identify the limitations in reviewing cost estimates and the key factors attributing for preparing inaccurate cost estimates, both the employer and Consultants will benefit from this;

- By evaluating the capacity of the Ethiopian Roads Administration Management System (ERAMS) and the deficiencies that hamper the validation system to perform in full capacity, remedial measures can be identified by both contracting parties;
- By assessing the impacts of the limitations of the cost estimate reviewing and validation system of ERA on the procurement of road projects, the employer will be recommended for administering the design contract depending on the assessment result.

1.6 Scope and Limitation of the Study

The focus of this study is limited to cost estimate reviewing, checking, and approval or validation system of Ethiopian Roads Administration on selected project mainly administered under the Design-bid-build (DBB) project delivery system.

The two popular project delivery systems (PDS) that are most frequently utilized in both the local and international construction industries are design-build (DB) and design-bid-build (DBB). Under DBB PDS, the employer might enter into separate contracts with the consultant for design services and the contractor for construction work while the DB PDS enables the employer to enter into a single contract with a "design-builder" for the completion of both design and construction duties, (Shibru, 2020).

According to Muluken Shibru (2020), DBB and DB PDS employ different methods of cost estimation: DB uses lump sum forms of contracts, while DBB uses admeasurement. The total project cost under the admeasurement modes of contract can be calculated using the priced Bill of Quantity (BOQ). In contrast, DB PDS requires converting the given DB project into DBB format in order to investigate the effect. This involves identifying those cost-dictating factors and adjusting them accordingly, computing the work quantities for DB projects based on Employer's Requirements, endorsing a unit rate submitted for similar DBB projects, and estimating the project cost. Whereas, the DBB PDS are easier to make the detail analysis item wise (item by item) as they are priced Bill of Quantity (BOQ) (admeasurement type). Thus, this study is limited only to road projects administered through DBB project delivery system.

Apart from the time and budget constraints, the factors which limit this research work includes current internal data management system (ERAMS) of the organization, ERA, which makes it difficult to extract data easily from the database as Engineering Cost Estimates are confidential by their nature.

The research only focuses on the assessment of the actual practice of cost estimate validation system of ERA (ERAMS) in relation to bid evaluation with the aim of identifying the shortcomings in the current practice of reviewing and validating Engineering Cost Estimates and finally, it provides recommendations as a remedial for improvement of the gaps identified on the course of the study.

1.7 Organization of the Study

This research study is divided into five chapters, each of which is briefly discussed below;

Chapter One (Introduction): This chapter is devoted to the background of the study, problem statement, objective of the study, the significance of the study, the scope of the study and organization of the study. It gives a brief description of the overall work in this research.

Chapter Two (Literature Review): tries to overview the different literatures including journals, articles, previous thesis, books, different manuals and guidelines related to the scope of this research.

Chapter Three (Methodology and Materials): discusses the research design, materials and methodology used for the study, the research area, and the methods used for data collection and analysis of the data used.

Chapter Four (Analysis of Data and Discussion): summarizes the results of the surveys, research project chosen for the evaluation, and then discussions are held in comparison with the chapter 2 literature findings.

Chapter Five (Conclusion and Recommendation): this last chapter summarizes the outcomes of the research and gives recommendations based on the findings of the study.

CHAPTER TWO

2 LITERATURE REVIEW

2.1 Introduction

In the literature review part, both theoretical and empirical works of literature related to the study have been reviewed. Different journals, articles, thesis, manuals, guidelines and books are also referred to for compiling this part of the research. From these concepts and theories, the theoretical basis for the current study was formulated. Finally, it also tries to summarize the literature and gaps that will be addressed by this study.

2.2 Definition and Concept of Cost Estimating

Cost estimation is the process of calculating the projected total cost of a project or the amount of money required to finish a specific amount of work within the year the estimate was generated.

Estimating is a scientific method of calculating the approximate cost of an engineering project before any work is done. It differs from calculating the exact cost after the project is finished because estimation involves predicting the most likely cost of completion. It also calls for a thorough understanding of the cost of labor and materials, as well as skill, experience, foresight, and good judgment, (Alumbugu *et al.*, 2014).

During the development process, cost estimating is a predictive technique that helps with budget management by calculating the cost and pricing of resources needed for a project, ensuring that projects stay within their allocated budget and are completed on schedule, (WSDOT, 2015).

The process of cost estimation often includes gathering, examining, and compiling data that is easily accessible for a building project. In addition, cost estimation is typically a subjective process where estimators take into account other essential elements to the success of a building project rather than being a precise scientific and analytical procedure, (Amade and Akpan, 2014).

According to Project Management Body of Knowledge (PMBOK), a quantitative evaluation of the expected costs of the resources needed to finish the task is called a cost estimate, (*Project Management Body of Knowledge (PMBOK)*, 2017). It's a forecast that's based on knowledge at a specific moment in time. The process of estimating costs involves determining and weighing the many options for starting and finishing a project. As the project moves through the project life cycle, the accuracy of a project estimate will rise. Cost estimates should be evaluated and adjusted during the project to reflect new information as it becomes available and assumptions are tested.

Serpell, cited in (Alumbugu, Polycarp Olaku *et al.*, 2014) described that pre-tender cost estimation, also known as early-stage cost estimation, is the process of project cost forecasting that takes place during the planning and design phase. Cost control and decisions about financial support are made using this estimate as a basis. Clients want to know the entire project cost commitments at the pre-tender stage.

According to association for the advancement of cost Engineering (AACE) international recommended practice, Estimate validation is a quality assurance procedure that is a type of benchmarking that contrasts pertinent estimates of time, money, and/or resources with those of a chosen basis of comparison. It can be used at any suitable level of cost detail or cost summarization, as well as on any portion of an estimate.

The fundamental procedures for validating estimates are: Taking into account the estimated cost strategy when planning the estimate validation, determining the project estimate's metrics, comparing the estimate metrics to the comparison measurements and conducting an evaluation after obtaining comparison metrics normalized to the estimate metrics basis and finally, check to see if the estimated cost plan (as well as any qualitative findings) has been met. (AACE international recommended practice 110R-20, Cost Estimate Validation).

2.3 An Overview of the Ethiopian Construction Industry

The construction industry is a sector of the economy that transforms various resources into constructed physical, economic and social infrastructure necessary for socio-economic development which includes building, Transportation systems and facilities which are airports, highways, subways, bridges, railways and others.

This industry contributes significantly to the socio-economic development of most developing countries, (Seid, 2008) mainly by providing new infrastructure in the form of roads, railways, airports as well as new hospitals, schools, housing and other buildings.

To what extent it contributes to the socio-economic development is measured in terms of gross domestic product (GDP) of the national economy and capital assets or gross capital formation. Thus, the construction industry accounts for a large share of gross domestic product and employs many people in all developing countries (Welde and Dahl, 2021).

In the context of Ethiopia, the sectors that contributed to the Gross Domestic Product (GDP) include Agriculture, Industry and Services. According to the annual report of the National Bank

of Ethiopia for the year 2022/2023, Ethiopia showed slight economic growth (6.4% to 7.2%) resulting from growth in the service at 7.9%, industry at 6.9% and agriculture at 6.3%.

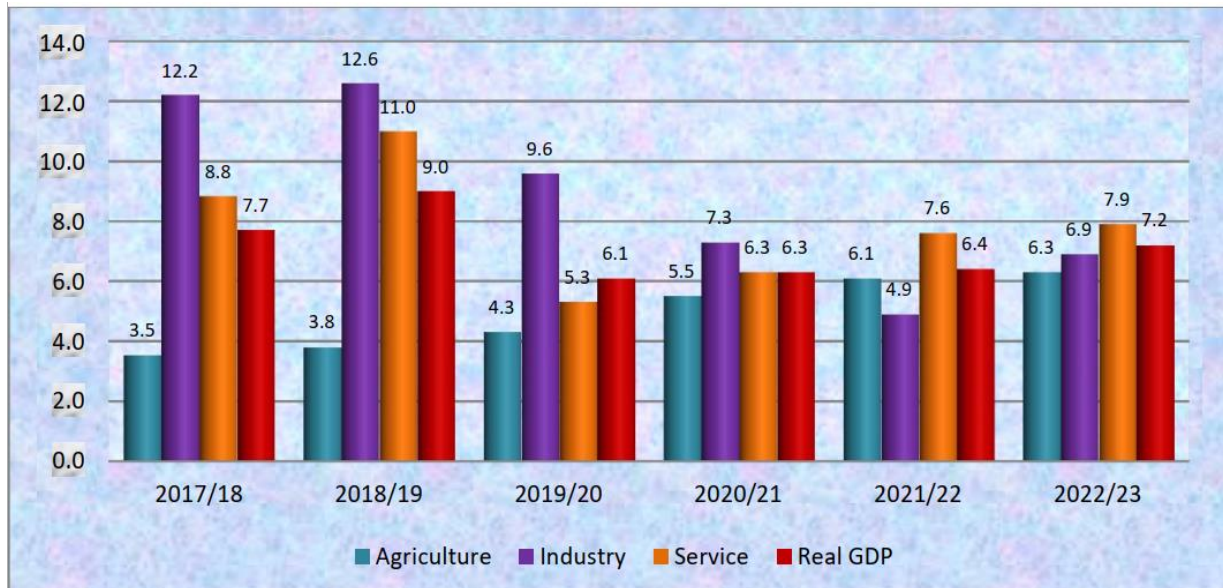


Figure 2-1: Share of Agriculture, Industry and Services to GDP over the past Decade

(Source: NBE Yearly Annual Report 2022/23)

As indicated in figure 2.1, the service share to GDP show a gradual decrement between the year 2017/2018 and 2022/2023 mainly due to market inflation and the recent outbreak of COVID-19 pandemic. In the meantime, the industry share of the overall GDP has improved over the past decade. Industry comprised sub-sector of mining and quarrying, manufacturing, electricity and water, and construction. Among those sub-sectors, Construction accounts for a great share than others and shows an increment from year to year as depicted in the figure below.

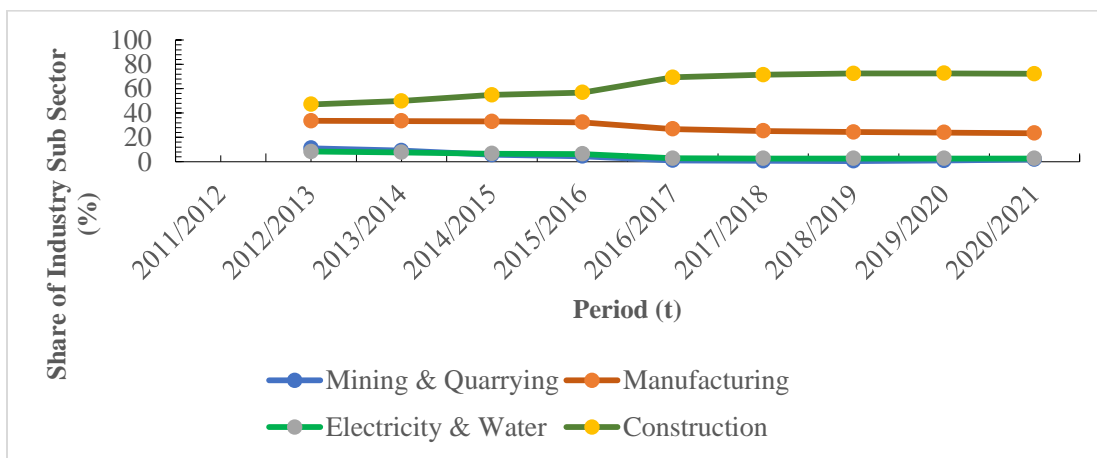


Figure 2-2: Share of Construction Sector in the Domestic Gross Development of Ethiopia

(Source: NBE Yearly Annual Report)

2.4 Purpose of Cost Estimating

Determining the project's anticipated cost is the primary goal of cost estimating. For the client, this goal is crucial when deciding whether to proceed with construction because estimates serve as the foundation for tender comparison and negotiation, (Mustapha Muhammed, Abdulazeez, Abdulmuminet *al.*, 2014). The goal of a pre-tender cost estimate is to provide an idea of the most likely construction cost at the earliest stage of a building project.

The construction industry's main job is to estimate costs. Since these estimates serve as the foundation for later project cost control, their accuracy from the beginning of a project to the tender estimate can determine whether the project succeeds or fails. A project's estimate that is too low could result in financial losses for the organization when the work is carried out. The company can lose the contract as a result of overcharging or cost overruns if the estimate is excessively high, (Alemayehu, 2014).

Marjuki,(2006) cited in (Alumbugu, Polycarp Olaku *et al.*, 2014) outlines the purpose of a cost estimate as:

- a. Gives an estimate of the capital cost of a particular project;
- b. The framework for planning and control by outlining the tasks involved and their projected costs;
- c. Contains a large amount of the fundamental data (hours, resources, tasks, and durations) required for creating a timetable, together with the quantities of workers, materials, and construction equipment;
- d. Provides the financial information required to create cash flow curves;
- e. Pulls together a lot of the pertinent project data into one easy-to-read document, which acts as a catalyst for brainstorming, idea generation, team participation, clarity, and buy-in.

It is important to note that the cost estimate has uses beyond just setting a project's budget. Additionally, it is a resource or tool for project scheduling and cost control. Effective and economical projects are driven by the interplay among estimating, scheduling, and cost control - a relationship that is sometimes referred to as cost engineering. Thus, an effective estimate must not only establish a realistic budget, but must also provide accurate information to allow for scheduling, cost monitoring, and progress measurement of a project during execution.

In our context, the purpose of Engineer's Estimate generally is to enable ERA allocate sufficient budget for the construction of the works and assess the reasonableness of the bids during the

procurement of contractors for the works by evaluating and computing the current market price and associated factors. Accordingly, this should be reviewed, validated and tested properly.

2.5 Overview of Ethiopian Roads Administration (ERA)

The Ethiopian Roads Administration (ERA) is a federal organization established on January 26, 1951 and is currently responsible to construct federal road construction projects in the country in collaboration with regional road authorities to achieve the intended objectives of the sector (ERA, 2011).

The ERA, as a public body of the Federal Democratic Republic of Ethiopia for the development and administration of federal highways; outsources the design and construction of road projects to different national and international contracting firms.

ERA is headed by a director general who reports to the board of directors. ERA as a legally autonomous organization the organization has gone through a series of structural changes in many times one being in July 2011 by the Council of Ministers Regulation No. 247/2011. This regulation corroborates the split of the operational and regulatory wings as two independent entities, leaving ERA to focus on road network development and asset management rather than construction and maintenance of same.

Consequently, ERA's operations department which was responsible for carrying out routine and heavy maintenance of federal roads and construction of road projects with more than ten (10) thousand employees was established as independent public contractor named as Ethiopian Road Construction Corporation (ERCC).

Despite several reestablishments, the organization's major responsibility, i.e., development and management of roads, has never been substantially altered. ERCC had operated as profit making public organization. ERA awarded to ERCC road projects that would be too expensive if awarded to private contractors because of reasons such as difficult terrain and remoteness. ERA also awarded to ERCC most of the routine and heavy maintenance of federal roads through direct negotiation. ERCC's 70 years' experiences in the construction of both gravel and asphalt roads as force account of ERA would enhance its competitiveness in bidding. ERCC as government organization plays crucial role in stabilizing cost of road construction in the sector.

In order to solve the absence of bidders for maintenance projects due to its unattractiveness to contractors because of its lower price; ERA reclaimed and requested the return of maintenance

districts. This request is of course ratified by the council of ministers and the maintenance wing of ERCC; i.e. the districts are returned to ERA in 2019/20.

Recently, ERA has made organizational structure change specifically on the construction project management regions to be restructured in to project administration program unit following government's restructuring of government organizations and their accountability offices.

Currently, ERA has an organizational structure comprising five Deputy Director Generals (DDGs); namely, the Office of Director General, construction projects management program deputy director general (CPM DDG), project development deputy director general (PD DDG), Road asset management deputy director general (RAM DDG) and corporate services deputy director general (CS DDG) which is indicated in the chart below. Specifically, the project development directorate has the mandate to administer the entire design service contracts with its Design management (DM) directorate and procurement of road projects with its Engineering procurement directorate (EPD) under ERA. Whereas, the CPM DDG have six construction projects management program that administer construction projects all over the country. These are:

1. East Construction Projects Management Program
2. West Construction Projects Management Program
3. South Construction Projects Management Program
4. North Construction Projects Management Program
5. Central Construction Projects Management Program
6. Expressway and Special Projects Construction Projects Management Program

The organizational structure of ERA is depicted in the figure below.

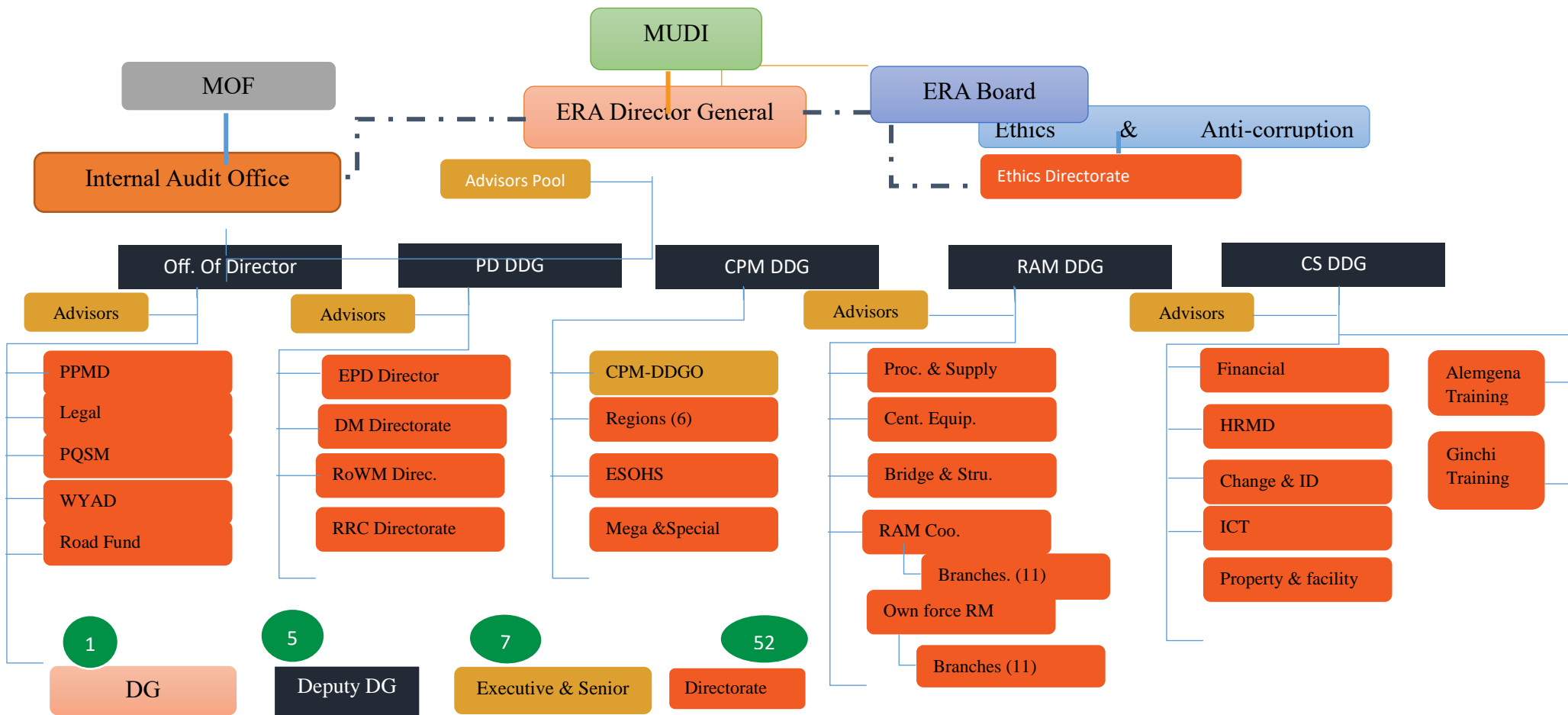


Figure 2-3: ERA Revised Organizational Structure

(Source: ERA)

2.6 Road Sector Development Program (RSDP)

The road is the most important infrastructure that provides access to rural and urban areas in the country. Road plays a crucial role to reduce transportation costs and support economic growth in the country (ERA, 2021). The road development sector plays a significant role in the economic, political and social development of a country.

Recognizing the road infrastructure contribution to rapid and sustainable economic growth and poverty reduction, the government of Ethiopia is expanding, upgrading and maintaining a wide range of road networks. The Government of Ethiopia therefore initiated the Road Sector Development Program (RSDP) in 1997 after realizing that the existing road network's poor quality and uneven coverage had impeded economic recovery and growth, aiming to:

- ✓ Boost transportation operational effectiveness and lower freight and passenger transportation expenses on the road to support production, distribution, and export;
- ✓ Provide access to previously neglected food deficit rural areas to support efficient production, exchange and distribution throughout the country, and
- ✓ Develop an adequate institutional capacity of the road sub-sector both at central as well as regional levels.

Since then, five phases of RSDP were implemented over the period of 1997 – June 2020 and the sixth phase, RSDP VI has been launched and being implemented since July 2020, (ERA, 2024).

- RSDP I - From July 1997 to June 2002 (5 years plan)
- RSDP II - From July 2002 to June 2007 (5 years plan)
- RSDP III - From July 2007 to June 2010 (3 years plan)
- RSDP IV - From July 2010 to June 2015 (5 years plan)
- RSDP V - From July 2015 to June 2020 (5 years plan)
- **RSDP VI - From July 2020 to June 2025 (ongoing)**

Federal and regional roads have been constructed by the Ethiopian Roads Administration (ERA), Regional Roads Authorities (RRAs), Woreda Road Offices (WRO), the Community, and Municipalities over the course of the RSDP's 26 years. These physical works include the rehabilitation and upgrading of trunk and link roads, the construction of new link roads, the construction of rural and Woreda roads, and maintenance of existing link roads.

The Twenty-Six (26) years performance Assessment report of the Road Sector Development Program developed by ERA indicates that the RSDP financing over the last twenty - six years came from the government of Ethiopia (GoE) and other internal sources. The GoE has financed 78%, whereas 5.9% came from the office of the Road Fund and the Community has contributed 1% of the total finance of RSDP. The remaining 15.1% was pooled from development partners (IDA (4.8%), China (3.3%), AfDB (2.4%) and others collectively 4.6%), (ERA, 2021). The share of the financial fund of the RSDP is shown in figure 2.3.

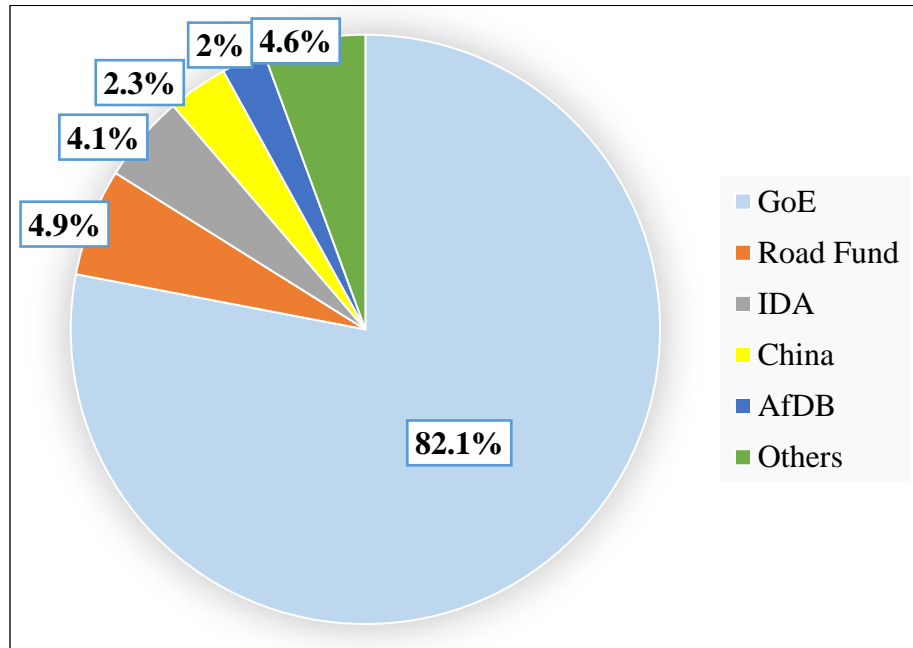


Figure 2-4: Share of Financial Pattern of RSDP

(Source- [ERA (2024), 26Years RSDP Performance Assessment Report])

The RSDP program is achieving satisfactory progress against its objectives and benchmarks in terms of improving rural accessibility and the condition of the road network. The country's road network has increased from 26,550 km in 1997 to 165,863 km in 2023. As a result, the road density per 1000 sq. km has increased from 24.1 km in 1997 to 144.5 km in 2023. The improvement has been also registered in the condition of the country's road network. The proportion of the road network in acceptable (good and fair) condition is 62.3% in 2023.

The proportion of road networks (only federal and rural gravel road networks) in good condition was 22% in 1997 and in 2023 of the total federal, regional and universal rural road access program (URRAP) road network. Besides, the difference in road network coverage in 1997 and 2023, the decline in the proportion of road networks in good condition in 2023 from the previous

years is due to a change in categorization, definition and class of road condition of the federal road network, (ERA, 2024).

The twenty-six years of performance of RSDP have brought significant improvements in the restoration and expansion of Ethiopia's road network. Physical achievements have been matched by significant improvements in the condition of the network, strengthening of the management capacity of the road agencies and delivery of policy reform.

As a result, a total of 182,566 km of major physical road works excluding routine maintenance were carried out of which 56,995 km were on Federal Roads, 38,726 km were on Regional Roads construction and 86,845 km on URRAP Roads. Overall, physical accomplishment against the plan was 65% and total disbursement was about ETB 597.8 billion, and this disbursement was 74% of the plan.

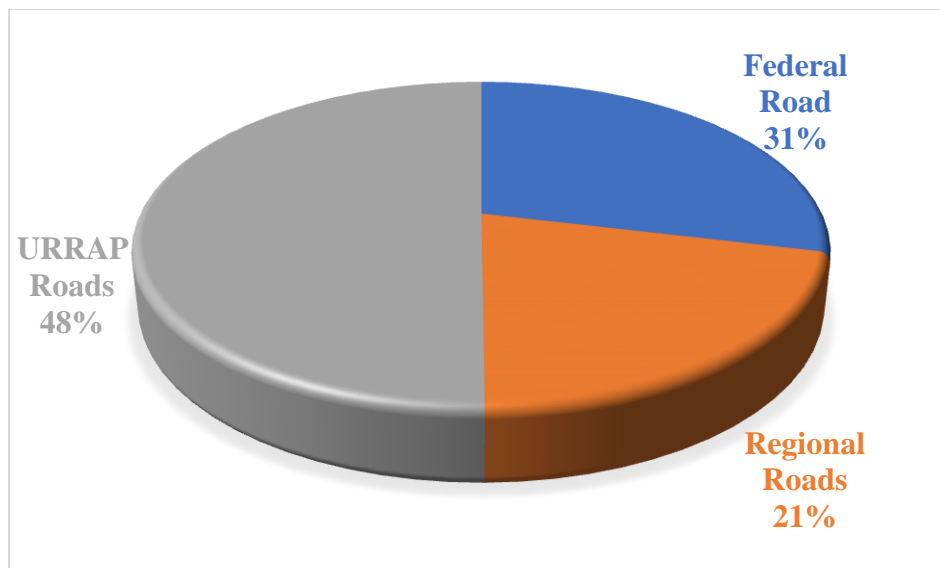


Figure 2-5: Distribution of constructed road projects

[Source: ERA (2024)]

With regards to Federal Roads, 4,206 km of rehabilitation of trunk roads and 14,417 km of upgrading of trunk and link roads and 16,112 km construction of new link roads and 397 km of construction of expressway roads and 1,724 km of heavy maintenance were carried out under the program. In parallel with this, 20,138 km of Federal periodic maintenance was also carried out, (ERA, 2024).

The table below depicts Summary of the Performance of RSDP over the past Twenty-Six Years.

Table 2-1: Summary of the Performance of RSDP over the past Twenty-Six Years

Type of Work	Total RSDP 26 Years					
	Planned	Actual	% age	Financial Plan	Disb.	% age
A. Federal Roads						
Rehabilitation of Trunk Roads	6,135	4,206	69	56,726	28,964	51
Upgrading of Trunk & Link Roads	17,749	14,417	81	19,2140	152,140	79
New Link Road Construction	16,551	16,112	97	23,1626	221,502	96
Expressway	692	397	57	65,165	31,252	48
Federal Heavy Maintenance	3,492	1,724	49	55,009	4,440	8
Federal Roads Periodic Maintenance	21,179	20,138	95	14,168	10,713	76
Federal Roads Routine Maintenance				10,687	11,510	108
Performance Based Maintenance				931	73	8
Others				24,452	17,469	71
Sub Total Federal Roads	65,798	56,995	86	651,076	478,064	73
B. Regional Roads						
Construction of RRAs Gravel Roads	40,350	38726	95	42535	55,468	130
RRAs Upgrading to Asphalt	1,229	-	29	14865		
Regional Roads Maintenance				7387	8,485	114
Others	-	-		203	116	57
Sub Total Regional Roads	41,579	38,726	93	64,990	64,068	99
C. Woreda Roads						
Construction (URRAP)	171,499	86,845	50	77,719	49,076	63
Maintenance (URRAP)				6096	3516	58
Sub Total Woreda Roads	171,499	86,845	50	83,815	52,592	59
D. ERTTP/Community Road						
Community Roads				2643	2,296	87
Sub Total Community Roads				2,643	2,296	87
E. Urban Roads						
Sub Total Municipalities Maintenance				1,007	829	82
TOTAL	278,876	182,566	65	803,531	597,849	74

[Source: ERA 26 Years RSDP Assessment Report (2024)]

As depicted in Table 2-1, an average of 86% of planned federal road projects are completed (rehabilitate, upgrade, and construct), and 73% of the allocated budget is disbursed.

Generally, the overall achievement of the RSDP over the past 26 years in terms of road sector investment has shown success in respect of road accessibility, quality and mobility, impact on the domestic construction industry and the participation of domestic and foreign contractors.

Since 1997, the total road network has expanded from about 26,550 km at the beginning of the RSDP to its current 165,863 km including Woreda and Municipality roads, increasing the road density from 24.1 to 144.5 km per 1000 sq. km area and from 0.46 to 1.42 km per 1000 population in 2022/23.

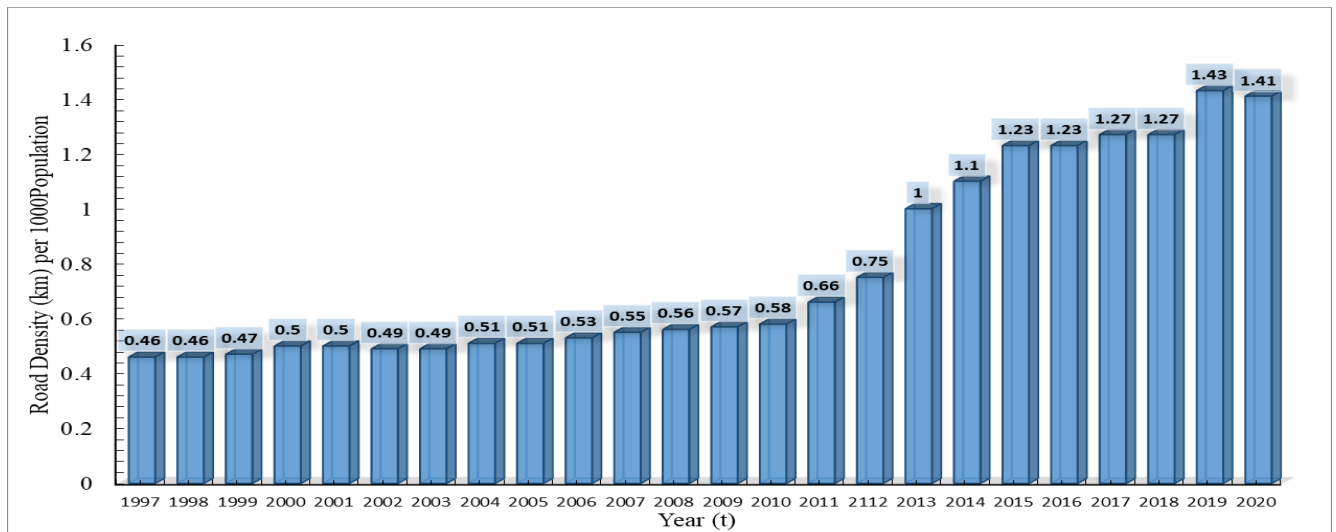


Figure 2-6: Road Density (km) per 1000 Population over the 23 Years

[Source: ERA (2024)]

As indicated in figure 2-6, the total road network expands over the past twenty six years with an increase of 0.96km per 1000 population between the year 1997 and 2023, showing a significant increment 208.70%.

Further assessment of traffic on the main roads shows the presence of a rapid and continuous increase in the volume of motorized traffic. Vehicle kilometers of travel increased from 3.8 million in 1997 to 30.73 million in 2020, whereas it shows a decline from 30.73 million in 2020 to 22.63 million in 2022 showing an average annual increase of 7.6%.

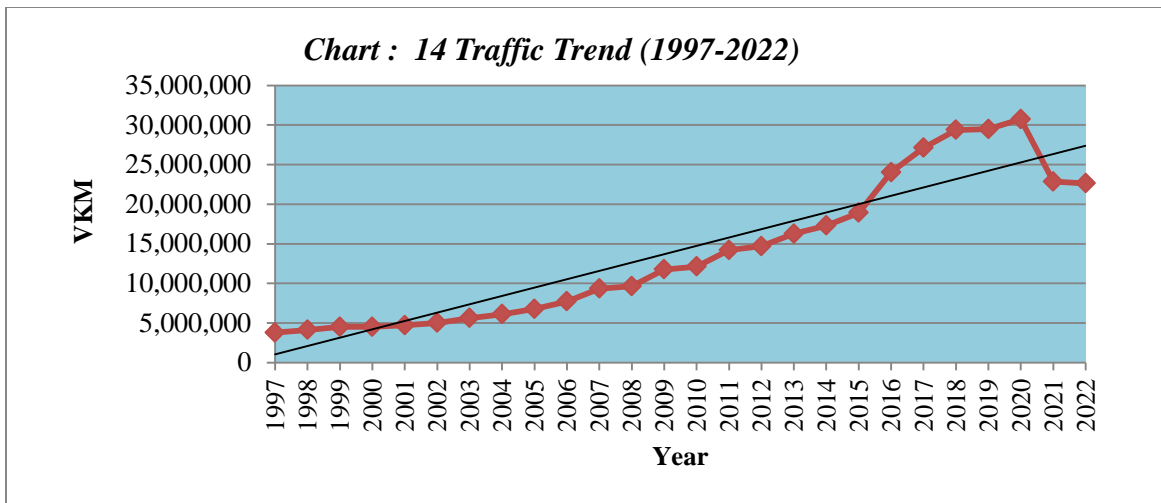


Figure 2-7: Traffic Trend from 1997 to 2022

[Source: ERA, 2024]

RSDP has also impacted on building the capacity of the domestic construction industry by increasing the participation of the local contracting industry in terms of both the value and number of projects over the last twenty-six years. For instance, the total value of contracts awarded to local contractors is about ETB 309.5 billion, which accounts 61.8% of the total contract amount awarded since July 1997. In addition, some local contractors are now taking bigger contracts, with values amounting as much as ETB 8.4 billion

In terms of number of projects, of the 2,254 contracts (both construction & consultancy) awarded over the last twenty - six years of the RSDP; some 1,779 (close to 79%) contracts were awarded to local companies of which 56% were for consultancy services and 44% for construction contracts.

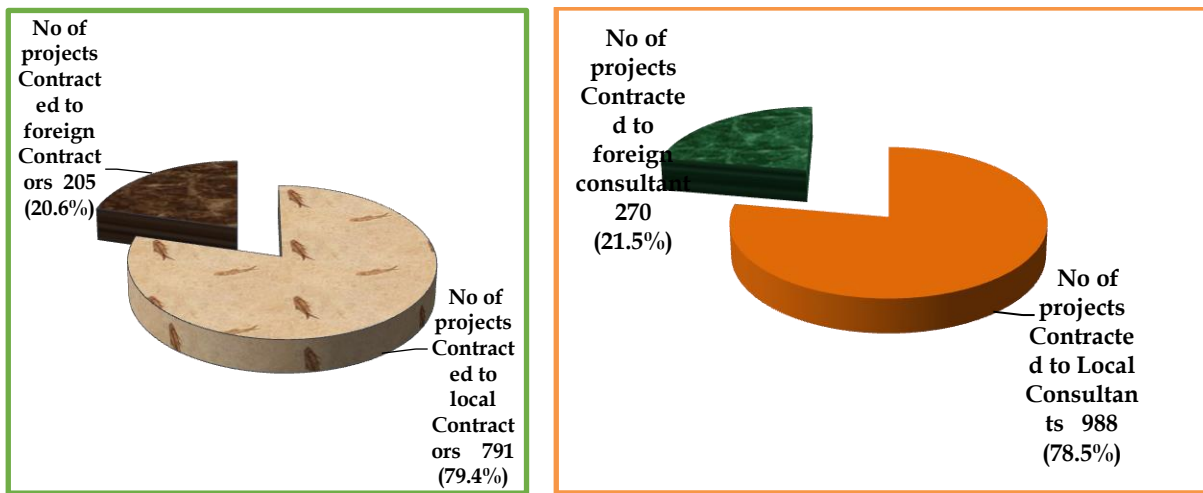


Figure 2-8: Projects Awarded to Local and Foreign Contractors & Consultants

(Source: ERA, 2024)

2.7 Overview of Ethiopian Roads Administration Management System (ERAMS)

2.7.1 Description and purpose of ERAMS

ERA Management System (ERAMS) Manual had been prepared by *Richard Langford-Johnson* in December 2017. The purpose of the manual is to familiarize ERA staff with the ERA Management System (ERAMS) and to give instruction for its use and management.

A tool called ERAMS is installed on a computer server at the ERA Data Center and can be accessed via a secure website on the Intranet or the Internet. It can help with project and contract management at every level, from project engineers carrying out their responsibilities on specific contracts to executive chain members reporting to the director general.

According to (Langford-Johnson, 2017), its function is to provide centrally accessible reliable information considering the following basic points:

- By validating estimates using the **Estimate Validation System (EVS)**, a single source of management information may be provided, improving management accountability and responsibility and improving budget allocation assurance;
- Improved efficiency and enhanced examination of Works and Maintenance Contract Bids through the analysing of the **Tender Analysis System (TAS)**, which gives assigned personnel the capacity to assess bidder rates by contrasting them with the Engineer's Estimate and any other bidders' offers which will assist in:
 - Identifying inconsistent rates which may highlight misinterpretation or error in the Bill of Quantities that can be addressed before contracts are signed,
 - Identifying potential over or exceptional underpricing,
 - Providing historical rates for validation of estimates through EVS.
- Monitoring progress of construction and maintenance works through the **Works Monitoring System (WMS)** allowing:
 - Regular monitoring of physical and financial progress,
 - An emphasis on final costs, projected completion dates, and the causes of overspending and delays that can be resolved in subsequent contracts,
 - A review of typical features that raise expenses and cause delivery delays.
- Improving performance of Contractors and Consultants through the **Performance Appraisal System (PAS)** which provides;
 - a straightforward performance monitoring input that indicates the need for consultants, contractors, and ERA to perform better during contracts and

- Simple Performance Evaluation input that rates the entire performance of consultants and contractors, providing ERA with the chance to enhance its selection process

2.7.2 *Concept of ERAMS*

To enable other systems to integrate with previously saved data, ERAMS offers centrally connected data storage. From detail design to job completion, the system is essential for tracking the performance of consultants, contractors, and contracts.

Consider ERAMS as a wheel running smoothly over the road surface.

- The **Hub** of the wheel as the holder of DATA
- The **Spokes** are the interface between the DATA and the INFORMATION
- The **Rim** is the INFORMATION and KNOWLEGE extracted through the Spokes from the Hub
- The **Tire** is how the Users, ERA staff, use that INFORMATION and KNOWLEDGE

The tables within the Hub are multi-layered but for illustrative purposes, if layers were pulled apart, they would see the linkages as shown in the sample illustration below. The links may change dependent on the type of contracts awarded.

Alternatively, the Project Region, Firm, or any other table at the center can be used to draw the image. Reports can be generated by project, contract, region, firm, or any other factor by linking in this manner. ERAMS becomes a highly powerful reporting tool as a result.

Directorates within ERA have specific responsibilities in maintaining reliable data in the ERAMS.

- Projects are developed and monitored by the Planning Directorate,
- Contracts identified by Planning Directorate and given budgets,
- Consultancy Contracts are awarded on ERAMS by Procurement Directorate,
- Works Contracts are tendered through CAC and TAC and awarded on the ERAMS by Procurement Directorate,
- Works contracts are managed by the Implementing Directorates, e.g. Regional, Design and Build (Know Design Directorate), Expressway and Districts,
- Consultancy Services can be managed by any Directorate,
- Responsibility for audit is the Quality Assurance Inspection and Road Safety Management Directorate (QARISM).

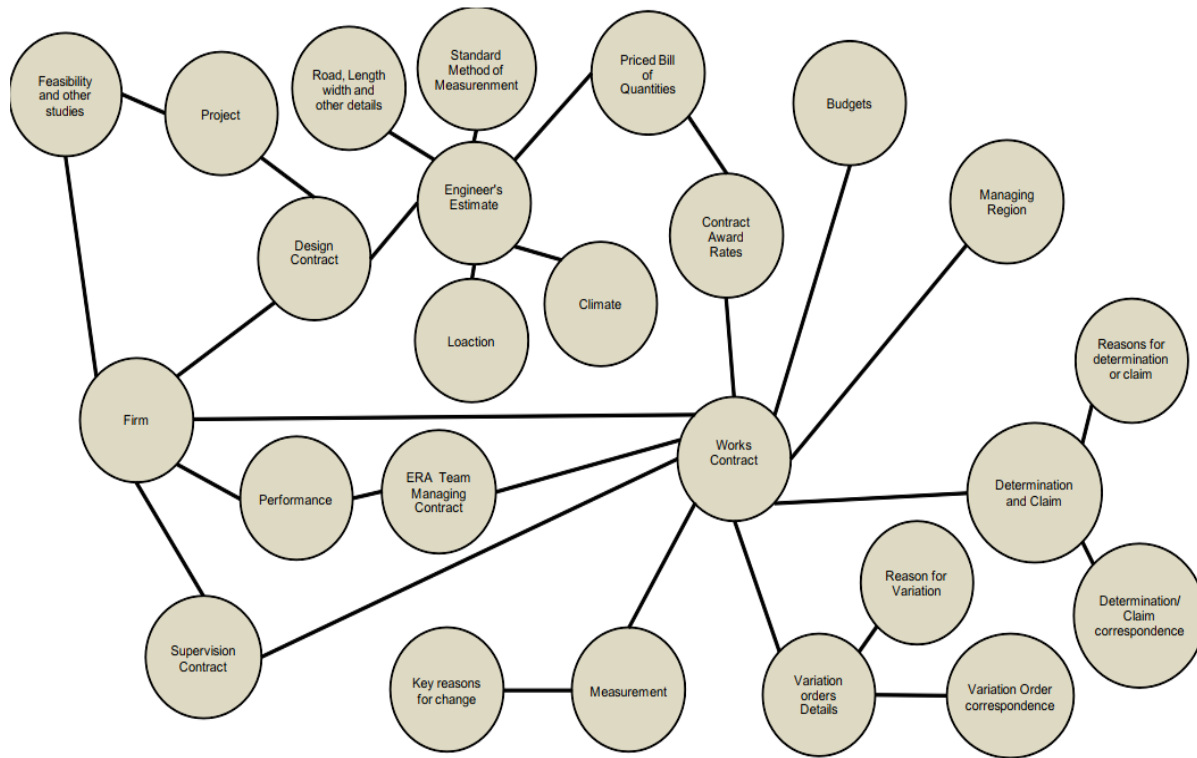


Figure 2-9: Schematic illustrating some of the linking within the data hub

[Source: ERAMS Manual]

Only the Directorate representatives have access to data associated with their areas of responsibility. As a result, unless Planning identifies the Project and specifies the Contract, Contracts cannot be entered into the system by Procurement. Similarly, the Regions are unable to access a Contract until Procurement awards it.

Since the Directorates depend on one another for the system to work correctly, it is crucial that each Director to make sure his or her directorate fulfills its commitments. From the above lists of purposes of the ERAMS, however, this paper focuses mainly on *Estimate Validation System (EVS)*.

When we come to our concern i.e., Engineering Cost Estimates Validation, ERAMS attaches the Engineer's Estimate from the Design Consultant and is managed by an Implementing Directorate. Once approved the Estimate is available to Procurement to manage the tender process to award. Procurement awards the contract by entering award and start dates and other details, (Langford-Johnson, 2017).

2.7.3 Tender Analysis System (TAS)

The main function of this part of ERAMS is to provide historic rates and at the same time allow checking of bid amounts and a simple analysis rate by rate. The Bill of Quantity (BoQ) is identical to the Engineer's Estimate; however, there is a facility in the system to allow the user to change the quantity not rate. The system then follows on to award works contracts.

2.7.4 Management of ERAMS

The Management of the system on behalf of Senior Management (Director General, his Deputies and Directors) is the Director of QARISM. The role will include promoting the system and working with Senior Management to provide further expansion and development of the base system. The ERAMS Manager (QARISM Director) is responsible for ensuring that each Director has procedures in place to ensure accuracy and consistency of data.

The system is only as good as the data entered. It is essential that Team Leaders across all Directorates take responsibility for their teams entering reliable data. Reports within the system will allow effective review of data being input. Team Leaders should be held accountable to their Directors for the quality of data. The Estimate Validation system is the responsibility of ERA's Design Management Directorate and the end users of the information are regions, asset management and procurement. Consequently, the Tender Analysis System (TAS) and award of bid is the responsibility of ERA's Procurement Directorate.

Responsibility for Validating and Approving Estimates prior to tender implementing director is the Director (i.e., Design Management Director). Works and maintenance estimates must be approved by the Director responsible before the Procurement Team Leader can prepare a tender and allocate TAC. The Director must be satisfied that his/her Team Leader has validated the Engineer's Estimate and that it is fit to proceed.

In the Manual, the role of the director is stipulated as Review, validate and Approve Estimates once validated. Besides, its accountability is Management and Leadership of the Directorate with respect to ERAMS and overall responsible for the data on the system emanating from the Directorate and Validation and Approval of Engineer's Estimates. Whereas, the accountability of the Project engineer is to input details of the Engineers Estimate including BOQ and to amend ECE as agreed with the Engineer.

The duties and role of ERA's QARISM Directorate is that to keep rate build rates up-to-date and calibrate regularly against historic rates and make appropriate adjustments with a major review on an annual basis. His accountability includes, but not limited to, assigning staff to Rate build responsibilities ensure there is knowledge of the ERAMS and users are properly trained. In doing so, the team leader under the director assists him in updating Rate-build to the satisfaction of the Director. The project Engineer (PE) under the team leader have the accountability to help and support staff from other directorates and in rate build up as assigned by the Director. On written request from an Implementing Team Leader, the QARISM Team Leader can enter the system, open the Data screens for the required contract and remove approval, and unlock or amend data fields.

ERA's ICT Directorate has a role and accountability to ensure twice daily backup, maintain security of System and carry out special queries on the system and allow for correction to erroneous data. ERAMS uses the date and time on the server and is critical for its operation. Therefore, the dates and times on the server must not be modified.

2.8 Elements of Cost Estimate

The cost of a construction project has various elements within it which could be categorized into different sub categories. This paper focuses on the detailed cost estimate prepared based on the Bottom-Up Estimating technique which requires a detailed breakdown of the work into smaller items of work to determine the costs that are developed in close review of the bidding documents prepared at the conclusion of the detailed design. It's also essential to note here that all the concepts and assumptions made in other estimating techniques are either employed here or qualified.

According to PMBOK, Costs are estimated for all resources that will be charged to the project. This includes labor, materials, equipment, services, and facilities, as well as special categories such as an inflation allowance, cost of financing, or contingency costs. Cost estimates may be presented at the activity level or in summary form.

Most service contract requires the cost estimator to adopt a unit rate analysis approach during the development of the Engineer's Estimate wherein a unit cost of each item of work be quantified together with the anticipated profit, (Yoseph Kidane, 2023). This unit cost includes among other things:

- The labor, material and equipment cost of undertaking each item of work

- The site and head office overheads of the project
- Financing charges; like insurance, bonds and/or guarantees
- Sampling, testing (including trial lengths of pavement), and checking information given by the Engineer
- Damage caused to the works under construction, equipment, materials and consumable stores by weather conditions
- The provision, erection and removal of all the Contractor's and Engineer's offices, equipment, yards, stores and temporary works, including fencing and all site restrictions
- Repairs to the Works during the Defects Liability Period
- All haulage, if there is no overhaul separately paid
- All other risks as appropriated in the conditions of contracts; like Liquidated Damage, Price Escalation, Inflation and currency exchange rate

Hence, to consider all the above obligations, the cost of executing any pay item per the specified unit of measurement is estimated as a combination of direct cost and indirect cost as shown in the chart shown below.

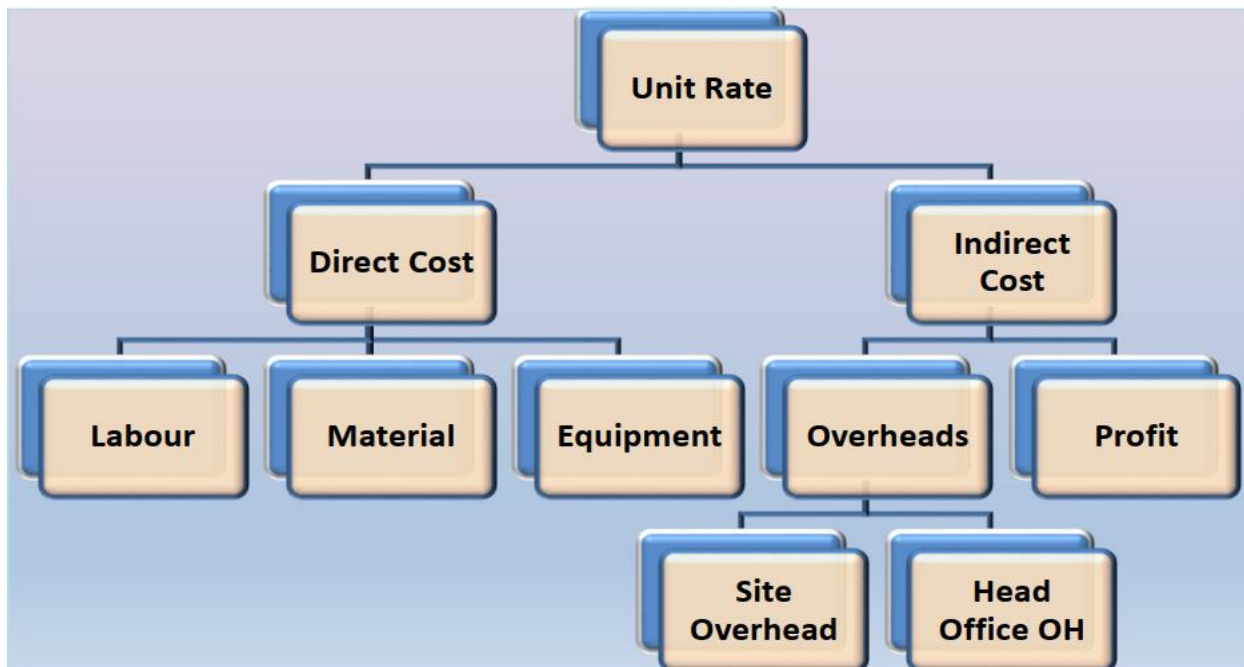


Figure 2-10: Unit Rate Breakdown Chart

(Source: ERA Cost Estimate Training Manual)

Rate build involves a clear understanding of the elements that making up the rate and how they are valued. It highlights the need of appraising the various materials hauled in construction as

well as the material produced on site, and it differentiates between direct and indirect rates. It also breaks down the direct element into plant, labor, and material. Finally, it shows how all of these factors are combined to achieve a rate build, (RL-J, 2018). The following element of cost estimate has to be included in developing a rate:

2.8.1 Direct Cost

The direct cost of each pay item consists of inputs like materials, labor and equipment that are directly applicable on those particular items of work and required to carry out the work right at the designated spot.

Basically, productivity of each item of work depends on the effective combination of the labor, material and equipment and in this respect, it could be estimated using previously published Manual (ERA Construction Management System (CMS) Manual), typical current Contractor's performance and the Engineer's general construction supervision experience. However, these figures should be adjusted taking into consideration the prevailing project settings of altitude, climate and other restrictions so that they reflect the actual working condition and expected productivity of the work force. The three essential elements of direct cost are briefly discussed below:

2.8.1.1 Labor Cost

The construction industry is among the highest industries to use large number of workforce in a particular project that could be classified as Skilled/Professionals, Semi-Skilled and Unskilled labors. Usually, semi-skilled and unskilled labors are involved directly on the construction work while the skilled professionals act as site overheads and are not included in the computation of direct cost. Hence, determining the labor cost (semi-skilled and unskilled labors) is an integral part of the direct cost computation.

The labor cost consists of the estimated number and utilization of a particular labor required per planned hourly output of any single activity having due regard to the following;

- The required supervision for the works (supervisory personnel such as foremen)
- The type and number of equipment (drivers and operators)
- The specific nature of the activity (bar setters for activities requiring rebar handling and placing, powder man in activities involving blasting etc.)
- Laborers, helper etc.

Labor cost of each project is greatly influenced by different factors such as climate, working culture of the project area, population density, security and location from Addis Ababa/major town. Each of these factors should be considered in the determination of labor cost for each particular project.

2.8.1.2. Material Cost

Material cost consists of the estimated appropriate quantity of materials required to execute the designated hourly output of each particular items of work. The material cost of the project is highly affected by location, climate, terrain, and other geological/engineering features of the project area.

The material used in the unit rate breakdown could be produced at the project site such as sand, aggregate etc. or purchased like reinforcement steel, bitumen, cement etc. An allowance should be made for transportation and loading/unloading and storage of the items to the project site to obtain the total material cost.

2.8.1.3. Equipment Cost

It covers significant portion of the direct cost which consists of the estimated type and number of equipment required to achieve designated hourly output of each particular bill item. The hourly equipment cost should be developed considering the following two associated costs. These costs are all those costs in which the owner of the equipment expends throughout the economic life of the equipment whether the equipment is working or not. [Yoseph Kidane (2023)]

a) Equipment Owning Cost

These costs include mainly the purchasing (basic) cost of the equipment, the depreciation costs of the equipment with the consideration of its salvage value, erection and installation costs, major repairs and overhauling costs, property taxes and insurance charges etc.

b) Equipment Operating Cost

The operating cost is dependent on the period of operation (hours), location of the construction site, the site conditions under which the machine is operating the type and category of the equipment. The Equipment Operating costs include cost of repair and maintenance, fuel cost, tire cost and service costs.

2.8.2 Indirect Cost

Indirect construction costs are all costs which cannot be directly booked under a specific activity in a construction project but rather required to keep the whole project operational. Besides, all activities could not be exhaustively seen in the bill of quantities; and cost of such items could only be seen as part of the indirect cost. Indirect costs are commonly estimated as percentage values of the direct costs. The following are the main categories of indirect costs:

2.8.2.1. Site Overhead

This element of the cost represents those cost that are not directly pertaining to any given construction work item but are nevertheless necessary for ultimate completion of the designated work. It consists of any costs that are incurred on the project site.

Typical items of site overheads are:

- Mobilization and Demobilization costs to and from the project site
- Inter-site movements/transportation of construction equipment
- Electricity, Telephone and Water at all sites of the project
- Construction of Storage, Workshops, Camps, offices, access roads
- Maintenance costs of Workshops, accommodations, workshops, storages, etc...
- Costs of some activities that are required to be done under the technical specification but not seen in the bill of quantity
- Salaries of Project Managers, Administrative Office staffs, General Superintendent, Non-working Foreman, Time Keepers, Securities, Janitors, etc.
- Other benefits of the aforementioned employees; like per diems, bonuses, etc.
- Office supplies, equipment, small tools and Engineering services
- Photographing, videos, permits and fees,
- Transportation of site workmen/women, to and from the site

According to ERA CMS manual, the suggested range for Site overheads is between 7% and 20%, (RL-J, 2018).

2.8.2.2. Head Office Overhead

This part of the cost estimate is to represent the contribution of the contractor's head office staffs and equipment for the completion of the project as they provide support and guidance to the on-site project team. Head office costs; such as salaries of the General Manager, Administrative

Staffs, Procurement Staffs, etc...and cost of supporting facilities are paid from the money received for undertaking the work on the company's projects.

This cost covers among others;

- Costs of senior management staff at head office (Salaries, Per-diems, bonuses, other benefits like medical insurance, etc...)
- Vehicles for Head Office (depreciation etc...)
- Cost of building and office (Depreciation or rental)
- Cost of maintaining and operating head office
- Office furniture and equipment expenses
- Insurance
- Travel expenses

According to ERA CMS manual, Head Office overheads seem to vary between 3% and 10%, (RL-J, 2018).

2.8.2.3. Financing Charges

These includes payments for Insurances and Bonds like performance bond, advance payment bond Contractor's all risk policy, motor vehicle insurance, Contractor's Workmen Insurance etc. throughout the contract period.

2.8.3 Profit

Contractor's profit allocation varies from contractor to contractor depending on their financing strategy. Nevertheless, for sake of estimating a project price, a certain percentage of the direct cost is usually considered. Usually, it ranges between 7 to 10 percent.

According to ERA CMS manual, Profit varies between 3 and 5% however some contractors have recorded up to 10% when tendering, (RL-J, 2018).

2.8.4 Taxes and Duties

Several taxes and duties are built in the Engineer's estimate and need to be considered during the estimation process; among them are: Import duties for good and materials, Value Added Taxes, Profit Taxes, Dividend Taxes, SUR Tax (if imposed) and other taxes as applicable.

2.8.5 Risk Allowance

This section of the cost estimate is one of the most essential sections that needs to be given due emphasis during preparation of the estimate. Particularly, construction sector exhibits various

and numerous types of risks which shall be properly identified, analyzed and managed for the successful completion of a project. It is defined as uncertainties that may have positive or negative outcomes on the project in the future to the extent of determining the fate of the project. We should also bear in mind that risks may arise from anyone and anywhere within the project.

Most of the time risk assessment is prepared for only DB projects in ERA's trend. However, Contingency is allocated for DBB projects.

2.9 Methodologies and Techniques for Cost Estimating

Owners find it extremely challenging to ascertain the bid cost of their unit priced items because of the dynamic nature of the bidding process. There is a lack of a reliable method that can forecast the bid price for a given project with accuracy based on past bidding patterns. Since a bid consists of several items, it is necessary to do a thorough item-level analysis in order to comprehend the bidding pattern for each item. The quantity of the item, its availability at the time the project is being carried out, the project's location, and many other factors can all affect the bidding pattern, (Shrestha, Pradhananga and Mani, 2014).

Depending on the project's development stage, several cost estimate development methodologies could be employed. Here, the researcher highlighted the main elements of construction cost estimating; however individual firms' approaches to costing may differ. It is essential to remember that any estimate's accuracy is based on the amount of data gathered; in other words, the more data we have, the more accurate the cost estimate will be.

Since it is used to confirm feasibility studies on facilities or to assess design alternatives, there are many different approaches for estimating construction costs. Additionally, it is a crucial component in organizing and getting ready for construction projects. Therefore, it is imperative to develop a technique that would increase the precision of construction cost estimation in the planning stage, (Shrestha, Pradhananga and Mani, 2014).

According to the Project Management Body of Knowledge (PMBOK), there are three types of cost estimating which are briefly presented below:

2.9.1 Analogous (Conceptual) Estimating

Analogous estimating is a strategy that uses past data from a similar activity or project based on approximate technical requirements and related materials and services for the project to estimate the cost of an activity or project. Typically, the real cost of comparable projects is used to

estimate the overall project cost. In order to ascertain the project's cost at the outset, estimators frequently employ the comparable estimating approach.

In order to estimate a future project, it bases its estimate on the expenses of prior, comparable projects as well as the expertise of the experts involved in the process. Its accuracy level may vary between 20 and 50 percent from the actual cost. In situations where the project manager can only identify a few top levels of the WBS, it can be utilized as a quick estimating tool. This type of estimating also called Top-Down Estimating as the rough estimation starts from the total project cost, (*Project Management Body of Knowledge (PMBOK)*, 2017).

A conceptual estimate is developed in the early stages of a project's development using limited project scope information as well as incomplete design and engineering data. As a result, getting a reliable approximation of the cost requires a great deal of knowledge and judgment. Consequently, a conceptual estimate's primary purpose is to inform the owner of the projected cost, providing them with important information to consider the project's viability and future development, (Nardos Tadesse and Abebe Dinku, 2017).

When it comes to road construction projects, this cost estimating technique is adopted during the pre-feasibility stage by the client itself taking into consideration the Per-Km cost of previous similar road projects carried out under the organization. This cost estimate sets a preliminary budget for the client to proceed with the project development phase. In general, analogous estimating is less costly and time-consuming than other methods, but its accuracy is lower. Comparable duration estimates can be utilized in conjunction with other estimating techniques and applied to sections of a project or the entire project.

2.9.2 Parametric Estimating

Parametric Estimating is an estimating technique in which an algorithm (Statistical relationship) is used to calculate cost or duration based on historical data and project parameters. This type of cost estimating uses more features of project characteristics or parameters than the analogous technique. To construct significant projects that are measurable and scalable, preliminary designs and feasibility studies with a lower degree of precision are used as the foundation for the preliminary cost. Estimates from earlier projects could be used to determine the unit rates. In order to identify and estimate the cost of the most challenging tasks and/or thoroughly detailed tasks, it is assumed at this stage of the project that 20% of the work will account for 80% of the project cost, (*Project Management Body of Knowledge*, 2017).

Projects that are in the planning, scoping, or early design phases use parametric approaches. These strategies require the use of historical data to describe the cost in terms of easily known metrics, such as cost per square foot, cost per interchange, cost per lane mile, and cost per intersection, in order to determine the usual transportation facility's cost, (WSDOT, 2015).

Parametric schedule estimates can also be applied to a total project or to segments of a project, in conjunction with other estimating methods.

2.9.3 Bottom-up (Detailed) Estimating

Bottom-up estimating is a method of estimating project duration or cost by aggregating the estimates of the lower-level components of the work breakdown structure (WBS). An activity's work is broken down into more detail when its duration cannot be determined with a reasonable level of certainty. Dependencies between activities may or may not have an impact on how resources are applied and used. The Bottom-up estimating technique is dependent on the detailed work breakdown structures to the smallest activities of the specified work. This is relatively the most accurate cost estimate as it assesses the cost of individual work items and based on the outcome of the detailed design of the project, (*Project Management Body of Knowledge (PMBOK)*, 2017).

According to PMBoK, this technique involves estimating the cost of individual work items, then summarizing or rolling-up the individual estimates to get a project total that is why it is called Bottom up Estimating technique. The cost and accuracy of bottom-up estimating is typically influenced by the size and other attributes of the individual work items (activity): the smaller the work items the higher the accuracy of the estimate.

This cost estimate method will be applied when the project is well defined; all work items are identified, quantified, and created to meet the client's specifications. Hence, this paper will focus on the bottom-up estimating technique and its validation impact on the procurement of road projects.

2.10 Factors Affecting the Accuracy of Cost Estimates

The degree of accuracy of the cost estimation determines whether a project will succeed or fail. Since estimates serve as the foundation for tender comparison, appraisal, evaluation, and negotiations, they must be as accurate as possible. If these estimates are grossly inadequate, award decisions may be extremely difficult as project managers can make better decisions and prevent misjudging technical and financial solutions by using accurate estimating.

Given the importance of pre-tender cost estimate accuracy, it is assumed that determining the factors influencing pre-tender cost estimate accuracy and considering them early in the design phase will enhance the precision and accuracy of the consultant quantity surveyor's initial cost recommendations to his client. Cost is influenced by a wide range of factors. This can be explained and given meaning by keeping in mind that the construction business and its works are interdisciplinary, combining the efforts of suppliers, contractors, owners, and professionals. The cost of the project as a whole will be significantly impacted by the proper integration of various stakeholders' combined efforts from the design stage to project implementation or execution, (Alumbugu *et al.*, 2014).

The accuracy of cost estimates for construction projects is mostly determined by historical data and the estimators' experience. Numerous direct or indirect factors can impact the degree of accuracy, thus it's critical to compare the estimate to other projects of a similar size and kind to determine the range of potential consequences. The estimator must be realistic in his prediction and take into account all the variables that could have an impact on the estimate (Bakr, 2019).

These factors were categorized as control factors and external factors. The control factors are those that the estimators can specify and that improve estimating efficiency. The variables beyond of the estimator's control are called external factors.

The accuracy of an estimate is measured by how well the estimated cost compares to the actual total cost. There are four determinants of the accuracy of an early estimate:

- (1) The person who prepared the estimate;
- (2) The manner in which the estimate was prepared;
- (3) Project information; and
- (4) Other factors that were considered while preparing the estimate.

The issue of inaccurate cost estimation is demonstrated by the increasing amount of projects that are finished late and beyond budget. Project delivery would undoubtedly improve by figuring out what caused the pre-tender cost estimate to be inaccurate. Increasing the effectiveness of tendering can assist clients, consulting companies, and contractors by giving them greater ways to refine their tendering process, (Alumbugu *et al.*, 2014).

Odusami and Onukwube (2008) identified seven (7) most important factors affecting pre-tender cost estimate as: expertise of consultants, quality of information and flow requirements, project team's experience of the construction type, tender period and market condition, extent of

completion of pre-contract design, complexity of design and construction, availability and supplies of labor and materials.

Aibinu and Pasco (2009) cited by (Bakr, 2019), carried out research to investigate the factors related to the project's factors that have significant effect on the accuracy of estimation through comparing the cost at the concept design phase and the tender phase. Their study revealed that the factors which have greater influence on accuracy of cost estimates are the size of the project, procurement method, and location of the project.

Aliyu (2008) cited by (Alumbugu *et al.*, 2014) revealed 25 factors influencing the accuracy of cost estimate such as: complexity of design and construction, location of project, project organization, site constraint, experience of consultant, duration between estimate and commencement of work, completion period of work, inflation on cost of materials, number of competitors, quality of information flow, accuracy of BOQ, availability of skilled labor, procurement method, magnitude of variation order, method of payment, type of employer, financial status of employer, financial status of contractor, volume and value of workload, equipment and their condition, period of execution, expected natural forces, clarity and quality of drawing, value of specialist work, and prefabricated works were all recognized.

According to G. A. Bakr (Bakr, 2019), the most significant factors affecting the accuracy of cost estimates at pre-tender stage can be grouped as:

- ***Client's characteristics related factors:*** these includes type of client (private, public, etc.), level of experience of the client, the client's payment method, the client's capacity for payment, Construction procuring experience, clarity and definition of scope, awarding guidelines and the client's assessment, Client specifications and expectations for quality Construction time.
- ***Contract and tendering requirements related factors:*** these include the type of tendering (open, selected, etc.); the clarity of the terms of the contract; and the type of procurement (conventional, management, design-build, etc.). The amount of any upfront payments made, value of specialized work.
- ***External conditions related factors:*** these consist of the quantity and quality of competition, time of advertisements and the impact of weather, the influence of social and cultural issues, impact of governmental initiatives, The contractor's class or category Unexpected circumstances.

- **Resources and market conditions:** these consist of the cost and accessibility of resources, the cost and accessibility of labor, the price and accessibility of equipment, fluctuations in the exchange rate of currencies, the work requires a certain level of skilled workmanship. Inflationary pressure market circumstances, Productivity of labor.
- **Project characteristics related factors:** These include the project's size, projected duration, location, site conditions (topography, etc.), site constraints (storage, access, services, etc.), and complexity of the project, construction method, and impact on the project timetable.
- **Consultant's related factors:** These comprises the degree of expertise and experience of the consultant, the project team's experience, the number of members in the estimating team, the availability of experts in all sectors within the estimation team, the project team's capacity to manage the project, Technique employed for estimating, volume of work performed by consultants during estimating, time allotted for cost estimate preparation, degree of detail in drawings and specifications, completeness of contract documents and Level of communication.
- **Information and design parameters related factors:** These consists of the design team's level of experience, database accessibility (previous cost information on comparable projects), the flow and quality of the information, accuracy of cost information, precision and dependability of cost data, Applicability of cost information, design constructability and cost information updating process (feedback systems).

According to (Alumbugu *et al.*, 2014), preparing a realistic cost estimate is an essential component of any construction operation. Pre-tender cost estimates, however, are susceptible to bias and inaccuracy since they are usually produced under tight deadlines and lacks a completed project scope. Overestimating or underestimating on a project can have serious consequences.

The author argues that overestimating could lead the client utilizing additional resources for unproductive purposes or prevent finance companies from providing the necessary amount of funding because of uncertainties about the project's cost and potential returns. An overestimation for a particular project means lesser (minimal) resources would be available for other projects. Conversely, underestimating could result in a project's scope being reduced and ultimately abandoned. Negotiations that are unrealistic may arise from an underestimate. An estimate that is too low may lead to client dissatisfaction, abortive or wasted development efforts, or litigation.

Prepared pre-tender cost estimates or Quantity Surveyors Estimates (QSEs) and contract sums (CSs) (accepted tender estimates) of the projects were obtained from the database of the firm.

The information also includes the year of estimates and awards, the type of project, and the sectors the projects emanated from, (Oladokun, Michael G. and Odesola, 2013). The deviation of QSEs from CSs (Estimate bias [Error]) was calculated in percentage form using the formula:

$$\text{Estimate bias [Error]} = \frac{(\text{QSEs} - \text{CSs})}{\text{CS}} * 100$$

Accordingly, when the Error (%) value is positive, it implies that QSEs overestimate costs and when it is negative, it shows that QSEs underestimate costs. CSs (which are the accepted tender estimates) were used instead of the lowest acceptable tender sums in order to establish the relationship between QSEs and CSs, (Oladokun, Michael G. and Odesola, 2013).

2.11 Essential Cost Estimate Validating Techniques in Road Projects

For an owner's restricted capital budget to be used as economically and optimally as possible, estimation is essential. The owner may not achieve the full financial return on the capital expenditure if the cost estimate is inaccurate. An estimate is crucial to a project's success; therefore it stands to reason that the estimate should go through a *thorough review process*. The estimate should be assessed not only for its quality or accuracy but also to make sure that it is presented in a way that all members of the project team and client staff can understand and that it includes all necessary information, (Fernandes and Salgado, 2007). A structured estimate review process should be a standard practice for all estimating departments.

Important management decisions are based on estimates, which are important project management process outputs and fundamental documents. Hence, every estimate needs to be reviewed to some extent. It is recommended to have estimating staff professionals, subject matter experts, and other relevant parties independently review all cost estimates, (WSDOT, 2015).

The comprehensive **basis of estimate (BOE)** document should be reviewed carefully to ensure that it is both correct and complete. (Fernandez and Salgado, 2007) states that these BOE serves to clearly define the design basis, planning basis, cost basis, and risk basis of the estimate. These can be described as follows:-

A) Design Basis - The project's overall scope should be outlined, with further information given for each area, unit, and work package. It is vital to document particular inclusions as well as, perhaps more crucially, specified exclusions of facilities or objects. All assumptions regarding project scope should be documented. A list of all the drawings, sketches, and specifications

utilized in the creation of the estimate should be included, together with the date and number of the drawing revision, and equipment lists should be attached or cited.

B) Planning Basis - Essential information from the integrated project plan that impacts the estimate should be recorded in this section of the BOE. It ought to have particulars regarding any engineering, design, procurement, fabrication, and construction contracting strategies. It needs to include details regarding project execution schedules and resource allocation, such as the number of shifts, overtime policy, and workweek duration. It should also contain details regarding the project timeline and significant dates for milestones that have an impact on the estimate.

C) Cost Basis - This portion of the BOE should provide documentation of the source of every pricing used in the estimate. This would include the source for all bulk material pricing, significant equipment pricing (with bids or purchase orders cited if applicable), and labor rates for all jobs, including engineering, construction, office, and fabrication. All labor work hours should have a documented source, and any labor productivity assumptions should also be recorded. Additionally, each provision contained in the estimate needs to be identified properly. Documenting the estimate's time basis and the rationale for any cost escalation that is included in the estimate is also crucial.

D) Risk Basis - It is apparent that every estimate entail risk and uncertainty since, by definition, an estimate is a projection of likely expenses. An estimate usually includes a contingency to cover the expenses related to this uncertainty. In addition to identifying important areas of risk and opportunity in the cost estimate, this section of the BOE should explain how the contingency was determined.

In conclusion, it's critical to make sure the basis of estimate (BOE) is *understandable and unambiguous*, and to confirm that all data and variables recorded in the BOE such as labor productivities, wage rates, material and subcontract pricing, etc. have been applied consistently throughout the estimate. Once more, if different labor or price rates are employed for the same item inside the estimate detail, the estimate may lose credibility, (Fernandes and Salgado, 2007).

2.11.1 Estimate Review Cycles

According to (WSDOT, 2015) and (Fernandes and Salgado, 2007), every estimating department should follow a systematic estimate review procedure as standard procedure. Reviews of the estimated cost could be performed by different methods and groups as described below: -

2.11.1.1. Estimating Team/Estimating Department Review

The first review of the estimate should be conducted by the estimating team that prepared the capital cost estimate which is also known as screening review. It helps to verify if the estimate's math is accurate throughout. It is important to thoroughly check the accuracy of all spreadsheet calculations, subtotals and totals.

Quantities and costs should be checked for quality control as part of the internal project team review. A quality assurance check to ensure that the right procedures were followed, the documentation is comprehensive and easy to understand, and the final expenses and timeline are considered appropriate for the project's size, complexity, location, and scope should also be included, (WSDOT, 2015). The internal project team review has the advantages of having reviewers with a foundational understanding of the project and a simpler timetable to arrange than outside resources.

In addition, it is important to carefully examine the cost estimate to make sure it complies with the department's standard estimating criteria (i.e., Estimating Department guidelines), (Fernandes and Salgado, 2007). This would include a review to verify that standard estimating procedures were followed regarding estimate format, cost coding, presentation and documentation such as: -

- Check that the appropriate estimation methodologies, approaches, and procedures were applied in accordance with the project's completion status;
- Verify that the estimate summary and information are arranged according to the correct format. The code of accounts and the project work breakdown structure should be followed by the estimate. The format of the estimate must also be appropriate for the intended use of the estimate and contain enough information to accomplish this goal.
- Make sure that all estimate backup data is arranged correctly. Is it possible to link every value on the estimate summary page to the estimate detail pages and every piece of information on the estimate detail pages to the estimate backup or source documents?
- Verify that all allowances and factors are appropriate for the type of estimate being prepared, and are consistent with comparable projects and estimates.

One useful double-check is making estimations in two distinct ways and comparing them. Consider ranking the top five to ten elements in terms of cost and estimating them using a cost-based technique (materials, equipment, and labor) if a project team, for instance, prepares the project cost estimate using historical bid-based methodologies.

2.11.1.2. Engineering/Design Review

The engineering team should participate in the next round of estimate review, which will assess the estimate's accuracy in describing the project's scope. Ensuring that the estimate accurately reflects the project scope as understood by the engineering team is the aim of this section of the estimate review. The engineering team should fully support the estimate at the conclusion of the engineering assessment and in any further reviews that follow, (Fernandes and Salgado, 2007). The following shall be checked: -

- **Completeness of Engineering Deliverables:** To make sure the estimate is complete, one of the first things to check is the list of all the drawings, sketches, specifications, and other engineering deliverables utilized in its preparation. It is necessary to verify that all late modifications have been included in the estimate if there have been any late revisions to the engineering drawings that are supposed to be included.
- **Equipment List:** The engineering team should verify the completeness and accuracy of the equipment list and equipment pricing twice. One of the main factors influencing scope and expense is frequently equipment, which should be thoroughly inspected for accuracy and completeness.
- **Basis of Estimate (BOE):** All exclusions listed in the BOE should be agreed, and all assumptions and allowances should be verified. The moment has come to talk with the engineers about the estimator's interpretation of the design basis of estimate and to ensure that the estimate appropriately reflects the project scope, should there have been any queries regarding the interpretation of the drawings or engineering deliverables. For the duration of this evaluation, all drawings utilized in the estimate should be available. It is sometimes beneficial to ask the estimator to describe how each drawing was utilized to create the estimate.

The estimate's engineering and design section's expenses and underlying assumptions should be examined by the engineering team as well. The engineering team should also examine the estimate's risk foundation and be prepared to concur with the estimate's cost risk analysis.

In this method, offices can frequently examine one another. This kind of review has one advantage over an internal review: it provides the project with an evaluation that looks at the estimate from a different angle. As a result, the estimate may have more confidence now. This helps to effectively use fixed engineering resources inside the department and is also an excellent

approach to disseminate knowledge and lessons learned between project offices, (WSDOT, 2015).

2.11.1.3. Project Manager/Project Team Review

The estimate is prepared for evaluation by the project manager and the other members of the project team after it has been thoroughly examined by the engineering and estimating teams.

The goal is to secure the estimate's endorsement from the entire project team, with the project manager leading the charge. Along with passing a quality review, this is also the first point at which the estimate should be able to pass overall validation tests. The following shall be checked under this category:-

- **Estimate Documentation:** The project team and project manager have reviewed the estimate documentation, which includes the estimate summary and detail pages in addition to the estimate foundation. The goal is to verify that standard estimating guidelines have been followed and to make sure the estimate is presented in an understandable manner.
- **Cost Review:** The goal is to confirm that estimators and engineers are correct by investigating the costs that each party includes in the estimate. In particular, the following areas should be discussed:
 - Check that the most recent project schedule, especially in regards to escalation, matches the estimate;
 - Examine the project management and other expenses associated with the home office are reasonable;
 - Perform a final constructability review to confirm that the installation and construction methods taken into account, as well as the indirect costs (field personnel, temporary buildings, temporary services, construction tools and consumables, etc.), are reasonable and cost-effective, (Fernandes and Salgado, 2007).

Review processes of this kind are usually more formal at the regional and headquarters levels. One benefit of this kind of examination is that the reviewers may offer a really unbiased viewpoint on the project because they are not part of the project team. Nevertheless, the greatest benefit is that the reviewers usually have a lot more experience doing this kind of independent review. Coordination of region reviews with region employees is possible. Staff from the Strategic Analysis Estimating Office should be involved in the coordination of headquarters reviews.

2.11.1.4. External

In this kind of assessment, outside specialists are invited to evaluate particular sections of the estimate or the estimate as a whole. To add to understanding of a particular piece of work or to offer an outside perspective, this kind of review can be used with any of the other sorts. The cost of this kind of review varies greatly, but it can give the estimate a great deal of confidence, (WSDOT, 2015).

2.11.2 Estimate Validation System (EVS) of ERA

According to the trend in our case, when ERA issues a call for bids for Works and Maintenance Contracts, it needs some guarantee of the expected bid values. Over the years, ERA has acquired figures that don't quite match the bids that were submitted. This causes fiscal uncertainties as well as worries about under- or overpricing. Contract awards have therefore occasionally been postponed or canceled. ERA employs consulting engineers who develop a priced Bill of Quantities based on rate build-up that they have generated from their own experience or by modifying spreadsheets created by others. With limited knowledge of past rates or an inability to thoroughly examine the rate build specifications, ERA Project Engineers are tasked with analyzing and disputing the Engineer's Estimate.

In order to validate the Engineer's Estimate, the Project Engineer receives assistance from the Estimate Validation System (EVS) which is one wing of ERAMS. However, it should not be considered as the "Employer's Estimate," but rather a tool to aid in this process. The Engineer should still be in charge of the Estimate. The Project Engineer can query the estimate using the system. The likelihood that estimates will more closely match bidding figures increases when the Engineer gets the chance to defend his rate, (Langford-Johnson, 2017).

ERAMS contains a validation system that allows ERA staff to compare the Engineers Estimate item rate by item rate with rates developed within the system and historical rates. The system should be considered as a guide only and identify those items which require further justification by the Engineering Consultant. If the Consultant can justify the rate developed in his estimate to the satisfaction of the Director, that figure should be used.

The Construction Management System (CMS) Manual of ERA describes that ERAMS gives the opportunity to monitor construction costs and validate estimates in a more robust way than pervious undertaken by provision of item rates that serve as a basis of validating estimates. The

purpose of CMS manual is therefore to give guidance on how to build the rates on ERAMS for each key item in the Administration's Standard Technical Specification, (RL-J, 2018).

The manual also covers sustainability of validation by the provision to consistently updating the item rate build and its elements to reflect increase costs and new work methods. The core of the system is the standard rate build-up of the Key items in ERA's Technical Specification 2002 (Standard Technical Specification 2014 Appendix B –was carried out using STS 2002 as base information modified to suit the new specification). The Key items being those that have most significance on the end price of a works contract.

During the validation process, the Estimate Validation System (EVS) helps determine a contract's total cost. For a variety of reasons, including assisting with anticipated cash flow, evaluating the risk of goods being used or not, and identifying opportunities to outbid rivals, contractors do modify their prices from one BOQ element to another. Nevertheless, ERA will be able to produce more thoughtful overall estimates that more accurately reflect bid pricing with the help of the validation method provided by EVS.

2.11.2.1. Rate Build-up for use in EVS

Estimate validation process uses basic rates with set variables developed on the system and during validation uses these with the variables adjusted to recalculate appropriate validation rates for specific estimates. Initially, Rate Build-up have been generated from site records on approximately 30 sites, build-up by Contractors, and consultants and a certain amount of critical judgment. Rates and output are significantly affected by ***terrain, climate, altitude and haul distances*** which are affected by the location and terrain of individual contracts, (RL-J, 2018).

The system is developed using rates determined from data on plant, labor and materials. In order to reflect specific sites within Ethiopia the ERAMS Estimate Validation System has provision for each Works contract to include its own variables based on haul distances, altitude, terrain and climate and has a risk adjustment that can be applied across a contract or to individual rates to suit site conditions. These adjustments are then applied to the base rate build-ups on the system.

The following are the factors considered in adjusting the base rates: -

A} Terrain: are the factors that adjust the output of equipment based on terrain.

B} Elevation Factor: increase fuel consumption based on elevation separately for turbo charged and non-turbo charged engines.

C} Climate factors: Labor indices used in non-desert and desert environments.

D} Indirect Costs: Percentages of Direct Cost used as a default in developing the base rates, these are adjusted on individual estimates based on the information given on the Estimate Screens.

E} Hauling Factors: default hauling distances used in developing the base rates, these are adjusted on individual estimates based on the information given on the Estimate Screens.

F} Truck Speed Calculation: the basic curved used in deriving truck speed

G} Regional Fuel Price: the fuel price used by ERAMS in deriving estimated rates

H} Historic Rates: Used in calculating the median historic rate, the shorter the period the more up to date the results median result will be. Normally set at between 18 and 24 months.

Any rate build system requires calibration to historic rates, without this it would be difficult to justify as a reliable system. The aim is to achieve a reasonable rate that can be justified against good engineering judgment and historic rates. Since the original development of rates in 2010/11 there are many more historical rates available on ERAMS making calibration stronger. Once initial rates were in place, calibration followed by adjustments made against historic rate until the team were satisfied that the rates were reasonable for use in estimate validation. During the assessment a number of alterations were made to ERAMS itself including making additional adjustments to fuel consumption due to elevation, separately for turbo and non-turbo equipment, adjustment to speed flow curve for the lower haul distances, (RL-J, 2018).

Regarding the Direct Costs, rate build-up costs were calculated using the rates for plant, labor and materials by reviewing the data received from the field and suppliers with Extensive use of Internet and user manuals to establish baselines for equipment output modified by judgment for the Ethiopian context and a review of historic rates recorded on ERAMS over the previous three years based. Regarding Equipment/plant, development of plant costs depends on the means of costing. Plant can be bought, financed and maintained by the contractor or can be rented from a plant hire company. Fuel is a significant element of the running costs of plant. Plant speed and efficiency can be influenced by *altitude and terrain*.

The key to rate build is establishing of reasonable production rates. These production rates can be per hour, per day or per week. The necessary plant, labor and materials to achieve the production rate are then established. ERAMS calculates the haulage build up based on the

equipment used, its capacity, the haul distance, and the speed given in Settings. The system also adjusts for material bulking.

According to (Langford-Johnson, 2017), the ERAMS generated rate for an item is compared to historical rates to validate the Engineer's Estimate. The person confirming the estimate communicates with the engineer who developed the rate about the validation procedure, and after some discussion, the engineer's estimate is modified until both parties are satisfied. Once satisfied the Director and Team Leader have a number of reports available to enable him to decide whether approval can be given to the estimate. These reports compare the Engineer's Estimate for the particular estimate to the “**Comparative Rate**” established by the System.

The Comparative Rate: is the rate for an item developed by the ERAMS using 70% of the Rate Build using the estimate data provided for the estimate +30% of MEDIAN Rate over the previous 3 years rates;

- where there are no historic rates available only the Rate Build element will be used;
- where a Rate Build is not available historic rate element will be used and
- Finally, where neither is available the item will be null, i.e. there is no Comparable Rate available.

The Director can choose the minimum and maximum threshold rates for the particular project however; rates in excess of 5% above the Comparative Rate will be shown as needing further investigation. Validation Reports available to Implementing Director are depicted in the table below: -

Table 2-2: Validation Reports available to Implementing Director

Safe Threshold Analysis	<p>* Where Comparative Rates are available a table showing each item and which validations band the estimate rate falls.</p> <p>* A color code system identifies ranges and also those items contributing 0.5% to 5% and above 5% of the Contract value which helps focus on the important items.</p>	This is for the use of the Director and not to be given to the Consultant.
Safe Threshold Analysis	This shows all items whose rate is within the range of the lower	Once the Director is satisfied this can be

	threshold defined by the Director and 5% above the Comparative Rate.	given to the Consultant.
Item Rates within the Threshold	This shows all items whose rate is within the range of the lower and the Upper threshold defined by the Director.	This is for the use of the Director and not to be given to the Consultant.
Item Rates requiring further justification	This shows all items whose rate is out with the range of the lower threshold defined by the Director and 5% above the Comparative Rate.	Once the Director is satisfied this can be given to the Consultant.

Once found to be satisfactory the Engineer’s Estimate needs to be approved by the Director responsible. ***The Director is the only person allowed to approve the Estimate*** before it passes to the Procurement Directorate for tender.

To develop rates build for specific contracts ERAMS uses a Basic Rate build using set parameters for material location, haul, fuel costs, elevation, terrain, climate and indirect costs percentages. Once the Basic rates have been validated against historic rates the system is ready to be used to validate engineers estimates by adjusting the Basic rate using the specifics location, material haul, fuel cost for the region, elevation, terrain, climate, indirect costs percentages and whether VAT is included in the item rate.

Each estimate requires the user to input the various major haul requirements appropriate to the specific contract. Adjustments are made to rates for terrain, climate and altitude which all have an effect on price.

Upon filling the estimate in ERAMS, add the Quantity and Rate – ensure the Units are the same as those used by the Engineer in his estimate, if they differ have the Engineer change his estimate to the correct unit. If the item is not on the list, check that there is a reason for using a ***non-standard item***, that it is truly necessary, there is a specification and method of measurement included in the Particular Specification for this item.

Custom Item: note that the use of a non-standard item is included in the estimate but will not be subject to any analysis by the system.

The main things to look for are haulage distances - are they sensible? Indirect Costs –are they sensible? Climate –if desert, rates will be higher and productivity lower. Review the BOQ itself does it covers the whole of the Works? – have the TL or PE identify the non-standard items? Only then should the next steps be taken, (Langford-Johnson, 2017).

The method of measurement is included in the Specification; each bill item is described followed by exactly what the item covers. It is important that the stated method is understood, what is covered and how the item is to be measured. Drainage and earthworks in particular need to be clearly understood as these are major items with a substantial impact on the overall cost of a contract.

Making a quick check estimate utilizing order of magnitude estimation techniques could be another means of validating an estimate. Possessing up-to-date strategic and conceptual estimating data and tools is essential for providing quick check estimates. The specifics of the project should be able to account for any significant differences in the estimations. The information and presentation style of an estimate review determine the effectiveness of an estimate, (Fernandes and Salgado, 2007).

Reviews by upper management frequently center on verifying the estimate's overall suitability for the intended purpose. Usually performed at an extremely high level of research, these assessments don't get into the specifics of the estimate. To put it another way, can management be certain that the amount of information available for the estimate, the estimating techniques used, the expertise of the estimating and project teams, the manner in which the contingency amount was developed, and the risk levels support their decision-making process on whether or not to proceed?

According to ERAMS, identifying key Bill items from the total bill items is very much important to focus and give emphasis to them during the validation. The focus of the validation of estimates must be on these key items such as earthworks, sub base and pavement layers on the first rank, next to this drainage, masonry and structural concrete and steel item and finally the other items of work, (ERAMS Manual).

Consequently, the information obtained from site records, contractors' rate build-up, contractors' evaluation of previous performance, and engineer's estimates along with a measure of professional judgment to filter out inaccurate data are then used to establish baseline direct costs.

Adjustments are made to account for site haul distances, climate, elevation, terrain, and geographic location once a baseline has been established.

Having established a baseline direct cost risks can be assigned to elements of the contract where, for example, the earthworks data is thought to carry with it significant risk to the contractor. To these it is necessary to add overheads for Site Office and Head Office. Finally, a percentage is added for profit, (Langford-Johnson, 2017).

2.11.2.2. ERAMS Rate Calibration Report, Adjusting the Base Rate and Frequency of updates

The results of the Basic Rate build are checked, or more correctly validated against historic rates. This process is important, as without validation there is no sound credibility in the rate produced. The scatter of historic rates produces a change to those carrying out the validation. There is no single correct answer it requires judgment that goes with experience. There are a number of tools within ERAMS to assist in the checking of these basic rates.

Crude Calibration: Based on the number of months given in Settings “Historic Rates” the system compares the median historic rate to the Basic Rate and flags those items outside twice standard deviation with a red flag and those outside a single standard deviation with an orange flag. This system has drawbacks as the median rate of an extended period of time is likely to be lower than a rate that would be received at the current time of the estimate.

ETHIOPIAN ROADS AUTHORITY ESTIMATE VALIDATION SYSTEM (EVS) Items Rate Calibration Report (Tabular) ERAMS Rate Against 1 and 2 Standard Deviation Points of Historic Rates														
Item Code	Item Description	Unit	Unit Rate	Median (M)	Mean Observation (O)	Standard Deviation (S)	Used Observations	Red Flagging Off Point	Lower Bound For Red Flagging	Upper Bound For Red Flagging	Orange Flagging Off Point	Lower Bound For Orange Flagging	Upper Bound For Orange Flagging	Flag
42.01 (b)(x)	Out and Borrow to Fill (in any compacted layer thickness): Ties for rock fill embankments	m3	222.03	170.66	170.66	36.31	2	72.62	98.06	243.29	134.37	206.99		🚩
61.01 (a)	Prime Coat: MC-30 cutback bitumen	litre	47.24	34.76	33.96	9.02	6	18.04	15.91	52.00	9.02	24.93	42.98	🚩
63C.02 (7)	Variations in the rate of application of Bituminous Binder: MC-3000 cut-back bitumen	litre	42.19	30.28	30.28	8.39	2	16.77	13.61	47.06	8.39	21.89	38.67	🚩
61.02 (a)(i)	Excavation of materials: Excavation of soft material situated in the following successive ranges: 0m to 2m	m3	71.90	315.66	315.66	0.48	2	0.96	314.70	316.62	0.96			🚩
61.05 (b)	Backfill to excavations utilizing imported material	m3	96.20	260.87	278.94	82.39	4	164.79	114.15	443.72				🚩
61.09 (c)	Foundation fill: Compacted granular fill	m3	170.10	389.15	389.15	46.47	2	90.93	268.22	460.08				🚩
63.01 (b)(i)	Steel reinforcement for structure: High yield stress bars (Grade 40)	ton	36,624.78	63,278.68	63,278.68	9,368.81	2	18,717.61	34,961.06	71,896.29	9,368.81	43,919.87	62,637.48	🚩
67.07	Concrete parapets	m	2,196.46	3,969.24	3,721.76	344.36	2	688.69	3,033.06	4,410.44				🚩
67.16 (a)	Sealing joints with: Sealant	m	66.34	781.00	781.00	521.84	2	1,043.69	-262.69	1,824.69	521.84	269.16	1,302.84	🚩
68.01	Stone masonry walls: Cement-mortared stone masonry walls: Class B (primarily for minor	m3	1,289.26	1,661.29	1,661.29	96.67	2	193.14	1,468.16	1,854.42				🚩

Figure 2-11: First Crude step in Basic rate Calibration
[Source: ERA CMS Manual]

Detail Calibration: All items should be reviewed with particular attention of those items that contribute to major proportion of the total construction cost these will include earthworks, pavement, drainage and structure items. Special concentration should be focused on the major cost items highlighted in the Crude Calibration. It is recommended that the “Historic Rate” on the Settings Screen be set at 36 months to carry out the detail calibration. This will usually reduce the median historic rate but gives the user a better view of the cost trends with a larger number of points.

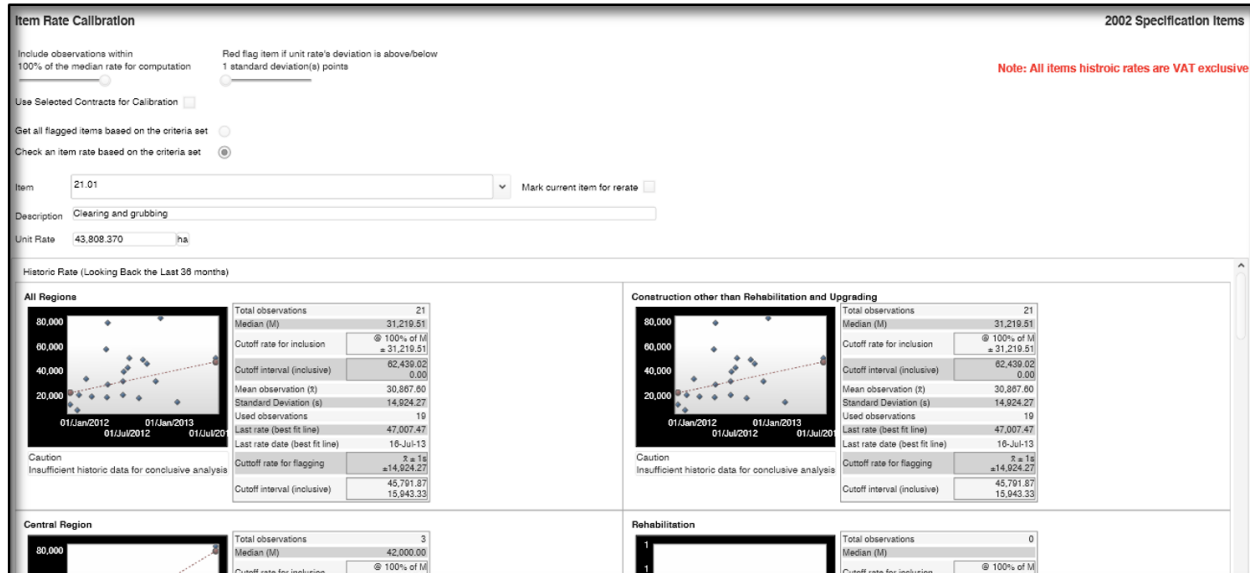


Figure 2-12: Base Rate Calibration Detail Analysis screen
 [Source: ERA CMS Manual]

This screen by showing the historic rates on a chart gives a better appreciation of the spread of the results and by altering the variables can eliminate some of the “wilder” historic rates. By reducing used observations to $\pm 50\%$ of the median reduces the standard deviation and, in this case, “red flags”.

Adjusting the Base Rate

There are various ways in which rates can be adjusted up or down but at all times the rate build must be a reasonable reflection of the work content. Remember there is no one answer the aim is to achieve a realistic basic rate. Like the basic rates the historic rates used in the calibration are without VAT, however the historic rates are for a cross section of work, and characteristics.

Initially do not look at one item at a time, look first for common features:

1. Are all high or are they low, if there is common ground possibly the first place is to look at the indirect cost percentages;

2. Look for those with common equipment, is there a pattern of high or low, if so look at the equipment rates;
3. Look for those with common material, is there a pattern of high or low, if so, look material rates; including the rate build of produced material in particular

Once reasonably satisfied of the changes and they are reasonable and justified make the adjustments in ERAMS, only then should you look at the items individually and make reasonable adjustments, possibly in production rate or the utilization of equipment and materials. Then the results may be published on the system for the use by Estimate validation.

Frequency of updates

The system needs regular updating of the basic rates of plant, fuel, materials and labor.

- **Fuel:** The Government review fuel prices throughout the country on a monthly basis, the system should be updated at each change;
- **Key materials:** like cement and bitumen should be reviewed at **6 monthly intervals**
- **Remaining other materials:** annually
- **Labor:** annually
- **Equipment:** annually

Updating of the item build should be checked whenever estimate validations consistently show a rate significantly lower or higher than the calculated rate. Whenever a new work method comes, commonly review the rate build. The introduction of new Specifications will mean a rebuild using the new items.

2.11.3 Reviewing Estimates Prepared by others

During the project review cycle, estimate validation is a crucial task that requires the right resources to be supported, such as a project history database that can gather, process, and display the necessary data. The project manager is ultimately in charge of seeing that the project is carried out in the majority of businesses. As a result, the project manager has a stake in confirming the estimate's reasonableness through "sanity checks" or other means. In any case, the estimate must come with an estimate review metrics report that lists and contrasts a number of important benchmark ratios and components with previous values from related projects. In the event that there is insufficient historical data from finished projects, information from other reliable estimations might need to be used instead, (Fernandes and Salgado, 2007).

The goal of this validation is to ensure that the estimate's important indicators match those from comparable projects. In case of a significant discrepancy, it must be accounted for by the unique features of the estimated project in comparison to comparable projects that have been finished. The percentages of administration (home office) costs, engineering/design costs, equipment to total project cost ratios, equipment to total field cost ratios, labor hours per piece of equipment, and cost to plant capacity ratios are a few examples of these comparison metrics.

According to (WSDOT, 2015), expert estimators with experience in the kind of work included in the project and no prior involvement in developing the project estimate should conduct *independent reviews, or check estimates*. When working on specialized tasks, the independent estimator consults with additional independent sources as needed, such as design engineers, construction managers, or other estimators. Checks performed by independent estimators include:-

- Checking the correctness of the Basis of Estimate document and the estimate file
- Making sure that the name(s) of the estimator(s) who prepared the estimate are displayed
- Ensuring that each individual work item has a notation about the estimate methods
- examining the entire estimate documentation, from the comprehensive backup to the summary phases, to make that the information is understandable and the numbers can be tracked
- Conducting a detailed check of the estimate to include:
 - Monitoring the development of unit rates and quantities of the 20% of items that account for 80% of the project's expected cost that drive the majority of the bottom line costs
 - Noting remarks on quantity and unit rates
 - Checking for mathematical errors

The review of an estimate prepared by others is usually accomplished by a critical assessment of the estimate, its documentation, and a series of questions to assist in evaluating the level of diligence used in preparing the estimate. Most of the time, the problem is that the amount of time allowed for a complete estimate review is very short, (Fernandes and Salgado, 2007).

Guidelines that we can use to efficiently review estimates prepared by others are: -

{A} *Basis of Estimate*

Is it well organized and complete? Does it provide the required information regarding the design basis, planning basis, cost basis, and risk basis of the estimate? Does the design basis clearly

document the scope of the project, and have all engineering deliverables used in developing the estimate been identified? Have all scope assumptions been acknowledged? Is the planning basis, which includes the schedule, resource plan, and construction plan, reasonable? Are the material prices, labor rates, and labor productivities reasonable, in line with expectations, and consistently applied throughout the estimate? Has the risk basis been clearly defined, and is it reasonable for the level of information available to prepare the estimate?

{B} Estimating Personnel Used

We are expected to know who prepared the estimate, and their level of estimating experience. Do they have established estimating procedures and guidelines? Was the estimate checked and reviewed before publication?

{C} Estimating Methodology and Procedures

What estimating methods, techniques and procedures were used in preparing the estimate? Are they appropriate for the level of information available and project type? Were different estimating methods used for different parts of the estimate? Is the level of detail in the estimate sufficient for the purpose of the estimate? Were parts of the project difficult to estimate, and why? Was sufficient time available to prepare the estimate? What adjustments were made to the estimate for location, complexity, etc., and are they reasonable? Was the estimate prepared using a code of account structure?

{D} Estimate Documentation

Is the estimate documented clearly? Is the estimate summary and detail pages well organized, and presented at an appropriate level of detail? Is every cost appearing on the estimate summary traceable to the estimate detail and other estimate backup?

{E} Estimate Validation

The goal of an estimate review is to determine that a high quality and sufficiently accurate estimate has been prepared. The review should ensure that the proper estimating methods, procedures, techniques, data, and guidelines have been employed in the preparation of the estimate. The use of a structured estimate review process and estimating review techniques will help to ensure that quality estimates are consistently prepared which effectively support the decision-making process by management.

The estimate for review will include a metrics report showing key estimating metrics and benchmark ratios for the estimate and similar past projects.

We should have our own set of metrics and statistics from our own project history to compare against. At this point, we may also develop our own quick check estimate for comparison purposes, typically using conceptual estimating techniques. Significant differences between the check estimate and the estimate being reviewed may indicate the need for taking a more thorough examination of the estimate detail.

The goal of these estimate validation is to check that selected areas of the estimate can withstand further scrutiny. An important point to remember here is the “80/20 rule”. This principle generalizes that 80 percent of the cost will come from 20 percent of the estimate line items.

For any particular estimate, the significant cost drivers may vary. Sometimes, the main cost driver may be a particular process unit of the project; other times it may be the type of process equipment or machinery throughout the project, and still other times it may be the overall bulk material quantities or labor man-hours.

We should examine the estimate summary and detail pages closely to ascertain which aspects of the estimate we may want to examine in closer detail. Basically, we should examine in detail those items of the estimate that will have the most significant cost effect if estimated incorrectly.

One review technique, which is often employed, is to thoroughly examine and review the estimating steps that were used for a particular part of the estimate. Select an area of the estimate, and ask how the quantities were derived. Ask the estimators to show you the drawings from which the quantities were generated. Perform a quick takeoff to see if the quantities can be verified. Ask what the basis was for the unit material price and labor work hours. Have these been consistent throughout the estimate? What adjustments were made and why?

2.12 Key Evaluation and Qualification Criteria for Selecting Contractors

According to ERA’s Engineering Procurement Directorate Modernization document, Annual construction turnover (ACT), General Construction experience, Specific construction projects experience (number, value, and nature, complexity & similarity of projects), Specific construction experience in key activities and Historical contract non – performing record are must to meet criteria requirements according to the criteria set out in the bidding documents.

A} Annual construction turnover (ACT): indicates the bidder’s financial soundness and prospective long term profitability. The construction turnover indicated by the bidder shall be the

same or greater than the minimum/average annual construction turnover requirement set in the bidding document, (ERA modernization document).

Most of the time annual construction turnover is checked for the last five years. According to the revised PPA qualification criteria (2016 edition), the ACT is calculated as:-

$$ACT = \frac{\text{Engineer's Estimate} * F}{\text{Contract Period in years}}$$

The multiplying factor F will be 1 for local bidders, 2 for foreign bidders and 1.5 in case joint venture formed by local and foreign bidders.

The other related qualification requirement is liquid asset/cash flow (CF) requirement, which is calculated with the formula:-

$$CF = \frac{\text{Engineer's Estimate} * F}{\text{Contract Period in months}}$$

The multiplying factor F will be 3 for local bidders and 4 for foreign bidders.

B} General Construction experience: The general construction experience of the company in the construction business since its establishment shall be checked. The General Construction experience indicated by the bidder shall be the same or greater than the minimum years requirement set in the bidding document, (ERA modernization document).

C} Specific Construction projects experience: indicates whether the bidder has performed a similar type of work or not. The Specific construction projects experience indicated by the bidder shall be the same or greater than the requirement set in the bidding document in its number, value, and nature, complexity and similarity with the project under consideration, (ERA modernization document).

According to the revised PPA qualification criteria (2016 edition), the value of the project for Specific construction projects experience shall be at least 70% [for local bidders] and 80% [for foreign bidders] of the estimated value of the subject contract.

D} Specific Construction experience in key activities: indicates whether the bidder has performed a similar type of activities in its previous or current works. It is usually requested on annual basis. The TAC has to sum up those quantities on each category (earthwork, gravel wearing coarse, base coarse, pavement works, etc.) of each project if it falls on the same year. The Specific construction experience in key activities indicated by the bidder shall be the same or greater than the requirement set in the bidding document in its quantity.

E} Historical contract non – performing records: it shall be checked whether the bidder is performing its contractual obligation or not. In this case, if the bidder has an ongoing/completed project contracted with ERA, the ERA's monthly performance assessment will be checked if it has met the aggregate expected performance requirement or if it has completed the project with a good performance. If the bidder has no project with ERA and it has an ongoing/completed project contracted with other Client, the TAC has to check if the bidder has attached its performance confirmation letter from its Client. Any contractor's performance shall be evaluated based on the ERA's contractor's performance assessment framework and rated accordingly, (ERA modernization document).

From the above points, it is noted that the key evaluation and qualification criteria for selecting the civil works contractor, such as Annual Construction Turnover, Specific construction experience and liquid asset/cash flow requirements are directly related to the estimated cost of projects and hence, evidently the level of effort exhausted in the preparation, checking and approval of the cost estimate and quality of the deliverables would affect the selection of the right contractor in terms of capability and experience.

Therefore, this study tries to fill the existing gaps assessing the checking, reviewing and validating of cost estimates provided from Design Consultants hired by ERA and their impact on the procurement of Federal Road Projects and the output of this research will be used as a reference for the future action and researchers.

CHAPTER THREE

3 MATERIALS AND METHODS

3.1 Introduction

Research is an organized and systematic way of finding answers to questions. This chapter presents and discusses the research methodology adopted in this research. It covers the research design, study area, the data collection procedure, target population, sample size determination and data processing and analysis techniques applied to address the objectives of the research. As the study will gather data regarding the applicability and current capacity of the ERAMS considering selected road design projects in Ethiopia, a questionnaire survey along with interviews with relevant bodies will be conducted.

3.2 Research Design

According to Creswell (2012), research designs are plans and the procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis. A research design is the arrangement and framework of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose, (Cresswell, 2012). It is the overall plan for connecting the conceptual research problems with the pertinent (and achievable) research.

Therefore, the research designs adopted for this study are both descriptive and explanatory research design methods. Descriptive research design describes and interprets some aspect of phenomena using surveys, correlational studies, observation studies and case studies whereas explanatory research design establishes cause and effect relationship between variables for testing a theory's predictions or principles. Descriptive research method mainly involves the collection, describing and analyzing the facts related to the study. In explanatory research method, the researcher uses the facts or information already available for analysis and makes a critical evaluation of the data or information.

From the descriptive research design, an in-depth study research which studies detailed contextual analysis of a limited number of conditions and their relationships is adopted with the presumption that this method enables in-depth focusing as the objective of this research is to assess and investigate ERA's cost estimate reviewing and validation system and its impact on the procurement of Federal Road Projects.

3.3 Study Area

This study is performed in Addis Ababa city, Ethiopian Roads Administration head office. As discussed in the previous chapters of this study, the Ethiopian Roads Administration is a federal organization established in aiming to achieve the Ethiopian government's economic growth in terms of expanding the road network throughout the country in collaboration with regional road authorities.

To meet these objectives, the administration initiates roads, related policies, directives, and laws prescribe road design standards, prepare coordinated national road network development plans and programs and implement same upon approval, render consultancy and technical support to the regional road agencies and other relevant organs upon request, train man power required for the development of roads as necessary, cause the use of land and quarry substances required for the purpose of road related works, acquire land required for road works by paying compensation for the land possessors and property owners in accordance with the law, remove properties unlawfully placed within the right of way roads, take necessary measures to protect the environment whenever road works are undertaken.

ERA has revised its organizational structure in different times. The main objectives was enhancing the performance of road construction projects mainly focusing on solving problems usually created during project development periods by properly organizing the works of design management, and Right of Way issues and separating the mixed project and project implementation responsibilities. The project development phase which includes Design Management projects, Procurement of Engineering works, Right of Ways Management and Road research center were considered as pre-construction ventures and separately organized under the Project Development stream led by Deputy Director General.

Accordingly, the study will try to encompass selected federal Road Project whose design is completed in ERA's Design Management Directorate and being administered under Ethiopian Roads Administration with a design-bid-build (DBB) delivery system.

3.4 Source of data and Data Collection Methods

Primary and secondary data are the two main categories in the data collection. Primary data collection refers to research that has involved the collection of original data specific to the particular research. It is prepared based on the process and procedures appropriately suited for the research. Secondary data refers to research where no such original data is collected, but the researcher uses available verified existing (secondary) sources of data which have already been collected, analyzed and used as references by someone else.

Therefore, this research uses a combination of both primary and secondary data collection methods.

3.4.1 Primary Source of data

The primary source of data collections adopted for this research is Questionnaire and interview. Questionnaires will be prepared in advance and pilot tested for its use worthiness as it is the simplest and time saving method to collect data effectively from a number of respondents. First draft question is listed to be included in the study based on the result of review of different articles. Then, those draft questions are rephrased again in appropriate way to make it more understandable for respondents. In this study, questionnaires are applied to answer the first objective of the study.

The questionnaires are series of both open-ended and close-ended structured questions that are related to the research work. Five Likert Scales are used to create the surveys so that respondents can express their opinion on the scales and are expected to read the questions carefully, comprehend them and respond in the area provided on the actual questionnaire.

The other primary data collection method carried out in this study is conducting interview and focus group discussions (FGDs). Using semi-structured interviews, relevant data is collected from relevant ERA administrative bodies presented under section 2.7.4 of the literature review to gather their views and opinions regarding the reviewing and validating technique of Engineering Cost Estimates.

3.4.2 Secondary Source of data

In addition to collecting primary data, in-depth study will be carried out for selected project with relevant document reviews collected from ERA such as Consultants Engineering Cost Estimates, Contractor's offer (i.e., winning contractor), works contract document of the selected project, other guidelines and manuals. Moreover, theoretical basis of the desk study focuses upon

pertinent literature reviews by critically analyzing various archival sources that include the company records, books, peer reviewed journals, articles, previous thesis and any other published and unpublished documents.

In this study, the researcher employed more than one type of data collection instrument such as questionnaires, interview and focus group discussions (FGDs) to increase the precision of the result.

3.5 Research Approach

The approach to carry out this research is more of quantitative deductive approach which involves collecting and analyzing numerical data and applying statistical tests based on measurements. However, qualitative approach will also be applied for the portion of the study.

3.6 Sample Design

3.6.1 Sampling Frame

Sampling is the process of selecting representative units from a defined population for the study in research investigation. For this study, design-bid-build (DBB) road project that have been managed by ERA's Design Management Directorate whose engineering cost estimate is validated in ERAMS and works contract signed in the recent year (2025) is the frame of the study.

3.6.2 Population of the Study

The population or universe represents the entire group of units which is the focus of the study. Employees of ERA working in Design Management Directorate, Performance, Quality & System Management (PQSM) directorate and Engineering Procurement Directorate are the population of the study.

3.6.3 Sample Size Determination and Sampling Technique

This refers to the number of items to be selected from the population to constitute a sample. For the interviews and focus group discussions (FGDs), 10 relevant ERA administrative bodies working in Design Management Directorate, Engineering Procurement Directorate and Performance, Quality & System Management (PQSM) directorate are selected using purposive sampling technique to gather their views and opinions regarding the reviewing and validating technique of ERA and its impact on the procurement of road projects. Thus, interview is conducted for 6 management bodies (3 Directors & 3 Team Leaders) and the remaining focus

group discussions (FGDs) are held with senior project engineers. For PQSM Directorate, staffs working in rate build-up and ERAMS under Road Cost and System monitoring team are selected using purposive sampling as the other teams are not related to this study.

Further, for the questionnaire part, questionnaires are directed to respondents of staffs from the client (ERA) working in Design Management Directorate, who are the major focus area to achieve the first objective, particularly responsible for reviewing cost estimates provided from Design Consultants hired by ERA and exploit the ERA Management System (ERAMS) to validate cost estimates of the federal road projects. Hence, Design Management Directorate staffs and management bodies (i.e., Team Leaders & Director) from all the four teams are selected using purposive sampling for conducting the questionnaire.

Table 3-1: Number of samples taken from Responsible Directorate

Responsible Directorate	Engineering staffs	Management	Total
Design Management	27	5	32

The following chart depicts the number of sample taken from the population of the responsible corresponding directorate;

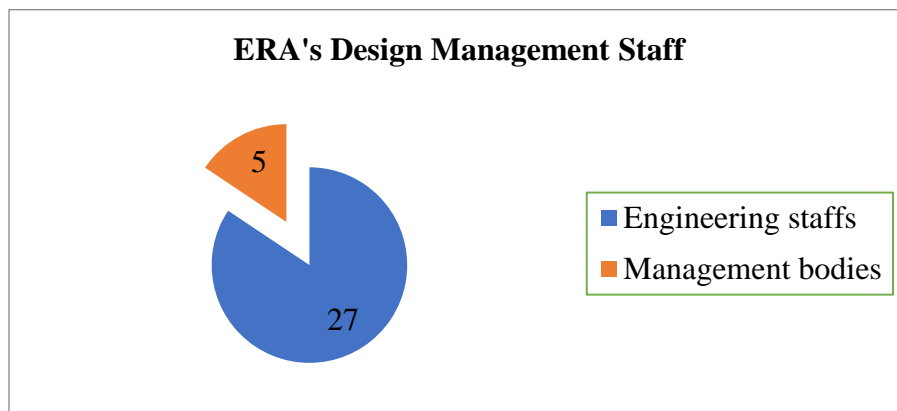


Figure 3-1: Number of samples taken for the questionnaire

3.6.4 In-depth study

An in-depth study is a contemporary research method usually conducted by selecting a best fit phenomenon under study based on predefined selection criteria. It requires defining the research context, (Shibru, 2020) which in this case is ERA as it has rich experience in administering road projects with different project delivery systems.

In this regard, this study applies an in-depth study considering the project cost estimate and validation data availability in ERAMS using purposive sampling technique. Using the selected

in-depth study project, ERA's Cost estimate validation system has been evaluated in detail. Further, the consultant's validated cost estimate is compared to the winning contractor's offer of the corresponding project to recognize its impact on the procurement of road projects.

3.7 Data Processing and Analysis

The collected data must be processed and analyzed to meet the goal of the study which includes summarizing, structuring, editing, coding, classifying and tabulation of the data. The data collected through a questionnaire has been organized, arranged and coded then processed to retain as much detail as possible. Therefore, the result of the questionnaire is analyzed using statistical techniques and results are presented in the form of diagrams, charts, and tables used to form the basis for recommendations as well as for future study. SPSS (Statistical Package for Social Science) Version 28.0.1.0 software has been used for coding, determining the frequency and presentation of data. Further, information gathered through an interview and focus group discussions (FGDs) is described.

The study was analyzed based on descriptive statistics analysis. The descriptive statistics was employed to quantitatively describe variables using mean, standard deviations, frequency or mode. Microsoft Excel Spreadsheet is used for data analysis purposes. For summarizing the collected data and to determine the number of responses belonging to each category, frequency tables and charts have been used. Tables, graphs and figures have been generated accordingly.

3.8 Ethical Considerations

The researcher will acquire the data from respondents as desired. The study's findings or report should only be used for academic purposes, and participant responses are kept private and analyzed in aggregate by the researcher without alteration. Additionally, the researcher respects and honors the work of earlier research or study and correctly cites those works that served as a basis for this study.

4 RESULTS AND DISCUSSIONS

4.1 Questionnaire Survey and Data Analysis Results

4.1.1 General Information about the respondents

➤ Questionnaire Response Rate

A total of 32 questionnaires were distributed, to identify the major shortcomings, deficiencies and limitations in reviewing cost estimates provided from Design Consultants hired by ERA. Further, the questionnaire's response was coded for ease of reference during the analysis of the data. The detail of the respondents' responses and their rate is summarized in the table below.

Table 4-1: Questionnaire response rates

Respondents Category	Questionnaires		Percentage	Valid Response	Percentage
	Distributed	Returned			
Employer	32	31	97.00%	31	97.00%

Out of 32 respondents from the employer (ERA), 31 professionals have responded which is 97% of the total. The returned questionnaires were checked for reliability using the SPSS software results and excel spreadsheet whether all the requested questions have been answered or not. Hence, they are found completed and suitable for analysis.

➤ Qualification of Respondents

In the first section of the questionnaire, questions related to educational background, years of services, current position working in the organization and experience/participation in the process of preparation/validation of Engineering Cost Estimates were asked and the summary of the responses are described below.

➤ Educational Background

Educational background has a significant effect on the validity and reliability of responses in terms of understanding questions and knowing more technical skills in the construction sector. The total surveyed respondents and their response is depicted in the chart below.

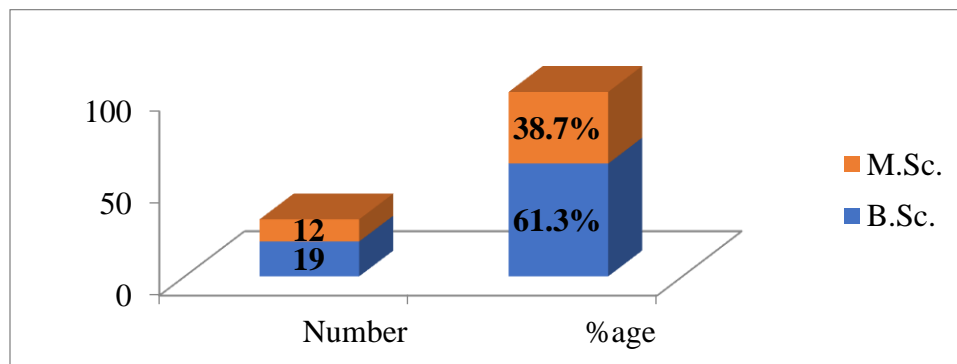


Figure 4-1: Chart depicting the educational background of respondents

Out of the total surveyed respondents, 19 of them which accounted 61.3% are B.Sc. holders, 12 of them which accounted 38.7% are M.Sc. holders with different qualifications related to Civil Engineering and none of the respondents have Ph.D. This implies that all the respondents can understand, interpret and conceptualize the validation of cost estimates.

➤ ***Years of Experience***

Another important characteristic used to categorize the respondents was the number of years of experience that has a significant effect on the validity and reliability of responses in terms of understanding questions and knowing more technical skills in the construction sector. The years of experience of the respondents are depicted in the chart below.

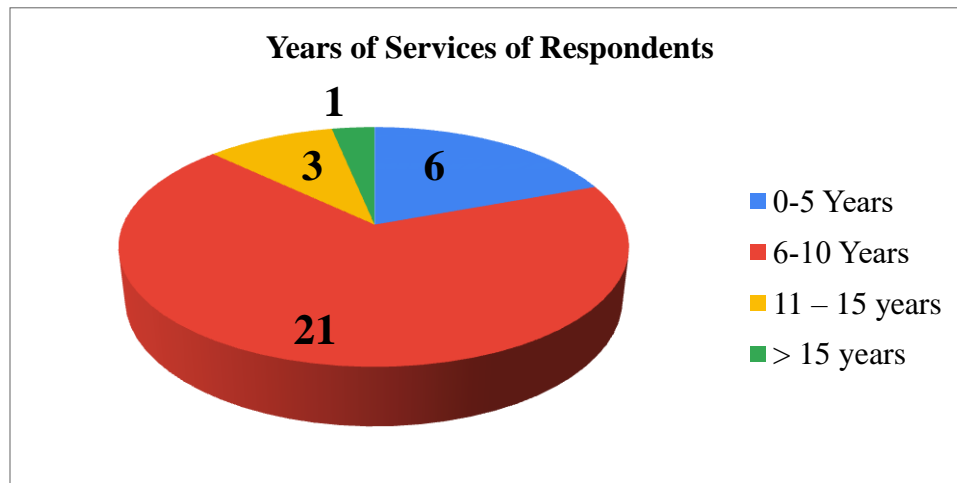


Figure 4-2: Chart depicting years of experience of respondents

The survey result indicates that the majority of respondents (67.7%) have 6 to 10 years of experience, followed by 19.4% with 0 to 5 years of experience. Additionally, 9.7% have 11 to 15 years of experience, while a small fraction (3.2%) possess more than 15 years of experience. This distribution suggests that most respondents have a moderate level of experience, with fewer individuals at both the entry-level and highly experienced ends of the range.

➤ ***Experience in the process of preparation/validation of Engineering Cost Estimation***

The survey results indicate that the majority of respondents (96.8%) have experience in the validation of engineering cost estimates as reviewers, while only a small fraction (3.2%) have experience in the preparation of engineering cost estimates as estimators.

This suggests that the respondent group primarily consists of professionals specializing in review and validation rather than cost estimate preparation. This will have greater role for this study as it is focused on the reviewing & validating approach of ERA instead of EE preparation.

The second section of the questionnaire is intended to answer the first objective of the thesis and summary of which is described below.

4.1.2 To assess & identify the major deficiencies and limitations in reviewing cost estimates provided from Design Consultants hired by ERA

To attain the first objective of this research described in the above subtitle, the average mean score is used. Using a five point Likert scale, the respondents from ERA who has direct responsibility in reviewing cost estimates provided from design Consultants, were asked to rate the levels of significance of each of the possible several points that they are going to consider in reviewing and validating the engineer’s estimate. The five Likert scales were:

- 1 = Strongly Disagree (SD) 2 = Disagree (D) 3 = Neutral (N) 4 = Agree (A) and
5 = Strongly Agree (SA)

There were numerous questions included in the questionnaire and it is deemed to categorize the questions with similar nature to conduct the analysis. Hence, the questions were categorized into four (4) groups as depicted below:-

- Group 1: Basis of Estimate (BoE) Review
- Group 2: Accuracy & Consistency of Estimate Components
- Group 3: Documentation & Traceability
- Group 4: Review Process & Quality Control

The details of the questionnaire are annexed in appendix A of the study.

Analysis with Categorization

- **Group 1: Basis of Estimate (BoE) Review**

Regarding considering & checking the completion and well organization of the Basis of Estimate (BoE) in the inclusion of required information’s regarding the Design basis, Planning basis, Cost basis and Risk basis of the estimate, as per section 2.11 of the literature review, five questions were integrated and the results of the respondents are depicted in the table and chart below.

Table 4-2: Basis of Estimate (BoE) Review

Questions	SD	D	N	A	SA
Consider & check the completion and well organization of the Basis of Estimate (BoE) in the inclusion of required information’s regarding to Design basis, Planning basis, Cost basis and Risk basis of the estimate	0	2	2	21	6

<i>Questions</i>	<i>SD</i>	<i>D</i>	<i>N</i>	<i>A</i>	<i>SA</i>	
Review whether the design basis clearly document the scope of the project, and have all engineering deliverables such as list of all the drawings together with the date and number of the drawing revision, specifications and equipment lists used in developing the estimate been identified	0	4	2	21	4	
Review the reasonability of Schedule, Resource and Construction plan which are included in planning basis	0	5	10	13	3	
Check whether the risk basis is clearly defined and is reasonable for the level of information available to prepare the estimate	0	7	7	13	4	
Review carefully the cost basis of the estimate whether documentation of the source of every pricing [material pricing, significant equipment pricing (with purchase orders cited if applicable), and labor rate] used in the estimate	0	6	4	16	5	
Total	0	24	25	84	22	155
		0.15	0.16	0.54	0.14	
		5	5	17	4	31.00
		15%	16%	54%	14%	100%

As depicted in the table above, regarding considering & checking the completion and well organization of the Basis of Estimate (BoE) which is the inclusion of required information's regarding the Design basis, Planning basis, Cost basis and Risk basis of the estimate, 17 (54%) and 4 (14%) of the respondents agreed and strongly agreed respectively. However, each of 5 [i.e., 15% & 16%] of the respondents disagree and are neutral respectively.

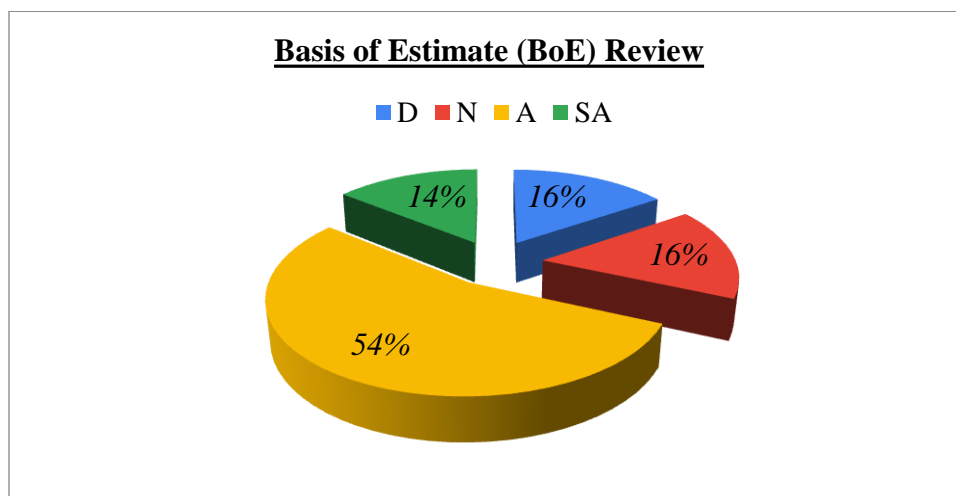


Figure 4-3: Basis of Estimate (BoE) Review

This suggests that while most professionals acknowledge the significance of checking the components of BOE, there may be a need for further clarification, training, or standardization to ensure a more consistent understanding and application across all stakeholders.

➤ **Group 2: Accuracy & Consistency of Estimate Components**

Regarding accuracy & consistency of estimate components, five questions were integrated and the results of the respondents are depicted in the table and chart below.

Table 4-3: Accuracy & Consistency of Estimate Components

<i>Questions</i>	<i>SD</i>	<i>D</i>	<i>N</i>	<i>A</i>	<i>SA</i>	
Check whether the material prices, equipment prices, labor rates and productivities reasonable in line with expectations and consistently applied throughout the estimate	0	2	0	13	16	
Review strictly the appropriateness of the method, technique, assumptions and procedures used in preparing the estimate for the level of information available and project type	0	6	4	17	4	
Check if different estimating methods used for different parts of the estimate and the level of detail in the estimate is sufficient	0	4	9	14	4	
Check what adjustments were made to the estimate for location, complexity, terrain, hauling distance etc.... of the project and their reasonability	0	4	3	17	7	
Cross checking is made with the previous design documents to keep the consistency with the cost estimate	1	3	3	18	6	
Total	1	19	19	79	37	155
	0.006	0.123	0.123	0.510	0.239	
	0	4	4	16	7	31
	1%	12%	12%	51%	24%	100%

As depicted in the above table, regarding accuracy & consistency of estimate components 16 (51%) and 7 (24%) of the respondents agreed and strongly agreed respectively. However, each of the 4 (12%) of the respondents disagree and are neutral while the remaining 1% of the respondents strongly disagree.

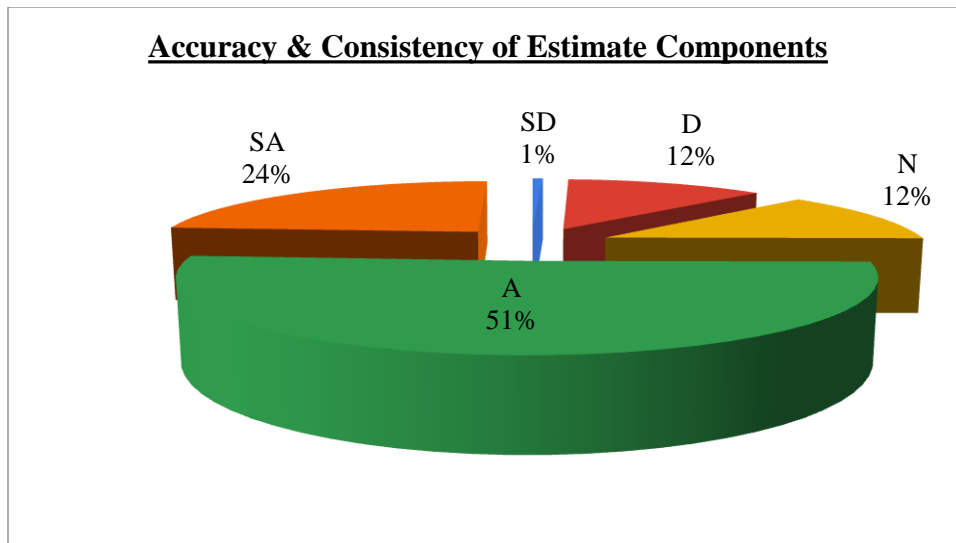


Figure 4-4: Accuracy & Consistency of Estimate Components

The survey results indicate that a majority of respondents (75%) agree or strongly agree on the importance of accuracy and consistency in estimate components. However, 25% of respondents disagree, remain neutral, or strongly disagree.

This suggests that while most professionals acknowledge the significance of maintaining precise and consistent estimates, there may still be areas for improvement in standardization, training, or methodology to ensure a more uniform understanding and application across all stakeholders.

➤ **Group 3: Documentation & Traceability**

Regarding Documentation & Traceability of estimate components, five questions were integrated and the results of the respondents are depicted in the table and chart below.

Table 4-4: Documentation & Traceability of estimate components

<i>Questions</i>	<i>SD</i>	<i>D</i>	<i>N</i>	<i>A</i>	<i>SA</i>
Review whether the estimate summary and detail pages organization and presentation is at an appropriate level of detail	0	5	3	16	7
Check every cost item appearing on the estimate summary is traceable to the estimate detail breakdown and other estimate backup	0	4	2	16	9
Key professional and/or consulting firm’s management staff responsible for preparation, checking and approval of the estimate document put their signature on the submitted estimate properly	2	3	3	11	12
Book of Computation containing calculations and summaries of quantities has been enclosed to form the integral part of the cost estimate document	0	2	5	15	9

There are guidelines and manuals that help to review the cost estimate prepared by design consultants	0	10	4	15	2	
Total	2	24	17	73	39	155
	0.01	0.15	0.11	0.47	0.25	
	0	5	3	15	8	31
	1%	15%	11%	47%	25%	100%

As depicted in the above table, regarding documentation & traceability of estimate components, 15 (47%) and 8 (25%) of the respondents agreed and strongly agreed respectively. However, the other 3 (11%) and 5 (15%) are neutral and disagree respectively with this idea and the remaining 2 (1%) of them strongly disagree on the same.

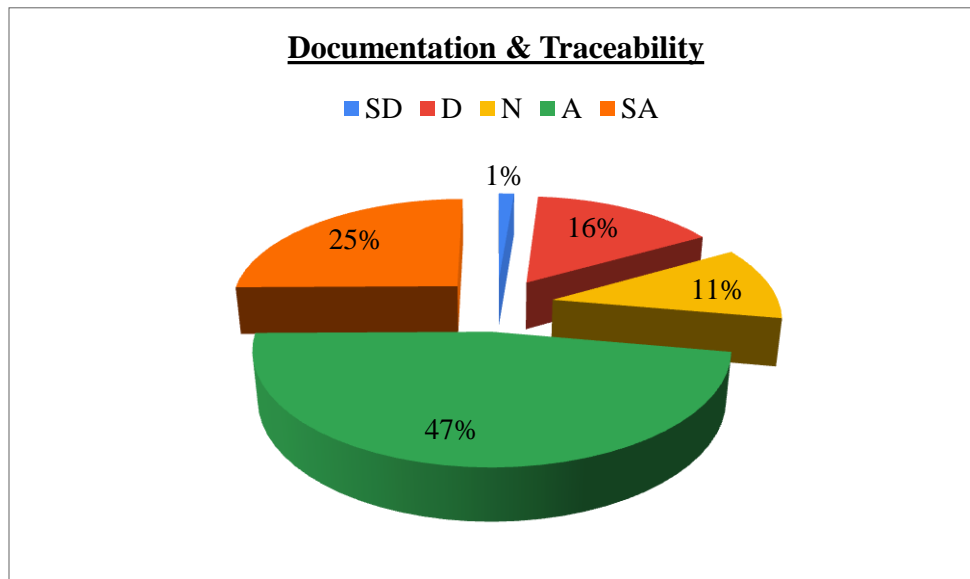


Figure 4-5: Documentation & Traceability of estimate components

In conclusion, the majority of respondents (72%) agree that the documentation and traceability of estimate components are satisfactory. However, there are distinguished portion (26%) who either disagrees or are neutral, indicating that improvements in this area especially in preparation of clear guidelines and manuals that help to review the cost estimate may be necessary to enhance transparency and accuracy in the estimation process.

➤ **Group 4: Review Process & Quality Control**

Regarding Review Process & Quality Control of estimate, five questions were integrated and the results of the respondents are depicted in the table and chart below.

Table 4-5: Review Process & Quality Control of estimate

<i>Questions</i>	<i>SD</i>	<i>D</i>	<i>N</i>	<i>A</i>	<i>SA</i>	
Check the level of estimating personnel experience	3	7	8	9	4	
Review the time to prepare the estimate has been sufficient	0	14	7	6	4	
There is a clear checklist specifically prepared for reviewing engineering cost estimates prepared by design consultants	2	7	9	8	5	
Presentations and communications are held frequently with the estimators by giving due emphasis to the engineering cost estimate as of the other design deliverables	2	5	4	13	7	
There is a separate independent team who review the engineering cost estimates	15	7	2	5	2	
Total	22	40	30	41	22	155
	0.142	0.258	0.194	0.265	0.142	
	4	8	6	8	4	31
	14%	26%	19%	26%	14%	100%

As depicted in the above table, concerning the Review Process & Quality Control, 8 (26%) and 4 (14%) of the respondents agreed and strongly agreed respectively. However, the other 6 (19%) and 8 (26%) are neutral and disagree respectively with this idea and the remaining 4 (14%) of them strongly disagree on the same.

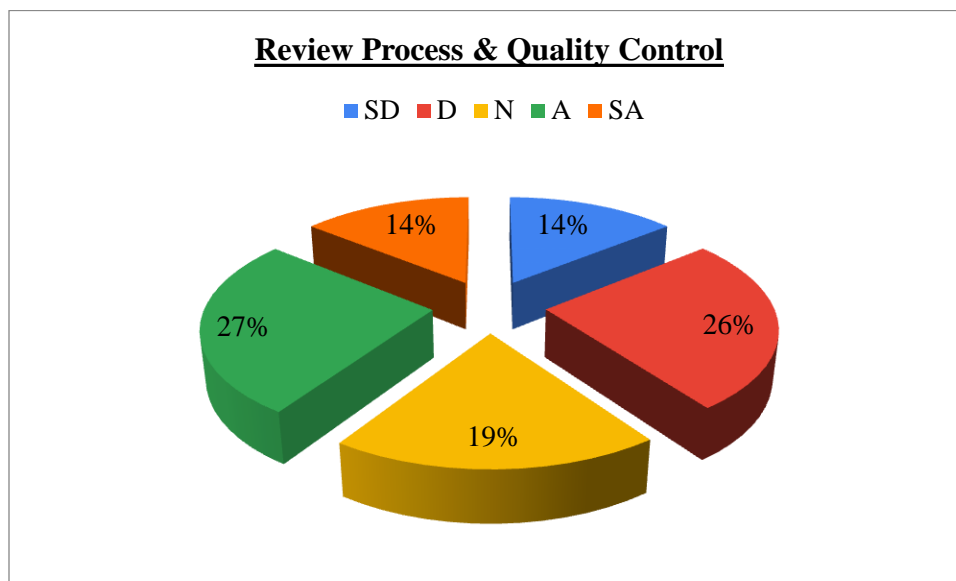


Figure 4-6: Review Process & Quality Control

In conclusion, while 40% of respondents agree or strongly agree with the review process and quality control, however, a majority 60% are either neutral, disagree, or not, indicating that there are concerns or areas for improvement in the effectiveness of the review and quality control

processes especially in providing clear checklists and establishing a separate independent team who review the engineering cost estimates.

4.2 Qualitative Result and Discussion

In this section the interview analysis was conducted for interviewees from the three Directorates of ERA namely Design, Engineering Procurement, Performance, Quality & System Management Directorates (i.e., DMD, EPD & PQSMD). The analysis was conducted face to face in Amharic and interpreted to English without changing the main points of the interviewee. The interviewer was the researcher of this study and started by introducing the title and purpose of the study.

Table 4-6: Interviewees Work Position, Year of Experience and Educational Level

<i>Respondent Code</i>	<i>Directorate</i>	<i>Current Work Position</i>	<i>Years of Experience in Road Projects</i>	<i>Educational Level</i>
Respondent 1 (R-1)	EPD	Director	18	MSc.
Respondent 2 (R-2)	EPD	Team Leader	13	MSc.
Respondent 3 (R-3)	PQSMD	Team Leader	13	MSc.
Respondent 4 (R-4)	PQSMD	Director	16	MSc.
Respondent 5 (R-5)	DMD	Team Leader	17	MSc.
Respondent 6 (R-6)	DMD	Director	17	MEng.
Respondent 7 (R-7)	DMD, FGD	Lead Engineers	7 -10	BSc. & MSc.
Respondent 8 (R-8)				
Respondent 9 (R-9)	EPD, FGD	Lead Engineers	8 & 9	MSc.
Respondent 10 (R-10)				

4.2.1 Trend/culture of ERA in validating/checking Engineering Cost Estimates before the deployment of ERAMS

Initially, to conduct before and after analysis of EVS, the interviewer asked *what was the trend/culture of ERA in validating/checking Engineering Cost Estimates before the deployment of ERAMS?* Accordingly, the following are responded from the interviewees:-

R-1: There was a dedicated Design department in place. The team conducted a review of the Engineer’s Estimate (EE) using the CMS manual, which was current at the time, to verify crew formations and productivity rates. Since the ERAMS system is primarily based on the CMS manual, the verification process was eventually transitioned from manual into the system as part of an update. At that time, inflation was not a concern, and material costs remained stable due to a regulated market. As a result, an Engineer’s Estimate (EE) could remain valid for up to a year without any changes. Only project-specific factors such as hauling distance, terrain, and temperature had the potential to influence the EE. Additionally, EEs were compared against

recently awarded projects during the procurement stage, and the estimates closely aligned with those projects, making the comparison reasonable and reliable.

However, despite changes in market conditions and advancements in construction technology over time, the CMS manual has not been updated accordingly. As a result, consultants are often required to adapt their rate build-up (RBU) methods independently. These adaptations lead to varying assumptions among experts, which in turn cause discrepancies in the foundational assumptions used to develop the Engineer's Estimate (EE).

R-2: Initially, there was a standalone Design Department responsible for reviewing the estimates. Later, it evolved into a Design & Implementation unit. To validate submitted estimates, market prices were referenced from the rates of recently signed nearby projects. Additionally, project engineers developed their own Excel to support cost estimation. Since the design and implementation functions were integrated, the engineers remained closely engaged with cost-related aspects in their day-to-day work. Given the stable market conditions and well-documented material prices at the time, predicting and forecasting costs was relatively straightforward. Engineers in the implementation phase independently develop their own estimates using actual field data and compare them with the estimates submitted by consultants. However, it is important to recognize that each project is inherently unique. No two projects are exactly alike; therefore, cost data from other projects is used solely for assessment and comparative analysis purposes, rather than as a direct benchmark.

R-3: Before the deployment of the system, the trend was taking recently signed projects and making them average then compare the estimate with the average rates taken from the aforesaid signed projects. Each item of the estimate will be compared with the average rate or sometimes the weighted average developed for the purpose of the comparison. This approach served as the foundation for the system, which utilizes historical rates as median rates contributing 30% to the aggregate rates. As such, the system essentially builds upon the processes that were originally carried out manually.

R-5: Previously, estimates were reviewed by calculating averages for comparison purposes. Two types of averages were used: estimate-based averages and averages derived from recently signed projects, typically using a minimum of three projects to ensure reliability. Contractor rates were often accepted, as procurement data was considered a reliable reflection of the current market. At that time, multiple projects were in the pipeline, and the market was stable, making it easier to obtain dependable prices for construction materials and equipment directly from suppliers. Using

the available cost information, ERA staff would engage in discussions with the consultant, who was expected to provide justifications for the submitted estimates. A mutually agreed estimate would then proceed to the procurement stage. However, in recent times, it has become increasingly difficult to find signed projects from the past two years. With only one or two relevant projects available, applying the average rate comparison method has become challenging and less reliable.

4.2.2 Concerning to the importance of the deployment of the system (ERAMS) for validating the Engineers Estimate and the basic problems encountering

The next question was: *How do you realize that the importance of the deployment of the system (ERAMS) for validating the Engineers Estimate? What are the basic problems encountering in your administration of the system (related to user problems, the system itself and management of the system)?*

R-1: The system plays a crucial role as it was developed with consideration of essential resources such as materials, productivity, labor, and equipment. Additionally, by factoring in project-specific characteristics like climate, productivity, hauling distance, and terrain, the system provides more reliable estimate validation. At the very least, it establishes boundaries with maximum and minimum limits to cross-check the Engineer's Estimate (EE), helping to guide and challenge the consultants effectively. The gaps observed starts from the fact that the system is still in its first version. Some items show prices that are either significantly higher or lower than the market rates. This suggests that certain formulas, inputs, and productivity rates have not been properly calibrated. As a result, a revision is necessary, taking into account the current site conditions in the construction industry. Additionally, the outdated CMS manual needs to be updated to reflect the latest market trends.

Moreover, the Rate Build-Up (RBU) requires frequent updates to its inputs, ideally within a month or less, to ensure the system remains reliable. However, collecting up-to-date construction material prices for these inputs is a challenge, as there is no central organization in our country dedicated to regularly updating material prices. The Central Statistics Agency (CSA) is unable to provide updated input prices specifically for road projects. Instead, they may only provide aggregate prices, such as the overall cost of concrete, without breaking down the individual components like cement, reinforcement bars, etc. As a result, updating the system frequently becomes difficult due to the challenges in obtaining accurate and timely material prices.

Additionally, suppliers are unwilling to provide material prices to ERA. Furthermore, the quotations they do offer are often only valid for a very short period, such as one day. In order for the system to function at its full potential, a reliable and consistent source of material prices must be established.

R-2: While the system itself is valuable, it cannot control market volatility. For instance, fuel costs were subject to changes twice a month in the past. At the design stage, many factors remain uncertain, which can lead to discrepancies. Contractors often make assumptions beyond technical aspects, considering factors such as security and political conditions, as well as policy changes. As a result, the risks they factor in can lead to higher rates for each bill series. Additionally, the system is based on the outdated CMS manual, which needs to be revised. The source of materials required to update the Rate Build-Up (RBU) in the system is currently insufficient, as both suppliers and the Central Statistics Agency (CSA) are unable to provide frequent updates on material prices.

The system does not account for variations and inflation. To incorporate price indices and devaluation concepts, the system would need to be significantly simplified. We could add features to calculate price indices and forecast future costs based on current market adjustments, but this would require standard items as a prerequisite. Custom (non-standard) items would not allow for this type of analysis. Given that we cannot control the market today, relying on trend analysis becomes challenging, as it requires a stable market to accurately identify which trends to follow. However, incorporating these features is crucial for supporting top management decision-making and improving our daily cost-related activities.

R-3: In my view, the deployment of the system is crucial for guiding staff working in EVS. It facilitates the process of requesting consultants to justify major deviated items. However, there are reliability concerns regarding the acceptance of the system's results. Most of the fundamental issues start from the users themselves. It largely depends on the manager's efforts to encourage and motivate the staff to use the system properly. At the time the system was launched, the internet infrastructure was very weak, and there were only a limited number of computers with internet access. As a result, this hindered staff interest in using the system. Additionally, getting staff to embrace the new way of working was a significant challenge.

A communication gap between the implementing directorates is also a fundamental issue. Many complaints are passed between departments, with each pointing to the system as the problem. These issues are typically raised only after a long delay, during formal meetings, and often only

when there is pressure from top management. This delay in communication prevents timely problem-solving for the system. A lack of accurate data and information regarding material, equipment, and labor costs is another significant challenge, as rates are market-dependent. While we request current cost data from both internal and external stakeholders, most are unwilling to provide the necessary accurate information. The Central Statistics Agency is not collecting current cost data and refuses to share the requested information. Further, there are no positive replies from internal Directorates to support each other for the better implementation of the system. Once agreed on the rate build up items initially, the adequacy of the number of professional's and level of experience of the estimate validation team will not be the cause for the problems.

R-4: System increases efficiency, minimizes resource wastage and errors, enhances human capabilities, and improves accuracy, among other benefits. In EVS, the system is essential for accurately verifying or cross-checking estimates. A significant issue is the knowledge gap resulting from the high staff turnover at ERA, which affects continuity and efficiency within the organization. Problems are not communicated in a timely manner, which causes them to accumulate and worsen over time. Besides, the CMS manual has not been updated yet, which could be contributing to the challenges in the system's effectiveness. An outdated manual can limit the accuracy and relevance of the system's data, making it harder to adapt to current market conditions and operational needs. The primary issue is the inconsistent use of the system. Frequently, resistance to change from individuals contributes to this problem. Further, the Director General has not been consistent in enforcing the use of the system. It is essential for the management bodies to actively promote and push the staff under them for its consistent utilization.

R-5: The system as a system is important. The basic problem is that we don't update it frequently since collecting the material costs is very much challenging as suppliers are not willing to give reliable costs to ERA. Consultants that develop estimates might fill rates or costs from unrecognized sources that makes it difficult to accept their EE. Hence, the system has to be robust in distinguishing such uncertainties. The other problem is that users may not be knowledgeable about EVS and would made mistakes during filling the bill items. There is knowledge gap between implementing directorates and the corresponding staff.

R-9&10: The system itself is fundamentally sound, and a significant investment has been made in its development. However, it requires regular maintenance and frequent updates to cost elements to remain effective. Moreover, active input from the implementing departments is essential to ensure optimal performance. Consistently and responsibly completing work item data will strengthen the historical rates, making them more reliable for future projects.

RBU needs subjective judgement hence; it needs experienced professionals that have extensive experience in field works for developing reliable crew formation and equipment combination. We don't know the algorithm of the system plus we couldn't see the regression assumptions of the system. Further, only the director had the access to see each item comparison in the RBU as it is secrete to keep the confidentiality. We can't trace from where the problems are originated from either from the system or from the Consultant. Besides, Standardization of BoQ is very much important. If Consultants are developing their own BoQ we cannot find the items and accordingly, we are enforced to use the custom (non-standardized) items which are not subjected to validation and hence, these creates problems on the output of the system.

R-7&8: The system has minimized the work load since you simply take the data feed to the system for your work. Besides, the system has the advantage of integrity of different decisions which is important. However, the system is not user-friendly, which is why we do not use it for TAS. We are unable to view the assumptions, and it does not generate the reports required for our daily activities. Our comments are not addressed. For instance, the system does not account for market devaluation and inflation, even though it should include a price index to forecast future market trends. The impact of foreign currency devaluation should also be considered. Additionally, manufacturers do not provide reliable information, raising concerns about the system's reliability in this regard.

4.2.3 Regarding the current practice of cost estimation in Ethiopian Roads Administration Design Directorate

Based on your previous work experience how would you describe the current practice of cost estimation in Ethiopian Roads Administration Design Directorate? Are there any standard estimating guidelines in ERA?

R-5: ERA has a standard estimating guideline known as the CMS manual. However, it is outdated, having been developed 38 years ago, and cannot be considered complete in its current

form. Despite this, it remains in use by both ERA and consultants, particularly for productivity rates and crew formation, even though it does not reflect the current types and capacities of machinery. As a result, actual productivity is expected to exceed the figures stipulated in the CMS manual. This leads to inconsistencies in assumptions and methodologies among different consultants, highlighting the urgent need to update the manual.

R-9&10: The current practice involves identifying bill items based on previous designs. The draft Engineer's Estimate (EE) is reviewed on our side, and the data is then entered into ERAMS. Each cost breakdown is checked to ensure it corresponds to the respective bill items. The system-generated report is then shared with the consultants, who are expected to either revise the estimates or provide justifications for the comments received. Fixing Index is ambiguous. The combination of material, equipment, and labor also depends on the consultant's assumptions, which leads to issues with standardization. Presentations are not specifically conducted to review the cost estimates prepared by consultants, particularly regarding their assumptions and considerations. However, to maintain confidentiality, such meetings should be attended only by the Project Engineer, the Team Leader, and the Director.

The Book of Computation (BOC) is currently inadequate, with noticeable discrepancies and issues related to completeness. There is a clear need for a standardized checklist to ensure its accuracy and consistency. Defined clear check list shall be prepared as ERA is a big organization administering federal road projects allocated with a huge budget.

During the review of cost estimates, the primary focus is often on the rates rather than the quantities. However, in practice, most of the issues that arise during implementation are actually related to design quantities. The system has no any quantity checking/validating mechanism in this regard. Conducting reviews with experts from various fields of expertise is a valuable approach to improving the quality of design. However, confidentiality must be carefully maintained. To balance both, it is advisable for the Project Engineer (PE) to manage the review process while consulting with specialists from each relevant discipline. Additionally, the guidelines and checklists used for reviewing the Engineer's Estimate (EE) should be made more practical and functional, as a high level of accuracy above 90% is crucial for this document.

4.2.4 Impacts of inaccurate cost estimates on the procurement of Road Projects

What do you think are the Impacts of inaccurate cost estimates on the procurement of Road Projects?

R-1: Inaccurate cost estimate can be seen in two directions. It could be in the higher side or in the lower side. Both of them have their own effect. These affects the qualification and evaluation criteria of the procurement as the criteria's are developed based on the estimate. The suppliers know that the criteria are developed based on the EE. Hence, they mostly follow and converge to estimate instead of developing their own cost break-down that will mislead them as they are not properly conducting the rate build up. If the EE is underestimated, the cost offer will be low hence the work will be affected whereas if the EE is overestimated, the cost offer become higher and hence the government will incur a higher cost beyond the allocated budget. Therefore, it has a negative impact on both sides considering the quality of work and the higher cost. This is because of the fact that our criteria bases on EE and Contractor's does not develop their own rate build up.

In addition to the above, inaccurate Engineer's Cost Estimates (ECE) lead to dissatisfied stakeholders. For example, some suppliers create their own cost breakdowns and raise queries regarding the EE. Furthermore, issues such as time overruns, claims, contract disputes, poor project quality, and cost overruns related to delays are common. Therefore, it is very much crucial for us to develop properly validated accurate cost estimates. By improving our accuracy, we also enhance the accuracy of the suppliers, as we follow a formula-based approach rather than relying on ranges, addressing the issues mentioned earlier.

R-2: The impacts of inaccurate cost estimate can result in cancellation of Bid, repeated re-bid of projects that takes long time, affects the qualification criteria, unreasonably low/high price. For instance, if ECE is on the higher side, local firms could not compete as it demands very high turnover, we could award with expensive price and etc.

In addition to the above, inaccurate cost estimate can create unsatisfied stakeholders, time overrun, claim and contract dispute due to less project quality.

R-7&8: The impacts on the procurement are: we set unreasonable criteria's for the Evaluation of Bidders that consequence incompetent contractor selection, a number of Re-tender that will waste time and energy, it will minimize fair competition between bidders, difficulty to get experienced contractors and after all it will kill the industry.

4.2.5 Scenarios occurring most of the time in comparing the contractor's winning bid to the consultant's detailed cost estimate

Based on your expertise working on procurement of road projects, how would you compare the contractor's winning bid to the consultant's detailed cost estimate and what scenarios occurred most of the time?

R-1: It depends on the Contractors' competition. Before in the last years, when there were high competitions, the average annual Contractors' offer had been 80%-90% of the Consultants' estimate. Currently, the computation is very much less and contractors' have no interest on the bid and hence, only two, three or four bidders compete and accordingly, they come with a higher offer. Due to this, the average annual Contractors' offer become $\geq 110\%$ of the Consultants' estimate. Currently, a contractor's offer is not solely based on the cost breakdown but also takes into account current market fluctuations (inflation) and security issues in the country, which cannot be controlled through price adjustments. As a result, additional costs are incorporated into their offer, making it significantly higher than the anticipated estimate.

Furthermore, many suppliers input varying costs for the same items. For example, one bidder may allocate 10 million for a dozer, while another may allocate 30 million, yet they both control the output rate, resulting in similar rates in the bill items despite such a significant difference in inputs. To address this discrepancy, a controlling mechanism should be put in place. In this regard, standardization of bill items is crucial, involving all the three parties (Contractor, Consultant, and Employer) to ensure that mutually agreed-upon bill items are used.

Another fundamental issue in comparing the contractor's winning bid to the consultant's detailed cost estimate is the difference in approach regarding the constructability of the designs. Consultants tend to be theoretical, focusing only on quantities derived from the design, without factoring in the costs associated with the practical aspects of construction on the ground. In contrast, contractors consider every cost related to constructability, leading to significant differences in assumptions and considerations based on actual conditions. To avoid using custom items that are not subject to validation, the system may need to offer flexibility in bill items by providing two or three options during preparation. By agreeing on standardized BoQ, we can minimize changes to technical specifications and reduce reliance on custom items, thereby strengthening the validation process. Therefore, as mentioned above, methodologies,

assumptions and considerations for analysis of the cost elements are far between Consultants cost estimate and Contractor's winning bid.

Though it is not found in public procurement and property administration (PPPA) & other procurement directives, the 20% threshold still applies in ERA's procurement process. According to the law, which follows the least bidder concept, an offer below 20% can be awarded, as there is no legal basis to reject the bidder. However, if the offer exceeds 20%, the bidder's proposal may be rejected due to the anticipated government budget. Ultimately, the decision depends on the specific project conditions; we may award a contract for bids above 20% or reject those below 20%, depending on the project circumstances. Currently, the comparison process indicates that overestimation of costs is common, particularly for new construction and road upgrading projects.

R-2: Substantially, most contractors' offers exceed the Engineer's Estimate (EE) due to significant differences in assumptions between contractors and consultants. Contractors account for every potential risk, including security and political instability, based on the actual conditions, which cannot be fully assumed in the EE. Additionally, contractors are more proactive in frequently updating themselves on material costs, whereas consultants often fail to stay current with prevailing material prices. As a result, the assumptions and considerations in the final consultant's cost estimate differ considerably from the contractor's winning bid.

In this context, the cost breakdown requires consensus and standardization, as it is highly subjective. Different professionals within the same company can develop varying Engineer's Estimates (EEs) based on different assumptions. Therefore, to standardize the bill items, it is essential to reach consensus among all three parties involved in road design and construction projects.

Do you think ERA's checklists, guidelines and manuals for reviewing the Engineers Estimate prepared by design consultants are sufficient to assert the quality of EEs? If not, what do you suggest to rectify the problems encountered?

R-6: The only comprehensive guideline for the estimate checking is CMS manual which is outdated. The other checklists are not that much complete which needs modification to include wide areas of the estimate elements. So far, regarding the crew formation, assumption and methodology perspective, CMS is the only manual which has been developed a long time ago and needs to be updated. Taking the manual as it is will not be realistic so it needs expertise

judgment. In general, ERA's checklists, guidelines and manuals are not sufficient to review the estimate. To rectify this, a technical assistant Consultant has been hired to enhance ERA's Design management capacity and hence, is developing the necessary all-inclusive checklists and updating the guidelines.

4.2.6 Recommendations given to improve the engineering cost estimate reviewing, checking and validation system and obtain an accurate estimate

There should be dedicated government organization that collects and timely updates the major construction material costs periodically. Management relation with Ethiopian Central Statistics Agency (ECSA) or government suppliers should be strong to get the reliable prices for sustainable input updating of basic construction materials. The top management of ERA should engage with higher government bodies and the CSA to establish a clear decision on who will be responsible for collecting the prices of basic construction materials. This will help us obtain updated costs, enabling the effective utilization and sustainability of the deployed system. Previously, we updated the inputs every 6 months. However, due to the current volatile market, we now update the RBU on a monthly basis. To keep up with the market, we have also made the historic rate optional, allowing for the use of 100% RBU (setting historic rates to zero), even though the RBU primarily relies on the CMS manual.

The basic problem is that our usage of the system is not consistent. Most of the time human being is change resistant. The Director General and the management team, at all levels, must be consistent in enforcing the utilization of the system. System has a greater role in minimizing the construction industry problems. Routine and periodic evaluation & monitoring has to be conducted by the top management as this is crucial to enhance the system. Every directorate (Director, TL & PE) has its own role and responsibility. Hence, everyone should now and properly apply its role and responsibilities. Additionally, there must be a sense of ownership, with the acceptance of the idea that this is "my tool." Improving communication is essential. The implementing directorates mentioned above must collaborate effectively for the system's successful usage. Instead of assigning blame to one party, there should be effective communication (both formal and informal) to identify and address critical problems.

The adequacy of the number of professional's for estimate validation shall be supported with frequent trainings. There is a gap between draft and final submissions indicating that the accuracy and reliability of cost information on the draft stage are not that much satisfactory.

Hence, developing our own quick check estimates with a well-developed and strong excel that will be updated automatically upon the inputs are updated frequently is crucial.

Standardization is crucial! The system currently develops rate build-ups only for major items that contribute significantly to the total cost. However, this approach needs modification, as each project is unique. In some project-specific cases, even a minor item with a large quantity can significantly impact the overall project cost. Therefore, the system's rate build-up should be all-inclusive to capture the effect of all items as accurately as possible. For example, pile structures are not included in the system, but they may be necessary for certain projects. Similarly, rock fill may not be required in the Tigray region, but it is essential in the Gambella region. The engineer's facility, which currently represents about 5% of the overall cost, is not included in the system under series 1000. It is therefore crucial to develop the RBU by considering project-specific scenarios, as this has a significant impact on the validation of Engineer's Cost Estimates (ECEs) in particular and the procurement process in general.

The database could be vulnerable to hacking, as the infrastructure is robust, and the interest from external parties may increase. While we cannot eliminate insecurity entirely, we can take measures to protect it. Previously, we encountered a database failure where the data up to the last backup could not be recovered due to a hijacking incident as the security license has not been updated at the time when the data base is hacked. Hence, it is essential to store the data on different servers in collaboration with ERA's ICT department for added security and reliability.

4.3 Evaluation of ERAMS

The purpose of this evaluation is to achieve the second and third specific objective of the study. These are:

- To assess and evaluate the capacity of ERA's cost estimate validation system (ERAMS) in checking, reviewing and validating cost estimates and
- To compare and contrast the Design Consultants' Cost Estimates validated by ERAMS with the bidder's (winning contractor) offer and recognize its impact on the procurement of road projects identifying the major gaps encountering.

Before looking for the details of the evaluation of the system, it is essential to show the structure and background of ERAMS.

4.3.1 Background and Structure of ERAMS

The ERAMS was originally developed by the Consultant IMC Worldwide who is the UK Company. Since the original development of rates in 2010/11 there are many more historical rates available on ERAMS making calibration stronger. Once initial rates were in place calibration followed by adjustments made against historic rate until the team were satisfied that the rates were reasonable for use in estimate validation.

ERAMS contains a validation system that allows ERA staff to compare the Engineers Estimate item rate with those rates developed within the system and historical rates. ERAMS uses the rate-build established as a base and adjusts them based on the variables given against each estimate. The variables include location, haulage distances for various materials, climate, altitude and terrain all of which have an effect on cost of carrying out the works.

Before the estimate validation, the cost management of ERA Management System containing Estimate and BOQ needs to be feed with the required data from the implementing responsible directorates. There are three interfaces that have to be filled accurately with the respective particular project. These are:

- **Basic Data** contains date of estimate, bid type, functional classification, form of contract, specification form, design standard, climate, traffic volume, project name with the corresponding typical section figures. The details of which are depicted in the figure below for indication.

The screenshot displays the 'Basic Data' section of the ERA Management System. It includes various input fields for project details such as 'Date of Estimate', 'Bid type' (ICB), 'Functional Classification' (B - Link Road), 'Road Number' (S/71/ICB/PP/GE/2005E.F.Y), 'Form of Contract' (Unit Rates), 'Specification Form' (2013), 'Design Standard' (DC6), 'Climate' (C3. Weina Dega), 'Design Traffic Volume' (AADT), and 'Traffic Volume' (3297.00). It also shows 'Engineering Estimate Name' (Alaba -Angacha -WATO- and Damboya-Durame spur road), 'Locations' (Alaba -Angacha -WATO), and 'Project Route Derived Name' (Alaba -Angacha -WATO). A table lists surface types (Asphalt) with their respective dimensions (Road Width, Shoulder Width, Road Length, % of Length, Road Area, Left Parking Lane Width, Right Parking Lane Width, Left Walkway Width, Right Walkway Width). Summary statistics include 'Total Road Length (Km) 82.00' and 'Total Road Area (sq. m) 574,000.00'. The interface includes navigation buttons like 'Open Estimate' and 'Save'.

Figure 4-7: ERAMS Basic data under cost management system (Source: ERA)

➤ **Estimate Data** contains Engineering Estimate Name, Average Haul Distance consisting Haul Earthwork to Placing or Spoil (Km), Haul Bitumen to Placing (Km), Haul Aggregate to Bitumen Plant (Km), Haul Aggregate to Concrete Precast Site (Km), Haul Precast Concrete Material to Placing (Km), Haul Batched Concrete to Placing (Km), Haul Cement to Site (Km), Haul Sand to the site (Km) and Distance from Addis Ababa (Km). The details of which are depicted in the figure below for indication.

The screenshot displays the 'Estimate Data' section of the ERA Management System. It features a table for 'Average Haul Distance' with columns for description and distance in kilometers. The table includes items like 'Haul Earthwork to Placing or Spoil (Km)' (1.00), 'Haul Aggregate to Placing (Km)' (22.12), 'Haul Bitumen to Placing (Km)' (20.50), 'Haul Aggregate to Bitumen Plant (Km)' (26.93), 'Haul Aggregate to Concrete Precast Site (Km)' (22.12), 'Haul Precast Concrete Material to Placing (Km)' (13.46), 'Haul Batched Concrete to Placing (Km)' (13.14), 'Haul Site Won Sand or Masonry Stone to Placing (Km)' (86.93), 'Haul Selected Earthworks to Placing (Km)' (5.00), 'Haul Gravel to Placing (Km)' (22.12), 'Haul Cement to Site (Km)' (13.46), 'Haul Sand to Site (Km)' (86.93), and 'Distance from Addis Ababa (Km)' (245.00). Other sections include 'Road Properties' (Altitude, Terrain), 'VAT and Contingency' (Applying VAT Rate: 15.00, Applying Contingency Rate: 10.00), and 'ER VO Delegation Under Contract' (One Time VO Limit (ETB): 5,000,000.00, Multiple VOs Limit (%): 25.00). The interface includes navigation buttons like 'Open Estimate' and 'Save'.

Figure 4-8: ERAMS Estimate data under cost management system

- **BOQ** contains each bill items of the project including General, Site clearance, Drainage structures, Earth works, Sub base, road base and gravel wearing course, Bituminous surfacing, Structures and Ancillary works series and the corresponding divisions. The details of which are depicted in the figure below for indication.

The screenshot displays the ERA Management System interface for cost management. The top navigation bar includes 'home', 'maintenance', 'administration', and 'Logout'. The main content area is divided into several sections:

- Basic Data:** Engineering Estimate Name: Alaba -Angacha -WATO- and Damboya-Durame spur road; Design Contract: Alaba-Angecha-Wato Feasibility,EIA ar
- Estimate Data:** Bill Number, Bill Description, Add Bill, New Bill buttons.
- BoQ:** Select Series & Division (Series: 1000 GENERAL, Division: 1000 GENERAL), Item Code, Item Description, Unit table.
- Summary:** Total of Bills: 1,398,290,245.49; SPS: 3,100,000.00; Dayworks: 2,622,870.10; Bills Less SPS: 1,395,190,245.49; Contingency (10.00%): 139,519,024.55; Bill plus Contingency: 1,537,809,270.04; VAT (15%): 230,671,390.51; Total: 1,768,480,660.54.

Figure 4-9: ERAMS BOQ data under cost management system (Source: ERA)

After the above data are filled necessarily, the following reports compare the Engineer’s Estimate for the particular estimate to the “Comparative Rate” established by the System.

Bill Items comparison

Estimate rates are compared with 70% ERAMS Rate Build and 30% median of all historic rates over the last 3 years. Where historic rates are absent, 100% ERAMS Rate Build is used. And where no ERAMS Rate Build exists 100% median historic rate is used. When both are missing the item is kept blank if its rate constitutes **0.5% or more** of project cost otherwise removed from report. Custom items are kept in report if they constitute **more than 0.5%** or more of project cost and are indicated by appending (*) after the item code. Hence, methods ERAMS uses for predicting rates are categorized as rate trends based on Historic rates and rates based on Rate-Build up.

Rate trends of the historic rates are based on factual information (objective) and Visual interpretation of trend. Therefore, limited data reduces reliability. Whereas, rates based on Rate-Build-Up are characterized by subjective approach to rate development using Plant, Labor and

Materials, potentially better reflects Individual site parameters, uses much judgement (subjective), correlation is essential, time consuming to develop and it should be used sparingly. Rates are affected by the market situation of our country followed by the Market Volatility due to security in the country and large change in exchange rate affecting imported products, large increase in fuel costs. *Currently, as the market inflation is very high historic rates are not considered for EE validation. Hence, as it is mentioned above the comparative rate will depend on only the rate buildup of the system.*

The management can choose the minimum (lower) and maximum (upper) threshold rates for the particular project. In the current ERA's trend, this threshold is taken as 20% for both lower and upper limits. Consequently, to testify the capacity of the system and its results, the following in-depth study project with DBB project delivery system whose ECE is validated in ERAMS and works contract signed in the recent year (i.e., *January 2025*) is selected and the corresponding results has been analysed accordingly.

4.3.2 Evaluation of the system

Description of the selected project

The project road is located in the Central part of the country, and lies entirely in the Oromia and the South Nations, Nationalities and People's Regional States (SNNPRS) of the Federal Democratic Republic of Ethiopia, particularly, in West Shoa Zone of Oromia, the Graghe, Silite, Hadia, and Wolita Zone of the SNNPRS. The project road is classified as a link road and starts at Alemgena which is about 15 km from the Capital Addis Ababa. The road traverses south western direction linking the Capital with major towns along the project road such as Butajira, Worabe, Hossana, and Sodo and further down to the south Arabaminch town.

Tender Analysis Committee's (TAC's) finding during Evaluation

In checking the bid evaluation report reserved from ERA's Engineering Procurement Directorate, TAC has checked the unit rates of the lowest evaluated bidder with the unit rates of the Engineer's Estimate (EE) by selecting major items which contributes greater percentage of the series total of the project cost and the Engineer's estimate. Accordingly, TAC has noted that the items highlighted below which are found to be higher than the Estimate.

- Item 33.18(ii) [Paved ditch in rolling and other terrain as per Drawings (structure, type, size and dimensions indicated); Concrete (Class 25/20) LD Type B],
- Item 44.05 [Fill Flattening)],

- Item 52.01 (a)(ii) [Crushed stone base compacted to 103% of modified AASHTO density, layer thickness],
- Items 64.01 & 64.02 (a)(i) [Continuously graded Asphalt concrete (AC) wearing course with 50 mm thickness, 19mm nominal Aggregate size], and
- Item 84.01(iii) [Class 30/20 Concrete, including formwork to provide Class F2 surface finish].

Table 4-7: TAC finding with ERAMS Validation Result

<i>No.</i>	<i>Bill item No.</i>	<i>%age of lowest bidder as compared to EE</i>	<i>ERAMS Validation Result</i>
1	33.18(ii)	294.68%	Filled as CUSTOM item not subjected to comparison
2	44.05	190.00%	Filled as CUSTOM item not subjected to comparison
3	52.01 (a)(ii)	98.57%	Estimates Below Lower Threshold
4	64.01(a)(i)	88.96%	Estimates Below Lower Threshold
5	64.02 (a)(ii)	109.98%	Estimates Below Lower Threshold
6	84.01(iii)	148.30%	Filled as CUSTOM item not subjected to comparison

As it can be seen from the above table, referring to TAC’s findings correspondingly with ERAMS report, most of the above mentioned items are filled as custom items not subjected to comparison and estimates below lower threshold which are not properly validated by the system and hence, these items are departed from the EE and great difference has been observed in the procurement process in comparing the EE with the lowest bidder’s offer.

In order to start the analysis, the above TAC’s finding is taken into account and the detail assessment of the Engineer’s estimate with the system is done to meet the objectives of the study.

Overall Comparison of Consultant Rate with the Rate Build up Bill Items

To check the capacity of the system, it is crucial to know how many items of work are subjected to validation using the current system (ERAMS). Accordingly, the following table describes the number and percentage of bill items as a general comparison of the Engineer’s Estimate of the Consultant with the system Rate Buildup.

Table 4-8: Percentage of rate build up items with no. of bill items of ECE

<i>No.</i>	<i>Bill Series</i>	<i>Description of Bill Series</i>	<i>No. of Bill Items of the Consultant EE</i>	<i>Items whose Rate build up found in ERAMS*</i>	<i>Percentage of rate build up items with No. of bill items</i>
1	2000	Site clearance	5	5	100.00%
2	3000	Drainage structures	42	23	54.76%
3	4000	Earth works	11	6	54.55%
4	5000	Sub base and road base	5	3	60.00%
5	6000	Bituminous surfacing	10	7	70.00%
6	7000	Rigid Pavement	10	2	20.00%
7	8000	Structures	57	12	21.05%
8	9000	Ancillary works	19	13	68.42%
		Total	159	71	44%

Source: *(after ERA's Data base 2024)

The data is found from the ERA's data base which is at the time of estimate (i.e., Nov. 2024). As it can be seen from the above table, from the total of 159 bill items only 71 bill items (i.e., 44%) are subjected to ERAMS rate buildup denoting that the remaining 95 bill items are not validated in the system. This would have a significant effect on the estimate validation as comparison is made for only those listed 64 bill items whereas the remaining 56% of the total items (i.e., 88 bill items) are not validated. *The general (1000) series is not considered in this case since the rate build up is not part of it as most items are Provisional Sum (PS) and Lump sum (LS).*

The study tried to check the data for ERAMS Rate build up, aggregate comparative rate and validation report of the system which is presented below in the process of the system assessment. Besides, the bid evaluation findings are reviewed and compared to the system outputs to extract problems encountering in the procurement process. However, currently validation is executed only using the rate build-up items with no historic rates for the current working system as many Rate-Build items do not match historic rate data trends due to the fact that large market instability of the country.

Initially, it is very much important to separate the standard items from the non-standard items so as to check the capacity of the system distinguishing which items are validated and which are not. Thus, the following table depicts the number of non-standard (custom items) and percentage of custom items with total number of bill items in each bill series of the ECE which is derived from the system validation report.

The system validation report is annexed in the Appendix B of the study.

Overall Series Comparison of Engineer's Estimate with Contractor's Offer

The following table depicts the weighting percentage of Engineer's Estimate and winning Contractor's offer for all series (General - Day Works) which will be used in the next detail evaluation.

Table 4-9: Overall Series Comparison of Engineer's Estimate with Contractor's Offer

I. No.	Description	Engineer's Estimate	Contractor's Offer	Contractor's Offer / EE	Weighting % age EE	Weighting % age Contractor's Offer	Difference b/n Contractor's Offer & EE
1	Series 1000: General	301,109,000	372,200,256.61	123.61%	3.21%	3.35%	71,091,256.61
2	Series 2000: Site Clearance	23,865,980.65	33,722,368.65	141.30%	0.25%	0.30%	9,856,388.00
3	Series 3000: Drainage	1,413,171,282.11	2,507,079,985.74	177.41%	15.06%	22.54%	1,093,908,703.63
4	Series 4000: Earth Works	1,331,009,566.82	1,486,856,359.43	111.71%	14.18%	13.37%	155,846,792.61
5	Series 5000: Sub base, Road base and gravel wearing coarse	1,211,696,070.99	1,176,183,516.78	97.07%	12.91%	10.57%	-35,512,554.21
6	Series 6000: Bituminous Surfacing	3,852,061,981.20	3,898,658,880.19	101.21%	41.04%	35.05%	46,596,898.99
7	Series 7000: Rigid Pavement	226,774,808.60	306,443,579.10	135.13%	2.42%	2.75%	79,668,770.50
8A	Series 8000a: Structures (Retaining Walls, Slab & Box Culvert)	263,477,786.01	367,328,855.34	139.42%	2.81%	3.30%	103,851,069.33
8B	Series 8000b: Bridge Works	647,788,875	749,732,237.53	115.74%	6.90%	6.74%	101,943,362.53
9	Series 9000: Ancillary Works	113,786,209.19	222,627,405.17	195.65%	1.21%	2.00%	108,841,195.98
10	Series 11000: Day works	1,330,200.00	2,486,672.92	186.94%	0.01%	0.02%	1,156,472.92
	Total of Series (1000 to 11000)	9,386,071,760	11,123,320,117.46	110.13%	100.00%	100.00%	

Apart from this, the following table depicts the total No. of Bill Items of the Consultant EE, Items whose Rate build up found in ERAMS, No. of non-standard (Custom Items) and Items that are kept blank (neither found in RBU nor filled as Custom Items).

Table 4-10: Number of non-standard (Custom items) and Percentage of Custom Items with No. of Bill items in each bill series

<i>No.</i>	<i>Bill Series</i>	<i>Description of Bill Series</i>	<i>Total No. of Bill Items of the Consultant EE</i>	<i>Items whose Rate build up found in ERAMS*</i>	<i>No. of Custom Items</i>	<i>Items that are kept blank (Neither found in RBU nor filled as Custom Items)</i>
1	2000	Site Clearance	5	5	0	0
2	3000	Drainage Structures	42	23	7	12
3	4000	Earth Works	11	6	2	3
4	5000	Sub Base and Road Base	5	3	1	1
5	6000	Bituminous Surfacing	10	7	0	3
6	7000	Rigid Pavement	10	2	0	8
7	8000	Structures	57	12	2	43
8	9000	Ancillary Works	19	13	0	6
		Total	159	71	12	76

As depicted in the above table it can be seen that from the total of 159 items 12 are non-standard (Custom items) and whereas 76 items are kept blank that are not subjected to estimate validation. These have a significant effect on the estimate validation as comparison is made for only those that are standard items whose rate build up are developed in the system. The other items are filled in the system however they are not validated since their rate buildups are not developed so that only used to conduct the arithmetic checkup.

Considering the data in the above depicted tables, the following points are outlined for the in-depth study with the assessment of selected major items that contribute to greatest percentage of the overall estimate checking the input data, the assumption differences and accordingly major gaps have been identified as a result of the assessment of the validation system.

For presenting the description of the analysis, the major items with a significant effect on the total project cost are selected and the following illustrative tables and charts has been utilized with the corresponding cost estimate validation result of the ERAMS for the selected specific project that are depicted here under for ease of reference.

Table 4-11: Comparison of Engineers Estimate (EE) with the Contractor's offer for selected Major Items

Item No.	Description	Unit	Quantity	Engineers Estimate (EE)		Weighting %age of EE	Contractor's Offer		Weighting %age of Contractor's	Contractor Offer/ Engineer's	Difference b/n Contractor's Offer & EE	Remark {Result of the system}
				Rate (Birr)	Amount (Birr)		Rate (Birr)	Amount (Birr)				
21.01	Clearing and grubbing	ha	255	90,464.63	23,068,481.63	0.25%	125,699.03	32,053,252.65	0.29%	138.95%	8,984,771.02	Estimates Below Lower Threshold
32.22	Supply and lay plastic service duct for Street Lights	m	145,600	650.00	94,640,000.00	1.01%	475.00	69,160,000.00	0.62%	73.08%	-25,480,000.00	Filled as CUSTOM Item
33.01(a) (i)	Concrete kerbing Class 25/20 concrete with dimension of 17mmx40mm	m	147,500.00	707.10	104,296,926.71	1.11%	1,532.65	226,065,875.00	2.03%	216.75%	121,768,948.29	Filled as CUSTOM Item
33.17 (a) (ii) ₁	U-shaped drains in urban areas Concrete (Class 25/20) LD Type C Pedestrian	m	62,050	6,109.00	379,063,217.44	4.03%	11,692.98	725,549,409.00	6.52%	191.41%	346,486,191.56	Filled as CUSTOM Item
33.17 (a) (ii) ₂	U-shaped drains in urban areas Concrete (Class 25/20) LD Type C Vehicular	m	10,950	6,859.51	75,111,644.39	0.80%	13,537.85	148,239,457.50	1.33%	197.36%	73,127,813.11	Filled as CUSTOM Item
33.17 (b) (i)	Pedestrian crossing covers as per the detail Drawing	no.	62,100	3,688.44	229,052,018.09	2.44%	4,526.61	281,102,481.00	2.53%	122.72%	52,050,462.91	Estimates Below Lower Threshold
33.18 (ii)	Paved ditch Concrete (Class 25/20) LD Type B	m	20,740	4,450.40	92,301,313.65	0.98%	13,114.32	271,990,996.80	2.45%	294.68%	179,689,683.15	Filled as CUSTOM Item
41.01	Removal of unsuitable material	m ³	572,111	247.16	141,404,679.15	1.50%	328.49	187,932,742.39	1.69%	132.90%	46,528,063.24	Estimates Below Lower Threshold
42.01 (a) (i)	Cut to fill Material in layer thicknesses of 200mm and less compacted to 95% of modified AASHTO density	m ³	1,158,771	367.13	425,414,627.53	4.53%	401.35	465,072,740.85	4.18%	109.32%	39,658,113.32	Estimates Below Lower Threshold
42.01 (b) (iv)	Borrow to fill material Improved Upper selected subgrade	m ³	490,800	606.12	297,484,105.17	3.17%	550.19	270,033,252.00	2.43%	90.77%	-27,450,853.17	Filled as CUSTOM Item
42.03 (a)	Cut to spoil material obtained from Common (Normal) excavation	m ³	696,761	245.46	171,029,533.42	1.82%	247.87	172,706,149.07	1.55%	100.98%	1,676,615.65	Estimates Below Lower Threshold
42.03 (b)	Cut to spoil material obtained from Hard (Rock) excavation	m ³	151,051	606.33	91,586,924.11	0.97%	835.77	126,243,894.27	1.13%	137.84%	34,656,970.16	Estimates Below Lower Threshold

Item No.	Description	Unit	Quantity	Engineers Estimate (EE)		Weighting %age of EE	Contractor's Offer		Weighting %age of Contractor's Offer/ Engineer's	Contractor Offer/ Engineer's	Difference b/n Contractor's Offer & EE	Remark {Result of the system}
				Rate (Birr)	Amount (Birr)		Rate (Birr)	Amount (Birr)				
51.01 (b) (ii)	Sub-base layer constructed from Gravel sub-base	m ³	452,708.9	989.49	447,950,434.29	4.77%	947.84	429,095,603.78	3.86%	95.79%	-18,854,830.51	B/n 5% above comparison rate & Upper threshold
52.01 (a) (ii)	Base layer construction Crushed stone base	m ³	383,700.0	1,543.43	592,213,634.35	6.30%	1,521.39	583,757,343.00	5.25%	98.57%	-8,456,291.35	Estimates Below Lower Threshold
53.02 (d)	Milling out existing bituminous material with an average milling depth 150mm	m ²	869,000.0	115.9	100,688,679.34	1.07%	110.11	95,685,590.00	0.86%	95.03%	-5,003,089.34	Filed as CUSTOM Item
61.01 (a)	MC-30 cut-back bitumen applied at 1.0 litres per sq.m.	lit	1,846,000.00	156.24	288,417,758.14	3.07%	157.69	291,095,740.00	2.62%	100.93%	2,677,981.86	Estimates Below Lower Threshold
62.01 (a)	Tack coat_ RC-70 cut-back bitumen	lit	550,000.00	156.24	85,931,618.08	0.91%	184.64	101,552,000.00	0.91%	118.18%	15,620,381.92	N/A
64.01 (a) (i)	Dense Bituminous Macadam Binder course; Continuously graded, 60 mm thick, with 60/70 penetration grade bitumen, 25 mm nominal aggregate size	m ²	1,207,200.00	1,247.25	1,505,684,267.84	16.02%	1,109.57	1,339,472,904.00	12.04%	88.96%	-166,211,363.84	Estimates Below Lower Threshold
64.02 (a) (ii)	Continuously graded Asphalt concrete (AC) wearing course with 50 mm thickness	m ²	1,773,000.00	1,092.00	1,936,116,000.00	20.60%	1,200.98	2,129,337,540.00	19.14%	109.98%	193,221,540.00	Estimates Below Lower Threshold
71.02 (b)	Concrete pavement - Manual Construction	m ³	11,400.00	14,676	167,301,795.85	1.78%	21,763.76	248,106,864.00	2.23%	148.30%	80,805,068.15	Estimates Above Upper Threshold
83.01 (a)	Reinforcement for structures, mild steel bars, deformed grade 40	t	539.20	181,779.82	98,015,677.15	1.04%	138,335.16	74,590,318.27	0.67%	76.10%	-23,425,358.88	B/n 5% above comparison rate & Upper threshold
83.01 (b)	Reinforcement for structures, high yield stress steel bars, deformed grade 60	t	550.40	184,467.32	101,530,811.09	1.08%	153,705.73	84,599,633.79	0.76%	83.32%	-16,931,177.30	Filed as CUSTOM Item
84.01 (iii)	Class 30/20 Concrete, including formwork	m ³	8,641.00	14,675.60	126,811,826.14	1.35%	21,763.76	188,060,650.16	1.69%	148.30%	61,248,824.02	N/A
89.01 (b) (ii)	Class B Cement-mortared stone masonry walls	m ³	19,240	5,326.19	102,475,807.29	1.09%	6,233.33	119,929,269.20	1.08%	117.03%	17,453,461.91	Estimates Above Upper Threshold
95.01 (a) (ii)	Center line Marking with White thermoplastic road marking paint 100 mm wide broken line	km	278	55,254.13	15,360,647.99	0.16%	204,250.00	56,781,500.00	0.51%	369.66%	41,420,852.01	N/A
95.01 (b) (i)	Edge Marking with Yellow thermoplastic road marking paint 100 mm wide continuous line	km	278	55,254.13	15,360,647.99	0.16%	237,500.00	66,025,000.00	0.59%	429.83%	50,664,352.01	N/A

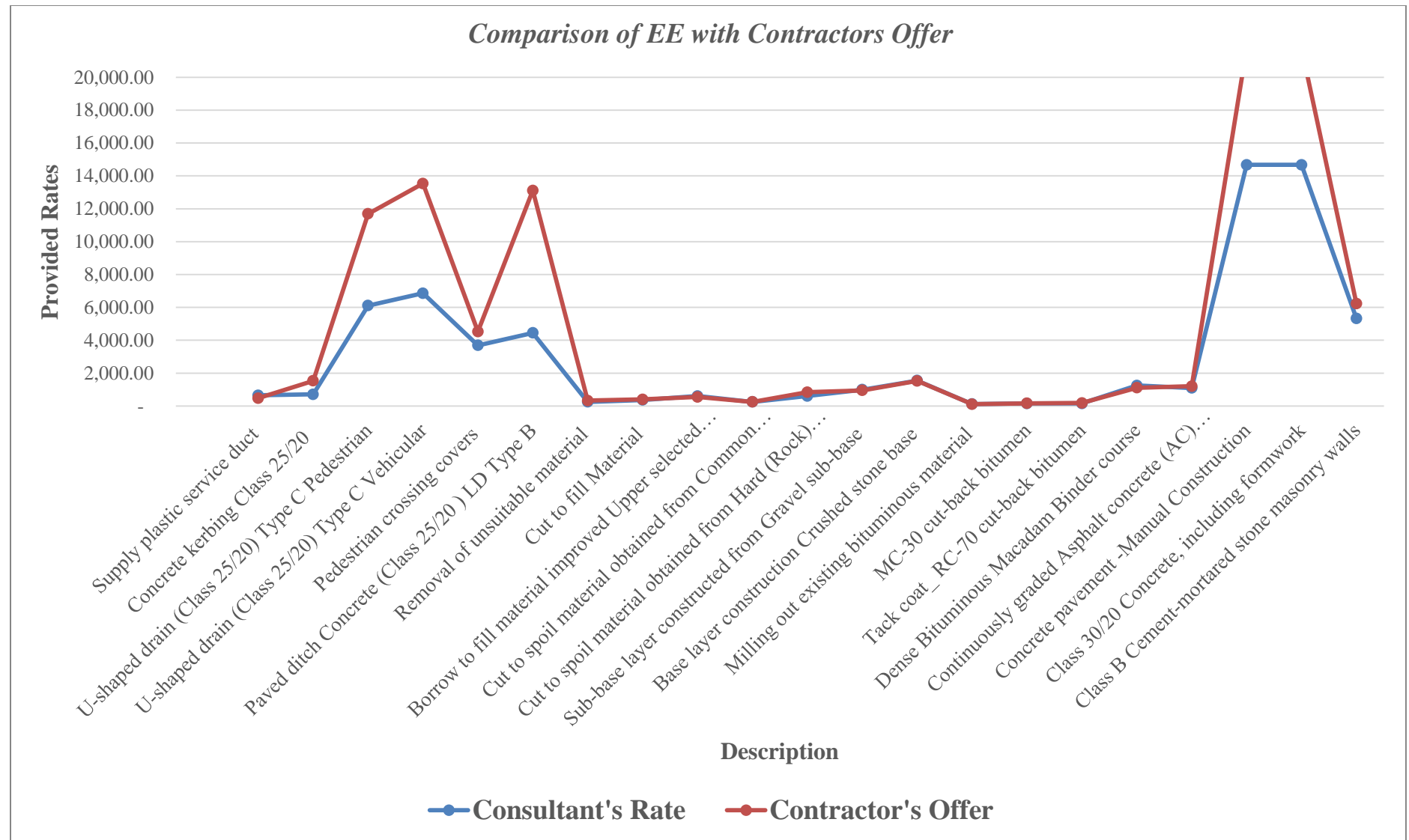


Figure 4-10: Chart depicting the Comparison of EE with Contractors Offer

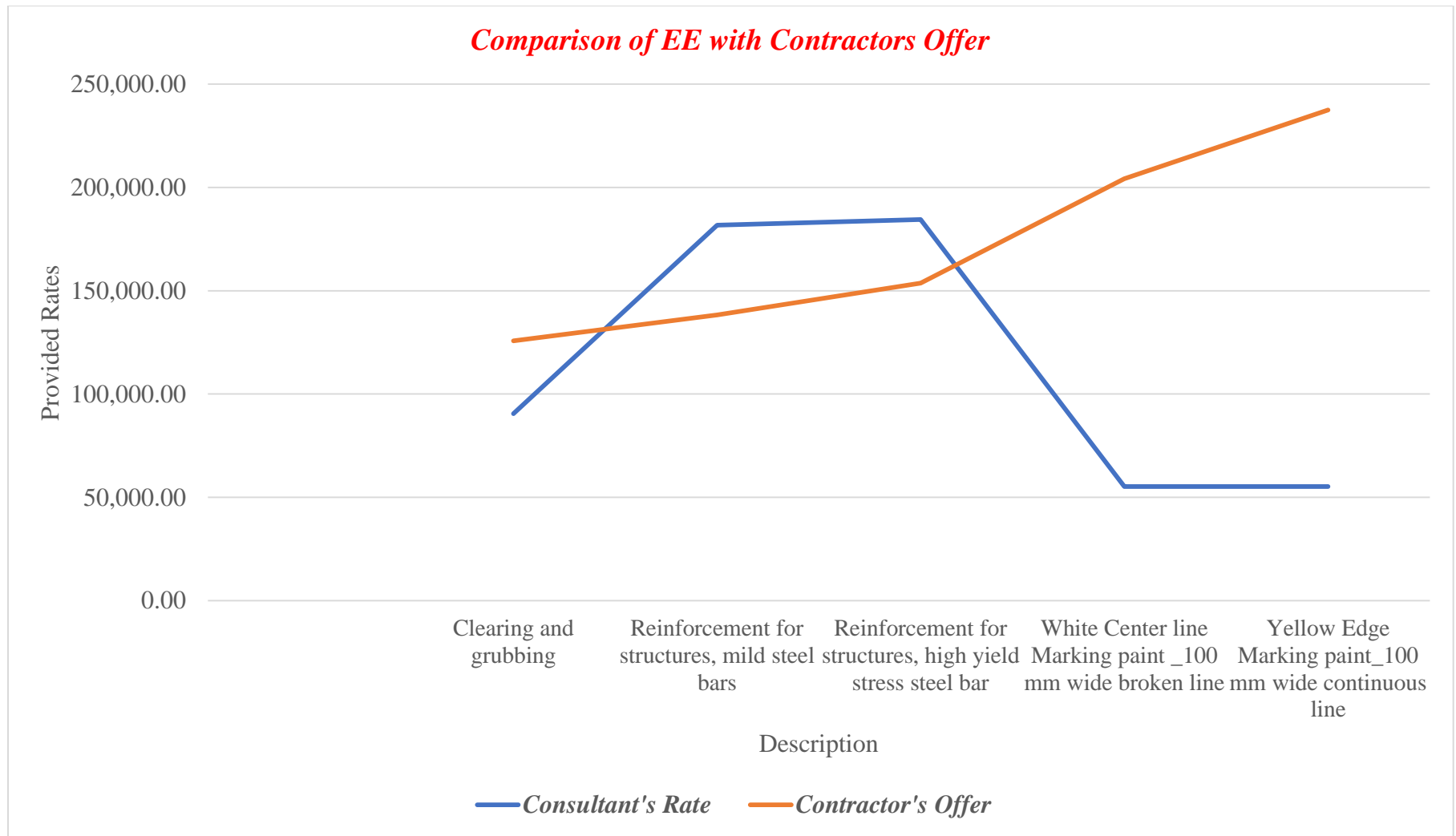


Figure 4-11: Chart depicting the Comparison of EE with Contractors Offer provided for items with higher rates

Table 4-12: Comparison of Engineers Estimate (EE) with the ERAMS Rate Buildup for selected Major Items

Item No.	Description	Unit	Quantity	Engineers Estimate (EE)		RBU_ERAMS		Weighting % age of ERAMS
				Rate (Birr)	Amount (Birr)	Rate (Birr)	Amount (Birr)	
21.01	Clearing and grubbing	ha	255	90,464.63	23,068,481.63	360,968.28	92,046,911.40	0.25%
32.22	Supply and lay plastic service duct for Street Lights	m	145,600	650.00	94,640,000.00	N/A	–	1.03%
33.01(a) (i)	Concrete kerbing Class 25/20 concrete with dimension of 17mmx40mm	m	147,500.00	707.10	104,296,926.71	N/A	–	1.14%
33.17 (a) (ii) 1	U-shaped drains in urban areas Concrete (Class 25/20) LD Type C Pedestrian	m	62,050	6,109.00	379,063,217.44	N/A	–	4.14%
33.17 (a) (ii) 2	U-shaped drains in urban areas Concrete (Class 25/20) LD Type C Vehicular	m	10,950	6,859.51	75,111,644.39	N/A	–	0.82%
33.17 (b) (i)	Pedestrian crossing covers as per the detail Drawing	no.	62,100	3,688.44	229,052,018.09	6,948.31	431,490,051.00	2.50%
33.18 (ii)	Paved ditch Concrete (Class 25/20) LD Type B	m	20,740	4,450.40	92,301,313.65	N/A	–	1.01%
41.01	Removal of Unsuitable material	m ³	572,111	247.16	141,404,679.15	1,025.73	586,831,416.03	1.54%
42.01 (a) (i)	Cut to fill Material in layer thicknesses of 200mm and less compacted to 95% of modified AASHTO density	m ³	1,158,771	367.13	425,414,627.53	695.9	806,388,738.90	4.64%
42.01 (b) (iv)	Borrow to fill material Improved Upper selected subgrade	m ³	490,800	606.12	297,484,105.17	N/A	–	3.25%
42.03 (a)	Cut to spoil material obtained from Common (Normal) excavation	m ³	696,761	245.46	171,029,533.42	329.99	229,924,162.39	1.87%
42.03 (b)	Cut to spoil material obtained from Hard (Rock) excavation	m ³	151,051	606.33	91,586,924.11	2,456.43	371,046,207.93	1.00%
51.01 (b) (ii)	Sub-base layer constructed from Gravel sub-base	m ³	452,708.9	989.49	447,950,434.29	1,151.59	521,335,042.15	4.89%
52.01 (a) (ii)	Base layer construction Crushed stone base	m ³	383,700.0	1,543.43	592,213,634.35	5,486.17	2,105,043,429.00	6.46%
53.02 (d)	Milling out existing bituminous material with an average milling depth 150mm	m ²	869,000.0	115.9	100,688,679.34	N/A	–	1.10%

Item No.	Description	Unit	Quantity	Engineers Estimate (EE)		RBU_ERAMS		Weighting % age of ERAMS
				Rate (Birr)	Amount (Birr)	Rate (Birr)	Amount (Birr)	
61.01 (a)	MC-30 cut-back bitumen applied at 1.0 litres per sq.m.	lit	1,846,000.00	156.24	288,417,758.14	255.56	471,763,760.00	3.15%
62.01 (a)	Tack coat_ RC-70 cut-back bitumen	lit	550,000.00	156.24	85,931,618.08	N/A	–	0.94%
64.01 (a) (i)	Dense Bituminous Macadam Binder course; Continuously graded, 60 mm thick, with 60/70 penetration grade bitumen, 25 mm nominal aggregate size	m ²	1,207,200.00	1,247.25	1,505,684,267.84	1,630.32	1,968,122,304.00	16.42%
64.02 (a) (ii)	Continuously graded Asphalt concrete (AC) wearing course with 50 mm thickness, 19mm nominal aggregate size	m ²	1,773,000.00	1,092.00	1,936,116,000.00	1,805.34	3,200,867,820.00	21.12%
71.02 (b)	Concrete pavement -Manual Construction	m ³	11,400.00	14,676	167,301,795.85	5,734.43	65,372,502.00	1.83%
83.01 (a)	Reinforcement for structures, mild steel bars, deformed grade 40	t	539.20	181,779.82	98,015,677.15	190,868.81	102,916,461.00	1.07%
83.01 (b)	Reinforcement for structures, high yield stress steel bars, deformed grade 60	t	550.40	184,467.32	101,530,811.09	N/A	–	1.11%
84.01 (iii)	Class 30/20 Concrete, including formwork	m ³	8,641.00	14,675.60	126,811,826.14	N/A	–	1.35%
89.01 (b) (ii)	Class B Cement-mortared stone masonry walls	m ³	19,240	5,326.19	102,475,807.29	4,260.95	81,980,678.00	–
95.01 (a) (ii)	Center line Marking with White thermoplastic road marking paint _100 mm wide broken line	km	278	55,254.13	15,360,647.99	N/A	–	–
95.01 (b) (i)	Edge Marking with Yellow thermoplastic road marking paint_100 mm wide continuous line	km	278	55,254.13	15,360,647.99	N/A	–	–

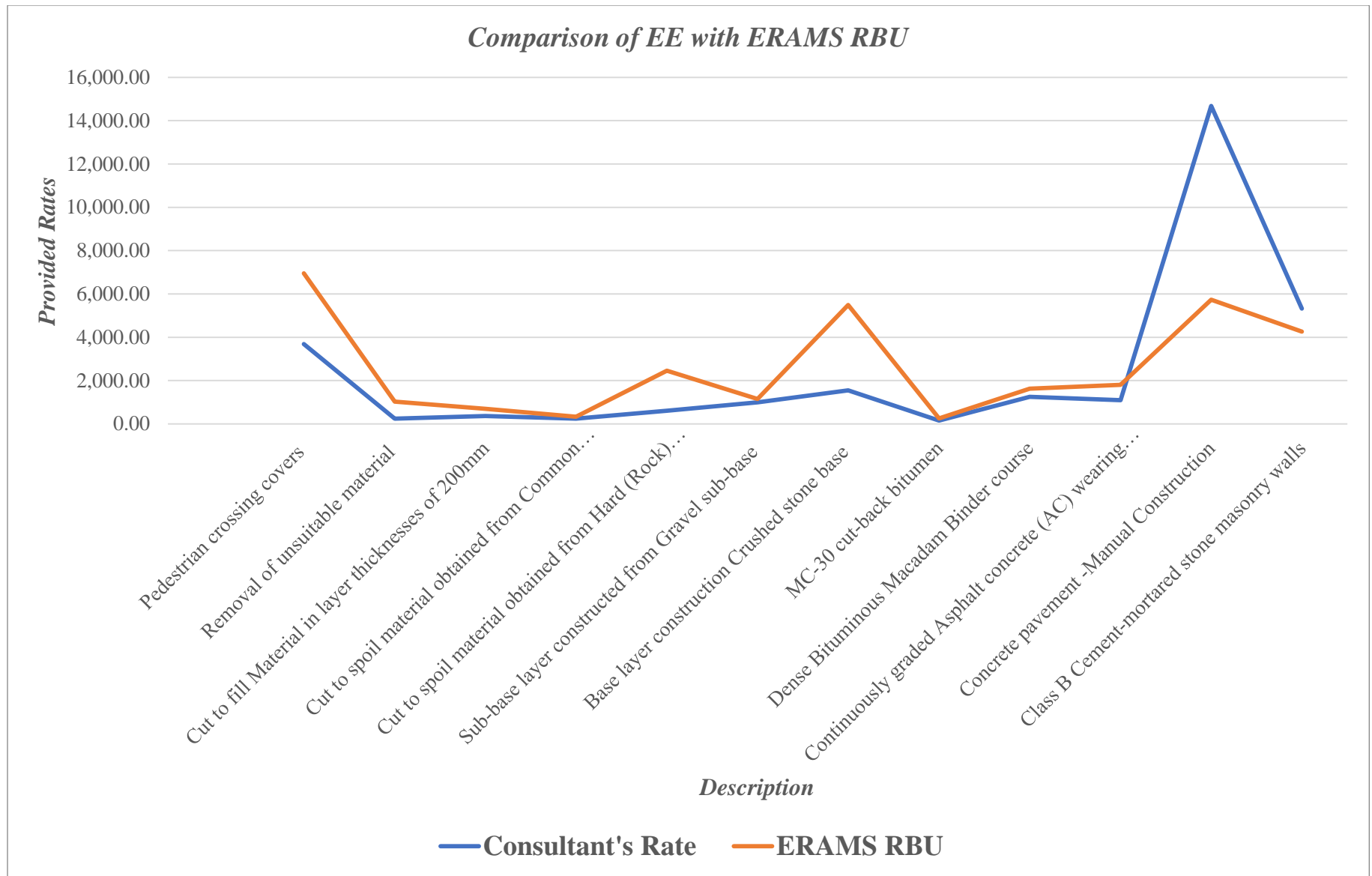


Figure 4-12: Chart depicting the Comparison of EE with ERAMS

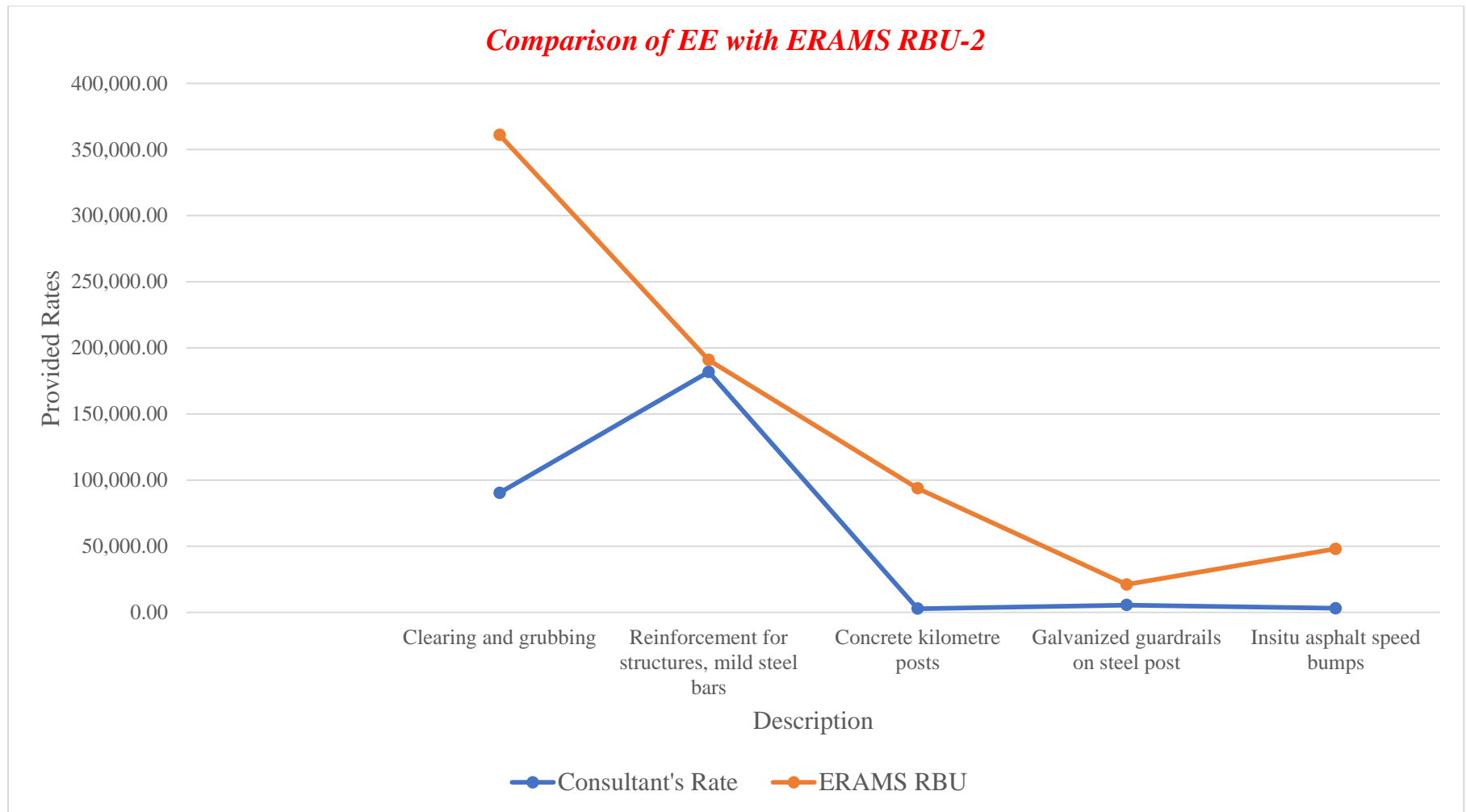


Figure 4-13: Chart depicting the Comparison of EE with ERAMS RBU provided for items with higher rates

From the above tables and charts whose details are presented below, the following assessment points are noted:-

- In reviewing **Series 2000** (i.e., item 21.01_ **Clearing and grubbing**) having 0.25% proportion in the estimate and 0.29% of project cost in the contractor's offer, the ERAMS rate build up is too far from the Consultant rate (i.e., around 300% greater) which is not reliable as per the prevailing current market and it needs the necessary amendment. This huge difference is due to the assumption difference in Equipment selection as the ERAMS used excavator, dozer, loader and dump truck whereas dozer is the only equipment assumed in the consultant rate. Accordingly, the number of labor increase with the additional equipment usage in the system. Besides, Equipment hourly costs have been taken considering only rental basis of the market price. Whereas, this seems unrealistic as the Contractors are not expected to utilize the required equipment through 100% rental basis. Hence, the proposed equipment hourly costs shall be a combination of owning and rental costs by considering the current practice of the market and also the labor cost observed in the proposed rate build up seems high with respect to our country payment status as such the rate goes to the higher side.
- **Upon reviewing Series 3000 [Drainage]:-**
 - ❖ Items 32.22 [1.01%], 33.01(a) (i) [1.11%], 33.17 (a) (ii) 1 & 2 [4.03% & 0.8%], 33.18 (ii) [0.98%] in the EE with the corresponding weighting percentage of 0.62%, 2.03%, 6.52% & 1.33%, 2.45% respectively in the contractor's offer are **filled as custom item** in the system. This have a greater impact in the validation and procurement process since these major items within this series are not validated in the system and hence, the outcome of the validation report affected the procurement process of the project which needs due emphasis in this case.
 - ❖ The remaining major item in this series i.e., item 33.17 (b) (i) {Reinforced Concrete Drain Covers_ Pedestrian crossing covers} with 2.44% and 2.53% weighting percentage in the EE and contractor's offer respectively has 22.72% difference in comparing the provided rates. Here, the basic assumption difference is difficult to identify as the Consultant's EE assumed the item as a precast item that do not specified the necessary cost elements whereas the ERAMS assumed various equipment, material and labor costs which makes it difficult to compare and as an output of the system report it shows that the provided estimate is *below lower threshold* and indicates that it needs modification in

the cost assumption. However, as the necessary modification is not made according to the report of the system, the problem is reflected in the comparison of the Contractor's offer with the EE in the procurement process.

➤ **Upon reviewing Series 4000 [Earth Work]:-**

- ❖ Item 41.01 (Removal of unsuitable material) with 1.5% and 1.69% weighting percentage in the EE and contractor's offer respectively has 32.90% difference in comparing the provided rates. This is due to assumption difference in Equipment combination as the ERAMS dump truck, loader, excavator and dozer whereas excavator and dump truck are the only equipment assumed in the consultant rate. Accordingly, the number of labor increase with the additional equipment usage in the system. Besides, Equipment hourly costs have been taken considering only rental basis of the market price. Due to this, the system validation report reveals that estimate is *below lower threshold*. Considering the abovementioned differences into account and the low marginal difference between the Consultant's rate and Contractor's offer, the major deviation in the assumption shall be modified as the effect of the validation result is reflected in the procurement process as well.
- ❖ Item 42.01 (a) (i) [Cut to Fill] with 4.53% and 4.18% weighting percentage in the EE and contractor's offer respectively has 9.32% difference in comparing the provided rates which is significant as the quantity provided for this item is huge though the rate difference seems insignificant. The system validation report for this pay item demonstrates that the estimate is *below lower threshold*. However, since the same is not modified accordingly it is reflected in the procurement process crafting a problem thereto.
- ❖ Items 42.01 (b) (iv) {Borrow to fill- Improved Upper selected subgrade} with a proportion of 3.17% and 44.05 {Fill Flattening} with a proportion of 0.71% in the EE with the corresponding weighting percentage of 2.43% and 1.14% respectively in the contractor's offer are *filled as custom item* in the system. This have a greater impact in the validation and procurement process since these major items within this series holding a huge quantities of 490,800.00 m³ and 665,000.00 m³ are not validated in the system and hence, the outcome of the validation report affected the procurement process of the project which needs to be given due emphasis in this regard.

- ❖ The remaining major items under 42.03 [Cut to Spoil] are common (Normal) excavation and Hard (Rock) excavation with quantities of 696,760.596 m³ and 151,051.00 m³ that have a proportion of 1.82% & 0.97% in the EE and with the corresponding weighting percentage of 1.55% and 1.13% respectively in the contractor's offer respectively. The validation report for these pay items demonstrates that both the estimates are *below lower threshold*. However, when we realize the assumption difference in the detail breakdown, the system input utilized additional Dozer besides to loader and dump truck for common (normal) excavation which are the only equipment in the Consultant EE. Whereas, when we come to Hard (Rock) excavation, the system input utilized a combination of excavator, dozer and dump truck with the corresponding operators and the Consultant utilized Dozer, Jack hammer, Wagon Drill and Compressor which indicates that there is discrepancies between the assumptions and makes the EE become below the lower threshold as Equipment hourly costs have been taken considering only rental basis of the market price. Whereas, this seems unrealistic as the Contractors are not expected to utilize the required equipment through 100% rental basis. Hence, the proposed equipment hourly costs shall be a combination of owning and rental costs by considering the current practice of the market. Such discrepancies in between the system and the EE inputs are reflected in the procurement process as the necessary modification is not made according to the result and it needs due emphasis as an outcome of the assessment.

This series that holds a significant huge quantities shall be given a due emphasis as it contains most major items of work in it that contribute a higher percentage from the total project cost and hence, the abovementioned discrepancies shall be cleared and corrected so as to produce a reliable cost estimate and conduct a smooth procurement process.

➤ ***Upon reviewing Series 5000 [Subbase, Road Base and Gravel Wearing Course]:-***

- ❖ Item 51.01 (b) (ii) [Gravel sub-base] with 4.77% and 3.86% weighting percentage in the EE and contractor's offer respectively has 4.21% difference in comparing the provided rates that seems okay as the validation result of the system demonstrates that the estimate is between 5% above comparison rate & upper threshold which is in safe range though it contains a huge quantity and hence, the researcher does not go for further assessment.
- ❖ Item 52.01 (a) (ii) [Crushed base layer] with 6.3% and 5.25% weighting percentage in the EE and contractor's offer respectively has 1.43% difference in comparing the provided rates that seems okay with the contractor's offer even if the validation result of the system

demonstrates that the estimate is *below lower threshold*. Checking further the inputs for this specific pay item reveals that the provided rate for the system is 255% greater than that of the Consultant rate with the assumption difference in equipment combination of dump truck, loader, water truck, roller, and asphalt paver with the corresponding operators whereas the Consultant utilized the equipment combination of only motor grader, roller and water truck which has a huge difference in the computation of the rate and would have significant effect as the item contains a huge quantity and hence, its effect is reflected in the procurement process.

- ❖ The remaining major item in this series i.e., item 53.02 (d) {Milling out existing bituminous material} with 1.07% and 0.86% weighting percentage in the EE and contractor's offer respectively has 4.97% difference in comparing the provided rates. However, the report of the system reveals that the item is *filled as custom item* in the system. This has a greater impact in the validation and procurement process since this major item within this series holding a huge quantity of 869,000.00 m³ is not validated in the system and hence, the outcome of the validation report affected the procurement process of the project which needs to be given due emphasis in this regard.

This series that holds a significant huge quantities shall be given a due emphasis as it contains most major items of work in it that contribute a higher percentage from the total project cost and hence, the abovementioned discrepancies shall be cleared and corrected so as to produce a reliable cost estimate and conduct a smooth procurement process.

➤ Upon reviewing **Series 6000 [Bituminous Surfacing and Road Bases]**:-

- ❖ Item 61.01 (a) [MC-30 cut-back bitumen] with 3.07% and 2.62% weighting percentage in the EE and contractor's offer respectively has 0.93% difference in comparing the provided rates that seems okay with the contractor's offer even if the validation result of the system demonstrates that the *estimate is below lower threshold*. Checking further the inputs for this specific pay item reveals that the provided rate for the system is 64% greater than that of the Consultant rate with the assumption difference in the productivity rate that the system utilized 750 performance rate and Equipment hourly costs have been taken considering only rental basis of the market price. Whereas the Consultant utilized 1000 performance rate and the proposed equipment hourly cost is a combination of owning and rental costs which has a huge difference in the computation of the rate and

would have significant effect as the item contains a huge quantity (1,846,000.00 lit) and hence, its effect is reflected in the procurement process.

- ❖ Item 62.01 (a) [Tack Coat RC-70 cut-back bitumen] with 0.91% weighting percentage in both the EE and contractor's offer respectively has 18.18% difference in comparing the provided rates. The validation result of the system does not reveal anything (empty result) while it has 0.94% proportion of Project Cost. Here it is crucial to describe that the system could not validate this item though it is greater than 0.5% proportion which have a significant effect as the item contains a huge quantity (i.e., 550,000.00 lit) and hence, its effect is reflected in the procurement process.
- ❖ Item 64.02 (a) (i) [Dense Bituminous Macadam Binder course] with 16.02% and 12.04% weighting percentage in the EE and Contractor's offer respectively has 11.04% difference in comparing the provided rates. Here the contractor's offer is 11.04% less than that of the EE and it seems okay. However, the validation result of the system demonstrates that the *estimate is below lower threshold*. The equipment combination utilized for the system are Dump truck, Roller (vibrator & pneumatic), Asphalt paver & Air compressor and equipment hourly costs have been taken considering only rental basis of the market price whereas the EE utilized a combination of only Asphalt plant and Loader and the proposed equipment hourly cost is a combination of owning and rental costs which has a significant assumption difference in the computation of the cost breakdown. This shows that the discrepancy needs a modification /solution since it has a significant effect as the item contains a huge quantity (i.e., 1,207,200.00 m²) with a greater proportion of the total cost and hence, its effect is reflected in the procurement process.
- ❖ Item 64.02 (a) (ii) [Continuously graded Asphalt Concrete (AC) Wearing Course] with 20.6% and 19.14% weighting percentage in the EE and Contractor's offer respectively has 9.98% difference in comparing the provided rates that seems okay. However, the validation result of the system demonstrates that the *estimate is below lower threshold*. The equipment combination utilized for the system are Dump truck, Roller (vibrator & pneumatic), Asphalt paver, Water truck & Air compressor and equipment hourly costs have been taken considering only rental basis of the market price whereas the EE utilized a combination of only Loader, Dump truck and excavator and the proposed equipment hourly cost is a combination of owning and rental costs which has a significant assumption difference in the computation of the cost breakdown. This shows that the

discrepancy needs a modification/solution since it has a significant effect as the item contains a huge quantity (i.e., 1,773,000.00 m²) with a greater proportion of the total cost and hence, its effect is reflected in the procurement process.

This series that holds a significant huge quantities shall be given a due emphasis as it contains most major items of work in it that contribute a higher percentage from the total project cost and hence, the abovementioned discrepancies shall be cleared and corrected so as to produce a reliable cost estimate and conduct a smooth procurement process.

➤ Upon reviewing **Series 7000 [Rigid Pavement]**:-

- ❖ Item 71.02 (b) [Concrete pavement -Manual Construction] with 1.78% and 2.23% weighting percentage in the EE and Contractor's offer respectively where the bidder's offer has 48.3% increment in comparing the provided rates. However, the validation result of the system demonstrates that the *estimate is above upper threshold*. The basic difference is that the equipment combination utilized for the system are concrete paver, concrete vibrator & hand tools and equipment hourly costs have been taken considering only rental basis of the market price whereas the detail breakdown for the Consultant's EE is not computed in the breakdown document which makes it difficult to trace where this huge difference is emanated from and hence, the effect of the same is reflected in the procurement process.

➤ Upon reviewing **Series 8000 [Structures]**:-

- ❖ Item 83.01 (a) [Reinforcement for structures, mild steel bars, deformed grade 40] with 1.04% and 0.67% weighting percentage in the EE and Contractor's offer respectively where the contractor's offer is 24% less than the EE in comparing the provided rates. However, the validation result of the system demonstrates that the *estimate is between 5% above comparison rate & upper threshold* which is in safe range though it is difficult to compare & contrast as the system does not contain the detail breakdown of which the rate is derived from. Hence, it is crucial for the system to incorporate the detail cost computation so as to conduct the necessary comparison as it would have a significant effect in the overall cost.
- ❖ 83.01 (b) [Reinforcement for structures, high yield stress steel bars, deformed grade 60] with 1.08% and 1.69% weighting percentage in the EE and Contractor's offer respectively where the contractor's offer is 16.68% less than the EE in comparing the provided rates.

However, the validation result of the system demonstrates that the *estimate is filled as Custom Item*. This has a greater impact in the validation and procurement process since these major items within this series are not validated in the system and hence, the outcome of the validation report affected the procurement process of the project which needs due emphasis in the future.

- ❖ 84.01 (iii) [Class 30/20 Concrete, including formwork] with 1.35% and 0.76% weighting percentage in the EE and Contractor's offer respectively where the bidder's offer has 48.3% increment in comparing the provided rates. The validation result of the system does not reveal anything (empty result) while it has 1.35% proportion of Project Cost. Here it is crucial to describe that the system could not validate this item though it is greater than 0.5% proportion which has a significant effect as it is a major item (i.e., Concrete work) and hence, its effect is reflected in the procurement process.
 - ❖ 89.01 (b) (ii) [Class B Cement-mortared stone masonry walls] with 1.35% and 0.76% weighting percentage in the EE and Contractor's offer respectively where the bidder's offer has 17.03% increment in comparing the provided rates. The validation result of the system demonstrates that the *estimate is above upper threshold*. The detail breakdown for the Consultant's EE is not computed in the breakdown document which makes it difficult to trace and compare where this difference is emanated from and hence, the effect of such discrepancies is reflected in the procurement process.
- Upon reviewing *Series 9000 [Ancillary Works]*
- ❖ Item 95.01 (a) (ii) [Center line Marking with White thermoplastic road marking paint _100 mm wide broken line] with 0.16% and 0.51% weighting percentage in the EE and Contractor's offer respectively has 269.66% difference in comparing the provided rates. In checking the validation result of the system, it does not reveal anything (empty result). This makes it difficult to check/validate the huge difference identified above and would have a significant effect as the same is reflected in the procurement process.
 - ❖ Item 95.01 (b) (i) [Edge Marking with Yellow thermoplastic road marking paint _100 mm wide continuous line] with 0.16% and 0.59% weighting percentage in the EE and Contractor's offer respectively has 329.83% difference in comparing the provided rates. In checking the validation result of the system, it does not reveal anything (empty result).

This makes it difficult to check/validate the huge difference identified above and would have a significant effect as the same is reflected in the procurement process.

- ❖ Items 91.04, 92.01 (c), 93.01, 95.04 (a) & 96.03 (a) have significantly escalated rates in the ERAMS with percentage increase of 449.45%, 2285.52%, 277.34%, 1428.78% & 1884.58% respectively that are considered as unrealistic & outliers due to the error in calibrating the RBU assumptions and needs attention to correct and clear the same. These are:-

Table 4-13: Outlier rates under series 9000

Item No.	Description	Consultant's Rate	ERAMS RBU	%age difference
91.04	Filter fabric	247.89	1362.03	549.45%
92.01 (c)	Concrete kilometer posts	2,860.07	93,882.49	3285.52%
93.01	Galvanized guardrails on steel post	5,583.90	21,070.15	377.34%
95.04 (a)	In situ asphalt speed bumps	3,147.03	48,111.18	1528.78%
96.03 (a)	Grassing includes preparation of grassing area with top soiling, stockpiling of top soil	500,000.00	9,922,917.18	1984.58%

The following basic points are summarized from the assessment analysis of the in-depth study on the validation system which briefly presents the gaps identified on ERAMS and the recommendations to mitigate the problems encountering:-

- The number of validated items in the system is considerably lower compared to that of the total bill items for the project, suggesting that many items have not been validated as the system doesn't recognize for customized items and the generated Estimate Validation reports of projects became incomplete.
- Equipment hourly costs have been taken considering only rental basis of the market price. Whereas, this seems unrealistic as the Contractors are not expected to utilize the required equipment through 100% rental basis since it is difficult to find some equipment like asphalt and crusher plant through rental basis and for this case, 100% of owning costs shall be considered during items rate buildups. Hence, the proposed equipment hourly costs shall be a combination of owning and rental costs by considering the current practice of the market since it has a significant impact on the rate of work items (the current recommended

combination is 60% owning cost and 40% rental cost). Besides, it is better to include Column for Utilization factor.

- The validation report for some pay items contains misinterpretations, where the consultant's rate lower than ERAMS buildup rate is inaccurately shown as higher, and vice versa. This misrepresentation distorts the comparison between the rates, leading to incorrect conclusions that could influence the decision maker. Additionally, some project's validation reports are not generated at all, which showed incompleteness of the system. To ensure the accuracy and reliability of the validation reports, it is crucial to correct these discrepancies and present the rates correctly while generating the validation report.
- The system occasionally becomes inaccessible or stops functioning, disrupting workflow and delaying critical tasks. Hence, ensuring consistent system functionality is crucial for overall effectiveness and seamless project execution.
- Engineer's facility currently become around 5% of the overall cost but it is not included in the system under series 1000. Hence, it is crucial to develop the RBU considering the project specific scenarios that have greater effect in the validation of ECEs in particular and procurement process in general.
- Some activities shall be subdivided into sub-activities for proper evaluation of the unit price. For instance, sub base activity comprises of sub base production, sub base hauling and sub base placing. After the unit prices of the sub-activities are determined, the unit price of the main activity will be drawn from the summation of these figures. When we do the unit price calculation in one table, we fix similar productivity values for all sub-activities, which is not true in the real case.
 - Similarly, unit costs of many activities that have sub-activities (Example: Detour construction, which involves clearing, material production, hauling and placing) must be computed by determining unit costs of each sub-activity with its own performance rate and summing up these unit costs. Adopting this approach produces quite different unit price than the one determined in the presented way. This is the major and fundamental problem of the cost breakdown formulation.
- The calculated man power index shall be separately depicted for head office staffs, site permanent staffs and site contract staffs since the assumptions taken to develop the hourly index in case of the three scenarios are different. Hence, it is better to review the hourly index with the consideration of the aforesaid three cases instead of applying unique man power

index as the hourly labor rates are consistently reported as high compared to the local market rates. Besides, superintendent and foreman are replaced by site Engineers nowadays, Hence, it is required to review the proposed positions of required labor as per the current practice as it has cost implication.

- The system does not generate the average cost per kilometer; which is a crucial parameter for effective project planning, budgeting, and decision-making. As a result, accurate financial forecasting and comparative assessments of projects become challenging.
- The system has no price index that updates the project cost by itself that is previously filled using the developed RBU unless the user updated the rates provided in the EE.
- The performance or productivity is as per the old CMS manual which has to be modified considering the current situations.
- There is no effective communication between the responsible directorates. The system provides for and requires the interaction of the users. Besides, it requires the manager to continually evaluate results and change assumptions and criteria. Hence, effective internal and external communication between the ERA implementing Directorates and ERA with the Design Consultant is mandatory to use the estimate validation system properly in its full capacity and to find a better output from it.
- In general, the system is not user-friendly, as certain fields, such as terrain and altitude in the basic engineering cost estimate data are inactive. This limits counterpart's to enter or modify crucial information, by hindering the overall functionality. Hence, it is recommended that these fields be made active and accessible, allowing users to efficiently input and update data. Besides, while searching the name of the projects, the full names are not shown and displayed and forcing us to use many trials to get the appropriate project name which is consuming much of our time.

Hence, it is crucial to address the findings outlined above so that it will allow for a more precise and fair rate buildup that reflects the real costs associated with the construction tasks while considering local market conditions. This will also enhance project budgeting and management efficiency.

Finally, if the abovementioned issues are solved and if the system is linked with the reliable price indexes it will generate more useful outputs and is recommended for other similar companies to deploy it.

5 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This research has examined the internal mechanisms, procedural gaps, and technological limitations in the review and validation of engineering cost estimates prepared by design consultants hired by Ethiopian Roads Administration (ERA).

One of the foremost findings of this study is the absence of a consistent and well-established standard for reviewing cost estimates submitted by design consultants. While the preparation of estimates is an essential step in any infrastructure project, the lack of comprehensive and up-to-date checklists, manuals, and reference documents means that the reviews often lack uniformity and completeness. The existing guidelines, such as the Construction Management System (CMS) manual, are outdated and do not address the complexity and extent of modern road projects.

Moreover, the documentation practices surrounding the cost estimate submissions are significantly deficient. In many cases, the Basis of Estimate (BOE) lack completeness, clear source references, and traceable assumptions. Pricing inputs for materials, equipment, and labor are not always supported by credible market data or properly documented sources.

The deployment of the Estimate Validation system (ERAMS) by ERA has been widely recognized as an important step as it was designed with valuable features including consideration of materials, equipment, labor, and site-specific variables like terrain and climate, offering a strong technical foundation for estimate validation. However, significant challenges remain in the full realization of ERAMS potential that are categorized and presented below:

System Calibration and Data Limitations: Many components of the system, such as Rate Build-Up formulas and productivity assumptions involving CMS manual, which guides much of the system's methodology, are outdated or not properly calibrated. Besides, the number of validated items in the system is considerably lower compared to that of the total bill items for the project

Lack of Reliable Market Data: The effectiveness of ERAMS is compromised by an absence of reliable, frequently updated market data for construction inputs. The absence of a robust market data system, combined with the reluctance of suppliers to provide updated pricing information, severely hampers the ability of both ERA and its consultants to generate realistic and market-reflective estimates. The Central Statistics Agency (CSA) does not provide current price data relevant to road projects.

Operational and User Challenges: Staff resistance, insufficient training, limited access to system mechanisms, and knowledge gaps especially due to staff turnover have undermined the consistent use and acceptance of the system.

Management and Communication Issues: Weak management enforcement and poor inter-departmental collaboration have resulted in inconsistent system usage and problem-solving delays.

Technical and Functional Gaps: ERAMS lacks features essential for addressing current economic realities such as price indexing, inflation adjustments, and currency devaluation tracking.

BoQ Standardization and Custom Items: The lack of standardized Bills of Quantities (BoQ) contributes to validation problems. The system cannot effectively validate non-standard items as the system doesn't recognize customized items.

Another significant insight from the research reveals recurring discrepancy between consultant-submitted cost estimates and the winning bids offers from contractors. Overestimated costs tend to inflate procurement budgets and decrease competition as bidders tend to align their offers with the Engineer's Estimate (EE), while underestimated estimates attract low bids that are not economically feasible, often resulting in compromised quality, disputes, increased claims and cost overruns during implementation.

Across both scenarios, common negative outcomes include bid cancellations and frequent re-tendering, development of unrealistic evaluation and qualification criteria, reduced competition and failure to attract competent or experienced contractors and loss of trust among stakeholders and increased administrative burden. A major contributing factor is the heavy reliance of contractors on the EE without conducting independent rate build-ups, which further amplifies the risks associated with inaccurate estimates. The divergence between consultant estimates and contractor bids stems from differing assumptions, methodologies, and risk considerations. Key observations include:

Risk Adjustment by Contractors: Contractors incorporate extensive risk allowances into their bids to account for inflation, currency devaluation, security risks, and unpredictable market volatility factors not adequately addressed in consultant estimates.

Inconsistency in input Assumptions: While consultants often rely on theoretical and design-based quantities, contractors ground their estimates in field realities, considering constructability and logistical challenges.

Lack of Standardization: Discrepancies arise due to subjective methodologies and non-standardized bill items. Even within a single organization, different professionals can produce significantly varying estimates based on personal assumptions.

Limited Competition: Recent trends show decreasing bidder participation, leading to higher average winning bids (often exceeding 110% of the Engineer's Estimate), compared to earlier years where bids averaged 80–90% of the EE.

Without an integrated and standardized estimation framework, this divergence is likely to persist, thereby continuing to undermine the credibility of the cost estimation process within ERA.

In summary, the current state of cost estimate preparation and validation within ERA reveals a critical need for systemic reform. The challenges identified ranging from outdated guidelines and poor documentation practices to inadequate system functionality and weak institutional coordination represent serious barriers to effective project cost estimate validation. These deficiencies compromise ERA's ability to achieve value for money, ensure transparency in procurement, and maintain public confidence in its road project investments.

5.2 Recommendation

Based on the study's findings and the challenges identified in ERA's current cost estimation review and validation processes, the following five key recommendations are proposed to improve the accuracy, transparency, and effectiveness of engineering cost estimate validation for road projects:

1. Develop and Implement Comprehensive Estimation Review Guidelines and Checklists

ERA should urgently develop updated, standardized, and comprehensive guidelines, manuals, and checklists specifically tailored to various project types and complexities for the review of engineering cost estimates prepared by design consultants. These documents must outline clear procedures, include verification steps for each estimate component (materials, labor, equipment, overhead, etc.), and ensure traceability of all pricing sources. These tools should replace outdated references like the CMS manual and be regularly revised based on market conditions and lessons learned from ongoing projects.

2. Strengthen Documentation, Accountability, and Approval Procedures

To enhance transparency and auditability, all estimate submissions must be accompanied by a complete and well-documented Basis of Estimate (BOE) and Book of Computation (BOC). All responsible professionals both from the consultant and ERA should be required to formally endorse their submissions through signatures on the documents, confirming the completeness, accuracy, and responsibility of the inputs used. ERA should establish a formal procedure for reviewing, approving, and storing these documents for future reference and quality assurance.

3. Upgrade and Recalibrate the ERAMS System for Greater Functionality

ERA should invest in upgrading and recalibrating the Estimate Validation and Management System (ERAMS) to address its current technical and functional limitations. Enhancements should include activation of currently inactive fields (e.g., terrain, altitude) along with the proper data mining tools, improved user interface, integration of a price index for inflation adjustments, and capabilities to evaluate customized or non-standard bill items. The system should also be able to calculate unit cost per kilometer, enable sub-activity level unit rate analysis and allow for real-time updates using reliable market data sources.

4. Build Institutional Capacity through Training and Dedicated Estimation Units

To improve the quality of estimate reviews, ERA should establish specialized internal units with trained personnel dedicated for independent review of engineering cost estimates. Regular

capacity building programs, workshops, and continuous trainings must be provided for both new and existing staff to ensure familiarity with ERAMS and estimation principles. Besides, in-house panel of experts from various departments of ERA, that updates existing systems considering the problems encountering them time to time and adds features on the system such as quantity checking and validation mechanism in addition to the rate and/or that develops new software is very much critical for continuous usage of the system.

5. Improve Interdepartmental Collaboration and Data Sharing

Effective cost estimation requires consistent communication and coordination among ERA departments including design, procurement, planning, and quality. ERA should establish a formal mechanism for cross-functional collaboration during the estimate preparation and review stages. Furthermore, ERA should collaborate with the Central Statistics Agency (CSA) and industry stakeholders to develop a reliable, frequently updated, and disaggregated market price database for key construction inputs, including region-specific variations.

Hence, to move forward, it is imperative that ERA addresses both the technical and organizational shortcomings of its cost estimate validation practices through the modernization of its systems, the standardization of its procedures, and the capacity-building of its personnel can ERA enhance the accuracy, reliability, and transparency of its engineering cost estimates. These improvements are not only necessary for better procurement outcomes but also essential for the sustainable development of Ethiopia's transport infrastructure sector in general.

5.3 Recommendation for Further Research Works

- Assessment on the quantity checking and validation mechanism of DBB Projects
- Evaluation of the Effectiveness of Digital Estimating Tools in Public Agencies
- Assessment on the best practices of cost estimate validation system for DB projects

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APPENDIXES

Appendix A: Questionnaire Survey

Questionnaire Designed for Ethiopian Roads Administration

Dear Respondents,

My name is Biruk Yersaw. I am studying my Master's degree at Addis Ababa University. Nowadays, I am working my thesis on *Assessment on Ethiopian Roads Administration Cost Estimate Validation System and its Impact on the Procurement of Road Projects in the department of Construction Technology and Management (CoTM)*. Hence, this questionnaire is developed to collect data concerning the research title. The questions will solely be used for a thesis conducted for the partial fulfillment of a master of science in Construction Technology and Management. Your genuine response will only be used for academic purposes, and the data will be kept strictly confidential. Please note that your personal details and affairs are not required in the survey.

I, therefore, kindly request that you carefully read all the questions, give your answers with due care, complete all questions and return as soon as possible. Please complete all questions as missed responses could not be incorporated in the analysis.

Thank you in advance for sacrificing your time and effort to fill out the questionnaire.

Instruction for completing the questionnaire

- Please put “√” mark in the space provided to indicate your response.
- Please do not hesitate to contact me if you need any clarification/justification.

Biruk Yersaw

Email: birukyersaw@gmail.com

Part I- General Information

1. Name of the Company: _____
2. Educational Background
 - A. B.Sc.
 - B. M.Sc.
 - C. Ph.D.
3. Years of Services
 - A. 0-5 Years
 - B. 6-10 Years
 - C. 11 – 15 years
 - D. >15 years
4. Current Position you are working in the organization
 - A. Senior Engineer
 - B. Lead Engineer
 - C. Team Leader
 - D. Director
5. Do you have experience/participation in the process of preparation/validation of Engineering Cost Estimation?
 - A. Yes
 - B. No

If yes, in what role?

 - A. Estimator
 - B. Reviewer
 - C. If other, please specify _____

Part II- Research Questions

To identify the major shortcomings, deficiencies and limitations in reviewing cost estimates provided from Design Consultants hired by ERA before feeding to the system

- 1) In reviewing and validating the engineer’s estimate, there are several points that you are going to consider. The following questions are used to assess the engineering cost estimate reviewing and validation practice in ERA. Hence, I would like request you to answer the questions below in the sense of **whether you are considering the listed issues or not** while you are reviewing/validating the engineer’s estimate. Please indicate your response by using a tick mark (√) according to your choice.

Note that:

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

No	Issues	1	2	3	4	5
1.	Consider & check the completion and well organization of the Basis of Estimate (BoE) in the inclusion of required information’s regarding to Design basis, Planning basis, Cost basis and Risk basis of the estimate					

2.	Review whether the design basis clearly document the scope of the project, and have all engineering deliverables such as list of all the drawings together with the date and number of the drawing revision, specifications and equipment lists used in developing the estimate been identified					
3.	Check whether the material prices, equipment prices, labor rates and productivities reasonable in line with expectations and consistently applied throughout the estimate					
4.	Review the reasonability of Schedule, Resource and Construction plan which are included in planning basis					
5.	Check whether the risk basis is clearly defined and is reasonable for the level of information available to prepare the estimate					
6.	Review carefully the cost basis of the estimate whether documentation of the source of every pricing [material pricing, significant equipment pricing (with purchase orders cited if applicable), and labor rate] used in the estimate.					
7.	Check the level of estimating personnel experience					
8.	Review strictly the appropriateness of the method, technique, assumptions and procedures used in preparing the estimate for the level of information available and project type					
9.	Check if different estimating methods used for different parts of the estimate and the level of detail in the estimate is sufficient					
10.	Review the time to prepare the estimate has been sufficient					
11.	Check what adjustments were made to the estimate for location, complexity, terrain, hauling distance etc.... of the project and their reasonability					
12.	Review whether the estimate summary and detail pages organization and presentation is at an appropriate level of detail					
13.	Check every cost item appearing on the estimate summary is traceable to the estimate detail breakdown and other estimate backup					

14.	Key professional and/or consulting firm's management staff responsible for preparation, checking and approval of the estimate document put their signature on the submitted estimate properly					
15.	There is a clear checklist specifically prepared for reviewing engineering cost estimates prepared by design consultants					
16.	Book of Computation containing calculations and summaries of quantities has been enclosed to form the integral part of the cost estimate document					
17.	There are guidelines and manuals that help to review the cost estimate prepared by design consultants					
18.	Presentations and communications are held frequently with the estimators by giving due emphasis to the engineering cost estimate as of the other design deliverables					
19.	Cross checking is made with the previous design documents to keep the consistency with the cost estimate					
20.	There is a separate independent team who review the engineering cost estimates					

Please list if there are additional issues you take into account in addition to those listed in the above table:

A) Which kind of technique is used to validate the Engineer's Cost Estimate in Ethiopian Roads Administration?

Checklist Guideline System

If any other, please specify _____

B) How do you rate the importance of the technique for validating the engineer estimate?

Fair Very Important Satisfactory Not Satisfactory

C) In which of the following do you focus most of the time during checking or reviewing of cost estimates?

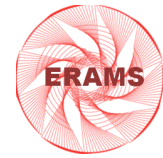
Quantity Rate Both

- How do you rate your understanding regarding the role design reports, drawings, specifications and contract conditions play in the preparation of Engineering cost estimates ?
A) No idea B) Fair C) Good D) Excellent
 - How do you rate the reports generated from ERAMS in validating the Cost Estimates?
A) Reliable B) Good C) Satisfactory D) Not reliable
 - How do you rate the response of the design consultants when forwarding them the Cost estimate validation results of ERAMS?
A) Fair B) Good C) Satisfactory D) Not Good
 - What do you think of the problem in using ERAMS in its full capacity?
A) User Problem B) the system itself C) Management of the system
 - While reviewing engineering cost estimates prepared by others, I _____ (more than one box can be checked)
 - Focus on the final unit rate
 - Use rates extracted from ERA database for comparison
 - Use rates from other Engineering cost estimates for comparison
 - Focus on the cost breakdown
 - Develop my own cost breakdown and derive unit rates for comparison
- What do you recommend to improve the engineering cost estimate reviewing, checking and validation system and obtain an accurate estimate?

Appendix B: ERAMS Validation report of the selected sample project



ETHIOPIAN ROADS ADMINISTRATION ESTIMATE VALIDATION SYSTEM (EVS)



Safe Envelope Analysis

Engineering Estimate Detail

Design Contract Name: Consultancy Services for the Feasibility Study, Environmental Impact Assessment (EIA), Resettlement Action Plan (RAP), Detailed Engineering Design and Tender Document Preparation of XXX Road Project

Engineering Estimate Name:

Date of Estimate: 11/15/2024

Note: Items codes with * mark are custom items

ERA Directorate:	Project	Team
DESIGN	Design Consultant:	XXX
Project Start Oromia	ERA Team Leader	XXX
Project End Oromia	ERA Project Eng.	

Threshold Settings

Lower Bound	20.00 %
Upper Bound	20.00%

Comparison Rate

Estimate rates are compared with 70% ERAMS Rate Build and 30% median of all historic rates over the last 3 years. Where historic rates are absent, 100% ERAMS Rate Build is used. And where no ERAMS Rate Build exists 100% median historic rate is used. When both are missing the item is kept blank if its rate constitutes 0.5% or more of project cost otherwise removed from report. Custom items are kept in report if they constitute more than 0.5% or more of project cost and are indicated by appending * after the item code.

Code	Pay Item	Used Rate	Proportion of Project Cost	Estimates Below Lower Threshold	Between Lower Threshold and 5% Above Comparison Rate	Between 5% Above Comparison Rate and Upper Threshold	Estimates Above Upper Threshold
21.01	Clearing and grubbing	Rate Buildup	0.25%	*			
22.02.(c)	Cleaning out of existing hydraulic structures (pipes and slab/box culverts): Slab or Box culverts up to and including 1.5m vertical dimension	Rate Buildup	<0.01%				*
22.02.(d)	Cleaning out of existing hydraulic structures (pipes and slab/box culverts): Slab or Box culverts exceeding 1.5m vertical dimension	Rate Buildup	<0.01%				*
22.03.(a)	Take up or down and set aside for reuse; or remove to store off Site: Blockwork and stonework	Rate Buildup	<0.01%	*			
31.01.(a).(i)	Excavation for Open Drains: Excavating soft material situated within the following depth ranges below the surface level: 0 to 1.5m	Rate Buildup	0.02%			*	
31.01.(a).(ii)	Excavation for Open Drains: Excavating soft material situated within the following depth ranges below the surface level: 1.5 to 3.0m	Rate Buildup	0.01%			*	
31.01.(a).(iii)	Excavation for Open Drains: Excavating soft material situated within the following depth ranges below the surface level: > 3.0m in increments of 1.5m	Rate Buildup	<0.01%			*	
31.01.(b)	Excavation for Open Drains: Extra-over sub-item 31.01(a) for excavation in hard material, irrespective of depth	Rate Buildup	0.02%	*			

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31.03.(a).(i)	Excavation for subsoil drainage Systems: Excavating soft material situated within the following depth ranges below the surface level: 0 to 1.5m	Rate Buildup	0.01%	*			
31.04	Impermeable backfilling to subsoil drainage systems	Rate Buildup	<0.01%	*			
31.06.(a)	Natural permeable material in subsoil drainage systems (crushed stone): Crushed stone obtained from approved sources on the site (state grade)	Rate Buildup	0.02%	*			
31.08.(a)	Pipes in subsoil drainage systems: Pitch-fibre pipes and fittings complete with couplings (state size and whether or not perforated)	Rate Buildup	0.10%				
31.10	Synthetic-fibre filter fabric (describe type, grade, etc)		0.06%				
32.01.(a).(i)	Excavation: Excavating soft material situated within the following depth ranges below the surface level: 0 to 1.5m	Rate Buildup	0.03%		*		
32.01.(a).(ii)	Excavation: Excavating soft material situated within the following depth ranges below the surface level: 1.5m to 3.0m	Rate Buildup	<0.01%			*	
32.01.(b)	Extra over sub item 32.01(a) for excavation in hard material, irrespective of depth	Rate Buildup	0.01%	*			
32.02.(a)	Backfilling: Using the excavated material	Rate Buildup	0.01%	*			
32.02.(b)	Backfilling: Using imported selected material	Rate Buildup	0.03%	*			
32.03.(a).(ii)	Concrete pipe culverts: On Class A bedding, Reinforced concrete pipe of diameter 1060mm	Rate Buildup	<0.01%	*			
32.03.(a).(iv)	Concrete pipe culverts: On Class A bedding, Reinforced concrete pipe of diameter 1220mm	Rate Buildup	0.29%	*			
32.03.(b).(ii)	Concrete pipe culverts: On Class B bedding, Reinforced concrete pipe of diameter 1060mm	Rate Buildup	0.02%	*			
32.03.(b).(iv)	Concrete pipe culverts: On Class B bedding, Reinforced concrete pipe of diameter 1220mm	Rate Buildup	0.08%	*			
32.06.(a)	Cast in-situ concrete and formwork: In Class A bedding, screeds and the encasing for pipes, including formwork (class of concrete indicated)	Rate Buildup	0.16%	*			
32.16.(a)	Service ducts: Ordinary pipes (type and diameter indicated)		0.06%				
32.17	Duct marker blocks (type indicated)		<0.01%				
32.22*	Supply and lay plastic service duct for Street Lights		1.03%				
33.01 (a) (i)*	Kerbing: Cast In-Situ Concrete Curbing (size 45cm X 17cm)		1.14%				
33.03.(a)	Chutes: Concrete (class of concrete indicated for in-situ concrete) (Descriptions of type with reference to Drawing)		0.01%				
33.17 (a)(ii)2*	Concrete (Class 25/20) LD Type C Vehicular		0.82%				
33.17.(b).(i)	Paved Drains in Urban Areas and Reinforced Drain Covers: Reinforced Concrete Drain Covers (as per Drawings): Pedestrian crossing covers (type, size and dimensions indicated)	Rate Buildup	2.50%	*			
	Paved Drains in Urban Areas and Reinforced Drain Covers: Reinforced	Rate Buildup		*			

33.17.(b).(ii)	Concrete Drain Covers (as per Drawings): Vehicle crossing covers (type, size and dimensions indicated)		0.49%				
33.17(a)ii) 1*	U shaped drain in urban areas Concrete Class 25/20 LD tYPE c Pedestrian		4.14%				
33.18(i)*	Concrete (Class 25/20) LD Type A		0.54%				
33.18(ii)*	Concrete (Class 25/20) LD Type B		1.01%				
34.01.(b)	Grouted pitching	Rate Buildup	0.06%	*			
34.02.(a)	Riprap: Packed riprap (class indicated)	Rate Buildup	0.01%	*			
34.02.(b)	Riprap: Dumped riprap (class indicated)	Rate Buildup	0.01%	*			
34.03.(a)	Stone masonry walls: Dry stone masonry walls	Rate Buildup	0.72%				*
34.04*	concrete pitching Pre-cast concrete blocks for side walk pavement (300x300x60mm Pre-colored concrete block on sand base including any jointing work)		1.47%				
41.01.(a)	Removal of unsuitable material and replacement with suitable material: In layer thicknesses of 200mm and less	Rate Buildup	1.54%	*			
41.02	Roadbed preparation and compaction	Rate Buildup	0.36%			*	
41.03.(a)	In-situ treatment of roadbed: In-situ treatment by ripping	Rate Buildup	0.07%	*			
42.01 b iv*	Capping layer or improved/selected subgrade		3.25%				
42.01.(a).(ii)	Cut and borrow to fill: Cut to fill material: Compacted to 93% of modified AASHTO density	Rate Buildup	4.64%	*			
42.03.(a)	Cut to spoil: Common (normal or soft) excavation	Rate Buildup	1.87%	*			
42.03.(b)	Cut to spoil: Rock (Hard) excavation	Rate Buildup	1.00%	*			
42.04	Stockpiling of material		0.96%				
44.05*	Side fills or Fill-flattening		0.73%				
51.01.(b).(ii)	Sub-base layer constructed from gravel or crushed stone: Gravel sub-base (unstabilised gravel) compacted to: 97% of modified AASHTO density (specify compacted layer thickness)	Rate Buildup	4.89%			*	
52.01.(a).(ii)	Base layer construction: Crushed-stone base compacted to: 100% of modified AASHTO density (Layer thickness indicated)	Rate Buildup	6.46%	*			
53.01.(a).(iii)	Excavating and removing existing bituminous material (except milled material): Material intended for recycling with the average depth of excavation: Exceeding 60mm		0.27%				
53.02 (d)*	Milling out existing bituminous material with an average milling depth of 150mm		1.10%				
54.01.(b)	Gravel Wearing course and Shoulder constructed from gravel taken from cut or borrow pits: Gravel shoulders wearing course compacted to 93% or 95% of	Rate Buildup	0.51%	*			

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	modified AASHTO density (specify compacted layer thickness)						
61.01.(a)	Prime coat: MC-30 cutback bitumen	Rate Buildup	3.15%	*			
62.01.(a)	Tack coat: Stable-grade bitumen emulsion (30%)		0.94%				
63.02.(a)	Double surface seal using: 19.0 mm and 9.5 mm chippings (with specified binder)	Rate Buildup	0.19%	*			
63.07.(a)	Variations in the rate of application of Bituminous Binder: 80/100 penetration-grade bitumen	Rate Buildup	0.01%	*			
63.08.(b)	Variations in the rate of application of Chippings: 19.0 mm chippings	Rate Buildup	0.01%				*
63.08.(d)	Variations in the rate of application of Chippings: 9.5 mm chippings	Rate Buildup	<0.01%	*			
64.01.(c)	Bituminous road base: Dense Bitumen Macadam	Rate Buildup	16.42%	*			
64.02.(a)	Asphaltic surfacing: Continuously graded	Rate Buildup	21.12%	*			
71.02.(b)	Concrete pavement (thickness indicated): Manual construction	Rate Buildup	1.83%				*
71.04	Variation in the rate of application of the curing compound		<0.01%				
71.05.(a)	Joints: Expansion joints complete (excluding dowels)	Rate Buildup	0.01%				*
71.05.(b)	Joints: Longitudinal hinge joints: Sealed hinge joints (type indicated with reference to Drawings)		0.05%				
71.05.(e)	Joints: Sealed transverse contraction joints sawn in two separate operations (widths as shown on the Drawings)		0.01%				
71.05.(f)	Joints: Dowel bars (mild steel) (diameter and length indicated): Installed in new concrete		0.01%				
71.05.(h)	Joints: Tie-bars (diameter and length indicated): Installed in new concrete		0.03%				
71.07.(a)	Steel reinforcement in concrete pavement: Mild steel bars (grade specified)		0.02%				
71.07.(b)	Steel reinforcement in concrete pavement: High tensile steel bars (grade specified)		0.44%				
71.08.(b)	Removing existing concrete in remedial/rehabilitation work: Reinforced concrete		0.07%				
81.01.(a)	Additional foundation investigations: Fixed cost		0.21%				
81.01.(b)	Additional foundation investigations: Percentage allowed for overhead and profit on item 81.01(a)		<0.01%				
81.02.(a).(i)	Excavation of materials: Excavation of soft material situated in the following ranges: 0 m to 2m	Rate Buildup	0.02%			*	
81.02.(a).(ii)	Excavation of materials: Excavation of soft material situated in the following ranges: Exceeding 2m to 4 m	Rate Buildup	0.02%			*	
81.02.(a).(iii)	Excavation of materials: Excavation of soft material situated in the following ranges: Etc in increments of 1m depth	Rate Buildup	0.02%			*	
81.02.(b)	Excavation of materials: For excavation in hard material irrespective of depth	Rate Buildup	0.12%	*			

81.03	Access		0.25%				
81.05.(a)	Backfill to excavations utilizing: Material from the excavation	Rate Buildup	0.01%	*			
81.05.(b)	Backfill to excavations utilizing: Imported material	Rate Buildup	0.05%	*			
81.17.(a).(ii)	Augered or bored holes for piles: Augered holes: Exceeding 10m and up to 15m		0.05%				
81.17.(a).(iii)	Augered or bored holes for piles: Augered holes: Etc in increments of 5m depths		0.04%				
81.18.(a)	Driving the temporary casing for driven displacement piling systems for forming holes for piles: 0m up to 10m		0.04%				
81.30.(a)	Steel reinforcement in cast in situ piles: High-yield stress-steel bars (type indicated)		0.38%				
81.30.(a)	Steel reinforcement in cast in situ piles: Mild-steel bars		0.16%				
81.31	Cast in situ concrete in piles, under reams, bulbous bases and sockets		0.21%				
81.32	Extra over item 81.31 for concrete cast under water		<0.01%				
81.34	Stripping/cutting the pile heads		0.11%				
81.35	Establishment on the site of the load testing of piles		0.18%				
81.36	Load tests on piles		<0.01%				
81.50.(a)	Nuclear integrity testing on bored piles: Constructing 5.0 m long calibration piles of (indicate diameter)		0.05%				
83.01.(a)	Steel reinforcement for structure: Steel bars (Size, Type, Class and Grade indicated)	Rate Buildup	1.07%			*	
83.01.(a).(ii)*	Steel reinforcement for structures: High yield stress steel bars (deformed Grade 60 or G-420)		1.11%				
83.01(iii)*	class 30/20 concrete, including formwork to provide class F2 surface finish		1.38%				
84.06.(a)	Demolishing existing concrete: Plain concrete (Member indicated)	Rate Buildup	<0.01%				*
84.06.(b)	Demolishing existing concrete: Reinforced concrete (Member indicated)	Rate Buildup	0.07%				*
87.07	Concrete parapets	Rate Buildup	0.03%	*			
87.08	Steel railings		0.06%				
87.14.(b)	Filled joints: Filled joints (Description of joint and thickness of joint filler for joints measured per meter)		<0.01%				
87.19.(b).(ii)	Drainage pipes and weep holes: Weep holes: (Type and size indicated)	Rate Buildup	<0.01%			*	
89.01.(a)	Stone masonry walls: Plain packed stone masonry walls (Class of masonry described)	Rate Buildup	1.50%				*
91.01.(b)	Foundation trench excavation and backfilling: Excavation (common) in all other classes of material	Rate Buildup	0.01%				*
91.01.(c)	Foundation trench excavation and backfilling: Backfilling	Rate Buildup	0.01%				*

91.03.(a)	Gabions and Mattresses: Gabion boxes (Type, size of box and mesh indicated)	Rate Buildup	0.13%	*			
91.03.(b)	Gabions and Mattresses: Gabion mattresses (Type, depth of mattresses, mesh size and diaphragm spacing indicated)	Rate Buildup	0.01%			*	
91.04	Filter fabric	Rate Buildup	0.01%	*			
92.01.(b)	Delineators, markers (guide posts) and kilometre posts: Kilometre posts (material)	Rate Buildup	<0.01%	*			
92.01.(b)	Delineators, markers (guide posts) and kilometre posts: Markers (guide posts) (material)	Rate Buildup	0.03%	*			
93.01	Guardrails on [material] posts Galvanized	Rate Buildup	0.12%	*			
94.01.(a).(i)	Sign faces with painted background. Symbols, lettering and borders in Engineering grade retro- reflective material with signboard constructed from (Specify material and thickness): Warning and regulatory signs: Area not exceeding 2 m ²	Rate Buildup	0.01%			*	
94.01.(a).(ii)	Sign faces with painted background. Symbols, lettering and borders in Engineering grade retro- reflective material with signboard constructed from (Specify material and thickness): Warning and regulatory signs: Area exceeding 2 m ²	Rate Buildup	<0.01%				*
95.04.(a)	Traffic Calming: In situ asphalt Speed Bumps (dimensions and spacing specified)	Rate Buildup	<0.01%	*			
95.04.(b)	Traffic Calming: In situ asphalt Rumble Strips (classification of set of 4 strips specified)	Rate Buildup	0.02%			*	
96.03.(a)	Grassing: Planting of grass cuttings	Rate Buildup	0.25%	*			