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An Evaluation into the Performance of Standard Unit Rates Estimation Practices in Public Constructions: in the Case of Tigray, Ethiopia

By

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The undersigned have examined the thesis entitled **An Evaluation into the Performance of Standard Unit Rates Estimation Practices in Public Constructions: in the Case of Tigray, Ethiopia,** presented by **Atsede Tekle Berhe is** proven for the degree of Master of Science in Civil Engineering (Construction Technology and Management).

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Atsede Tekle Berhe

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Declaration

I attest that the thesis research work titled "*An evaluation into the performance of standard unit rates estimation practices in public constructions: in the case of Tigray, Ethiopia*" is my original research work and has not been presented for a degree in any other university. The material sources used in this thesis research work are duly acknowledged.

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As research Advisor, I hereby certify that I have read and evaluated this thesis research paper prepared under my guidance, by Dr. Haddush Goytom and Eng. Yaekob Tsehaye Entitled "*An evaluation into the performance of standard unit rates estimation practices in public constructions: in the case of Tigray, Ethiopia*" and recommend and would be accepted as a fulfilling requirement for the Master of Science in Civil Engineering (Construction Technology and Management).

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Abstract

It is essential to understand the financial feasibility of construction projects in a market that is characterized by significant fluctuations. Project success depends on accurate cost estimation, however in Tigray, the least bidder system and differences between the Bureau's Standard Unit Rates and actual market pricing have resulted in cost overruns and delays in public building projects. Furthermore, a major issue identified above 80% the executed projects were under the estimated cost, indicating an overestimation. This paper examines the performance of SURs estimate in Tigray public construction projects and suggests ways to improve. An evaluation of 30 finished projects, interviews, and standardized 45 out of 65 questionnaires were used. The data were interpreted with the help of qualitative insights, and Paired T test, Multiple Regression, Correlation, and Variance analysis were conducted using Microsoft Excel and SPSS version 27. The results showed that, on average, published SUR were 3.43% (24.59 ETB per unit) higher than BUR. Even yet, early Engineering Estimates were 17.9% higher than bid values, showing overestimation, and actual project costs were 11.9% less than the engineering estimation. Project completion timelines also went 83.6% beyond schedule, resulting in significant time overruns. There was a correlation of SUR and BUR, $r = 0.728$ and according to the Regression analysis, the cost assumptions accounted for $R^2 = 0.975$, $p < 0.01$, of the cost variations; contract price was the most significant. Above 56% of the respondents indicated the SURs estimation are incorrect and around 65% -80% of those surveyed agreed that SUR error was a direct cause of delay, cost overrun and lower quality. Based on the findings, it is suggested updating SUR methodology, updating productivity, changing way of procurement is conducted, and enhancing stakeholders' cooperation imply improving contractors' performance, and feasibility of the projects, in the Tigray construction industry.

Keywords: Bid Unit Rate, Cost prediction accuracy, Engineering Estimation, Public Construction Projects, Standard Unit Rate

Abbreviations / Acronyms

SURave	Average Standard Unit Rate
BURave	Average Bid Unit Rate
EE	Engineering Estimation
AC	Actual Cost
CP	Contract Price
AT	Actual Time
CT	Contractual Time
SPSS	Statistical package for social science
CIDB	Construction Industry Development Board
BIM	Building Information Modeling
BOQ	Bill of quantities

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CHAPTER 1. INTRODUCTION

1.1 Research Historical Background

Any economy's growth is significantly influenced by the construction industry sector. About 80% of all capital assets are accounted for by significant construction activity, especially in many emerging nations and in these nations, building makes up nearly 50% of the wealth invested in fixed assets and 10% of GDP. Between 1997/98 and 2001/02, public construction projects in Ethiopia shared an average yearly rate of 58.2% of the capital budget (Wubshet, 2004) referred to in (Addis & Ababa, 2024). Despite the construction industry's vital role in the development of nations and its substantial economic contribution to developing countries, the industry's performance standards are still often inadequate. Many projects show cost overruns, time delays, failure to realize their intended benefit, or even the fact that they are completely terminated and abandoned before or after their completion due to conflicts amongst partners.

The Stability of project success and regional development is largely dependent on the accuracy of cost estimation in the ever-changing construction Environment. The accuracy of Standard Unit Rates (SUR) estimating techniques has a significant role in the Ethiopian, Tigray region, where construction activity is crucial in forming the cities and promoting economic progress. Policymakers and industry players use published reports from the Tigray Bureau of Construction, which outline SUR values that are indicative of current market rates. Still, doubts remain about how true this estimate is to the ground, and suggestions for improvement.

Problems of cost estimation in the construction sector are one of the contributing factors to poor performance. As Ketema N. (2021) stated, estimating is the primary function of the construction industry, and thus the accuracy of cost estimates starting from early phase of a project can affect the success or failure of any construction project. However, the industry is known for having poor price forecasting and cost estimating practices. The construction industry's problems must be recognized to offer integrated solutions that are appropriate for the situation and guarantee continuous performance improvement. Like the construction industries of most developing nations, Ethiopia's construction sector faces obstacles to growth. Clients, contractors, consultants, and other relevant stakeholders typically view completion of a construction project within a specified budget and timeframe as a critical success factor.

The poor cost estimating practices, like poor analysis of cost data, lack of knowledge in the construction process by the estimator, poor document analysis, and so on, generally lead to poor overall project performance. Schedule Delays and cost overruns which exist in real estate development have impacts and developers need to manage and minimize their effect on project performance and business as a whole. It is important to know the reasons that exist in local real estate developers for the escalation of price and time delay on their projects in comparison with foreign real estate developers, and their impact on project performance as a whole.

The construction industry in the Tigray region of Ethiopia stands as a cornerstone of economic development and social progress, contributing significantly to infrastructure enhancement, job creation, and overall prosperity. With a burgeoning population and evolving urban landscape, there is an ever-growing demand for construction projects ranging from residential complexes to transportation networks and public facilities.

The term Standard Unit Rate (SUR) describes a fixed cost for particular construction projects work item, that is based on estimated inputs such labor, material, equipment, and overhead. For public works, these rates serve as a benchmark for engineering estimations. Bid Unit Rates (BURs), on the other hand, are the costs that contractors provide during a competitive tender. Since underestimating or overestimating can result in cost overruns, disagreements, or project delays, SUR accuracy is crucial to project success. Furthermore, the frequently employed least-bidder selection technique in public procurement has a tendency to put price ahead of quality. This technique encourages low bids when SURs are out-of-date or unrealistic, which frequently leads to contractor standard, quality compromise, or monetary losses. Thus, it is essential to comprehend and assess SUR estimating techniques in order to enhance building results, particularly in environments with restricted resources like Tigray.

Two related theoretical frameworks public procurement theory and cost estimation theory support this investigation. According to cost estimating theory, accurate and data-driven estimation techniques are essential for realistic budgeting, effective resource allocation, and on-time project completion. It emphasizes the necessity of precise productivity measurements, up-to-date market data, and logical estimation methods. The effects of procurement procedures, including the lowest evaluated bidder system, on contractor behavior, project selection, and final performance are explained by public procurement theory. When combined, these theories offer a framework for

evaluating how well (or poorly) the Bureau's SUR estimating procedures match actual project results in the Tigray construction industry.

Central to the successful execution of these projects is the accurate estimation of costs, a task primarily facilitated by Standard Unit Rates (SUR). SUR values, essentially unit costs for various construction activities, serve as the bedrock for budgeting, tendering, and project management processes. As such, their precision directly influences the feasibility and success of construction endeavors.

The Tigray Bureau of Construction considers the responsibility of regulating and overseeing construction activities within the region. One of its key functions is the publication of reports containing SUR values, said to be representative of the market rates and construction costs. These published SUR values not only guide contractors and project managers in their financial planning but also inform government decision-making regarding infrastructure investments and resource allocations. However, the accuracy of these published SUR estimates has been a subject of contention and doubt. Instances of discrepancies between estimated SUR values and actual project costs have been reported, leading to concerns regarding the reliability and accuracy of estimation practices. Such discrepancies can have profound implications; including budget overruns, project delays, and even compromised structural integrity, posing risks to public safety and welfare.

A comprehensive evaluation of the effectiveness of SUR estimating techniques as presented in the Tigray Bureau of Construction reports is essential, given the importance of precise cost estimation in construction projects. This kind of investigation would look into the methods used to estimate SURs, examine the variables that affect estimation precision, and evaluate how well estimated values match actual values on the ground. This research work was done by fulfilling of the research work guiding rules and supervision of Mekelle university by considering of all the research limitation like time, financial shortage and difficulties to find complete research data.

Furthermore, this investigation has greater implication for the building sector and local development in addition to resolving issues. Through this research, hope to strengthen industry standards, advance professional practices, and provide insights about the reliability of SUR estimation procedures. The investigation's final objectives are to create a situation that is favorable for the growth of the economy, the development of sustainable infrastructure, and the well-being of society.

1.2 Research Problem Statement

A key component of construction project planning and execution is accurate cost estimation, which provides effective resource allocation, budget adherence, and on-time project completion. Standard Unit Rates (SURs) are used by the Tigray Construction, Road, and Transport Bureau, like many other organizations, to estimate the cost of public construction projects. But questions concerning the accuracy and dependability of these estimating techniques are becoming more common.

Even though cost overruns are a common problem in construction projects worldwide, especially in developing nations like Ethiopia. The Tigray region has also faced this characteristic. Public projects in many developing countries, including Ethiopia, are not performing up to standard these days in a variety of ways (Ketema N. 2021). According to the investigation above 80 % of public building projects that have been finished in Tigray in the last ten years, the estimated costs were more than the actual final expenditures which are executed using the unit price contract. The majority of projects, however, were finished later than expected, pointing to structural inefficiencies and discrepancies between SUR projections and actual execution. As direct costs like labor and equipment are still rising, most public construction projects have been finished over schedule and under estimated cost. That contradiction puts into question how accurate the SUR estimating procedures are. The study discovered that, on average, SURs were greater than bid unit rates (BURs) for typical work items like masonry, concrete, and earthwork. This implies that actual market pricing is not reflected in the standard rates.

A precise estimation methodology, in most cases taking the range average of the three suppliers' maximum price, and the use of outdated productivity to estimate SURs, could not accurately represent the realities of today's Tigray construction processes, leading to overestimated forecasts of costs. Furthermore, despite substantial labor and market changes, the productivity rates utilized in these SURs have not been changed in more than ten years. The Bureau's use of the least bidder process, which motivates contractors to submit bid unit rates, although this strategy could seem cost-effective at first, it frequently leads to contractors taking shortcuts, compromising the quality of their work, and having trouble completing projects on time. This idea supported by Oladimeji (2021) the intended cost, quality, and timeliness of building projects can all be negatively impacted by low bid unit rates. These difficulties point to structural problems with the estimation procedure, which can result in inefficiencies, disagreements among stakeholders, and an erosion in trust in

public building projects. However, no previous study has used real project data and stakeholder feedback to thoroughly assess the Bureau's SUR estimating procedures. This research deficit limits the implementation of well-informed initiatives.

This is in line with the study's conclusions, which showed that most of stakeholders said the least bidder method frequently leads to delays and poor outcomes. These problems are made greater by the lack of a comprehensive evaluation of the Bureau's SUR procedures as well as the absence of comments from important parties like customers, contractors, and project managers. If these gaps are not filled, the Bureau faces the risk of ongoing inefficiencies that might delay the development of regional infrastructure and have a detrimental effect on the Tigray region's economic growth.

The objective of this study is to evaluate the effectiveness of the Bureau's SUR estimating procedures, with particular attention to their methodology, accuracy, and effect on project results. The study aims to identify important issues and offer feasible solutions by evaluating data from finished projects over the previous ten years and taking stakeholder opinions into account. This assessment will promote the sustainable development of the Tigray region, improve project outcomes, and advance cost estimation techniques.

1.3 Research Objective

1.3.1 General Objective

The overall objective of this study is to evaluate the performance, accuracy, and practical implications of the Standard Unit Rates estimation practices in public building Constructions to develop guiding framework for improvements, in case the of Tigray, Ethiopia.

1.3.2 Specific objective

1. To assess the relationship and variability between Standard Unit Rates (SUR), Bid Unit Rates (BUR), and construction building project costs, in Tigray.
2. To Investigate the accuracy Standard Unit Rates by comparing with bid unit rates (BURs) and construction building costs in Tigray.
3. To analyze the impact of the discrepancies between SURs estimates, BURs, and construction building costs affect project feasibility and construction performance in Tigray.
4. Develop a guiding framework for improving the accuracy and consistency of SUR estimating practice used by the Tigray Bureau of Construction.

1.4 Research question

1. How well do Standard Unit Rates (SUR) align with the Bid Unit Rates (BUR) and project costs in Tigray's public construction projects?
2. How accurate are the Standard Unit Rates comparing to the Bid Unit Rates and Construction building Costs?
3. What are the impacts of the discrepancies on project's feasibility and construction performance in Tigray's public building projects?
4. What improvements can be made to enhance the accuracy and consistency of SUR estimation practices to better align with market conditions and project outcomes**?**

1.5 Research Scope

The main objective of this study is to assess how well the Construction, Road, and Transport Bureaus of Tigray's Standard Unit Rate (SUR) estimation techniques have performed during the previous ten years when it comes to public building construction projects. Fifty-one finished projects in Tigray that fall under the Bureau's control implementation times (contractual vs. actual) were taken as a population for the study.

Excavation and earthwork, concrete work, masonry and HCB work, and finishing work were the five main areas of concentration for Standard unit rates, bid unit rates, engineering estimation cost, bid price, actual costs, and actual versus contractual completion times are among the data for these projects. This provided a comprehensive evaluation of the accuracy and consistency of the Bureau's cost estimation processes.

To better understand the difficulties and viewpoints of construction participants, such as contractors, project managers, and other significant stakeholders engaged in the projects, the scope also incorporated stakeholder perceptions, which was obtained via questionnaires. Cost differences, project delays, estimating methodology, and the effect of market price fluctuations on the estimation process are some of the topics that was covered in the questionnaire.

To provide accurate estimations of costs, greater alignment with market developments, and enhanced project outcomes in terms of cost, time, and quality, this study concludes by recommending changes to the Bureau's SUR estimating procedures.

1.6 Research Significance

This study is significant because it aims to enhance the accuracy and reliability of Standard Unit Rates (SUR) used by the Tigray Bureau of Construction, which are crucial for effective cost estimation in construction projects and to use an alternative procurement method. Improved SUR accuracy can lead to more realistic budgeting, efficient resource allocation, and reduced cost overruns, thereby minimizing disputes and delays. By promoting data-driven decision-making and incorporating stakeholder feedback, the study can guide policy and practice improvements within the Bureau, fostering increased confidence among contractors, clients, and investors. Ultimately, this research has the potential to contribute to the sustainable development and economic growth of the Tigray region by ensuring more efficient and successful construction project outcomes.

1.7 Research Limitation

Even though there are a lot of studied areas related with the cost estimation in general, the performance of standard unit rates and how it accurate is not searched and studied, so there was limitation in getting different enormous studies to write literature review. The results of this study might not accurately represent private sector or other regional practices because it is restricted to public building projects managed by the Tigray Construction, Road, and Transport Bureau. Due to post-conflict disturbances and missing records, data access was difficult. Inflation, pricing changes throughout project implementation, and real-time market fluctuations were not fully taken into account in this analysis. The extent of data collection, including field trips and wider stakeholder involvement, was also constrained by financial considerations. Additionally, some targeted participants were unwilling to answer, which had a little impact on the completeness of the primary data. Political variables were not thoroughly examined.

1.8 Research Beneficiary

The findings of this study will benefit multiple stakeholders involved in public construction projects in Tigray, Ethiopia. Construction professionals, including quantity surveyors, project managers, and engineers, will gain insights into the effectiveness and limitations of standard unit rate estimation practices, enabling them to improve the accuracy of cost projections and resource allocation. Policy makers and government authorities responsible for budgeting and planning public infrastructure projects can use the results to enhance procurement procedures, minimize cost overruns, and ensure efficient utilization of public funds. Additionally, academic institutions

and future researchers will find the study valuable as it contributes empirical evidence to the body of knowledge on construction cost estimation in the regional context, providing a foundation for further investigations aimed at improving construction project performance in Ethiopia.

1.9 Research Organization

This research is organized into five main chapters to systematically address the evaluation of standard unit rate estimation practices in public constructions in Tigray, Ethiopia. Chapter One introduces the study, outlining the background, problem statement, objectives, research questions, significance, and scope of the study. Chapter Two reviews relevant literature, including theoretical frameworks, previous studies on unit rate estimation, and practices in public construction projects, highlighting gaps that this study aims to address. Chapter Three presents the research methodology, detailing the research design, data collection methods, sampling techniques, and data analysis procedures. Chapter Four discusses the presentation, analysis, and interpretation of the collected data, providing insights into the performance of standard unit rate estimation practices. Finally, Chapter Five summarizes the key findings, draws conclusions, and offers recommendations for construction professionals, policy makers, and future research in the field.

CHAPTER 2. LITERATURE REVIEW

2.1 General

The literature review of this study is structured to provide a comprehensive understanding of standard unit rate estimation practices in public construction projects. The theoretical and conceptual review examines the foundational principles and key concepts of construction cost estimation, including standard unit rates, cost control, resource allocation, and project performance, highlighting how these concepts influence the accuracy and efficiency of public construction projects. The previous research studies section analyzes both local and international empirical investigations into unit rate estimation practices, cost prediction methods, and their impact on project outcomes, identifying common methodologies, findings, and best practices. Despite this, a clear research gap exists, particularly regarding the evaluation of standard unit rate estimation practices in public construction projects within Tigray, Ethiopia, where contextual factors such as regional construction standards, resource availability, and administrative practices have not been thoroughly studied, emphasizing the necessity of this research to generate context-specific insights and recommendations.

2.2 Theoretical and Conceptual Review

2.2.1 Standard Unit Rate

The business of construction is quite a complex one, and so do is the construction projects need special performance. The costs associated with a construction project need to be known at the early stages of the design development, which is the conceptual design stage. The construction project participants need a schedule of unit rates and together with the design information available, the client can be briefed of on the probable costs that they might incur in the future.

A unit rate is composed of direct and indirect costs involved in the project as well as profits and overheads for the contracting firm. These components of a unit rate are discussed in detail as follows: Unit Rate = Cost of Materials + Cost of Equipment + Labor + Profits + Overheads.

Unit rate is the ratio of two different units, with the denominator as kilometer/hour, meter/sec, miles/hour, salary/month, etc. Arithmetic is probably the most basic and ancient branch of mathematics and is quite commonly used in our day-to-day life. This subject is all about the problems based on numerals and operations upon numerals. We solve problems of arithmetic intentionally or unintentionally during our daily routine.

A rate is a ratio that is used for comparing two different kinds of quantities that have different units. On the other hand, the unit rate illustrates how many units of quantity correspond to single unit of another quantity. Unit rates are used to estimate the total cost of a project by multiplying the unit rate by the quantity of items or activities required. For estimators, and contractors, understanding unit rates is essential for accurately pricing and managing construction projects. By breaking down costs into manageable units, professionals can ensure that their estimates are precise and reflective of actual project requirements. As Oladimeji (2021) indicated the unit rates of work items in construction project bills of quantities (BOQ) offer financial information that can help assess unit rate pricing strategies and the Locally owned construction firms bidding procedures, which are essential for businesses' financial stability.

A Unit rate estimating is a method that can be used to calculate building costs. In unit rate estimating the prices of items on the bill of quantities are each calculated separately. An alternative method of estimating is operational rate of estimating, in which a distinct parcel of work is priced as a package. The estimator will also need to establish the number of productive hours by estimating the allowable hours worked per week taking into consideration the seasons, sickness allowance and holidays. They can then estimate the effective working hours per working week. The labor constant can be difficult to estimate due to variances in output. It is well known that several factors, including the precision of historical data, its clarity of project specifications, and the experience of the estimators, affect how well unit rate estimation performs (Ibrahim & Mohamed, 2021). Historical data can help to estimate this as accurately as possible. Neural networks were used to analyze the eight components and calculate the proportionate breakdown of the cost factors in a particular building unit rate and The political environment was anticipated by neural networks to contribute for 44% of the unit rate, followed by contractor capacity (22%), financial delays, project feasibility, and overhead & profit (11% each) and The training data showed that the unit cost was not significantly affected by the project location, material availability, or corruption perception score and Unit cost estimating models (UCEM) can generate more precise estimates by incorporating quantified cost variables (Kaliba, 2015). Estimators can accurately apply unit rates to calculate the cost of materials and labor related to each project component by visualizing building elements and their associated expenses and This method encourages increased precision and efficiency in determining the overall cost of construction while also streamlining the estimation process (Samphaongoen, p. 2010).

A. Labor Costs in a Unit Rate Build-Up

Labor costs are a fundamental component of the Unit Rate Build-Up, directly influencing the accuracy and competitiveness of construction estimates. For a Quantity Surveyor, an understanding of these costs as they affect a particular contractor, as well as the industry at large is essential to ensure project budgets are realistic and reflective of current market conditions. Labor productivity is a critical factor that influences the overall efficiency and cost-effectiveness of a construction project. Incorporating these adjustments involves analyzing historical data, consulting with site managers, and applying industry benchmarks to modify labor cost estimates accordingly.

B. Materials in a Unit Rate Build-Up

Material costs are a pivotal component in the Unit Rate Build-Up, directly influencing overall budget accuracy and project feasibility. For Quantity Surveyors, a thorough understanding of material cost estimation is essential to ensure competitive and precise tender submissions.

C. Plant and Equipment Costs in a Unit Rate Build-Up

Plant and equipment costs are integral in the Unit Rate Build-Up, significantly impacting overall budget accuracy and project feasibility. Total costs encompass all expenses involved in construction, including materials, labor, overhead, and profit. For Quantity Surveyors, a comprehensive understanding of these costs is essential to ensure competitive and precise tender submissions.

D. Overheads and Profit in the Unit Rate Build-Up

Overhead and profit are two essential metrics that construction companies account for during every accounting cycle. Understanding how overhead expenses can affect the profits your company retains can help you streamline project costs, determine effective pricing Strategies and improve the outcomes of future projects.

Overhead=fixed monthly expense +indirect costs

Profit=project cost – (overhead+ direct cost)

E. Aligning with Project Cost Planning

To ensure coherence between the Unit Rate Build-Up and overall project budgets:

F. Integrate into Cost Plans: Incorporate unit rates into comprehensive cost plans to provide a clear financial roadmap for the project.

G. **Regularly Update Estimates**: Adjust unit rates to reflect changes in market conditions, material costs, and labor rates, maintaining budget accuracy.

H. **Collaborate with Stakeholders**: Engage with clients, suppliers, and subcontractors to gather insights and validate cost assumptions, fostering a collaborative approach to cost management.

This build up is not just a mechanical process. It's an exercise in understanding the nuances of a project and tailoring estimates to its specific needs.

A successful unit rate reflects the interplay of all components while anticipating risks and aligning with broader cost-planning strategies. Time spent on establishing a unit rate is an expensive activity, and since tendering time is finite, it needs to reflect the importance of the item being established for instance you would not spend hours on establishing a unit rate for an item of work that is small, yet you would spend a considerable time on a rate per meter where there is many, many thousands of meters of this item, as shown in Figure 2-1

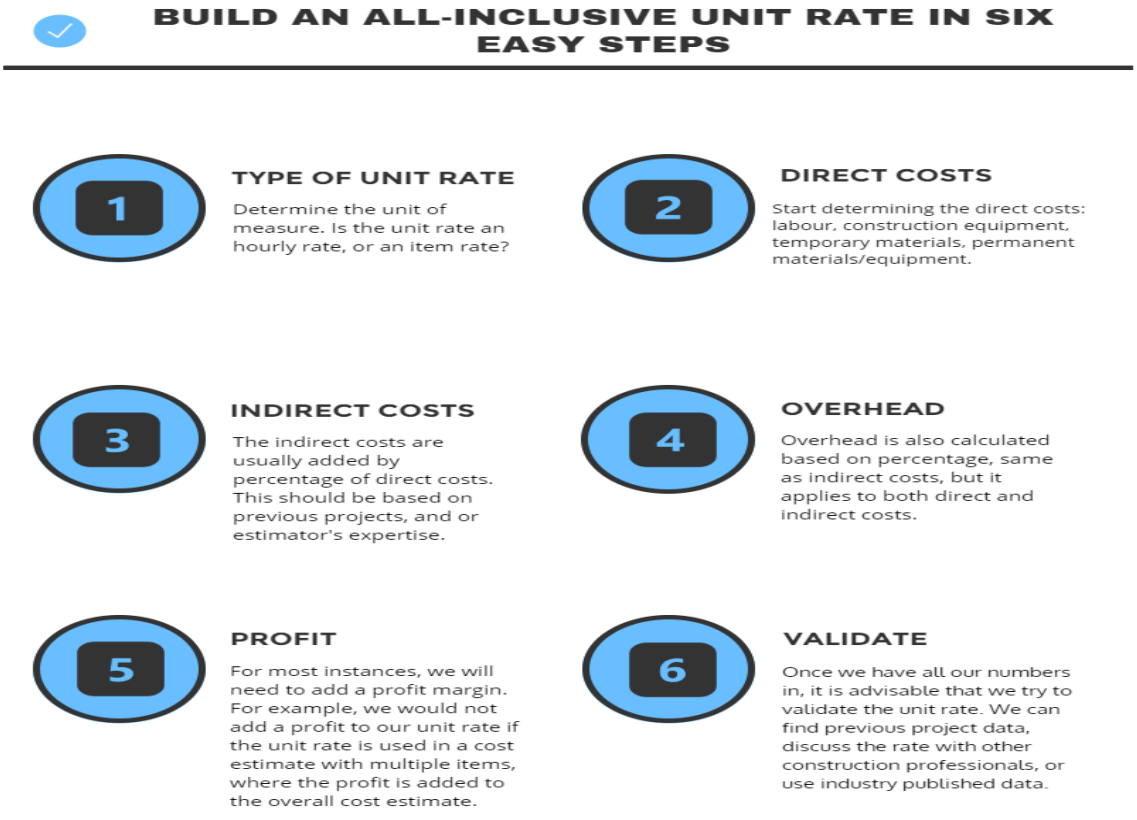


Figure 0-1: Unit rates' build up steps (https://emeraldgroup-learning.ca/construction-unit-rate)

2.2.2 Cost Estimation

The process of calculating an engineering project's approximate cost before work commencement is called estimation. Estimates of costs during the initial stages of public projects are essential for making sure that beneficial endeavors helping society are implemented (Berg et al., 2025). Construction project pre-tender cost estimations necessitate a high level of skill and knowledge (Enshassi et al., 2013).

Cost estimating in construction is the process of calculating the overall required costs for a new building project, including direct and indirect costs. The accuracy of the information at hand determines how accurate the estimate will be and Calculating project-specific costs based on a thorough analysis of the resources, such as labor hours, material costs, equipment costs, subcontractor costs, or other unit-cost-type items required to complete each activity of work. Next, where needed, indirect costs, overhead costs, contingencies, and escalation are included. Precise price estimates hold significant value for both the estimator and the clients (Addis & Ababa, 2024). According to Hatamleh et al. (2018) it is the strategic process of estimating the financial resources based on the extent of investment to create the project budget. Predicting a construction project's overall cost, including labor, materials, equipment, permits, and contingencies, is known as cost estimation. According to Alumbugu et al., (2014), it is a crucial component of project planning and budgeting since it guarantees that projects are finished on schedule and within the allocated budget. The process of projecting the overall cost of a project, including the profit margin, is known as price estimation.

The Cost estimate formula is a mathematical connection between a small number of technical characteristics and the final cost. In design-consultancy firms, a precise price estimate guarantees project success; inaccurate estimates will result in project failure. The failure could not only affect the ongoing project but also result in the linked company going out of business (Dinku & Tadesse, 2017). Inaccurate project pricing estimates lead to major problems with the planning, budgeting, and programming procedures, which in turn influence the ultimate budgetary choices Efficient and effective use of funds. Therefore, an accurate price estimate is one of the most important components of a successful building project and Inaccurate cost estimation results in a project that is delayed. There are two possible causes of inaccurate project estimates: bias related to the project itself and bias related to the estimating methods and operating environments, (as it is cited in (Enshassi et al., 2013)).

According to Fanny (2018), the ultimate objective of price estimating is to create estimates and measurements of the costs required to finish project tasks and activities. Furthermore, according to Alumbugu et al. (2014), a price estimate serves the following purposes:

- To estimate the total cost of a particular project.
- Give the basic information needed to create a schedule, such as tasks, resources, and durations, including labor, material, and equipment requirements.
- Supply the financial information needed to generate cash flow curves.
- In a clear paper, include a significant amount of complete project information.
- To create planning and control, identify the scope of the task and the anticipated cost involved.

Ibrahim & Elshwadfy (2021) Highlight the ten key elements influencing the precision of construction project price estimates. These include having clear and comprehensive drawings, specifications, and documentation for the project; the experience and skill level of the estimators; thoroughness of price data, including its accuracy, quality, and detail; the prices, availability, and quality of materials; familiarity with similar projects; the precision of the Bill of Quantities; the competence, experience, and effectiveness of the management team; and the financial capacity available.

2.2.2.1 Cost estimation methods

Planning and managing construction projects successfully require accurate cost estimation. It facilitates decision-making, resource allocation, budget preparation, and tendering throughout a project. Because there are several ways to estimate costs, academics and practitioners have determined which one is best based on the project's stage, the data at hand, and the level of precision needed. The cost estimation techniques that are most frequently discussed in building literature are as follows:

A. Historical or analogous estimation

Analogous estimation, sometimes referred to as top-down historical estimation, is the process of estimating a new project's cost by using the cost information of similar projects that have already been finished. The quickness and ease of use of this approach make it popular in the early phases of project planning. But it's not very accurate, particularly when the reference projects are very different in terms of location, scale, or execution time.

B. Bottom-up estimating

A comprehensive method known as "bottom-up estimating" involves estimating each project activity or component separately before adding them up to determine the overall project cost. The process of cost estimation in the Bottom-Up estimating approach begins with the software system's lowest- level component (Rashid et al., 2020).

It is renowned for being extremely accurate, especially when the work breakdown structure and project scope are well-defined. But because it takes a lot of time and resources, it is better suited for contractor pricing or later phases of project development.

C. Parametric estimating

The statistical correlations between past data and project variables, such as area, volume, or capacity, are used in a parametric estimate (64 International Conference, 2020). States that when proven models and adequate data are available, this approach is more accurate than similar estimating. Early on in planning and feasibility studies, it is especially helpful.

D. Top-down estimating

Top-down estimating, as opposed to the bottom-up approach then each component is given a percentage of that cost (Rashid et al., 2020). Begins with a project budget or cost estimate that is then divided into more manageable parts. Although helpful for preliminary project evaluations, this approach is prone to errors because it gives little thought to project-specific details.

E. Exprt judgment

The ability of experts to generate cost estimates based on comparable prior experiences and contextual information is the foundation of expert judgment. Although subjective and sensitive to variation across estimators, this approach is useful in situations where time or data are restricted It frequently works in conjunction with other techniques to increase dependability.

F. Three-point estimation

This method considers uncertainty by estimating three scenarios: optimistic, most likely, and pessimistic. A weighted average is then calculated to derive a more realistic estimate. This technique is commonly used in risk-sensitive projects to capture potential cost variability.

2.2.2.1.1 Under Estimation of Construction Projects

If there has been a systematic underestimation of expenses to obtain project approval or a far-flung activity, an owner may be faced with a more serious situation. Whatever the cause, early cost projection issues plague almost all major public building projects, necessitating more funding to

finish. The accuracy of standard unit rate estimation practice is evaluated by comparing the standard unit rate of the actual projects, that is by taking of actual bill of quantity to find the unit rate and then the researchers find the gap between the unit rate from the actual project and the standard unit rate published by the responsible body. In the Tigray Construction cost estimation practices, there is a gap between the actual project cost and the engineering estimation using the standard unit rate published by the construction bureau Unit rates.

2.2.2.1.2 Cost overrun

Cost overruns are a common occurrence that are nearly always connected to construction projects. The difference between the total cost of a construction project at completion and the sum agreed upon by the owner and the contractor at contract signing is known as a cost overrun and it is regarded as a clear sign of project failure, and it is a common occurrence in construction projects when budgetary estimates surpass estimates and settlement surpasses budget (Enrica et al., 2020). One of the main issues facing the construction sector is cost overruns. In the construction sector, cost overruns are a common occurrence and are usually always linked to projects. In poorer nations, where these overruns occasionally surpass 100% of the project's estimated cost, this pattern is especially pronounced (N. Azhar et al., 2008). To lower the project's overall risk, it requires close attention. Cost overruns are a common occurrence that practically always occurs in the building industry. Simply said, a cost overrun is the discrepancy that arises between the project owner and the contractor after the contract is signed to finish the entire project. According to S. Azhar et al. (2011), cost overruns can also be described as completion of projects beyond the agreed-upon project duration or the overall contract price in the case of construction projects. This matter It is rare for projects to be completed within budget, according to a study by (S. Azhar et al., 2011), despite its shown importance. A common source of contention among contracting parties, including owners, consumers, clients, and other participants in the project cost variation process, is the issue of cost overruns, which are particularly prevalent in the construction sector worldwide. A significant financial risk is created for the clients by project cost overruns. Regarding risks, the construction industry has a long history of projects that were finished with notable cost over runs (Creedy et al., 2010). Cost overrun has been defined by various researchers at different times. Cost overrun is a major area of concern for the construction industry, which can be simply defined as payments of funds that were unanticipated in the original contract cost (S. Azhar et al., 2011). Generally, cost overrun is the difference in the cost of a projects. It is the difference between

the actual cost used to complete the construction projects and the estimated or contract amount, agreed upon by and between the owner of the project and the contractor during the signing of the contract or if the actual cost used exceeds the contracted amount.

2.3 Previous Research Study

According to Mohamed & Moselhi, (2022) only 2.5 percent of construction companies effectively complete all of their projects without incurring delays or going over budget, even though the industry employs over 7% of the world's workers. Rate analysis provides the basis for informed decisions related to budgeting and resource management. By analyzing the rates of materials, for example, construction professionals can determine the cost-efficient materials and select appropriately to maintain the quality of the project. This strategy helps in reducing errors in cost estimation and optimally utilizing resources, promoting effective project management.

(Vamsidhar et al. 2014) Emphasized that rate analysis is a fundamental step in construction projects, as it allows architects, engineers, and contractors to make an adequate estimation of the costs associated with constructing a building. The cost of different work elements in construction projects can vary significantly. This can result in expenses exceeding budgets, progress slow-downs, and labor productivity issues. Therefore, to ensure a smooth and efficient construction process, the lean construction approach emphasizes reducing the variability in these costs. This involves achieving cost uniformity within each group of work elements to minimize cost differences. By doing so, the construction project can be completed timely, cost-effectively, and efficient manner.

2.3.1 Correlations and variabilities of standard unit rates, bid unit rates and projects costs

Rate analysis plays a crucial role in assessing the accurate cost estimation of a project and facilitates making informed decisions related to budgeting and management (Vamsidhar et al.,2014). Rate analysis is a significant technique in the construction industry that involves computing the costs of various components, including labor, materials, and equipment. It enables construction professionals to accurately estimate the cost of the project, understand cost trends, and identify factors influencing cost escalation.

Uniformity in cost is important for the successful implementation of lean construction principles, which seek to improve construction productivity. Unit rate is the speed at which a particular work

element is done, and it is critical to reduce the variability in this rate to enhance labor productivity and construction performance. In other words, consistency in the speed of completing each construction work element or group is important to minimize the risk of budget overruns, delays and time lost, which can hinder efficiency. So, one of the key principles of lean construction focuses on reducing the fluctuations in these unit rates across various work elements in a construction project, leading to increased productivity and improved performance. To improve the labor productivity and construction performance, it is essential to maintain a consistent unit rate, which is the speed at which a particular work element is completed. The concept of lean construction emphasizes reducing the variability in these unit rates across various work elements, thus achieving a uniform cost, and minimizing the risk of budget overrun. Ahsan & Gunawan, (2010) Identified several factors that contribute to poor project outcomes from those inaccurate project planning and insufficient cost estimation are among the factors.

Samphaongoen (2001) Aimed establishing a precise cost estimate, the steps that should include breaking down the project into individual work items, determining what labor, equipment, and material are required to complete each work item, defining the production rate, determining the cost of labor, equipment, and material, calculating the total cost for each work item by summing all work item costs, identifying taxes, overhead cost, and profits to complete the estimate, and reviewing the assembly's price to ensure that it seems reasonable for the amount of work that needs to be completed.

Oladimeji, (2021) compared the unit rates, the researchers collected and evaluated data from bills of quantities (BOQs) from various construction projects carried out in the Nigerian construction sector, and analyzed the BOQs using the regression analysis to obtain the unit rates of commonly used building materials, such as concrete, block work, iron reinforcement, sand Crete blocks, and tiles. Finally, the researcher compared both the unit rate with the published standard unit rate in Nigerian. This allowed them to identify any potential differences in unit rates. Numerous investigations and studies were carried out to pinpoint the variables influencing cost variances among various building projects. Using the information from building projects in Norway between 1992 and 1995, this analysis creates a humorous link between the estimated and real expenditures of construction projects, with a mean cost overrun of 7.9% ranging from -59% to 183%. The results demonstrate the discrepancy between estimated and actual costs. Ultimately, the study found that smaller projects are more likely to experience cost overruns than bigger ones, and that the projects'

completion dates can have an impact on how much of a cost overrun occurs. According to the findings of Oladimeji, (2021) there was a statistically significant relationship between the unit rates of specific materials, particularly iron, in the substructure and superstructure and the total project costs, indicated that out of 461, 119- bid unit rates (25.81%) were found to be higher than published rates, especially for iron products, demonstrating the variation in prices for these typical building supplies. According to Hassan & Razek, (2007), daily productivity variability is a significant determinant of project performance, indicating that better project management and results are linked to lower productivity variability.

2.3.2 Accuracy of standard unit rates estimations

A unit price estimate is the final estimate type prepared before a project begins construction. Before construction starts, the majority of projects will require a unit price estimate. A unit price estimate is the last and most accurate estimate of what the project's final cost may be, even though conceptual and square foot estimates assist project owners in making decisions early in the planning process and systems and assemblies estimates provide a quicker, more thorough understanding of the project's cost. Final prices can be predicted with a 5–10% accuracy rate using a reasonable unit price estimate. Construction projects must have accurate price estimates in order to succeed because inaccurate estimates can result in delays and budget overruns(Addis & Ababa, 2024). Addis & Ababa, (2024) Highlighted also the necessity of using sophisticated estimating methods and technologies to improve the accuracy of price estimates. Employing knowledgeable and competent experts is advised for clients in order to increase the precision of expense estimations (Hatamleh et al., 2018). Involving professionals that are both informed and skilled in estimation techniques is crucial for clients to obtain more accurate cost estimates. Competent specialists are able to generate more accurate and realistic estimates because they have a greater awareness of construction techniques, market price variations, and project-specific factors. Their knowledge eliminates mistakes, lowers the possibility of overestimating or underestimating, and eventually facilitates improved decision-making for project budgeting and planning.

The experience of estimators, the estimation methodologies and procedures, and the availability of trustworthy data are some of the elements that influence how accurate price estimations are (Addis & Ababa, 2024). The methods used, the experience of estimators, and the availability of trustworthy data all have a significant impact on how accurate cost estimation performs. Competent estimators can recognize hazards, make reasonable decisions, and prevent missing

hidden expenses. Errors are reduced and consistency is guaranteed by sound processes and established procedures that are backed by contemporary instruments. Estimates run the danger of being irrational and unreliable in the absence of reliable and current data on labor, material, and equipment costs. Babu Awari et al., (2022) Investigated that Variations in unit rate accuracy can have a substantial impact on the estimation process as a whole since they can cause disparities that impact project feasibility and budgeting. Czarnigowska A. (2014) Concluded that even though these estimated unit costs are meant to be reliable by avoiding theoretical assumptions, they might not fully reflect actual market conditions and are frequently regarded as "location neutral," therefore they may need to be adjusted depending on the particulars of each project. Standard unit costs frequently fall short of capturing actual market dynamics, despite being intended to be dependable by minimizing theoretical assumptions. They may not take into consideration regional price fluctuations, resource availability, or project-specific variables because they are usually created as "location-neutral" estimates. Adjustments are therefore frequently required to bring them into line with the real circumstances of a particular project.

2.3.3 least bidder mechanism and its effect on projects performance

In the construction industry, bidding strategy is a complex process that includes creating thorough proposals, precisely projecting project expenses, and selecting the appropriate pricing to stay competitive. The process of presenting a tender to start or oversee the start of a construction project is known as construction bidding. A cost estimate based on material takeoffs and designs is the first step in the process. The bidder with the lowest bid price is the lowest bidder. The bidder with the lowest estimated price is the lowest bidder. The lowest bidder indicates that the contractor was chosen solely on the basis of pricing. The owner selects a contractor using the low-bid approach based on financial performance; the lowest bidder wins the contract. The qualifications-based approach enables the owner to select a contractor primarily on the basis of the contractor's abilities, background, and possibly most importantly reputation. The bidding process has a crucial influence on project outcomes, as evidenced by the fact that 16% of the overall effects associated with incorrect bids are related to poor quality work (Salman & Noman, 2022) and (Hussain Khan & Khan, 2015) concluded that Participants in the construction sector have begun to realize that taking the lowest bid does not always mean getting the best profit and the study also investigated that 70% of the respondents consider the multi-parameter bidding method is to be more effective than lowest bidding method and ranked this method as best amongst all six selected methods and this

also supported by (Salman & Noman, 2022) by saying that bidding process is the early success determinant of a building project that directly affects cost and indirectly affects schedule and quality. Contracts awarded to the lowest bidder incentivize contractors to aggressively lower their pricing, which may result in cost-cutting practices that compromise the caliber of the work. This method does not guarantee that jobs are given to the most competent or trustworthy contractors; it only considers price (Hussain Khan & Khan, 2015). The lowest-bidder method puts financial savings ahead of skill. In order to win projects, contractors compete by lowering their costs unreasonably. Although this lowers the initial contract price, in order to control expenses, contractors are frequently forced to take shortcuts, utilize inferior materials, or postpone work. Consequently, the process does not ensure that the most qualified or experienced contractor is hired, which raises the possibility of subpar work, delays, and even long-term cost overruns.

Even though the Construction, Road, and Transport Bureau of Tigray frequently use Standard Unit Rates (SUR) to estimate the costs of public projects, ongoing differences between estimated, bid, and actual costs raise serious questions regarding the accuracy of the current estimating methodology. Current market realities, labor efficiencies, and building technologies are not well reflected by the persistent use of antiquated productivity rates, insufficient supplier price data, and a static averaging method. Furthermore, even though it's meant to save costs, the practice of giving contracts to the lowest bidder frequently jeopardizes project quality and on-time delivery. Crucially, the accuracy, consistency, and usefulness of SUR estimation in the Tigray setting are not well evaluated by local empirical investigations. The viewpoints of stakeholders, such as contractors and project managers, are crucial for comprehending and resolving the systemic problems, but they have seldom been included in prior study. In order to close these gaps, this study analyzes 150-unit rates that are the major key representative unit rates from the major work items, from finished projects, finds estimation-performance discrepancies, and incorporates field-based knowledge to suggest context-specific enhancements to the SUR estimating framework.

The gap initiated the researcher to perform this research work is, there is no study on the precision, dependability, and effectiveness of SURs estimation methodology in the Tigray region, despite a number of studies on cost estimation. Current estimation frequently ignores changing labor and equipment productivity, real market conditions, and the effects of lowest-bidder selection on project timeliness and quality. Additionally, it is uncommon for the review process to incorporate the viewpoints of important stakeholders, including clients, contractors, and project managers.

This disparity emphasizes the necessity of a thorough, data-driven evaluation of SUR estimate techniques and their applicability to Tigray's public building projects and other different construction stockholders.

2.4 Research Gap

Accurate cost estimation is essential for the effective planning, budgeting, and execution of building projects. The Construction, Road, and Transport Bureau of Tigray rely on Standard Unit Rates (SUR) to estimate prices for public construction projects. The estimated, bid, and actual project costs continue to differ, though, in spite of this uniform methodology. Even if direct costs like labor and equipment are still rising, it is concerning that many projects are finished under budget but ahead of schedule.

The accuracy and dependability of the estimation approach are called into question by this disagreement. The current estimation method may not adequately reflect the true cost variation among construction projects or actual market conditions because it uses the range averages the prices of the two highest items of the three suppliers. Furthermore, it has been more than ten years since the productivity rates used in SUR calculations were last revised, so they do not account for advancements in labor and machine efficiency, construction technologies, usage of incomplete price data and changing market conditions. The least bidder selection process also frequently forces contractors to make unreasonably low bids, which affects project quality and delays project delivery, even if its goal is to reduce costs. Adding to these problems is the absence of an accurate evaluation of SUR procedures in the local region, specifically with regard to their precision, reliability, and conformity to the tendencies of the building industry today. In addition, the input of contractors, clients, and project managers has been mainly disregarded in the process of recognizing and resolving these persistent problems.

This research aims to handle these gaps by systematically evaluating the accuracy and performance of SUR estimation practices, analyzing data from completed public projects over the past decade, and integrating insights from key stakeholders. The findings will provide practical recommendations to improve estimation accuracy, minimize project delays, and enhance overall project quality, contributing to the sustainable development of public infrastructure in the Tigray region.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 General

The Construction, Road, and Transport Bureau of Tigray's standard unit rate (SUR) estimates were examined for performance using the materials and methodology presented in this chapter. To assess the precision and dependability of SUR estimates in public building projects, this study will compare them with bid unit rates (BUR), actual project prices, and project results. Along with understanding the effects of inaccurate SUR estimating on time delays, cost overruns, and construction quality, it also seeks to provide ways to improve the current estimation procedures.

The study used a mixed-methods approach, incorporating both quantitative and qualitative data, to achieve the objective. While quantitative data was collected from SUR papers and finished public construction projects, qualitative data was acquired by distributing questionnaires to government officials, contractors, consultants, and engineers. This chapter describes the research design, data sources, sample strategies, data collection instruments, and analysis procedures used to meet the study's goals. The Research methodology is shown in the flowchart below:

3.2 Description of the Study Area

3.2.1 Location of the Study

This research study was conducted in Tigray, which is officially the Tigray national regional state, and is the northernmost regional state in Ethiopia. Eritrea borders it on the north, Sudan borders it on the west, Afar State borders it on the east, and Amhara State borders it on the south and southwest with There are mountainous in the region regions or challenging terrain conditions, though the construction industry is doing well in the state it is slowed down by numerous obstacles (Ethiopia, 2018).

The Tigray region is the homeland of the Tigrayan, irob, and kunama people. Its capital and largest city is Mekelle. Tigray is the fifth-largest by area, the fourth-most populous, and the fifth-most densely populated of the 11 regional states. Tigray is bordered by Eritrea to the north, the Amara region to the south, the Afar Region to the east, and Sudan to the west. Tigray lies between l2 °15’ to14°50’ N latitude, and 36°27’ to 39°59’ E longitude in northern Ethiopia. Many areas in Tigray are characterized by frequent drought, deforestation and high soil erosion due to long-term human settlement. The mean annual rainfall and temperature at a typical Boswellia site

in Tigray are 952 mm (mainly falling from June to August) and 22.3 °c, respectively, as shown in Figure 3-1.

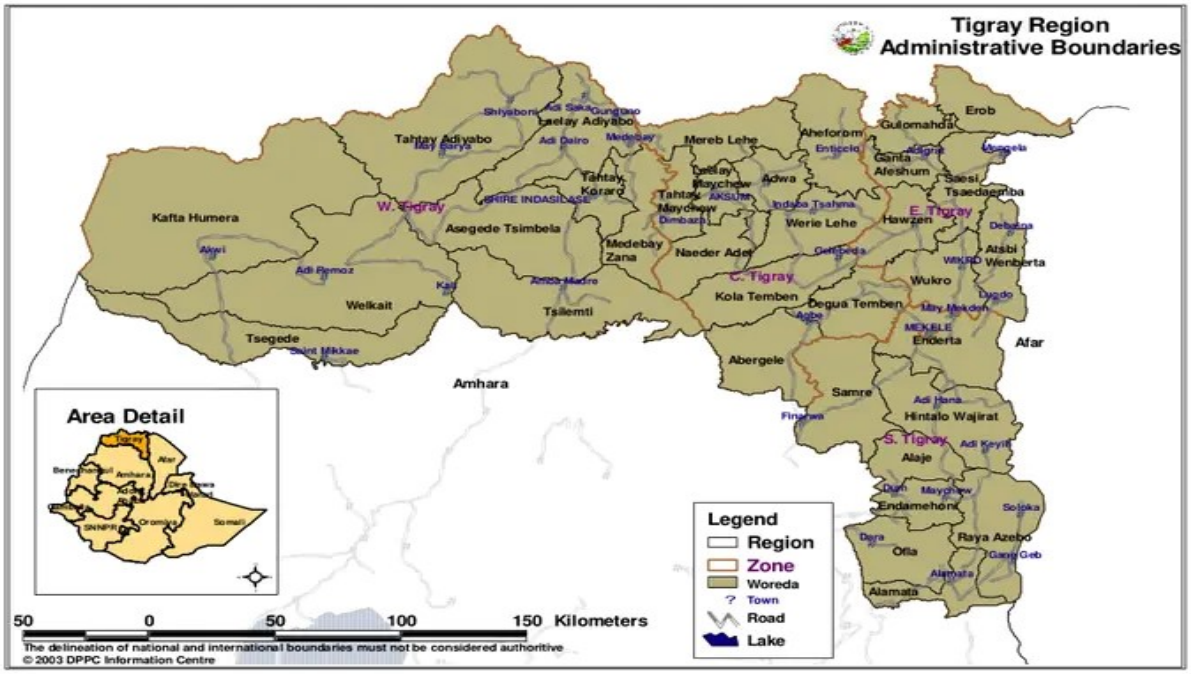


Figure 0-1:Study area (https://reliefweb.int/map/ethiopia/ethiopia-tigray-region-administrative-boundaries)

3.2.2 Construction of public buildings in Tigray

Tigray's socioeconomic development is greatly aided by the construction of public buildings, which provide the necessary infrastructure for community services, healthcare, education, and governance. The construction industry in the Tigray region is expanding quickly, although it faces some obstacles (Ethiopia, 2018). To increase access to essential services, the regional administration has launched several public construction projects during the last twenty years, including schools, health facilities, administrative buildings, and universities. Usually financed by public investment funds, assistance initiatives, and government budgets, these projects are carried out using regular procurement processes, with cost planning based on unit rate estimation. The main organization in charge of handling these projects, including creating the Standard Unit Rates (SURs), estimating costs, and administering contracts, is the Tigrayan Construction, Road, and Transport Bureau. However, public building construction in Tigray has experienced various problems in recent years. These include supply shortages, inflationary pressures, conflict-related disruptions, reliance on out-of-date unit rates, poor cost estimations, and restricted data

availability. Many contractors find it difficult to complete projects within the bid budget, particularly when predicted costs and actual market conditions differ greatly. Furthermore, using strict estimation processes in conjunction with the least bidder selection mechanism frequently leads to longer project timeframes and lower-quality construction. Public construction is nevertheless a significant industry that may aid in recovery and rebuilding despite these obstacles; thus, it is crucial to assess and enhance the precision and dependability of estimating techniques.

3. 3 Research Design

The performance and accuracy of the Standard Unit Rate (SUR) estimation technique used by the Tigray Construction, Road, and Transport Bureau were assessed in this study using a mixed-methods research design. A thorough evaluation of SUR estimation reliability, its effect on project outcomes, and areas for methodological improvement is made possible by the combination of qualitative and quantitative methodologies.

1. Research Approach

An analytical and descriptive methodology was used in the study. Whereas the qualitative data provides a contextual understanding of the estimation and stockholders' perspectives, the quantitative data offered quantifiable insights into the relationship between SURs, BURs, actual project costs, and time.

2. Study Area and Target Population

The study concentrated on public building construction projects managed by the Construction, Road, and Transport Bureau that were carried out in the Tigray region. University specialists, engineers, quantity surveyors, procurement officers, and project managers who work on estimation and implementation are all part of the target population.

3. Sampling Method

A stratified random sampling was used to select thirty sample-size projects out of the fifty-one large, medium and small completed public building construction projects. Additionally, a purposive sampling technique was employed to select sixty professionals for questionary distribution, from which forty-five valid responses were collected.

4. Data Collection Instruments

Data for this study were collected using a combination of document review, questionnaires, and semi-structured observations and interviews. For the document review, standard unit rates (SURs), bill of quantities unit rates (BURs), bid costs, engineering estimation costs, actual project costs,

and project time frames were analyzed through project data, cost breakdowns, and bidding documents to assess the accuracy and performance of unit rate estimations. A standardized questionnaire was also administered to gather perceptions from relevant stakeholders regarding the effectiveness and challenges of current estimation practices. Additionally, semi-structured observations and interviews were conducted with key informants from the bureau, related agencies, and other construction professionals to obtain in-depth professional perspectives on systematic impacts, gaps, and potential improvements in standard unit rate estimation practices.

5. Data Analysis Technique

Quantitative data were analyzed using Microsoft Excel and SPSS version 27. The statistical methods employed included a Paired Sample T-test to assess the mean differences between standard unit rates (SURs), bill of quantities unit rates (BURs), project costs, and project time frames; Multiple Regression Analysis to identify predictors of cost variation; Correlation Analysis to evaluate the relationships among estimation metrics; and ANOVA to determine variance across different project categories. Qualitative data collected from interviews were systematically coded and thematically analyzed to complement and provide deeper interpretation of the quantitative findings, ensuring a comprehensive understanding of the performance and challenges of standard unit rate estimation practices.

The research methodology employed in this study is illustrated in the flowchart below, which outlines the systematic steps followed to evaluate the performance of standard unit rate estimation practices in public construction projects in Tigray, Ethiopia. The process began with the identification of relevant projects and collection of secondary data, including standard unit rates (SURs), bill of quantities unit rates (BURs), bid costs, engineering estimates, actual costs, and project time frames through document review. This was followed by the design and administration of standardized questionnaires to capture stakeholder perceptions, complemented by semi-structured interviews and observations with key informants from the bureau, related agencies, and construction professionals to gain in-depth insights into the practices, challenges, and potential improvements. The collected data were then analyzed using quantitative and qualitative methods, including statistical tests such as Paired Sample T-test, Multiple Regression, Correlation Analysis, and ANOVA, while qualitative interview data were coded and thematically analyzed. Finally, the results were synthesized and interpreted to provide evidence-based conclusions and

recommendations for improving the accuracy and effectiveness of unit rate estimation in public construction projects, as shown in Figure 3-2.

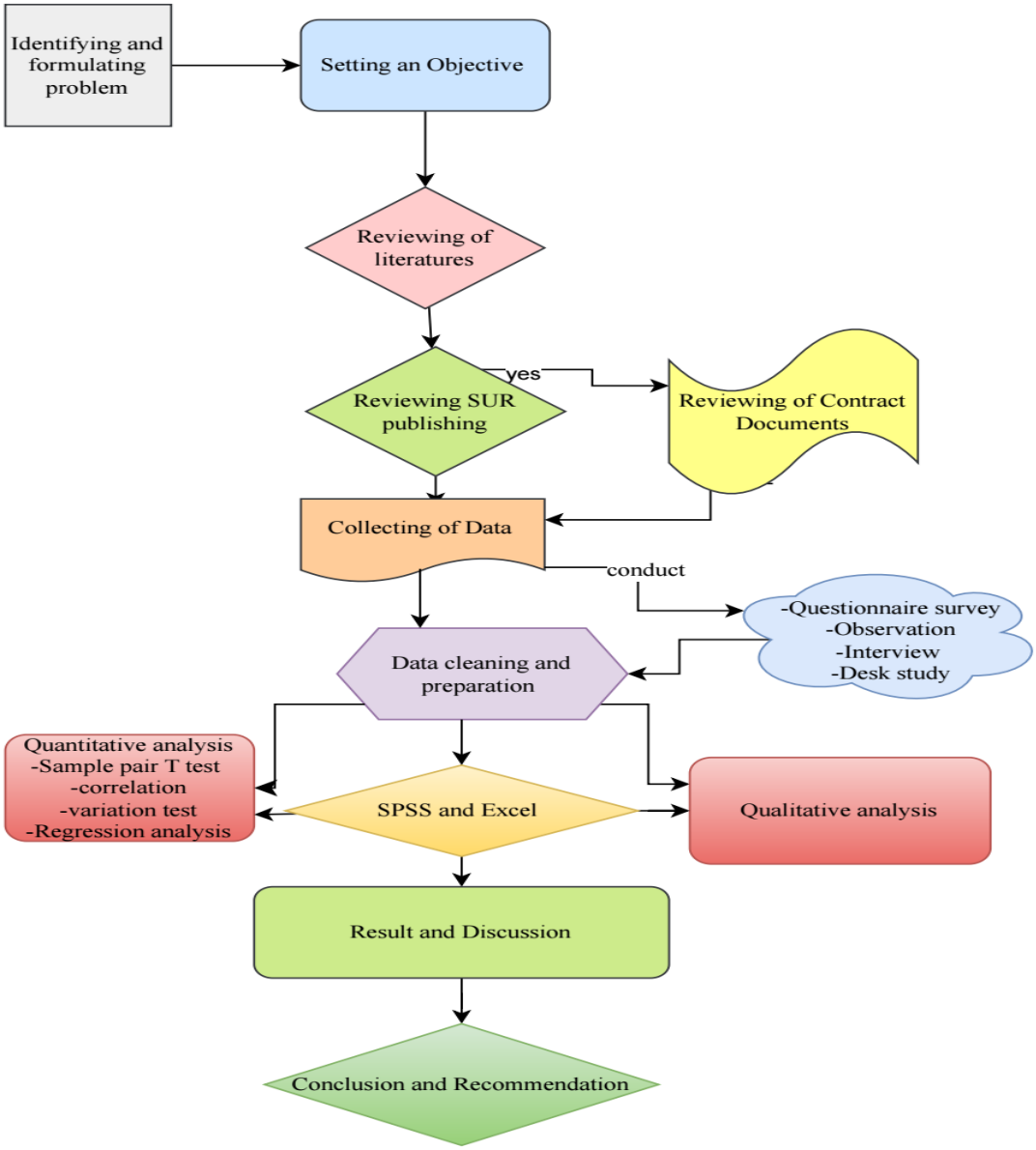


Figure 0-2: Flow chart of the research methodology

3.4 Data Collection

3.4.1 Source and Instruments of Data

The primary objective of the data gathering process for this study was to collect thorough information to assess the efficiency of the Tigray Bureau of Construction's standard unit rate estimating procedures. To provide accurate and reliable analysis, the study combined primary and secondary data, incorporating both quantitative and qualitative methodologies. The Bureau's project records, the thoughts of project stakeholders' interview, surveys and observation were the sources of the information.

Direct primary data collection was done from project managers, engineers, contractors, and quantity surveyors. This information offered qualitative insights into the difficulties and opinions around common unit rate estimation procedures. To get their thoughts and experiences, surveys and structured interviews were used. To verify information from project records and evaluate the caliber of finished work, field observations were also used.

The Tigray Bureau of Construction's official documents were the source of secondary data. This comprises engineering estimates, project contracts, and completion reports, bid documents including bid unit rates and bid prices, and published unit rates. Key metrics like the standard unit rates for specific work items (excavation and earthwork, concrete work, reinforcement, masonry and HCB work, and finishing work), total bid prices, estimated project costs, contractual timelines, and actual project outcomes were the focus of the quantitative data analyzed from these sources.

Different research instruments were used in this study to efficiently gather and examine data. Quantitative information, including bid prices, standard and bid unit rates, expected and actual project costs, and timetables extracted from project files using document review templates. With a focus on their experiences with unit rate estimating procedures, interview guides help gather qualitative information from stakeholders like as engineers and contractors.

The questionnaires were intended to get more comprehensive feedback on the performance of unit rates and associated issues through the combination of open-ended and close-ended questions. Observation checklists were used to evaluate finished work according to specified requirements. Descriptive statistics, correlation, and regression analysis are among the statistical evaluations performed on data using programs like Excel and SPSS. All participants get informed permission forms, and confidentiality agreements are maintained that protect private information in order to

maintain ethical standards. When combined, these tools ensure the quality and accuracy of the study results. Numerical measures, such as discrepancies between published and bid unit rates, bid prices and engineering predictions, and contractual and actual project costs and durations, were measured and compared using quantitative data. Conversely, qualitative data offered contextual information to comprehend the fundamental elements impacting the precision of unit rate estimates.

Essential project files were collected and carefully evaluated. A consistent template was used to extract data, classifying information into distinct categories like engineering estimates, contractual data, and actual costs, bid unit rates, bid prices, standard unit rates, and quality-related observations. A semi-structured questionnaire was used as the interview guide to ensure consistency in the responses while giving stakeholders the freedom to expound on significant concepts. Field observations were made; the results were recorded using an organized procedure.

The main obstacles encountered during data collection were inconsistent or missing records, access issues to sensitive information, and changes in stakeholder availability. To overcome these obstacles, the study gave priority to projects with comprehensive records, guaranteed appropriate permission to access files, and preserved flexible interview scheduling. After consulting with Bureau personnel, any discrepancies or gaps in the data were identified and explained.

3.4.2 Population and participants

The study's population consisted of 51 finished public building construction projects that were managed by the Tigray Bureau of Construction between 2007 - 2017 E.C. These projects serve as the basis for evaluating the precision and effectiveness of the Bureau's standard unit rate estimating procedures and encompass a wide variety of building operations.

The study focused on experts who are familiar with Tigrayan standard unit rate procedures and cost estimation, and who have firsthand experience with public construction projects. Four major stakeholder groups were used to select the respondents: (1) Tigray's Construction, Road, and Transport Bureau engineers and cost estimators; (2) contractors who have completed public building projects under the Bureau; (3) consultants engaged in project design and supervision; and (4) Three Tigray Universities experts with research or academic experience in construction management. These groups were specifically picked because they have direct control over or involvement in bid procedures, estimation procedures, and project execution.

The research includes significant participants who are either directly or indirectly involved in the planning, execution, and oversight of these construction projects in addition to the project records. Among these participants are contractors, project managers, engineers, quantity surveyors, and other pertinent experts. Their knowledge and experiences were essential for comprehending the real-world difficulties and variables affecting the precision of unit rate estimates.

Structured questionnaires have been created to collect information from these subjects. The questionnaires are intended to cover several topics related to the practice of unit rate estimation, such as the perception of accuracy, the causes of deviations, and the effect of estimation techniques on project budgets, schedules, and quality. These participants' participation guarantees that the study incorporates qualitative insights in addition to numerical analysis, enhancing the results with real-world and contextual viewpoints.

This dual approach offers an extensive structure for assessing the effectiveness of the Tigray Bureau of Construction's standard unit rate estimation procedures by concentrating on both the finished projects and the experiences of important participants. To provide a comprehensive and in-depth assessment, the study integrated quantitative information from project records with qualitative input from professionals in the field.

3.4.3 Sampling Technique and Sample Size

3.4.3.1 Sampling Technique

A sampling method is used to choose projects and participants for analysis in order to guarantee that the research is both manageable and representative. Purposive sampling is used for the study's participants, whereas stratified random sampling is used for the projects.

1. Sampling and Sample Size for Projects

The population is composed of 51 public building projects that were finished between 2007 - 2017 E.C. These attempts are categorized according to factors like project size, location, and budget to guarantee a varied representation. To incorporate a sample that represents the variation within the population, a random selection is taken from each stratum.

A sample size is a small portion of the population chosen for observation and analysis purpose. There are numerous methods of identifying and calculating an accurate and sound representative sample size from the known population for the research study.

According to Assaf et al. (2001), the following formula was used to calculate the minimum representative sample size from the given population using the sampling technique, by using equation 3-1.

$$\mathbf{n = n'/ (1+ (n'/N))} \quad (3\text{-}1)$$

Where: **N**=Total number of populations **n**= sample size from the finite population and $\mathbf{n' = S^2/V^2}$, where: S = is the variance of the population elements (usually S = 0.5) V= is the Standard error of the Sampling population (usually V=0.06)

The completed public construction building projects in the past ten years were about 51 public construction building projects and the minimum sample size with the standard error of 5% can be calculated as follows:

$n' = 0.5^2/0.06^2 = 69.44$

n =69.44/ (1+ (69.44/51)) = **29.4 ~30** projects were the sample size of the study and of these sample sizes: Tsegede primary hospital, Atsbi Wenberta hospital, Adigrat Administration building, Ofla Administration building, Shre endaslase edaga Enssat, Maycadra secondary school and Kafta humera kum Hntsa, among others. The full list of the projects with their ID is represented in Appendix 5.

2. Sampling and Sample Size of Questionnaire Respondents

The construction participants who have directly supervised or contributed to the chosen projects are identified by the study using purposive sampling. This covers contractors, Bureau estimators, consultants, and Tigray University students Who are involved with construction projects in Tigray. Given their positions and areas of knowledge, these people were chosen because they are most likely to offer insightful opinions on the calculation and use of unit rates. By ensuring that only individuals with pertinent experience are involved, the purposive approach produces qualitative data that is more trustworthy and sensitive.

Like the above for the projects, according to Assaf et al. (2001), the sampling technique's minimum representative sample size from the given population was determined using the following formula. Using the above equation of 3-1 (Assaf et al., 2001)**,** the sample size of the participants

For the questionnaire was as follow:

Where: **N**=Total number of populations

n= sample size from the finite population

And $\mathbf{n' = S^2/V^2}$

Where: S=is the variance of the population elements (usually S = 0.5)

V= is the Standard error of the Sampling population (usually V=0.06)

Table 0-1: Population's sample size respondents

	Respondents			
	Bureau Estimators	University Experts	Consultants	Contractors
Population(N)	15	12	5	28
Sample size (n)	12	10	5	20

The study employed a comprehensive data collection method that took into account the population in the above from the Consultants, Contractors, Bureau Estimators, and Tigray University experts. To guarantee widespread participation, the questionnaire circulated both online and in print. To go into detail more about the estimation, this study also performed observations and interviews. To be more accurate and reliable all the population of the were took as a sample size. The sampling way used in the research methodology was a censes sampling method, as shown in Table 3-1.

3.4.4 Questionnaire

(Zegeye, A., et al. 2009) Emphasized, a Questionnaire is used to give critical information for the subject matter of a research study as it is focused on issues that further serve to understand the main concerns and attitudes of the respondents towards the problem.

The questionnaire was an important instrument in this study for gathering primary data from contractors, Bureau estimators, consultants, and Tigray University students who are involved with construction projects in Tigray. With an emphasis on the alignment between estimated and actual project costs, the effect of market price fluctuations, and the efficacy of bid prices in reflecting actual costs, the questionnaire is intended to gauge opinions regarding the accuracy of the Construction, Road, and Transport Bureau of Tigray's Standard Unit Rate (SUR) estimation procedures. Quantitative and qualitative information will be obtained from both closed-ended and open-ended questions, assisting in the identification of important problems such as estimation errors, project delays, and their underlying causes.

This study intended to collect a variety of viewpoints by distributing the questionnaire to sixty stakeholders in both online and paper formats. These perspectives, when combined with secondary

data from project records and interviews, will provide a thorough understanding of the shortcomings and potential areas for development in the Bureau's cost estimation procedures.

The questionnaire used in this study consisted of 28 structured questions divided into five sections, along with one open-ended question to capture additional insights from respondents. Section one gathered general information about the participants, including their roles, education levels, and professional experience. Section two assessed the respondents' awareness and understanding of unit rate estimation practices implemented by the Construction, Road, and Transport Bureau of Tigray. Section three explored perceptions regarding the accuracy of these standard unit rate estimations, while section four focused on the perceived impacts of inaccurate estimation practices on project performance. Finally, section five sought respondents' ideas and suggestions for improving the unit rate estimation practices, allowing for practical recommendations to be drawn from the participants' professional experiences.

3.4.5 Desk Study

This study was mainly used to obtain actual data and information from the different sources of documents of public building projects like contract documents, payment letters, variation orders and supplementary agreement letters, and completion reports. After careful investigation and evaluation of those documents the main input data was taken for analysis.

3.4.6 Interview

Unstructured interviews were also conducted with different participants of the public building constructors, contractors, consultant's, quantity surveyors, unit rate estimators, project managers, and university experts in different parts of the Tigray region on the accuracy of standard unit rate estimation practices by the Construction and Transport Bureau of Tigray to get different ideas.

3.5 Data Analysis

After data is gathered, it is processed and examined using research techniques because raw data is useless without a clear way of analysis (Addis & Ababa, 2024). The data collected were analyzed using both qualitative and quantitative data analysis to perform an adequate evaluation in the accuracy and performance of standard unit rate estimation by construction, Road, and transport bureau of Tigray.

3.5.1 Quantitative Data Analysis Technique

Project cost data, such as standard unit rates, bid unit rates, engineering estimates, contract pricing, and actual costs, were analyzed quantitatively using statistical techniques. To evaluate the relationship between estimated and actual costs and identify the main factors causing cost variances, as Sample pair T-test, correlation and regression analysis was conducted. To determine how cost estimation affected project delays, project deadlines were also examined by contrasting contractual and actual completion times.

3.5.2 Qualitative Data Analysis

Along with quantitative techniques, this study also includes qualitative information gathered from key stakeholders, including contractors, bureau estimators, and project managers, through interviews and open-ended questionnaire responses. Thematic Analysis, a commonly used method for finding, examining, and summarizing patterns (themes) in qualitative data, was used to examine the data. Interviews were transcribed, the material was coded into understandable categories, and these codes were then grouped into broad themes pertaining to the implications, difficulties, and accuracy of SUR estimate procedures. This method complemented the quantitative results and allowed for a more thorough comprehension of the study topic by offering deeper insights into stakeholder views, experiences, and recommendations for enhancing the estimation process.

To gain a qualitative understanding of opinions regarding the precision and dependability of unit rate estimation procedures, questionnaires were sent to contractors, Bureau estimators, consultants, and Tigray University members. To find recurrent themes and issues, sixty surveys were issued in print and online, and the answers were statistically analyzed. Additional information about the estimation process, difficulties in cost forecasting, and the impact of market volatility was obtained through interviews with important stakeholders. The analysis was further reinforced by observations made during cost calculation procedures, which brought to light procedural irregularities and real-world difficulties.

The shortcomings of the Bureau's unit rate estimating framework were comprehensively understood through the combination of quantitative project data analysis and qualitative input. The results were utilized for identifying important areas where cost estimation techniques and decision-making procedures needed to be improved.

3.6 Reliability and Validity Test

3.6.1 Reliability test

Using SPSS, Cronbach's Alpha was computed to assess the internal consistency of grouped items, especially Likert-scale inquiries. This made it easier to determine if the pieces accurately measured the same primary idea. Within the acceptable range, a Cronbach's Alpha above 0.721 was found for the section on barriers affecting the accuracy of SUR estimation and, improvement strategies showing moderate internal consistency. When the Cronbach's Alpha is more than 0.721, it demonstrates satisfactory internal consistency, indicating that the grouped questions were accurately measuring the constructs they were designed to measure. This enhances the instrument's overall reliability. The coefficient alpha is interpreted as the degree to which all of the items measure a common construct and the measure of internal consistency as shown in Table 3-2.

Table 3-0-2:Cronbach's alpha for measuring reliability internal consistency

Cronbach's alpha	**Internal consistency**
$0.9 \leqslant \alpha$	Excellent
$0.8 \leqslant \alpha < 0.9$	Good
$0.7 \leqslant \alpha < 0.8$	Acceptable
$0.6 \leqslant \alpha < 0.7$	Questionable
$0.5 \leqslant \alpha < 0.6$	Poor
$\alpha < 0.5$	un-acceptable

3.6.2 Validity

Expert evaluation and alignment with the study's goals were used to address content validity. The questionnaire was created using a thorough literature analysis of earlier research, the Bureau's public cost estimation recommendations, and common difficulties found in estimating building costs. Five experts (two senior contractors, one consultant, one public cost estimator, and one academic from Mekelle University) evaluated the draft questionnaire to ensure that the items were clear and pertinent. To guarantee clarity, contextual appropriateness, and coverage of the main facets of SUR estimating procedures, several elements were changed in response to their input. This involved eliminating unnecessary or ambiguous material, making sure that portions made sense, and polishing technical vocabulary. Consequently, the questionnaire was found to have excellent content validity.

By ensuring that the questionnaire items were directly in line with the study's goals, these expert assessments improved the instrument's overall content validity and decreased the possibility of bias or misinterpretation.

3.7 Ethical Considerations

The research was conducted in strict adherence to established ethical protocols to ensure the protection and rights of all participants. Before any data collection, respondents were fully briefed on the purpose, objectives, and significance of the study. This briefing provided participants with a clear understanding of what their involvement would entail, allowing them to make an informed decision regarding their participation.

All respondents were assured of the confidentiality of the information they provided. Personal identifiers were neither recorded nor reported, and all responses were treated with strict confidentiality to ensure that participants' identities remained anonymous. This approach helped foster a trustworthy environment in which respondents could provide honest and accurate information without concern for repercussions.

Participation in the study was entirely voluntary. Respondents were informed that they could withdraw from the study at any stage without any negative consequences or loss of benefits. This voluntary approach ensured that data were collected from individuals who were willing and comfortable to contribute, thereby enhancing the reliability and integrity of the findings.

Furthermore, all collected data were securely stored and managed to prevent unauthorized access or misuse. Measures were taken to anonymize and protect data during both analysis and reporting, reinforcing participants' privacy and ensuring the ethical handling of sensitive information.

Ethical clearance was obtained from the relevant authorities to confirm that the research fully complied with established standards and guidelines. This approval underscored the study's commitment to protecting participants' rights, maintaining professional ethical norms, and minimizing any potential risks associated with the research process.

CHAPTER 4. RESULTS AND DISCUSSION

4.1 General

This chapter provides the findings from the data collection and analysis to meet the study's particular goals. The findings are arranged according to the four main goals: examining the Construction, Road, and Transport Bureau of Tigray's cost estimation procedure; calculating the difference between the published Standard Unit Rates (SUR) and current market prices; analyzing the impact of SUR discrepancies on project viability, cost, and contractor performance; and suggesting a framework for enhancing SUR estimation procedures. The assessment of the Bureau's SUR estimate performance is supported by the interpretation and discussion of both quantitative and qualitative data gathered through assessments of project documents, questionnaires, and interviews.

This study used a mixed-method approach, combining quantitative and qualitative data to assess the performance of the Tigray Construction, Road, and Transport Bureau's Standard Unit Rate (SUR) estimation procedures in-depth. While formal project records and documents provided secondary data, questionnaires, interviews, and observations were the primary data-gathering methods. Sixty structured questionnaires were sent out in print and online formats to important stakeholders, such as contractors, Bureau estimators, consultants, and university experts, to gather perceptions on the impact of market fluctuations, the difficulty and accuracy of estimation, and the performance of standard unit rates and from those forty-five completed questionnaires were analyzed.

Additionally, to obtain a deeper understanding of the methods employed in unit rate estimating and the variables influencing cost accuracy, semi-structured interviews were performed with Bureau officials, senior estimators, and project managers. In addition, observations were made to look at the Bureau's method of accounting for changes in market prices, cost documentation, and estimating processes.

To ensure representativeness, a stratified random sampling procedure was used to gather data from thirty sampled projects out of a total population of 51 projects for secondary data. Project timeframes, engineering estimates, contract pricing, actual costs, bid unit rates, and published standard unit rates (SUR) were among the important datasets for major work items of excavation and earth work, concrete work, masonry work, reinforcement work and finishing work. The

information was taken from bid documents, project contracts, completion reports, and Bureau records in to evaluate cost variances and compare estimated and actual costs. The dependent variable was Actual Cost, and the predictors were SUR, bid unit rate, engineering estimate, contract price, and time variables. To ascertain which factors had a substantial impact on cost fluctuations, a multiple regression analysis was conducted.

The combination of quantitative and qualitative data in this study provides an accurate evaluation of the estimation methodology used by the Bureau. The knowledge gathered from this data collection procedure will help provide suggestions for upgrading the unit rate estimation framework, which will ultimately improve the accuracy, dependability, and cost-effectiveness of estimates for public construction projects in Tigray.

4. 2 The SURs and Cost Estimation Practices by the Reginal bureau

The Construction, Road, and Transport Bureau of Tigray use the Standard Unit Rate (SUR) as a key tool for cost management, budgeting, and tendering. In this study, in addition to the project cost data it examined the current SUR estimation practices through observations, interviews, and project data analysis and discovered that the SUR prepares by gathering a limited maximum price to get an average of the range inputs typically from the three supplier costs of labor, materials, and equipment in addition to outdated productivity. These restrictions have an impact on SUR accuracy and cause a discrepancy between projected and actual project costs. As a result, many projects still go over budget and have delays even when a least-bidder technique is used to reduce bid prices. This emphasizes the necessity of updating and enhancing the estimation process.

A. Current Standard Unit Rate Estimation Practice by the Construction, Road, and Transport Bureau of Tigray

The Construction, Road, and Transport Bureau of Tigray currently used a cost assessment approach that is based on gathering and analyzing local market data for essential construction inputs like labor, material, and equipment. The Bureau collects prices from no more than three local suppliers for preparing the Standard Unit Rate (SUR). While naturally derived materials like stone and sand are priced according to local availability from adjacent woredas, industrially manufactured materials (such as cement and rebar) are primarily gathered from suppliers in Mekelle city for the city and then put in to Excel with productivity to prepare the Standard unit rate by adding a markup cost of overhead and profit to the collected price of items as the level of contractor to a specified work item.

To standardize the prices for use in SUR preparation of different weredas, the Bureau first gathers local pricing from woredas outside of Mekelle and then adds transportation charges. The productivity rates that are employed in SUR estimates were developed more than ten years ago and have not been updated since, which presents a considerable difficulty, according to the interviews. Because it doesn't account for modern advancements in construction technology, equipment capacity, or worker efficiency, this antiquated productivity input could call into suspect the correctness of the unit rates. Because of this, even though the Bureau uses a consistent approach, the estimation technique is less adaptable to changing market and field conditions due to its reliance on old productivity benchmarks and restricted data sources.

In addition to this, the specification and materials especially, for electrical installation and sanitary installation were not updated and most of the modernized materials, were not included in the prepared unit rate.

B. Challenges Identified

The cost assessment method currently used by the Construction, Road, and Transport Bureau of Tigray has several significant obstacles, according to the observations and interviews made during this study. Although the Bureau uses a methodology that entails gathering labor, material, and equipment price data from local marketplaces and woredas, the procedure is frequently challenged by suppliers' willingness to offer precise and current pricing information. The quality of the data gathered is severely weakened by this lack of collaboration. In addition, the Bureau often struggles to conduct thorough market surveys because of the lack of personnel. Price data was found to frequently be derived from a maximum or incomplete submission. These constraints make it more likely that the predicted and actual project costs may differ, which leads to errors in the creation of standard unit rates. To improve the accuracy and dependability of the Bureau's cost estimation procedures, researchers should update productivity standards, improve cooperation with market participants, and strengthen the estimation technique.

C. Impact on the project’s cost and delivery

According to the project data analysis, there was a persistent trend of overestimation in the standard unit rates (SUR), with over 80% of the evaluated public construction projects in Tigray being completed below the original Engineering Estimate. As a result, the procurement system typically uses a least-bidder selection process to lower inflated bidding prices. Even though the goal of this approach is cost efficiency, contracts are frequently awarded at unsupportable low bid costs. Due

to financial hardship during implementation, many contractors frequently experience cost overruns, in which the final real costs surpass the bid prices that were received. Furthermore, the contractor's capacity to execute within the estimated quality standards and contractual timeline is frequently undermined. Most of the projects have had delays as a result, which has affected stakeholder expectations and the schedule. These problems point to a serious weakness in the procurement and cost estimating process, as aggressive bidding to reduce costs offsets early overestimation, which ultimately degrades project performance. Estimating procedures must therefore be updated and revised immediately, realistic SURs must be guaranteed and balanced procurement strategies that give equal weight to cost realism and delivery capacity must be implemented.

4.3 Analyzing the unit rates, project costs and Time

4.3.1 Descriptive analysis of the Unit rates, Cost and Time of the projects

The descriptive data for the main variables that the Tigray Construction, Road, and Transport Bureau use to assess how well its standard unit rate estimation procedure’s function. The analysis covers a sample of 30 finished public construction projects that considered 150-unit rates of the most common work items were considered for both bid and SUR and the 92 Standard unit rates (61.33%) were higher than the Bid unit rates and contains average values, medians, and ranges for unit rates, cost components, and schedule performance. These 150-unit rates were used because of the representativeness of the most work items in construction of building projects. The unit rates that were published by the locally owned construction firms were higher than the bid unit rates by 74.7% (Oladimeji, 2021) .

In both standardized estimation and contractor bidding, the average SUR and BUR over the 150-unit rates are crucial because they offered a significant and representative picture of the overall pricing trend. Utilizing a large dataset aid in removing outliers and anomalies that could distort results if only a few things were taken into account. This thorough comparison makes it possible to assess whether the Bureau's standardized rates accurately represent real market dynamics, which supports the assessment of the precision, consistency, and dependability of the Bureau's estimating procedures. Additionally, when evaluating the viability of a project and the performance of contractors, the averages provide a solid statistical basis for examining discrepancies between bid and expected pricing.

Table 0-1: Descriptive analysis of the Unit rates, Cost and Time of the projects

Descriptive Analysis Summary		SURave (Birr/item)	BURave (Birr/item)	EE (10^6 Birr)	CP (10^6 Birr)	AC (10^6 Birr)
N	Valid	30	30	30	30	30
	Missing	0	0	0	0	0
Mean		717.53	692.94	20.6817463	16.9839084	18.2200639
Median		687.8	611.84	20.8397544	16.2472256	17.7898798
Minimum		373.87	230.48	3.9521854	2.8392691	2.4258838
Maximum		1164.86	1261.90	45.0740219	43.0531867	47.5825089

		CT(Days)	AT (days)
N	Valid	30	30
	Missing	0	0
Mean		483.6	888.1
Median		498	915
Minimum		134	173
Maximum		751	1570

From the analysis result conducted in the above table 4-1, the average Standard unit rates (SUR) range from a minimum of 373.87 ETB per item to a maximum of 1164.86 ETB per item, with an average of 717.53 ETB per item across all projects. This illustrates the variety of unit rate values that the Bureau has established and disseminated for various project kinds and work items. With a median SUR of 687.81 ETB per item, half of the unit rates are below this threshold. The observed variation can be the result of variations in the amount, complexity, and material inputs of the work. The average bid unit rate, which is what contractors offer on average during the bidding process, is 692.94 ETB, with a minimum of 230.48 ETB per item and a maximum of 1261.90 ETB per item. This implies that contractors typically bid marginally less than the SUR that is published, which a sign of the Bureau's SURs are higher than the present state of the market.

According to earlier research conducted, SURs might not accurately represent current market prices, which could result in differences between bid and projected prices (Czarnigowska A. 2014). This result is also consistent with cost estimate theory, which highlights the necessity of updating SURs on a frequent basis to take labor and material cost fluctuations into account. Although this descriptive remark refrains from making inferential conclusions, the median bid unit rate is 611.84. The average engineering estimate (EE) for the sampled projects,' total project costs was 20,681,746 ETB; the range of values was 3,952,185 ETB to 45,074,021 ETB. According to the median EE of

20,839,754 ETB, the majority of the anticipated expenses are likely to be grouped around this core figure. Projects were frequently awarded below the expected costs, as indicated by the EE values, which are typically higher than the average contract prices. This pattern is in line with the least-bidder procurement method, which encourages contractors to submit cheaper bids, sometimes jeopardizing the viability or quality of the project if prices fall short of reasonable projections (Hussain Khan & Khan, 2015)

The agreed-upon sum in the contract agreement, known as the contract price (CP), has a mean value of 16,983,908 ETB, a minimum of 2,839,269 ETB, and a maximum of 43,053,186 ETB. Most contracts were priced around the median contract value of 16,247,226 ETB. The average actual cost (AC) at project completion is 18,220,063 ETB, with a median of 17,789,880 ETB and a range of 2,425,884 ETB to 47,582,509 ETB. This information includes any modifications made during implementation and shows the final reported expenses. The real costs typically exceed contract pricing, indicating implementation-related cost overruns. This is consistent with research on public building projects, which shows shifting material prices, or underestimating at the time of bidding frequently result in differences between initial contract pricing and final costs (N. Azhar et al., 2008). The results also corroborate the cost estimating hypothesis, which holds that realistic bidding and precise SURs are essential for reducing cost overruns.

In terms of project time performance, the contractually stipulated completion time hovers around 483.6 days, with a minimum of 134 days and a maximum of 751 days. The average amount of time anticipated to complete a project at the signing stage is shown by the median contractual duration, which is 498 days. A minimum of 173 days and a maximum of 1,570 days are required for the project, which has an average duration of 888.1 days. To show how long projects usually take to complete, the median real time is 915 days. The fact that the actual project durations are much longer than the contractual ones suggests that there are often delays. low bid awards and underestimating time might jeopardize schedule and quality. This emphasizes how essential it is to match realistic project schedules and resource availability with SUR-based predictions.

4.4 Paired Samples T-test

Comparing the Bureau's conventional estimation procedures and the actual performance of finished public construction projects in Tigray by providing a thorough study of major project variables using paired sample statistics. The research compares engineering estimates, contract

prices and actual costs, standard unit rates and bid unit rates, and project duration predictions and actual completion times.

Table 0-2: Paired sample T test

Pairs		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	SURave (Birr/item)	717.53	30	163.93	29.93
	BURave (Birr/item)	692.94	30	250.17	45.67
Pair 2	EE (10^6 Birr)	20.6817463	30	9.2081311	1.6811670
	AC (10^6 Birr)	18.2200639	30	10.3403240	1.8878762
Pair 3	CP (10^6 Birr)	16.9839084	30	9.0667553	1.6553555
	AC (10^6 Birr)	18.2200639	30	10.34032400030	1.8878762
Pair 4	EE (10^6 Birr)	20.6817463	30	9.208131.10247	1.681167
	CP (10^6 Birr)	16.9839084	30	9.0667553	1.6553555
Pair 5	AT (days)	888.1000	30	316.53374	57.79089
	CT(Days)	483.6000	30	167.52429	30.58561

4.4.1 Standard Unit Rate (SUR) and Bid Unit Rate (BUR) comparison

As shown in the table above table 4-2, the average Standard Unit Rate (SUR) and Bid Unit Rate (BUR) showed a small but significant difference from one another. ETB 717.53 was the average SUR, while ETB 692.94 was the average BUR. The Bureau's published SUR is, on average, 24.59 ETB per Unit item (3.43%) higher than BUR, according to this data. According to cost estimation theory, the use of outdated productivity standards and small market samples lowers estimation accuracy and raises the possibility that published SURs and actual market conditions may vary (Ibrahim & Mohamed, 2021) and (Oladimeji, 2021)indicated a mismatch between projections and real market realities, suggesting that these unit rates could negatively impact building projects' expectations for cost, quality, and timeliness. Czarnigowska A. (2014) Suggested that SURs may not adequately reflect current market pricing, which could lead to discrepancies between bid and predicted costs. This disparity has resulted from the Bureau's current pricing approach, which includes averaging only three gathered market prices only two of which are utilized in the final calculation and a productivity benchmark that was created more than ten years ago and as a direct result of the Bureau's employment of the least bidder selection process, this discrepancy implies that contractors are submitting bids below the prices published by the Bureau. This way encourages contractors to price their work below the disclosed SUR to stay competitive by giving priority to projects awarded to the lowest bidder. According to earlier studies on public procurement in

Ethiopia and other developing nations, lowest-bidder procedures frequently produce misleading low prices that don't necessarily reflect the state of the market, which makes project delivery difficult (Hussain Khan & Khan, 2015). In actuality, this produces a structural incentive for cost underestimation, which may temporarily lower contract pricing but ultimately jeopardize contractor performance, project viability, and quality.

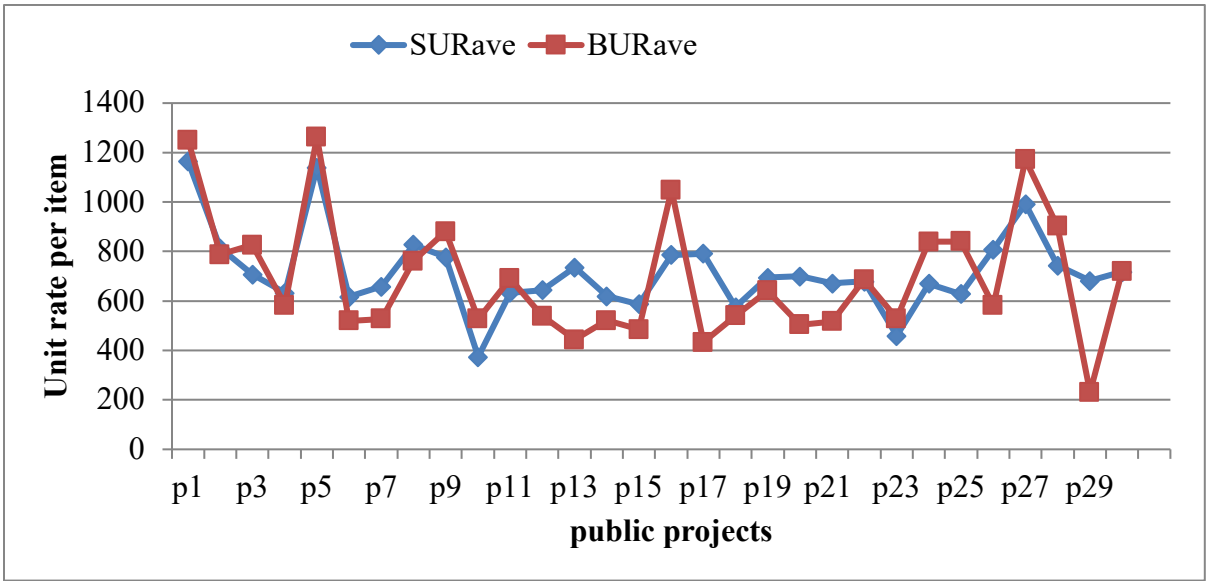


Figure 0-1: Average Standard unit rate and bid unit rate for the most common items

4.4.2 Engineering estimation (EE) and actual cost (AC) Comparison

In civil engineering, a construction project cannot be finished at actual operating costs without estimating (Elmardi & Khayal, 2024), creating accurate and dependable estimates to assist decision makers is the hardest task estimator's encounter (Samphaongoen, 2010) and for any construction project to be successful, an accurate cost estimate is crucial (Ibrahim & Mohamed, 2021). According to different studies an accurate estimation should be between 5-10% of the accurate estimation. According to the statistics comparing the Bureau's engineering estimate and the actual construction costs, the average engineering estimate was ETB 20,681,746.28, while the average actual cost was ETB 18,220,063.91. The result analysis indicated that the actual cost is higher than the engineering estimation around 12%. From the randomly selected projects above 80% are executed below the engineering estimation, but in reverse to this Flyvbjerg et al. (2002) indicated that actual costs exceeding estimated costs for a randomly chosen project is 86%. As (Addis & Ababa, 2024) indicated also Price underestimation is the most frequent type of inaccurate price estimation, but from this ETB 2,461,683.37 discrepancy indicates that actual expenses were

11.9% less than the Engineering estimation which mean it shows a clear over estimation. Although projects are completed within budget may seem like a good thing, this trend calls into question the accuracy and dependability of the Bureau's cost estimation procedures. Overestimations may bias feasibility studies, influence contractor selection, or result in the inefficient use of public funds. Ibrahim & Mohamed (2021) demonstrated inaccurate cost estimates, whether they are over or under, damage parties' credibility, undermine stakeholder trust, and expose them to additional financial risks. In accordance with these findings, the Bureau need to update its process to provide more accurate and data-driven cost forecasts because the use of antiquated productivity rates and generic market data during SUR estimating may have contributed to these exaggerated engineering estimates.

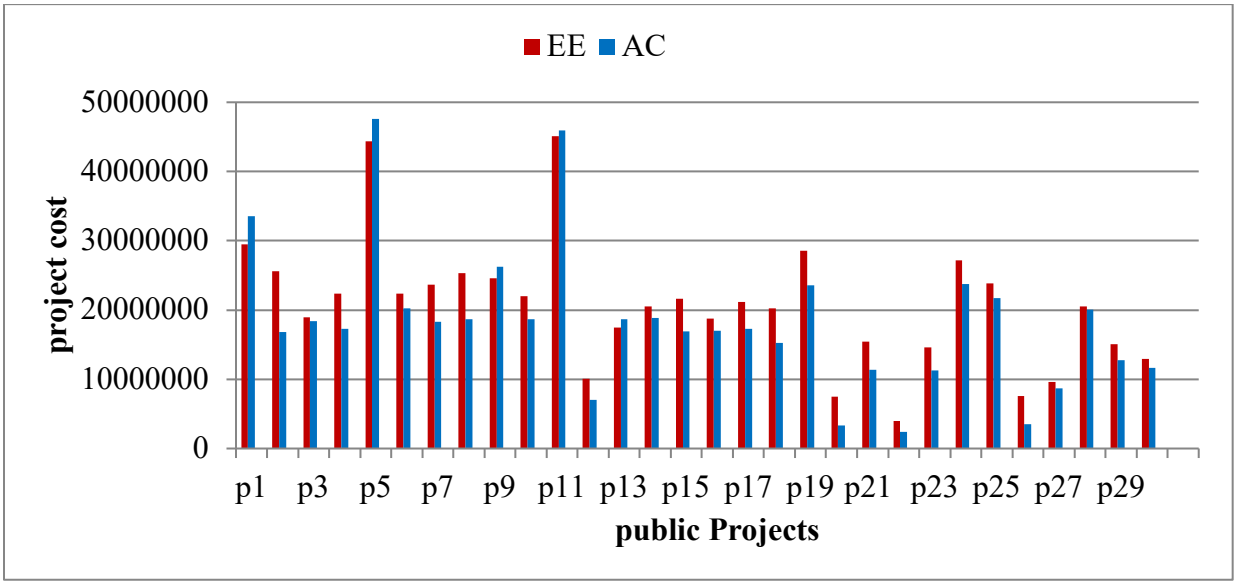


Figure 0-2: Engineering estimation and actual cost of the project

4.4.3 Engineering Estimation (EE) and contract price (CP)

The result analysis indicated that the contract prices are significantly less than the initial engineering estimates. The average contract price is ETB 16,983,908, whereas the average engineering estimate is ETB 20,681,746, indicating a discrepancy of ETB 3,697,838 or around 17.9%. According to the cost estimation theory, Reliable engineering estimates should reasonably approximate actual market behavior, such a persistent gap represents inefficiencies in estimation practices (Ahiaga-Dagbui & Smith, 2014).

Despite the size of the difference indicates possible concerns, this could initially be seen as a benefit of competitive bidding. But procurement literature suggests that although the lowest-bidder strategy lowers short-term costs, it frequently leads to delays, disagreements, and lowered quality (Olaniran, 2015). This big discrepancy implies that to acquire jobs, contractors bid much lower than the estimate. Although public expenditure may benefit from competitive pricing, such a significant disparity may result in unsustainable contracts and implementation-related cost increases. Consistently underbidding or placing bids much below estimation frequently results un sustainable in project execution that is not sustainable.

Additionally, it calls into doubt the accuracy of the Bureau's estimation methodology, namely its capacity to forecast realistic market behavior. Without sufficient risk assessment procedures, an over-reliance on the lowest bidder strategy could put at risk and raise the possibility of renegotiations or claims during the project.

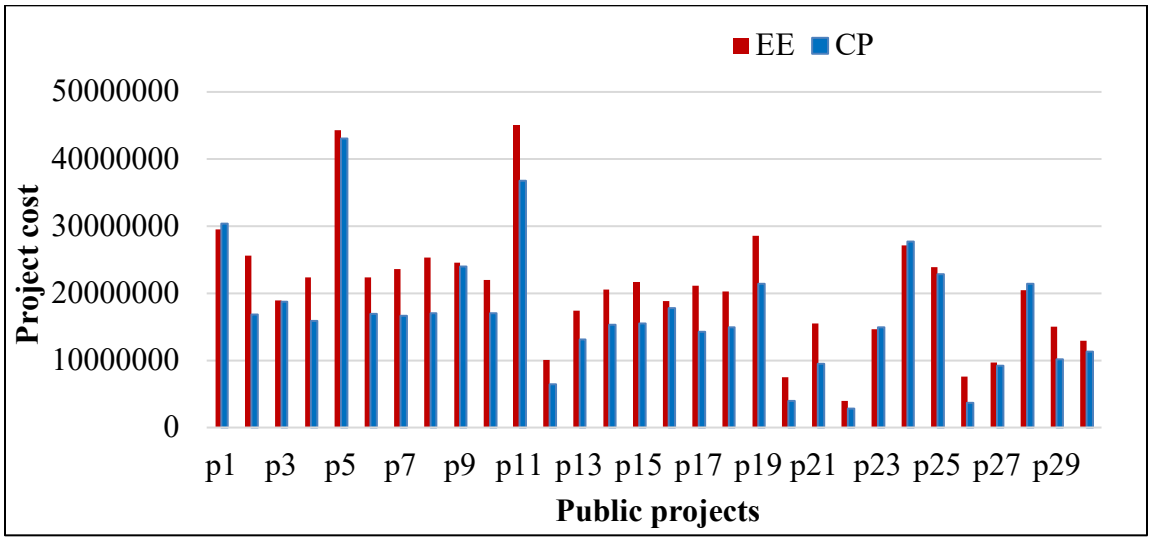


Figure 0-3: Engineering Estimation and Contract price

4.4.4 Contract price (CP) and actual cost (AC)

The result analysis indicated that there is a significant difference between the actual cost (AC) of execution and the contract price (CP). The average contract price is ETB 16,983,908, while the average real cost is ETB 18,220,063, indicating that projects usually cost ETB 1,236,155 more than the stipulated amount. The analysis shows a cost overrun of 7.28% and this result aligned with the investigation by Atapattu et al., (2023) the average cost overrun for construction projects is around 28%, but as Ketema (2021) Concludes that all housing site projects face cost overrun

within the ranges from 13.5%-38% of the original contracted amount due to different reasons. Even small overruns indicate systemic weaknesses in the estimating and procurement procedures; therefore, this study's overrun is important even though it is lower than these findings (Ahiaga-Dagbui & Smith, 2014). Using out-of-date rates and choosing the lowest bidder increases the problem by causing budgetary gaps and impairing project timeliness, quality, and financial performance.

When it compared with the result, there is a cost overrun and this could be due to the result of the least-bidder procurement mechanism's shortcomings estimation methods. Contractors may provide lower bids to get contracts, but they may find it difficult to maintain those bids when the work is being done. As a result, there is a significant chance of financial deficiencies, project delays, and even quality compromises when there is a discrepancy between the contract value and actual spending.

4.3.5 Contractual Time (CT) and Actual Time (AC)

Significant delays in project completion can be identified by comparing the contractual and actual durations over time. The actual average completion time is 888.1 days, compared to the contractual average of 483.6 days. In developing countries, challenges in construction projects are commonly caused by project experience related to time overruns (Mahdi & Soliman, 2021). In Malaysia, construction projects also face time overruns, with 80% of them experiencing unnecessary delays in their completion (Shehu et al., 2014). Schedule overrun runs from 61% to 80% (Lafhaj et al., 2016). Similarly, the result from this analysis showed 83.6% extra time than originally planned, or an average time overrun of 404.5 days. These results show that the Bureau's time estimation procedures are unfortunately insufficient and disconnected from the reality of actual execution.

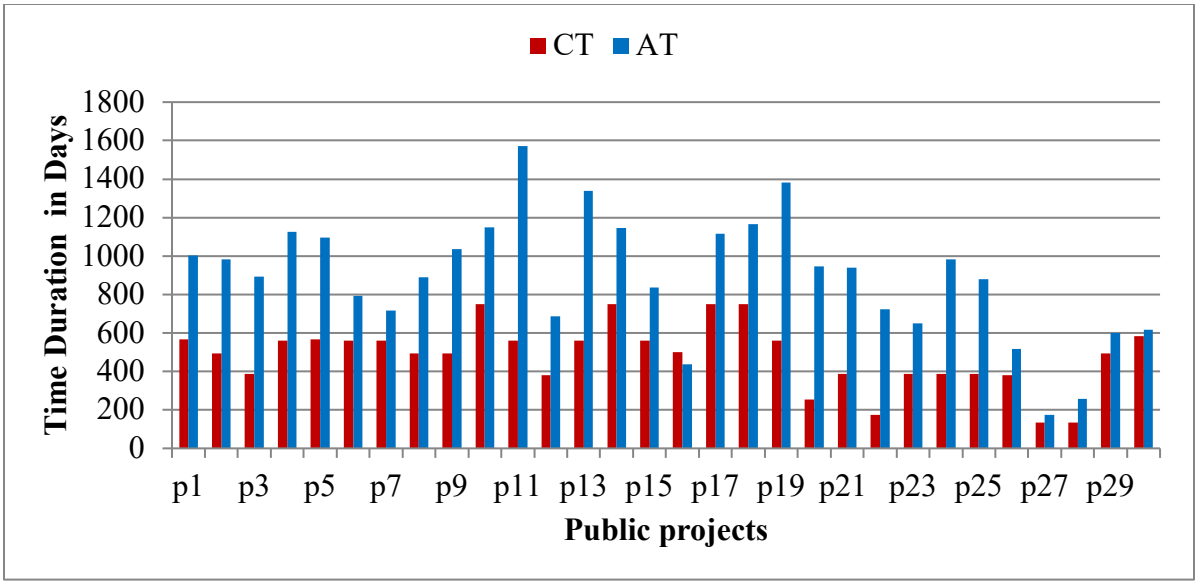


Figure 0-4: Contractual Time and Actual Time

A. Paired Difference Samples Test

Table 0-3: Paired Difference Samples Test

Pairs	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1 SURave - BURave (Birr/item)	24.591	172.416	31.48	-39.79	88.97	.781	29	.441
2 EE – AC (10^6 Birr)	2.4616823	2.838869	0.51830	1.401631	3.521733	4.75	29	.000
3 CP – AC (10^6 Birr)	-1.236155	2.613908	0.47723	-2.212205	-0.260105	-2.59	29	.015
4 EE – CP (10^6 Birr)	36978379	3.059492	0.55858	2.555404	4.840271	6.62	29	.000
5 AT (days) - CT(Days)	404.5	248.85	45.43	311.58	497.42	8.90	29	.000

The Construction, Road, and Transport Bureau of Tigray use Standard Unit Rate (SUR) estimating techniques and the paired sample analysis provides important insights into how well these methods work. The Bid Unit Rates those contractors submitted differed by an average of 24.59 Birr per item from the Standard Unit Rates that the Bureau published. Despite not being statistically

significant ($p = 0.441$), this discrepancy has major practical ramifications, particularly in light of the present increased trend in material prices. As discussed above (Czarnigowska A. 2014) suggested that differences between bid and anticipated costs could result from SURs' potential inability to accurately reflect current market pricing. Contractors frequently quote costs below the Bureau's normal rates, according to this lower bid rate, which is probably due to competitive pressure from the least-bidder selection process.

This is particularly problematic because the Bureau employs a unit price contract system, which means that regardless of future cost rises the specified bid rate serves as the basis for payment. In these situations, if the real market costs exceed their proposals, contractors could have to make quality compromises or postpone work. Furthermore, over 80% of the project data gathered indicated that the final real costs were less than the initial engineering estimates. SURs occasionally rely on antiquated assumptions or conservative estimates to absorb unforeseen risks, thus while this could indicate cost effectiveness, it could also indicate overestimation or project scope reduction (Flyvbjerg, 2009).

Although this would suggest cost effectiveness, it could also be a result of the Bureau's overestimation or project scope reductions during execution. The Bureau's estimation method may not accurately reflect actual project requirements, as evidenced by the significant mean differences between Engineering Estimates and both Contract Prices (3.7 million ETB) and Actual Costs (2.46 million ETB), both of which were statistically significant ($p < 0.001$). These outdated assumptions may not accurately reflect current market conditions or technological advancements, leading to inefficiencies and inflated cost estimates. As a result, the bureau's calculations may fail to provide a realistic framework for budgeting and resource allocation. Significant cost overruns (mean difference = -1.24 million ETB, $p = 0.015$) and time overruns (average of 404 days, $p < 0.001$) between Contract Prices and Actual Costs further suggest deeper inefficiencies in scheduling and budgeting. Deeper scheduling and budgetary inefficiencies, in line with worldwide data showing that mismatched estimating and antiquated productivity assumptions create ongoing cost and schedule overrun (Cantarelli et al., 2010). When combined, these results show that although SUR values might seem statistically similar to bid prices, the Bureau's methods for estimating costs are not able to adjust to changing market conditions and contractor realities, which raises questions about how reliable they are for directing public project budgeting, contracting, and decision-making.

B. Paired Samples Effect Sizes

Table 0-4: Paired Samples Effect Sizes

Pair		Effect size measure	Standardizer[a]	Point Estimate	95% Confidence Interval	
					Lower	Upper
Pair 1	SURave - BURave	Cohen's d	172.41608	.143	-.218	.501
		Hedges' correction	174.68637	.141	-.215	.495
Pair 2	EE - AC	Cohen's d	2838869.03	.867	.441	1.283
		Hedges' correction	2876249.98	.856	.435	1.266
Pair 3	CP - AC	Cohen's d	2613908.8	-.473	-.847	-.091
		Hedges' correction	2648327.6	-.467	-.836	-.090
Pair 4	EE - CP	Cohen's d	3059492.8	1.209	.729	1.676
		Hedges' correction	3099778.8	1.193	.720	1.654
Pair 5	AT (days) - CT(Days)	Cohen's d	248.8	1.625	1.070	2.168
		Hedges' correction	252.1	1.604	1.056	2.140

A. The denominator is used in estimating the effect sizes.
Cohen's d uses the sample standard deviation of the mean difference.
Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.

A modest practical impact is indicated by the effect size study, which reveals a minor difference between the Average Standard Unit Rate (SURave) and Bid Unit Rate (BURave) (Cohen's d = 0.143). In light of growing building prices, this little average difference of 24.59 Birr/item is surprising. Due to the Bureau's limited market sample techniques and use of out-of-date productivity data, it appears that the SUR does not accurately reflect current market trends.

As for the relationship between Engineering Estimates (EE) and Actual Costs (AC) and Contract Prices (CP), the large effect sizes (Cohen's d = 0.867 and 1.209, respectively) show constant overestimation. The negative impact size between CP and AC (Cohen's d = -0.473) indicates that, most likely as a result of strict contract terms and inflation, actual costs frequently surpass contract prices. Between Actual and Contractual Time, the biggest effect (Cohen's d = 1.625) was found, suggesting frequent and substantial project delays. These findings show that estimation procedures and actual project conditions are not aligned, which results in schedule overruns and inefficient use of funds.

4.5 Variation analysis

Table 0-5: Tests of Homogeneity of Variances

Rate value of SURave and BURave	Levene Statistic	df1	df2	Sig.
Based on Mean	6.217	1	58	.016
Based on Median	4.778	1	58	.033
Based on Median and with adjusted df	4.778	1	52.524	.033
Based on the trimmed mean	6.075	1	58	.017

Table 0-6: ANOVA Table

Difference	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9071.079	1	9071.079	.203	.654
Within Groups	2594413.258	58	44731.263		
Total	2603484.337	59			

A variance analysis and one-way ANOVA test between Standard Unit Rates (SUR) and Bid Unit Rates (BUR) across sampled construction projects were performed to assess the dependability of SUR, which is the unit rate employed by the Tigray Construction, Road and Transport Bureau. A statistically significant difference between the variances of SUR and BUR was found using Levene's Test for Equality of Variance (p-values = 0.016, 0.033, and 0.017 for mean, median, and trimmed mean, respectively). This suggests that the degree of variability between the two rate types varies across projects.

According to (Gastwirth et al., 2009), Levene's Test is a well-known and reliable technique for identifying variance heterogeneity. When findings indicate significant p-values, it indicates actual discrepancies across groups rather than sporadic fluctuations. This observation raises questions regarding the stability and representativeness of the published SURs over time because it suggests that while SURs may match BURs in certain projects, they differ radically in many others and this could be due to the rise of direct costs from time to time. However, the average values of SUR and BUR did not differ statistically significantly ($F = 0.203$, $p = 0.654$), according to the one-way ANOVA test, suggesting that the overall mean rates were comparable. However, the Levene's Test results, which demonstrate that the similarity in averages does not indicate consistency or reliability, dominate this finding. According to earlier research on unit-price contracts, there might

be serious hazards associated with differences between estimated and real unit prices, especially when market conditions change. The need for dynamic adjustments to estimation procedures is highlighted by Hyari et al. (2017), who point out that differences in unit rates have a direct impact on profitability and frequently result in contractual conflicts. The large range of unit rate variance indicates that SURs might not adapt well to changing markets Conditions or project-specific circumstances, which could result in erroneous cost estimates for individual projects. As a result, even though average SUR values appear to be in line with market bid rates, their uneven distribution among projects calls into question SUR's validity as a reliable assessment tool. This highlights the necessity of more market alignment and frequent changes to SUR inputs in order to lower variability and increase estimation accuracy across Tigray construction projects.

4.6 Correlations Analysis

Table 0-7: Correlation analysis

Correlation		SURave	BURave	EE	AC	CP	CT	AT
SURave	Pearson Correlation	1	.728**	.243	.343	.339	-.180	-.152
	Sig. (2-tailed)		.000	.195	.064	.067	.341	.423
	N	30	30	30	30	30	30	30
BURave	Pearson Correlation	.728**	1	.360	.459*	.556**	-.289	-.211
	Sig. (2-tailed)	.000		.051	.011	.001	.121	.264
EE	Pearson Correlation	.243	.360	1	.964**	.944**	.448*	.584**
	Sig. (2-tailed)	.195	.051		.000	.000	.013	.001
AC	Pearson Correlation	.343	.459*	.964**	1	.972**	.378*	.532**
	Sig. (2-tailed)	.064	.011	.000		.000	.039	.003
CP	Pearson Correlation	.339	.556**	.944**	.972**	1	.284	.431*
	Sig. (2-tailed)	.067	.001	.000	.000		.128	.017
CT	Pearson Correlation	-.180	-.289	.448*	.378*	.284	1	.625**
	Sig. (2-tailed)	.341	.121	.013	.039	.128		.000
AT	Pearson Correlation	-.152	-.211	.584**	.532**	.431*	.625**	1
	Sig. (2-tailed)	.423	.264	.001	.003	.017	.000	

**Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2-tailed).

As shown table 4-7 above, the correlation analysis offers important information about how well the Construction, Road, and Transport Bureau of Tigray's standard unit rate estimation procedures are working. The strong positive correlation between standard unit rates (SUR) and bid unit rates (BUR) ($r = 0.728$, $p = 0.000$) suggests that the Bureau's published rates and contractor pricing are somewhat related, while the weaker correlation between SUR and actual cost ($r = 0.343$, $p = 0.064$) suggests that the Bureau's rates might not be a good reflection of the market, which could result in differences in cost estimation. According to Flyvbjerg et al. (2002), this misalignment is an indicator of optimism bias and deliberate distortion in public project estimates. Additionally,

The consistency between declared rates and bid rates, even when real prices differ, can be explained by contractors' tendency to exhibit optimism bias while bidding, especially for lengthier projects (Joo Kim & Skibniewski, 2023).

A tendency of overestimation is further supported by the fact that engineering estimates far surpass both contract pricing ($r = 0.944$, $p = 0.000$) and actual costs ($r = 0.964$, $p = 0.000$).

This strengthens Flyvbjerg (2009) argument that public-sector estimating procedures often involve systematic overestimation, leading in a continuous difference between estimated and actual expenditures. This implies that there is a discrepancy between anticipated and actual spending because the Bureau's assessment procedure does not consider actual market swings. Bid unit prices are typically lower than standard unit rates, which may be related to the least bidder selection technique and could compromise project quality even while direct expenses in the construction industry are rising. Olaniran (2015) argued that aggressive underbidding to secure contracts can lead to hidden risks and undermine quality, particularly in the construction industry where direct costs are on the rise.

The fact that actual completion timeframes significantly surpass contractual durations ($r = 0.625$, $p = 0.000$) further emphasizes project delays. The correlation coefficient for this relationship is 0.80, meaning that there is a good degree of precision in the way the planned time distribution matches the actual time (Al-Momani, 2000). However, the poor relationship between time-related variables and unit rates suggests that inefficiencies in project execution, contractor capability, or resource limitations rather than inaccurate estimations are the primary causes of delays.

According to the analysis, bid unit rates have a stronger correlation to actual project costs than standard unit rates, indicating that contractors rely more on market-based pricing than the Bureau's published rates; project delays are common; however, the weak correlation between delays and unit rate estimation suggests that other project management factors, such as contractor capacity, resource availability, or administrative inefficiencies, significantly contribute to time overruns; and engineering estimates are consistently higher than contract prices and actual costs, raising concerns about overestimation and inefficiencies in standard unit rate estimation practices.

All things considered, the study emphasizes how the Bureau must update its estimation techniques to increase accuracy by utilizing current production rates and actual market data. To improve cost effectiveness and project performance, it is also necessary to reevaluate the usage of antiquated standard unit rates and the dependence on the least bidder selection process. By addressing these problems, public constructions projects can experience better resource allocation, reduce budget overruns, and better align predicted and actual costs.

4.7 Regression analysis

Table 0-8: Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.988[a]	.975	.969	1824916.45

a. Predictors: (Constant), AT (days), SURave, CP, CT(Days), BURave, EE

From the table 4-8 above, the predictors (Standard Unit Rate, Bid Unit Rate, Engineering Estimation, Contract Price, Contractual Time, and Actual Time) and the actual cost have a very strong association, as indicated by the R value of 0. 988.With an R-squared value of 0.975, the model has a high degree of explanatory power, accounting for almost 97.5% of the variation in Actual Cost. Even after taking into consideration the number of predictors included in the investigation, the model's strong predictive ability is confirmed by the Adjusted R-squared of 0.969. The average difference between the expected and observed Actual Cost values is 1,824,916.45 ETB, which is the Standard Error of the Estimate.

Table 0-9: ANOVA Table for multiple linear regression analysis

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3024149351577376.500	6	504024891929562.750	151.344	.000[b]
	Residual	76597360926565.310	23	3330320040285.448		
	Total	3100746712503942.000	29			

a. Dependent Variable: Actual Cost

b. Predictors: (Constant), Actual Time(days), Standard unit rate average, Contract Price, Contractual Time (Days), Bid unit rate average, Engineering Estimation

According to the ANOVA table 4-9, the total model's p-value is 0.000, or less than 0.05, indicating That it is statistically significant. This implies that there is a substantial correlation between the Actual Cost and at least one of the predictors. The model fits the data well, as evidenced by the F-statistic of 151.344 and this highly supported finding that they are strong predictors of the measured data might be reflected in the larger absolute value of the F-statistics presented (Al-Momani, 2000).

Table 0-10: Regression coefficient table

Coefficients							
	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	-6433622.6	2257790.1		-2.9	.009	-11104217.3	-1763027.8
SURave	8305.4	3179.5	.132	2.6	.116	1728.154	14882.594
BURave	-4815.4	3037.2	-.117	-1.6	.127	-11098.296	1467.518
EE	.234	.160	.208	1.5	.158	-.098	.565
CP	.870	.170	.762	5.13	.000	.519	1.220
CT (Days)	1031.790	2831.685	.017	.364	.719	-4825.997	6889.577
AT (days)	2172.057	1658.546	.066	1.31	.203	-1258.907	5603.021

a. Dependent Variable: Actual Cost

Constant: When all predictors are equal to zero, the anticipated Actual Cost, or intercept term, is -6,433,622.55. This result is statistically significant, as indicated by its p-value of 0.009. Standard Unit Rate Average: This statistic has a p-value of 0.116 and a coefficient of 8305.374.

Despite having a positive correlation with the Actual Cost, the p-value indicates that, at the 5% level, it is not statistically significant. Although the positive coefficient indicates that the Actual Cost tends to rise as the Standard Unit Rate does, this influence is not significant enough to be relied upon for making predictions.

Bid Unit Rate Average: The p-value for this variable is 0.127, and its coefficient is -4815.389, suggesting that it is not statistically significant. According to this, the Bid Unit Rate in this model is not a good indicator of the Actual Cost. The p-value for Engineering Estimation is 0.158, and the coefficient is 0.234, indicating that it is not statistically significant. Despite its benefits, Engineering Estimation's lack of importance means that it cannot be relied upon to accurately anticipate Actual Cost.

Contract Price: With a p-value of 0.000 and a coefficient of 0.870, the contract price is statistically significant. This indicates that there is a considerable link between the Actual Cost and the Contract Price, with the Actual Cost rising as the Contract Price does. The actual cost may be accurately predicted from the contract price. Contractual Time (Days): With a p-value of 0.719 and a coefficient of 1031.790, this variable is not statistically significant. This suggests that Actual cost is not significantly impacted by contractual time.

Actual Time (Days), with p value of 0.203 and a coefficient of 2172.057, Actual Time (Days) is not a significant predicator of actual cost. As a result, whilst certain variables show predictive relevance, others have no effect on actual cost (Oladimeji, 2021) .

According to regression analysis, the engineering estimation, standard unit rate, bid unit rate, contract price, contractual time, and actual time all account for 97.5% of the variation in actual cost ($R2 = 0.975$, adjusted $R2 = 0.969$). Of them, Contract Price is the most powerful predictor ($\beta = 0.87$, $p < 0.001$), with the impacts of the other variables being either less or not statistically significant. As demonstrated by the Standard Error of the Estimate (ETB 1,824,916.45), the model's estimates nearly match actual expenses, demonstrating its high predictive capacity.

The summary of the key findings of the models of the analysis indicated that the performance of the Bureau's SUR estimating procedures is better understood thanks to the inferential studies carried out in this study. According to the multiple regression model, the predictors (SUR, BUR, EE, CP, CT, and AT) have very significant predictive ability; taken together, they account for 97.5% of the variation in Actual Cost ($R2 = 0.975$, Adjusted $R2 = 0.969$). The strongest and most statistically significant predictor among these was Contract Price ($\beta = 0.870$, $p < 0.001$), indicating that ultimate expenses are closely influenced by agreed-upon contract values. SUR, BUR, and EE, on the other hand, did not reach statistical significance ($p > 0.05$), suggesting that conventional estimating techniques by themselves are not very good at predicting real spending.

Additionally, the correlation analysis revealed a strong correlation between SUR and BUR ($r = 0.728$, $p < 0.01$), indicating competitive alignment between contractor pricing and Bureau estimates. However, a weaker correlation between SUR and Actual Cost ($r = 0.343$, $p > 0.05$) indicates ongoing inefficiencies in predicting actual market outcomes. Additionally, significant overestimation between EE and both CP ($d = 1.209$) and AC ($d = 0.867$) was verified by effect size results (Cohen's d). Additionally, systemic schedule overruns are highlighted by the huge impact size between Contractual and Actual Time ($d = 1.625$).

These model-based results show that although SURs can occasionally seem statistically similar to BURs, they are not reliable in predicting Actual Cost and do not adequately account for changing market conditions. Rather, the most accurate indicator of expenditure consequences is contract pricing. This highlights the necessity of reducing reliance on descriptive averages in decision-making and updating SUR inputs (labor productivity, material pricing).

4.8 Analyzing the Accuracy and the Impact of Discrepancies on Project Feasibility and Construction Performance in Tigray.

4.8.1 Awareness, understanding, and weakness of SUR estimation

A. Cross tabulation: How familiar * Frequency of usage

Table 0-11: How familiar are * How often do they use the unit rate Cross tabulation

% within How often do they use the unit rate

How familiar were	How often do they use the unit rate				
	Very frequently	Frequently %	Occasionally%	Rarely %	Total %
Very familiar	100.0	54.5	18.2		44.4
somewhat familiar		36.4	63.6	100.0	46.7
Neutral slightly familiar		9.1	18.2		8.9
Total	100.0	100.0	100.0	100.0	100.0

B. Adequacy of the SUR estimation practice

Table 0-12: The Adequacy of the SUR estimation practice

Years of experience		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than five	11	23.9	24.4	24.4
	5-10	9	19.6	20	44.4
	10-15	17	37	37.8	82.2
	15-20	8	17.4	17.8	100
	Total	45	97.8	100	
Missing	System	1	2.2		
Total		46	100		

A. Weaknesses of the SUR estimation practices and updating of productivity and costs at Frequencies

Table 0-13: Weakness of the SUR estimation and updating of productivity and costs up Frequencies

a. Weakness of the SUR estimation practices **b.** Updating productivity and cost

Weakness of the unit Rate estimation	Responses		% of Cases	Are the productivity and costs up to date?		Frequency	%	Valid %	Cum. %
	N	%							
Outdated productivity rates	19	20.90	42.20	Valid	yes	18	39.1	40	40
					no	20	43.5	44.4	84.4
Lack of market price adjustment	33	36.30	73.30		unsure	7	15.2	15.6	100
Use of range average item pricing methodology	25	27.50	55.60		Total	45	97.8	100	
Lack of stakeholder involvement	14	15.40	42.20	Missing	System	1	2.2		
Total	91	100.0	202.20	Total		46	100		

The Construction, Road, and Transport Bureau of Tigray's Standard Unit Rate (SUR) estimating procedures have serious flaws, as shown in Table 16. 73.30% of respondents said that the absence of frequent market price adjustments was the most commonly mentioned problem. The accuracy of the unit rate estimates is therefore put at risk by the continuous use of out-of-date productivity rates and the lack of stakeholder involvement 42.20% in the estimating process was mentioned by of respondents, which restricts inclusivity and transparency and dependence on range average pricing approaches 55.60%. According to Addis & Ababa (2024), the main weakness of the price estimation was Insufficient data gathering and documentation methodology, incomplete data, and Inadequate communication and collaboration among project stakeholders

Additionally, just 40% of respondents said that productivity rates and direct expenses are maintained current level, compared to 44.4% who said they are not and 15.6% who were unsure. According to these answers, there are discrepancies between projected and actual project costs since the present SUR system depends on out-of-date and inadequate data inputs. In the end, these flaws reduce the accuracy of cost predictions and obstruct efficient project planning and budgeting.

4.8.2 Analyzing of Perception of the accuracy

A. Accuracies of SUR estimates

A questionnaire was given to important stakeholders to assess the precision and dependability of the Standard Unit Rate (SUR) calculation procedures used by the Tigrayan Construction, Road, and Transport Bureau. Respondents' opinions about the accuracy of SURs about actual project expenses and their suitability for actual project execution are shown in Table 4-14. It also records the frequency with which published SURs deviate from actual unit rates, as well as the comparison between bid prices and published SURs. The feasibility and cost-effectiveness of public construction projects are impacted by these insights, which help to determine the SURs are in line with actual market conditions and project reality. The most important aspect impacting the accuracy of the pre-tender cost estimate is the estimator's experience and skill level and This suggests that to generate a precise estimate that takes into account all relevant details, the estimator must possess the necessary expertise and experience (Alumbugu et al., 2014).

Table 0-14: Accuracies of SUR estimates

A. How accurate is it compared to actual Project costs?

How accurate are	Frequency	Percent	Valid Percent	Cumulative percent
Very accurate	3	6.5	6.7	6.7
Moderately accurate	17	37	37.8	44.4
Slightly accurate	13	28.3	28.9	73.3
Not Accurate	12	26.1	26.7	100
Total	45	97.8	100	

B. How is SUR in actual project execution?

How accurate are	Frequency	Percent	Valid Percent	Cumulative Percent
Very accurate	1	2.2	2.2	2.2
Accurate	7	15.2	15.6	17.8
Neutral	17	37	37.8	55.6
Inaccurate	20	43.5	44.4	100
Total	45	97.8	100	

C. How often are the published unit rates differ from the Actual unit rate?

How often	Frequency	Percent	Valid Percent	Cumulative Percent
Very often	6	13	13.3	13.3
Often	26	56.5	57.8	71.1
Sometimes	12	26.1	26.7	97.8
Rarely	1	2.2	2.2	100
Total	45	97.8	100	

D. Comparing the bid with the published unit rate

Comparison	Frequency	Percent	Valid Percent	Cumulative Percent
Higher	10	21.7	22.2	22.2
Similar	15	32.6	33.3	55.6
lower	20	43.5	44.4	100
Total	45	97.8	100	

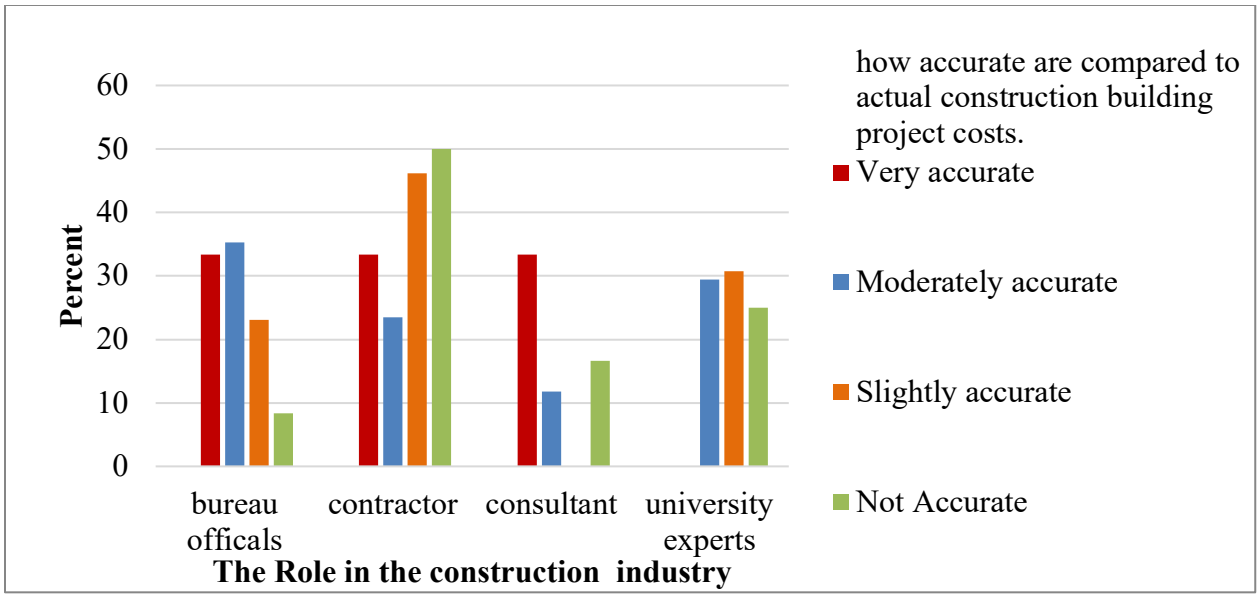


Figure 0-5: How SUR accurate compared to actual construction building projects

Unreliable Cost Estimation Issue was one of the most critical factors to go beyond contract price and budget (Enrica et al., 2020). Contractors are the most optimistic, according to the data, with the largest percentage (about 50%) rating estimates as inaccurate, followed by relatively correct (about 45%), and highly accurate Over 40% of consultants rated the estimation method as extremely accurate, whereas fewer chose moderate or low accuracy, demonstrating their confidence in the process. Although a sizable percentage of bureau officials thought estimations were highly accurate, most thought they were just fairly accurate (approximately 35%). However, university specialists are more skeptical; few chose highly accurate, and the majority assessed the projections as moderately or slightly correct. As Addis & Ababa (2024), the findings indicate that 74% of respondents believe there is no accurate price estimation, while 26% report that accurate price estimation does occur and This suggests that there are problems during the price estimation process for projects. The result from this analysis the perception of the stockholders also showed the inaccuracy of rate estimation.

B. Factors contribute Inaccuracy and Reasons for the Gap among unit rate costs

The main causes of cost estimating errors and the causes of cost gaps are presented in Table 18. Among the main causes are changes in market prices, out-of-date data, and improper techniques. Unaccounted market fluctuations, faulty productivity assumptions, and inadequate cost analysis procedures are the primary causes of cost disparities. These emphasize the necessity of updating estimating techniques and enhancing data reliability.

Table 0-15: Factors contribute Inaccuracy and Reasons for the Gap among costs

A. Factors contribute Inaccuracy

Factors contribute inaccuracy	Responses		Percent of Cases
	N	Percent %	
Market price fluctuations	34	32.4	75.6
Inadequate Resources (Human and material)	10	9.5	22.2
Outdated data like productivity	20	19.0	44.4
Methodology used	24	22.9	53.3
Lack of skilled personnel	8	7.6	17.8
Use of advanced estimation software/tools	9	8.6	20.0
Total	105	100.0	233.3

B. Reasons for the Gap among cost

Reasons for the Gap in costs	Responses		Percent of Cases%
	N	Percent %	
Poor productivity rate assumptions	20	23.5	44.4
not accounted for Market price fluctuations	31	36.5	68.9
Errors in quantity take-offs	11	12.9	24.4
Inefficient cost analysis methodology	23	27.1	51.1
Total	85	100.0	188.9

C. The Greatest Impact on the Difference between BUR and SUR

Table 0-16: The Greatest impact on the Difference between BUR and SUR* The Role in the Construction industry Cross tabulation

Impacts	The Role in the Construction Industry				Total%
	Bureau officials%	Contractor%	Consultant%	University experts%	
Inaccurate data input and analysis	18.2	11.8	20.0	50.0	24.4
Labor market fluctuations	9.1	11.8	40.0	33.3	20.0
Rapid changes in material prices	72.7	70.6	40.0	16.7	53.3
Supply chain issues		5.9			2.2
Total	100.0	100.0	100.0	100.0	100.0

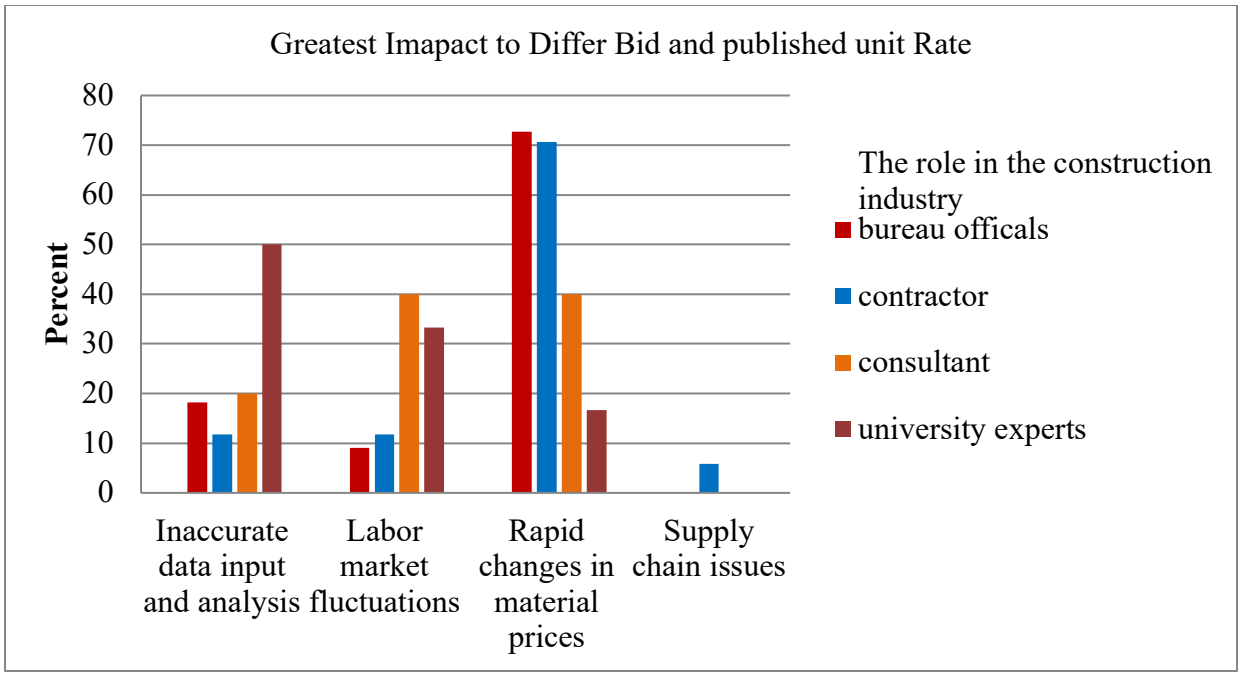


Figure 0-6: Greatest impact to differ Bid and Published Unit Rate * The Role

According to the analysis result Figure4-6, 53.3% of all respondents chose the biggest impact factor rapid fluctuations in material prices, as the main reason for the difference between bid and published unit rates. The majority of respondents, contractors (72.7%) and bureau officials (70.6%) agreed with this perspective. Similarly with this result Market Conditions is identified as the primary factor influencing price estimation as indicated by (Addis & Ababa, 2024).They also agreed that cost overruns occur when cost fluctuation occurs due to factors such as inflation, and when construction projects are not completed on time, within budget and with the appropriate technical or quality performance (Ikechukwu et al., 2017). The main problem, according to university experts, is incorrect data entry and analysis (50%), which highlights a gap between academics and practitioners. College experts (33.3%) and consultants (40%) expressed significant concern about changes in the labor market. These results show the importance of both technical and market-related estimating elements, pointing to the necessity of a more comprehensive and often updated unit rate estimation methodology. In addition, the Significances of the Barriers that have an impact on the inaccuracy of standard unit rate are shown in shown the figure below.

D. Significancy of Barriers that have an impact on the inaccuracy of SUR estimation

The accuracy of the Standard Unit Rates (SURs) employed by the Construction, Road, and Transport Bureau of Tigray is undermined by several systemic problems indicated by the examination of respondents' assessments of the main obstacles to accurate cost estimation.

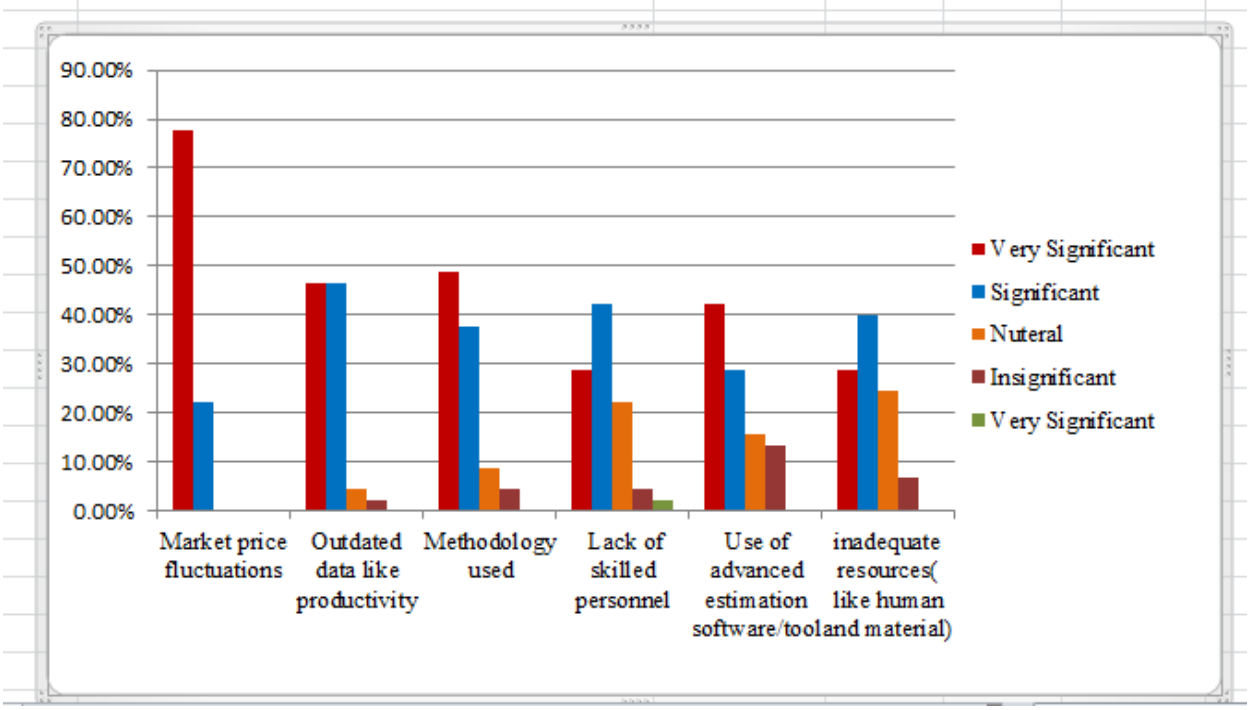


Figure 0-7: Significancy of impacts to the inaccuracy of standard unit rate estimation

According Addis & Ababa, (2024) the most common limitations were like the absence Well-defined and comprehensive drawings, specifications, and project documentation ranked first, followed by the estimator's experience and skill level in second place, incomplete of cost information, along with its accuracy, quality, and detailed data, was ranked third and the result of this analysis showed Most significantly, 77.78% of respondents rated market price goes as a "Very Significant" barrier, while 22.22% rated it as "Significant," making it the most important reason. This result also highly supports by Ibrahim & Mohamed (2021). The most important factors influencing estimation are like the cost estimator's experience and skill level; the accuracy, quality, and details of the cost information; the materials (prices, availability, quality, and imports); and prior experience with related project Concern over the continuous use of old inputs in the estimation process was also widely expressed, as seen by the 46.67% rating of outdated productivity statistics as "Very Significant" and another 46.67% rating it as "Significant." The

methodology employed also sparked concern, as 48.89% of respondents rated it as "Very Significant" and 37.78% as "Significant," suggesting that the estimation framework may be seriously incorrect or inadequately tailored to the circumstances of the project. Alternatively, although still noteworthy, concerns such as inadequate utilization of software tools (42.22% Very Significant, 28.89% Significant) and a lack of competent staff (28.89% Very Significant, 42.22% Significant) were viewed as less important. The fact that inadequate resources, including material and human inputs, were assessed as less critical (28.89% Very Significant, 40% Significant) suggests that methodological precision and data quality are more important than staffing or tools. To improve the precision, consistency, and applicability of SURs in the area, these findings highlight the fact that the main obstacles are systemic and data-driven rather than resource-based. Based on those immediate reforms, such as methodological change, enhanced estimation governance, and dynamic market-linked data updates.

Table 0-17: The Most and Least Accurate Unit Rate Costs

Most accurate	Responses		Percent of Cases	least accurate	Responses		Percent of Cases
	N	Percent%			N	Percent%	
Material costs	13	21.0	28.9	Labor costs	10	19.2	22.2
Overhead and profit margins	25	40.3	55.6	Material costs	23	44.2	51.1
Labor costs	14	22.6	31.1	Equipment costs	15	28.8	33.3
Equipment costs	10	16.1	22.2	Overhead and profit margins	4	7.7	8.9
Total	62	100.0	137.8	Total	52	100.0	115.6

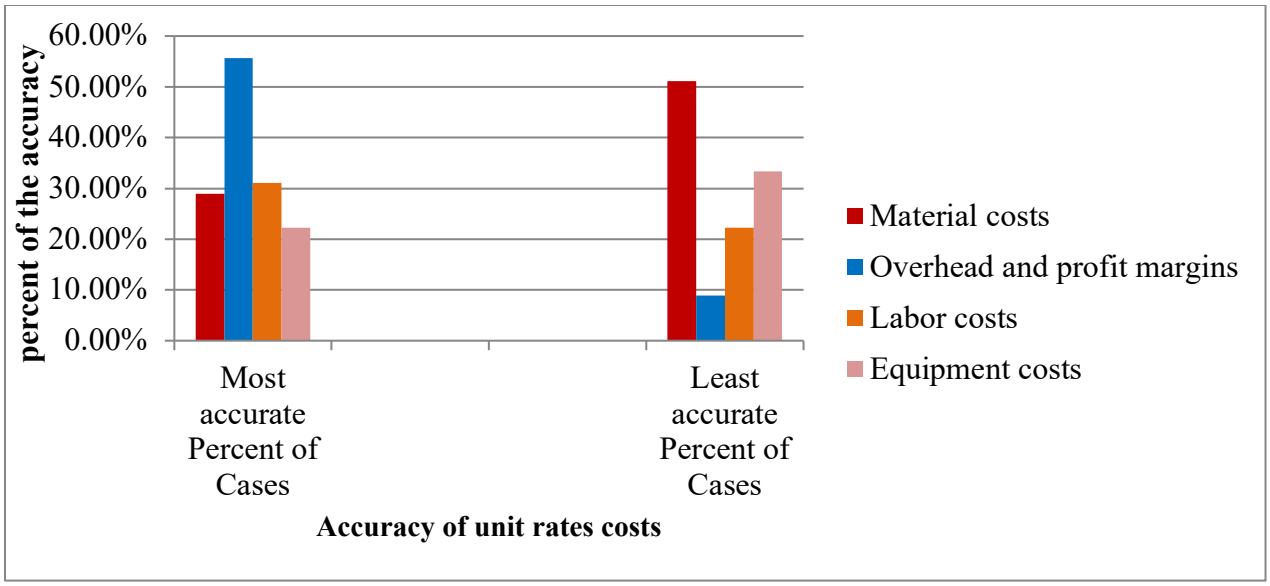


Figure 0-8: The Most and least accurate Unit Rate Costs

There were some significant discrepancies in the respondents' opinions about the correctness of the standard unit rate cost components. An accurate estimate of the project overheads acts as a profit center for the contractor in addition to increasing the likelihood that the bid will be successful and got The majority of interviewees thought the estimate of project overheads was correct (Tak et al., 2002) The majority of respondents (55.6%) chose overhead and profit margins as the most properly anticipated of the four primary components: material costs, labor costs, equipment costs, and overhead & profit margins. The costs of materials (28.9%), labor (31.1%), and equipment (33.3%) came next. On the other hand, 51.1% of respondents chose material costs as the least accurate cost component, followed by labor costs (31.1%), equipment costs (22.2%), and overhead and profit margins (8.9%).

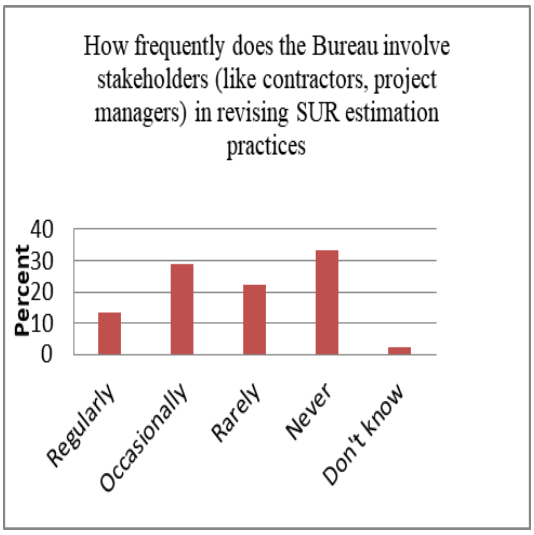
In contrast, material and labor expenses are seen as less dependable, probably because of their vulnerability to market instability and variations, although overhead and profit margins are typically well-estimated. These results demonstrate that to improve the accuracy of unit rate estimates in public construction projects, more dynamic and regularly updated estimating techniques are required, particularly for material and labor cost components.

Table 0-18: How often does project execute under the estimation but exceed the schedule and how frequently does involve stakeholders

A. How often does the estimation under the estimation and exceed the schedule?

B. How frequently does the Bureau involve stakeholders in revising SUR

How often under estimate and exceed the schedule		Frequency	Percent	Valid Percent	Cumulative Percent	How frequently Involves	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	4	8.7	8.9	8.9	Regularly	6	13.0	13.3	13.3
	Often	25	54.3	55.6	64.4	Occasionally	13	28.3	28.9	42.2
	Sometimes	14	30.4	31.1	95.6	Rarely	10	21.7	22.2	64.4
	Rarely	1	2.2	2.2	97.8	Never	15	32.6	33.3	97.8
	DO not know	1	2.2	2.2	100.0	Don't know	1	2.2	2.2	100.0
	Total	45	97.8	100		Total	45	97.8	100	
Missing	System	1	2.2			System	1	2.2		
Total		46	100.			Total	46	100.		



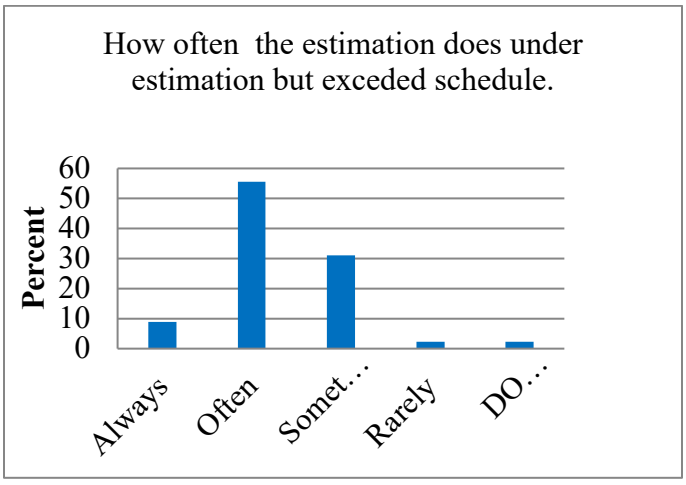


Figure 0-9: How frequently involve parties and how often projects exceed its Time but under estimation

According to the analysis, a significant number of respondents (55.6%) noted that public building projects that the Bureau estimates frequently go under budget but ahead of schedule. This occurs occasionally, according to another 31.1%, indicating an ongoing problem with time overruns despite of cost under runs. However, the Bureau doesn't seem to be doing much to involve

stakeholders in updating standard unit rate (SUR) estimates. Of those surveyed, just 13.3% said that such involvement occurs frequently, whilst a total of 55.5% said it occurred infrequently or never. The same result as Addis & Ababa (2024), over 50% of respondents said there isn't a dedicated group while estimating the price. A possible connection between low stakeholder participation and ongoing scheduling issues in project execution may be suggested by this trend.

4.8.3 Impact on projects

A. Impact of inaccurate unit rate estimation and Least bidder mechanism

The perceived effects of the least bidder selection process and imprecise unit rate estimation on public construction projects in Tigray are shown in Table 4-19. Inaccurate unit rate estimates frequently result in project delays, expense overruns, quality compromises, and unsatisfied clients, per the replies. Likewise, the least bidder system is said to be a factor in poor performance, contractor short cuts, and project execution delays. These results indicate the negative impacts that poor procurement and estimation procedures have on the overall performance of a project.

This is highly supported by (Hussain Khan & Khan, 2015), concluded that since it does not ensure that the best-performing contractors would be awarded contracts, the lowest bidding method encourages contractors to lower rates, which could compromise quality.

Table 0-19: Impact of inaccurate estimation and least bidder mechanism on projects

A. Impact of the inaccurate unit rate estimation on projects Frequencies

What an inaccurate unit rate estimation	Responses N	Responses Percent %	Percent of Cases
Project delays	31	32.3	68.9
Cost overruns	30	31.	66.7
Quality compromise	18	18.8	40.0
Client dissatisfaction	17	17.7	37.8
Total	96	100.0	213.3

B. How the least bidder influence project Frequencies

How least bidder mechanism affects the project[a]	Responses N	Responses Percent	Percent of Cases
Encourages shortcuts by the contractor	19	23.8	43.2
Leads to lower quality work	35	43.8	79.5
Causes project delays	26	32.5	59.1
Total	80	100.0	181.8

a. Dichotomy group tabulated at value 1

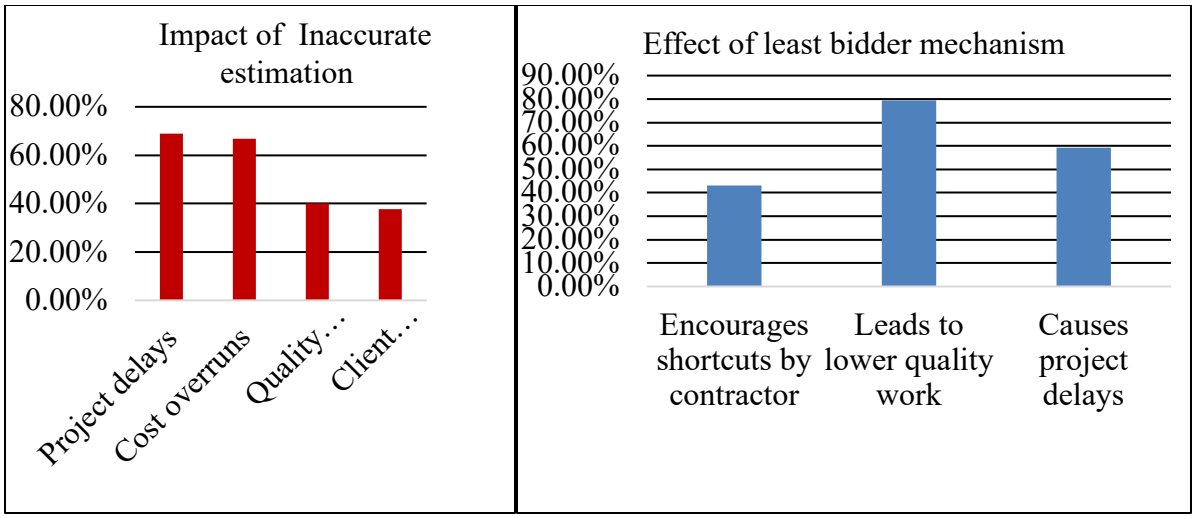


Figure 0-10: Impact of inaccurate estimation and Least bidder mechanism on public projects

The results show that Tigray's public building projects have been severely harmed by erroneous standard unit rate (SUR) estimates. Project delays (68.9%), cost overruns (66.7%) and this supported by Ethiopia (2018)indicated cost overruns ranging from 0% to 126%, and quality compromises (40%) are the most often reported outcomes. 37.8% of respondents also mentioned client unhappiness. Similarly**,** according to Addis & Ababa, (2024) the study results, cost overrun Project delay were the issues brought on by inaccurate price estimation that occurs the most frequently.

Most respondents said that the least bidder selection process results in lower-quality work (79.5%), delays in projects (59.1%), and encourages contractors to take cheap cuts (43.2%). According to these findings, the least bidder method and erroneous SUR estimates both have a detrimental effect on project outcomes in terms of budget, schedule, and quality.

E. How do the least bidder mechanism used by the Bureau impacts project outcomes

Table 0-20: How do the least bidder mechanism impacts project outcomes

How does the least bidder impact projects		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Positively	5	10.9	11.1	11.1
	Negatively	31	67.4	68.9	80
	Neutral	9	19.6	20	100
	Total	45	97.8	100	
Missing	System	1	2.2		
Total		46	100		

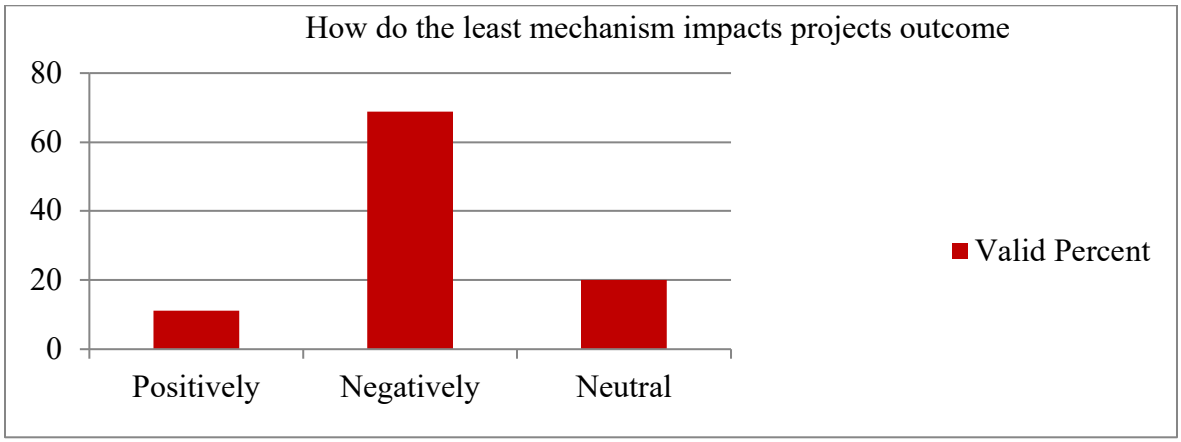


Figure 0-11: How does the least bidder mechanism used by the Bureau impacts project outcomes

According to the analysis, a sizable majority of respondents (68.9%) think that the Bureau's least bidder mechanism has negative impacts on project outcomes. This result is strongly supported by Low bid unit rates can hurt construction projects' intended budget, quality, and timeline. Just 11.1% thought the strategy had a favorable impact, while 20% had no opinion. These findings imply that difficulties in reaching the intended project quality, schedule, and cost efficiency may be exacerbated by the existing least bidder selection procedure.

F. Comparing with others and how it affects the projects quality

Table 0-21: Comparison the unit rate estimations and how influence project quality does

A. Compare the unit rate estimations with other regions or bureaus.

B. How does the use of SUR estimation practices influence project quality?

Comparing with others		Frequency	Percent	Valid Percent	Cum. Percent	How does the estimation influence quality	Frequency	Percent	Valid Percent	Cum. Percent
Valid	Much better	1	2.2	2.2	2.2	Significantly improves quality	9	19.6	20.0	20.0
	better	12	26.1	26.7	28.9	Slightly improves quality	9	19.6	20.0	40.0
	About the same	13	28.3	28.9	57.8	No impact on quality	9	19.6	20.0	60.0
	Worse	12	26.1	26.7	84.4	Slightly reduces quality	17	37.0	37.8	97.8
	Don't know	7	15.2	15.6	100	Significantly reduces quality	1	2.2	2.2	100
	Total	45	97.8	100		Total	45	97.8	100	
Missing	System	1	2.2			System	1	2.2		
Total		46	100			Total	46	100		

The Tigray Construction, Road, and Transport Bureau's unit rate estimates were scored as "much better" by 2.2% of respondents and "better" by 26.7% of respondents when compared to those from other regions or bureaus. On the other hand, 28.9% thought the estimations were "about the same," 26.7% said they were "worse," and 15.6% said they "don't know." This implies that a significant percentage of people believe Tigray's estimates could be improved in comparison to other bureaus, even though others view them as quite competitive.

When asked how standard unit rate (SUR) estimating techniques affect project quality, only 20% of respondents responded that they greatly enhance quality, and another 20% said that they just marginally enhance it. 20%, however, said the behaviors had no effect on quality, and 40% said the quality had decreased, either marginally (37.8%) or considerably (2.2%). According to these results, the quality goals of public construction projects might not be adequately supported by the SUR estimating techniques used today.

4.9 Guiding Framework for Improving the Accuracy and Consistency of SUR Estimation

A. Suggestions from the analysis

1. Preferable Improvement suggestions

From the analysis of the respondents, the key mechanisms to improve SUR consistency and accuracy have been found from the analysis by using improved data collection mechanisms, using updated cost and productivity, and use of advanced estimation software tools.

Table 0-22: Preferable Improvement suggestions

Preferable Improvement suggestions		N	Responses Percent	Percent of Cases
ways of Improvements	Use updated productivity and direct costs	23	17.2	56.1
	Improved data collection method and methodology used	26	19.4	63.4
	Increased transparency in the estimation process	19	14.2	46.3
	Training and development for personnel	19	14.2	46.3
	Better stakeholder engagement	21	15.7	51.2
	Use of advanced estimation software/tools	26	19.4	63.4
Total		134	100.0	326.8

a. Dichotomy group tabulated at value 1.

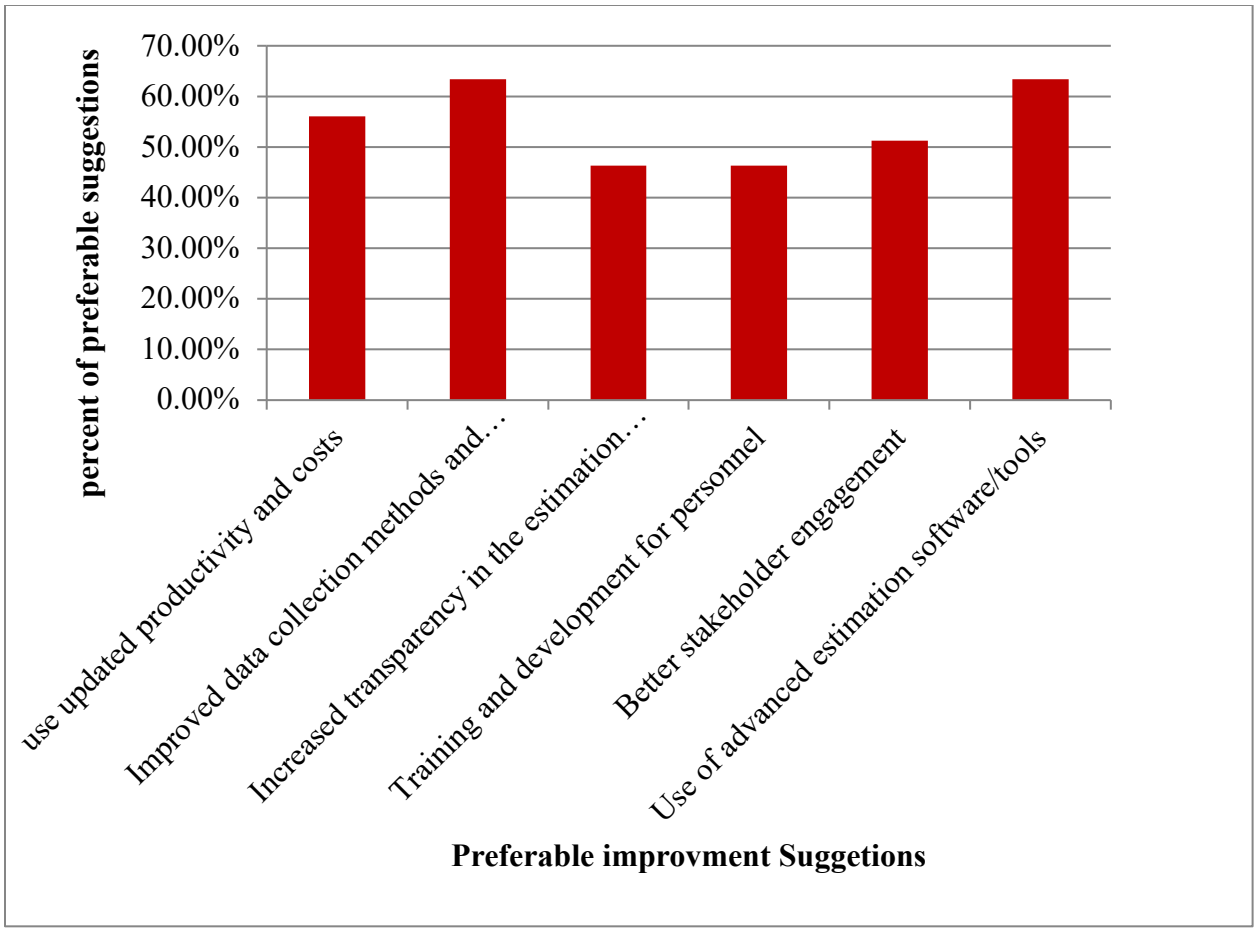


Figure 0-12: Preferable Improvement suggestions

Both methodological improvement and technical innovation are highly valued when it comes to enhancing unit rate estimate processes, according to the respondents' preferences. 63 percent of respondents advocated "Improved data collection methods and methodology" and "Use of advanced estimation software/tools" as the two most commonly suggested improvements. This result is highly supported by (Ikechukwu et al., 2017). Cost overruns can be addressed or avoided by implementing careful estimating practices, which involve the estimator thoroughly reviewing the estimate and factoring in the pricing from suppliers and certain contractors. This demonstrates a strong need to update estimating procedures using digital technologies and more precise, empirically supported methods.

Furthermore, a significant percentage of participants (56.1%) supported the use of updated cost and productivity statistics, expressing worries that the credibility of estimations may be compromised by out-of-date benchmarks. The need for inclusive and capacity-building strategies is further reflected in suggestions like "Better stakeholder engagement" (51.2%) and "Training and

development for personnel" (46.3%). Additionally, "Increased transparency" received support (46.3%), indicating a desire for more accountability and openness in estimation processes. In addition, the presence of the application of checklists and templates for standard price estimation indicated the most one selected to improve the accuracy of estimation (Addis & Ababa, 2024).

In conclusion, the results indicate that improving the accuracy and credibility of unit rate estimates in public construction projects requires a combination of improved methodologies, technological advancements, and institutional improvements, particularly through stakeholder involvement, training, and transparency.

2. Improvement measures

Table 0-23: Improvement measures

	Rate					
Improvement measures	Very effective %	Effective %	Neutral %	Ineffective%	Very ineffective%	Total %
An accurate market surveys, productivity and methodology used	84	16	0	0	0	100
Enhanced data analytics	37.78	44.44	17.78	0.00	0.00	100
Stakeholder feedback mechanisms	33.33	53.33	13.33	0.00	0.00	100
Training and development for personnel	37.78	40.00	20.00	2.22	0.00	100
Collaboration with academic institutions	48.89	37.78	13.33	0.00	0.00	100
Total	242.22	191.11	64.44	2.22	0.00	500.0

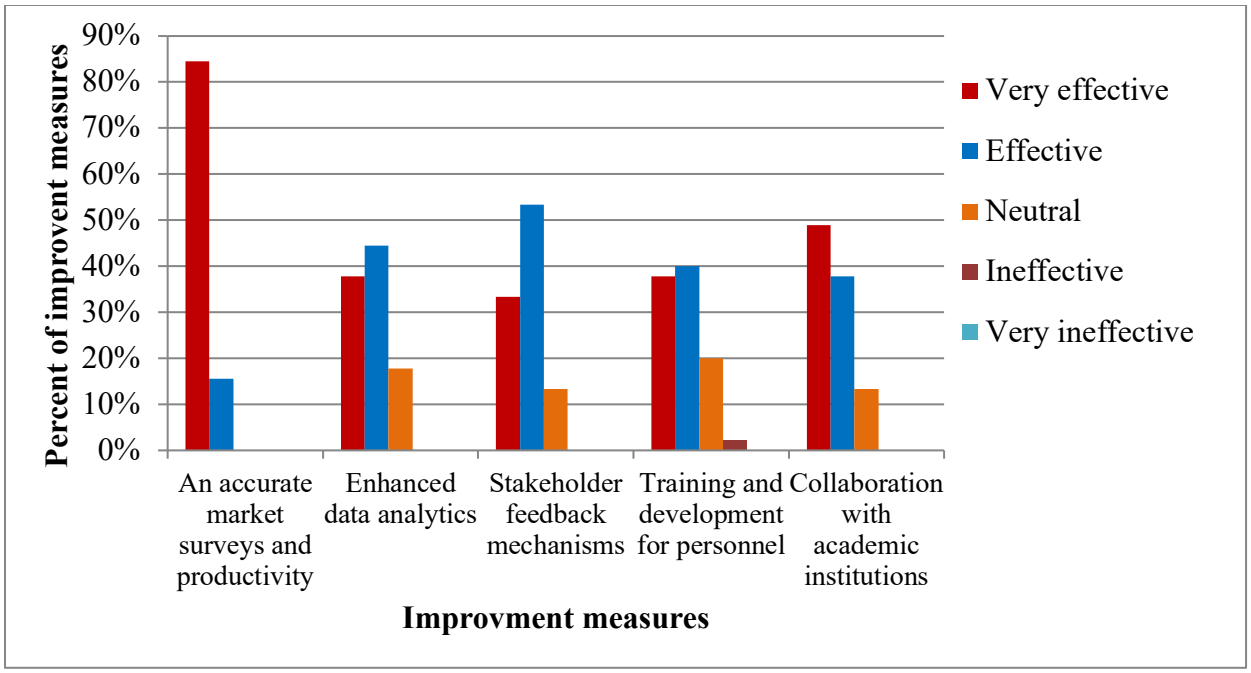


Figure 0-13: Improvement measures

According to the analysis of Table 4-23, there is broad agreement among respondents regarding the efficacy of the suggested improvement strategies for improving the Tigray Construction, Road, and Transport Bureau's standard unit rate (SUR) estimating procedures. The most highly rated measures were updating productivity statistics and performing accurate market surveys and methodology used; 84% of respondents evaluated these measures as very effective, and the remaining 16% assessed them as effective, suggesting almost complete percent agreement on their crucial importance. A strong correlation between performance improvement and lowering the variability in productivity (Hassan & Razek, 2007). This demonstrates unequivocally that a significant issue affecting SUR accuracy is out-of-date market data and irrational productivity assumptions.

The use of advanced data analytics (82.2% rated it successful or very effective), stakeholder feedback mechanisms (86.6%), cooperation with academic institutions (86.7%), and staff training and development (77.8%) were among the other highly supported methods. A holistic improvement approach that incorporates technology modernization, institutional learning, collaboration, and capacity building is valued by stakeholders, as indicated by the high effectiveness ratings for these metrics. Additionally, only 2.22% of respondents thought training was unsuccessful, and none of the measures received a "very ineffective" rating. This demonstrates

the general acceptability of the suggested improvement measures and shows the necessity of incorporating them into a framework that serves as a guide for SUR practice improvement.

4.9.1 Guiding Framework for Improving Performance of the Estimation

I. Modified market-based estimation practices and procurement method

Standard unit prices develop under the Tigray Construction, Road, and Transport Bureau's current cost estimation procedure by gathering price information from different weredas and getting inputs from regional suppliers for labor, equipment, and supplies. Following the collection of this data, the final Standard Unit Rate (SUR) was determined by applying productivity parameters that were defined more than ten years ago and adding transportation expenses to centralize prices in Mekelle. Despite its efforts to represent regional variation, this technique encountered several significant obstacles, such as inadequate labor market information, out-of-date productivity requirements, and incomplete data from non-cooperative suppliers. It would be advantageous to switch to a modified market-based estimating approach, which is employed in nations like the United States, India, Kenya, and Brazil, to overcome these problems.

While local pricing would still be collected, this better method would guarantee digital data monitoring, implement real-time productivity measures, and institutionalize quarterly or semi-annual updates. Additionally, it would provide a multi-source pricing system that improves accuracy by averaging supplier data and recent project prices. In the setting of Tigray, where Market volatility and inflation are prevalent, this hybrid model would improve cost estimation's adaptability, dependability, and alignment with real project conditions, lowering cost overruns and boosting the legitimacy of public infrastructure spending.

A. Make cost input collection more expanded and modernized

The Bureau's cost input collection methods must be updated and expanded to increase the Standard Unit Rate (SUR) estimations' precision, dependability, and representativeness in Tigray. With the low degree of supplier interaction, the Bureau currently gathers price data from a small number of suppliers typically no more than three per item which is frequently maximum data, incomplete, or non-representative data with in current situation. It became clear to me, as a researcher, from observations and interviews that the current approach is inflexible in reflecting changing market conditions and regional price variances.

A stronger, more systematic approach is advised. By working with woreda-level offices, regional supplier groups, and local contractors, the Bureau should first create a more extensive and

decentralized data collection network. As a result, the Bureau would be more capable of adapting to local cost fluctuations and capturing location-specific prices. Second, field estimators might improve update frequency, decrease human error, and submit data in real-time by utilizing digital tools like mobile apps, centralized internet platforms, or even SMS-based reporting systems.

The Bureau should also put in place a framework for supplier engagement that rewards cooperation through certification, recognition, or preferred supplier lists to guarantee continued data quality and involvement. Together, these steps would improve the cost database's validity and comprehensiveness, resulting in more realistic SURs that better assist with project budgeting, procurement, and cost control.

B. Update productivity factor regularly every 3-5 years

The Construction, Road, and Transport Bureau of Tigray's present cost estimation method has several serious problems, including the use of antiquated productivity rates some of which date back more than ten years. Inaccurate cost estimates are produced by these antiquated elements, which do not account for modern construction methods, technology, labor efficiency, and geographical conditions. Productivity criteria must be routinely updated every three to five years to overcome this.

The Bureau should start conducting thorough productivity time studies that collect actual data from ongoing building projects in various work categories and zones. By assessing real labor and equipment output under varied site conditions, these studies can guarantee that new productivity guidelines are supported by data. The statistics can also be made more realistic and appropriate to actual construction situations in Tigray by involving local contractors and site engineers in the assessment process.

The SUR estimates will be more reliable and in line with real site performance if productivity parameters are updated regularly. As a result, there may be fewer cost disparities, more accurate project planning, and improved budgeting and bidding reviews.

C. Institutionalize Regular SUR Updates

Establishing a systematic and regular method for SUR updates is essential to ensuring that the SUR stays responsive to changing market conditions and local construction realities. The Construction, Road, and Transport Bureau of Tigray should establish an annual or quarterly SUR revision process that is integrated into its operational framework rather than conducting improvements as temporary or reactive procedures.

Systematic data gathering methods from a variety of sources, such as area contractors, suppliers, local marketplaces, and active projects, should be a part of this institutional process. The Bureau should create a specialized SUR review committee or technical team to manage the gathering, confirming, and evaluating of labor, material, and equipment costs. Furthermore, technical assistance in data analysis and productivity validation can be obtained through cooperation with universities like Mekelle University. The Bureau can increase cost accuracy, openness, and stakeholder trust in the SUR's legitimacy by instituting a regular and policy-driven update process. Additionally, instituting updates will enable improved decision-making in project planning and procurement, reduce cost overruns, and match forecasts with inflationary trends.

D. Improve the estimator's capacity and tool

As Hussain Khan & Khan (2015) investigated Involving experts who are knowledgeable about and proficient in estimation methods is essential for consumers to receive more precise cost estimates. Strengthening estimators' capabilities and updating their tools are crucial for improving cost estimation's accuracy and dependability. Regular training and professional development programs should be offered by Tigray's Construction, Road, and Transport Bureau to keep estimators up to date on the latest software, market analysis methodologies, and estimation methods. The capacity of many of the estimators in use today to generate precise and context-sensitive estimates is constrained by their reliance on antiquated approaches and lack of access to real-time data or digital technologies.

Additionally, the Bureau should provide its estimation staff with the most recent software and data management solutions that enable the integration of historical project data, dynamic productivity factors, and local market conditions. The quality of estimation would be greatly enhanced by having access to databases that monitor changes in labor market patterns, regional material availability, and pricing fluctuations. Improving estimators' capabilities and equipping them with the appropriate resources will lower errors, boost productivity, and raise the general legitimacy of the SUR procedure.

E. Restructuring the Mechanisms for Contract Awarding and Tendering

The Construction, Road, and Transport Bureau of Tigray's current contract awarding and tendering procedures need to be reorganized to enhance project outcomes and guarantee equity, openness, and value for money. The poor performance of Ethiopia's public construction projects can be largely attributed to project contract management (Gadisa & Zhou, 2020).

As demonstrated by the research findings that more than 80% of projects were completed below the estimated cost but ultimately exceeded the bid price, the widespread use of the least-bidder selection method where contracts are awarded solely based on the lowest bid has frequently led to project delay, cost overruns, and quality compromises.

Bidders are assessed not just on price but also on technical ability, prior performance, resource sufficiency, and project delivery plans in a revamped approach that incorporates quality- and performance-based selection criteria. Incorporating a fair scoring system into the evaluation of tenders will encourage healthy competition and guarantee that contractors can complete projects. Furthermore, implementing auditable and transparent procurement procedures and encouraging local contractor involvement would improve sustainability and accountability in public building projects.

F. Collaborate with institutions and use post project evaluation for feedback

The Construction, Road, and Transport Bureau of Tigray should form cooperative relationships with educational institutions, research facilities, and industry stakeholders to improve the precision and applicability of standard unit rate (SUR) estimation. Universities and other educational institutions can contribute significantly through teaching, technical know-how, and research, enabling evidence-based enhancements to cost estimation techniques. Simultaneously, the Bureau ought to establish a methodical post-project assessment procedure to collect insights from finished projects.

The Bureau would be able to evaluate estimating accuracy, examine cost variations, and comprehend performance patterns with the use of this feedback mechanism. The Bureau can enhance future cost projections, make well-informed modifications to SURs, and better match estimation procedures with actual market dynamics and field realities by utilizing post-project assessments as a mechanism for ongoing learning. Maintaining a responsive and data-driven estimating framework requires such cooperative and feedback-driven methods.

II. Historic cost modelling

Historic Cost Modeling is a workable and flexible way to increase estimation accuracy in areas like Tigray where the construction industry frequently experiences price fluctuation, market instability, and a lack of supplier cooperation. This demonstrates that organizations strive to improve pricing tracking and control as well as the accuracy of price estimates. Additionally, 57%

of respondents say that previous project data is the main source of price estimation databases (Addis & Ababa, 2024).

To establish unit prices based on real cost outcomes rather than erratic market quotes, this approach which is popular in nations like South Africa systematically analyzes data from earlier projects. To better forecast future costs, especially in volatile markets, some nations have set up trustworthy historical cost databases to monitor patterns over time. Of the different kinds of historic cost modeling techniques, Elemental Cost Analysis (ECA) is the one that works best in the Tigray situation. In nations like Malaysia and the United Kingdom (via Building Cost Information Service, or BCIS), ECA is frequently utilized since it makes it possible to create cost estimates using historical data grouped by important construction components. In Tigray, where standard unit rates frequently depend on narrow supplier samples and antiquated productivity statistics, ECA provides a methodical approach to examining and reusing cost information from finished projects across comparable public buildings. This is especially important because the region's labor shortage and fluctuating market prices make the present ways of collecting prices unreliable.

Using ECA, previous project costs are broken down into standard components, and their costs are calculated per unit. Once these are corrected for scope differences or inflation, they can be used as benchmarks for estimating new projects of a similar nature. This study's analysis of more than 30 completed projects shows that Tigray already possesses the empirical data necessary to launch an ECA system. Additionally, the Construction, Road, and Transport Bureau would be able to reduce the risks of underestimating or overpricing by implementing ECA and moving away from unstable supplier-based pricing and toward evidence-driven forecasting.

The Bureau can create more context-specific and inflation-adjusted cost estimates by creating a localized database of elemental costs and updating it often. To improve flexibility, this strategy can potentially be combined with instruments like price indices and post-project assessments. ECA not only increases estimate reliability but also strengthens institutional memory and facilitates decision-making for upcoming budgeting, bidding, and policy reform in a dynamic economic climate like Tigray's.

III. Standardized Regional estimation Framework

It is essential to create a context-specific SUR (Standard Unit Rate) Manual as part of a Standardized Regional Estimation Framework to increase the accuracy, consistency, and

transparency of cost estimation in Tigray. A standardized framework would institutionalize a consistent methodology for predicting building costs based on locally relevant data, in contrast to the current practice, which relies on antiquated productivity factors and inconsistent data collection methods. In nations like South Africa (through its CIDB Estimating Standards) and India, where state-specific or national rate analysis guidelines direct public procurement and cost estimation by local market conditions, this strategy has been successfully applied.

In the case of Tigray, such a manual ought to be created using empirical data gathered from completed local projects and updated often to account for labor availability, transit logistics, and market fluctuations. Along with updating productivity rates and applying conventional markups for profit and overhead, it should also clearly explain methods for computing direct and indirect expenses. By providing a uniform "costing language," the framework would help public institutions, contractors, estimators, and consultants communicate more effectively and encourage fair competition.

Additionally, the Bureau can enhance accessibility and real-time updates by incorporating the handbook with digital tools like a mobile cost estimation app or an online rate library. This standardization would guarantee that estimates are both technically solid and economically justified in light of Tigray's particular geographical problems, improving the dependability of SURs used for budgeting, tendering, and contract management.

IV. Integrating BIM for standard unit rate estimation practice in Tigray

Adopting BIM-based cost estimating is strongly advised to increase the precision and consistency of the Standard Unit Rate (SUR) calculation in Tigray. Through the integration of design models with labor, productivity, and market pricing, BIM facilitates real-time, data-driven cost estimation. This is especially appropriate for Tigray, since the accuracy of hand estimations can be compromised by price fluctuations and outdated productivity rates. In contrast to conventional manual cost estimation methods, the BIM-based approach reduces reliance on the expertise of seasoned estimators, making it easier to implement. Moreover, by automating the quantity take-off process and necessary calculations, this method enhances the precision of cost estimations and lowers the chances of human errors or oversights (Fazeli et al., 2021)**.**

The implementation of BIM in housing projects resulted in a 45% increase in profit margins, a 45% decrease in waste, and a 5% reduction in on-site accidents (Abanda et al., 2017)**.** BIM has been used in public buildings in several developing nations, including South Africa, Kenya, and

India, to increase transparency and cost management. Regional SUR libraries connected to digital models and pilot projects are two ways to promote BIM in Tigray. The long-term advantages, such as fewer cost overruns, quicker estimating, and improved accountability, make it economically feasible even though the initial setup necessitates an investment in equipment and training. Better planning and project delivery would be supported by this digital transformation, which would also modernize estimation techniques.

4.9 Indicators to measure success of improvements

Table 0-24: Indicators to measure success of improvement

Indicators to measure success	Responses		Percent of Cases
	N	Percent%	
Improvement in the budget	32	27.1	71.1
Improvement in project completion times	27	22.9	60.0
Stakeholder satisfaction levels	29	24.6	64.4
Accuracy of cost forecasts	30	25.4	66.7
Total	118	100.0	262.2

a. Dichotomy group tabulated at value 1.

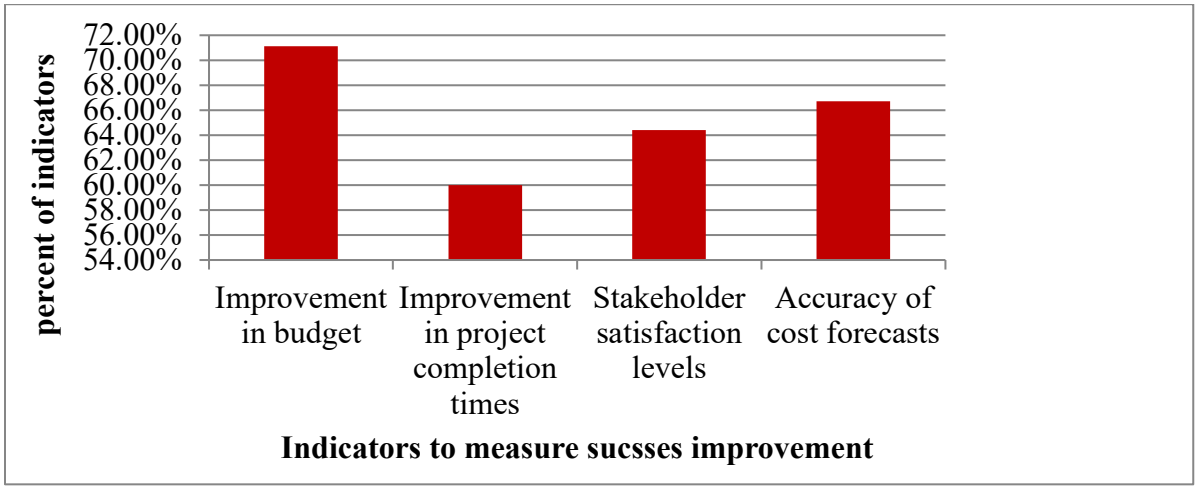


Figure 0-14: Indicators to measure success of improvement

According to the results, respondents believe that a variety of indicators are crucial for assessing how well unit rate estimating techniques have improved. 71.1% of participants selected "Improvement in budget" as their most popular indication, indicating a main focus on cost reduction and financial efficiency. Following closely behind were "Improvement in project completion times" (60.0%), "Accuracy of cost forecasts" (66.7%), and "Stakeholder satisfaction

levels" (64.4%). These findings demonstrate that stakeholders anticipate that effective estimation enhancements would result in increased predictability, timeliness, and stakeholder confidence in project delivery in addition to financial gains.

The study indicates that multidimensional metrics, which include cost, time, forecast accuracy, and satisfaction, are strongly preferred as the best way to measure responsibility and progress in the Tigray Bureau of Construction's unit rate estimating procedures.

CHAPTER 5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The Construction, Road, and Transport Bureau of Tigray use Standard Unit Rate (SUR) estimating techniques. This study evaluated their performance and accuracy rigorously, concentrating on how well they match real market conditions, how they affect project results and way of improvement. Using SPSS version 27 and Microsoft Excel, the study integrated quantitative and qualitative data from 30 finished public building projects to identify numerous important conclusions.

First, an important gap between stated SURs and bid unit rates was found. While actual project costs were 7.28% higher than contract prices, bid unit rates were, on average, 3.43% (24.59 birr/ item) less than the SURs. Furthermore, projects still faced severe financial suffering even though the engineering estimates were 17.9% higher than the bid prices that were received, and engineering estimation higher 11.9% higher than the actual cost of projects highlighting weaknesses in the estimation procedures employed currently. Furthermore, systemic delays were shown by the examination of project timeframes, which showed that actual completion dates were 83.6% longer than predicted.

The correlation showed Bid unit rates (BUR) show a moderate alignment with real costs, but standard unit rates (SUR) have a weak association. Both engineering estimates (EE) and contract pricing (CP) have good relationships with actual costs, suggesting that they are accurate indicators of actual project spending. The final agreed contract amount most closely matches actual project costs, with contract price (CP) having a slightly greater correlation ($r = 0.972$) than engineering estimates. These results emphasize the necessity of updating SURs to increase cost estimation accuracy and better represent current market realities The regression model indicated that errors in inputs like the standard unit rate (SUR), bid unit rate (BUR), and engineering estimates (EE) have a significant impact on actual construction costs by showing a very strong predictive relationship ($R2 = 0.975$) between key cost estimation variables and actual project costs. However, the standard and bid unit rates are positively correlated but not statistically significant at the 95% confidence level, whereas the contract price (CP) is the most statistically significant predictor ($p < 0.001$). This highlighted attention to a crucial problem: the Bureau's cost estimation system is inaccurate because of dated or poorly predicted inputs. This emphasizes the necessity of updating

the SUR framework with current productivity and market data to increase cost accuracy and SUR performance.

Over 56% of those surveyed responded that SUR estimates were inaccurate. According to statistical comparisons, SURs frequently overestimate some work items while underestimating others, which leads to inefficiencies in the budget. Stakeholders' qualitative comments revealed a general lack of confidence in the projects practical viability using the estimation techniques and procurement now in use.

According 65%-80% of the respondents, Inaccurate SURs result in cost overrun, delay, and decreased construction performance, A specific to the situation improvement framework was developed to address these issues.

It suggested changing productivity inputs regularly, implementing a hybrid estimation method that combines real-time and historical data, and implementing a dynamic market data monitoring system. Enhancing the region's cost estimation procedures' precision, openness, and consistency is the goal of this framework.

The study's findings emphasize how urgently the SUR estimate procedures in Tigray's public building industry need to be changed. Improving cost predictability, reducing financial risks, and promoting sustainable project delivery in an uncertain economic climate all depend on updating estimation processes to reflect current market realities.

5.2 Recommendation

The following important suggestions are put to enhance the, performance, accuracy and usefulness of the standard unit rate estimating procures employed by the construction, road and transport bureau of Tigray.

1. SURs should be updated on a regular basis by the Bureau using contractor idea in collecting material prices and current market data to make sure they reflect bid trends and real project conditions. Additionally, a database system for tracking changes in unit rates over time should be set up.
2. The Bureau should update Standard Unit Rates (SURs) on a regular basis using current market data and include actual cost information from recently finished projects in order to improve SUR accuracy. In order to make sure the estimates accurately reflect the state of the economy, this entails strengthening data collection procedures, incorporating industry stakeholders in the

rate revision process, and using a dynamic cost database to better align SURs with Bid Unit Rates (BURs) and actual construction costs.

3. Use a value-based approach to procurement rather than just the lowest bidder. When evaluating tenders, incorporate bid reality checks and update planning rules to take potential market swings into consideration and this critically by supported by (Hussain Khan & Khan, 2015) the multi-parameter bidding approach is more effective than the lowest bidding method, according to 70% of respondents.
4. The Bureau should be practicing the following frameworks to improve the SURs estimation and way procurement.

a) **Create a system for monitoring the dynamic market price:** This often indicates monitor, document, evaluate, and adjust and an updated market database that gathers up-to-date information on building supplies, labor prices, and equipment expenses should be established by the Bureau. In a dynamic economic climate, this method will assist in guaranteeing that SURs accurately represent the state of the market.

b) **Update data collection method, cost input methodology and productivity:** The present standard for productivity is out of data, and the methodologies for data collection mean taking the maximum range average are very limited and incomplete. To overcome this, the bureau should establish a plan for updating input costs by collaborating with different suppliers using Technological way and updating the productivity rates.

c) **Use a hybrid approach to estimation:** To make estimation procurers more reliance, include current market data with project data from the past. By increasing flexibility and decreasing reliable on set rates, this hybrid approach improves forecast accuracy in both stable and volatile markets.

d) **Improve data sharing, stakeholder and institutional collaboration:** Through discussions and a feedback mechanism channel, include project managers, consultants, contractors and universities in the estimation process. This all-inclusive strategy will support the development of SURs by identifying gaps, validating assumptions, and fostering transparency.

e) **Describe the mechanism for inflation adjustment and risk allowances:** To account for price volatility, current changes, and market instability, incorporate risk allowance and inflation adjustment variables in to the SUR estimating framework. Contractors will be less likely to experience financial difficulty and cost overruns as a result.

f) **In corporate feedback loops and performance monitoring:** Create a feedback system that compares bid, estimated, and actual costs when a project is finished to assess the accuracy of the estimation. This cycle of continuous development will guide SUR updates and aid in the gradual improvement of estimating techniques. The Bureau may greatly increase the efficacy of its SUR estimating procedures, increase budget predictability, and promote a more effective, fair, and transparent public construction industry in Tigray by putting these suggestions into operation.

g) **Change the least cost method to the most economically advantageous:** It is recommended to shift from the traditional least-cost method of contractor selection to the most economically advantageous approach, which considers multiple factors beyond simply the lowest bid. This approach emphasizes overall cost-effectiveness rather than just the cheapest option, ensuring that project quality and value are maintained. Factors such as the contractor's technological proficiency, demonstrated performance in previous projects, the financial health of the contractor, and the ability to adhere to a detailed employment or project schedule should be carefully evaluated. By incorporating these criteria, decision-makers can select contractors who are better equipped to deliver high-quality work on time and within budget, ultimately improving the efficiency and success of public construction projects.

It is advised that more research be done to examine the effects of poor performance in standard unit rates on the durability and quality of building projects, updating of productivity data's to accurate SUR employing of new methodology for accurate estimation, examining contractor bidding practices may help identify how strategic low bids impact project outcomes, A comparative analysis of SUR estimating methods in various Ethiopian regions could reveal gaps and best practices and Investigating the usage of digital tools can also enhance unit rate monitoring and updating.

5.3 Future Research

Based on the findings and limitations of this study, several areas for future research are recommended to further enhance understanding and improve the performance of standard unit rate estimation practices in public construction projects in Tigray, Ethiopia:

1. **Broader Geographic Scope:** Future studies could extend the research to other regions of Ethiopia to compare unit rate estimation practices and identify regional variations and best practices.
2. **Longitudinal Studies:** Conducting longitudinal research would allow for the examination of trends and changes in estimation accuracy and project performance over time.
3. **Technology Integration:** Further research could explore the impact of modern technologies, such as Building Information Modeling (BIM) and automated cost estimation software, on improving the accuracy of unit rate estimations.
4. **Stakeholder Perspectives:** Future studies could include a wider range of stakeholders, such as contractors, subcontractors, and clients, to capture a more comprehensive view of the challenges and opportunities in unit rate estimation.
5. **Impact Assessment:** Additional research could investigate the direct impact of inaccurate unit rate estimations on project outcomes, including cost overruns, delays, and quality issues, to quantify the practical implications more precisely.

These recommendations aim to provide a foundation for further investigation that can strengthen cost estimation practices, improve project efficiency, and inform policy decisions in public construction projects.

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Appendix

Appendix 1-questionnaire

Study on: An Evaluation into the performance of Standard Unit Rates (SUR) Estimation Practices by the Construction, Road, and Transport Bureau of Tigray, in the case of Tigray

Dear respondents…

The objective of this questionnaire is to understand stakeholder perceptions on the performance of the unit rate Estimation Practices by the construction, Road, and transport Bureau of Tigray while practicing it, and to identify any concerns or suggestions for improvement. This helps to assess the unit rate estimation practices and the validity of SUR rates by comparing estimated costs based on SUR rates with actual project costs, to identify factors that affect the consistency and to provide recommendations to enhance the consistency and validity of SUR rates and improve construction cost estimation practices.

As you are one of the participants in construction projects, especially public projects, I am requesting that you kindly answer the following questions. Finally, I want to assure you that all the information collected by using this questionnaire will be treated formally and it will be used for research work.

With regards,

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Section 1: Respondent Information

1. What is your role in the construction industry (please indicate with "ے" **or** pick it like ○

○ project Engineer ○ Contractor ○ Consultant ○ Government Official (write if it's other)

2. How many years of experience do you have in the construction industry? (please indicate with "ے")

○ Less than 5 years' ○ 5-10 years ○ 10-20 years ○ More than 20 years

3. What is the education level (please indicate with "ے")

○ PhD ○ MSc ○ BSc ○ diploma

Section 2: Awareness and Understanding

4. How familiar are you with the unit rate estimation practices used by the Tigray Bureau of Construction? (please indicate with "ے")

○ Very familiar ○ somewhat familiar ○ Neutral slightly familiar ○ Not familiar at all

5. How often do you use the unit rate estimation provided by the Construction, Road, and Transport Bureau of Tigray? (please indicate with "ے")

○ Very frequently ○ Frequently ○ Occasionally ○ Rarely ○ Never

6. How would you rate the adequacy of the SUR estimation practice used by the construction, Road, and transport Bureau of Tigray reflecting current market conditions? (please indicate with "ے"(

○ Less than five ○ 5-10 ○ 10-15 ○ 15-20 ○ More than 20

7. Do you think the construction, Road, and transport Bureau of Tigray SUR estimation practice for setting productivity rates and materials cost are up-to-date? (Please indicate with "ے"(

○ Yes ○ No ○ Unsure

8. What do you are think the main weaknesses in the current SUR estimation practice? (Please indicate with "ے" and select all that apply)

○ Outdated productivity rates ○ Lack of market price adjustment ○ Use of range average item pricing methodology

○ Lack of stakeholder involvement ○ Other (please specify)

Section 3: Perceptions of Accuracy

9. Based on your experience, how accurate are the construction, Road, and transport Bureau of Tigray's cost estimates compared to actual construction building project costs? (Please indicate with "ے"(

○ Very accurate ○ Moderately accurate ○ Slightly accurate ○Not Accurate

10. In your opinion, what are the reasons for the gap between estimated costs and actual costs? (Please indicate with "ے" and select all that apply)

○ Poor productivity rate assumptions ○ not accounted for Market price fluctuations

○ Errors in quantity take-offs ○ Inefficient cost analysis methodology ○Other (please specify)

11. How often do public building projects estimated by the Bureau come in under the estimation but exceed the schedule?

○ Always ○ Often ○ Sometimes ○ Rarely

12. How do you find the unit rates published by the construction, Road, and transport Bureau of Tigray in actual project execution? (Please indicate with "ے")

○Very accurate ○Accurate ○Neutral ○Inaccurate ○Very Inaccurate

13. What factors contribute to the accuracy or inaccuracy of the unit rate estimations? (Select all that apply) It should be based on the above question. (Please indicate with "ے")

○Market price fluctuations ○ inadequate resources (Human and material)

○Outdated data like productivity ○ Methodology used

○ Lack of skilled personnel ○ Use of advanced estimation software/tools ○other (Please specify)

14. How significant do you find the impact of each of the following barriers on the accuracy of unit rate estimations?

○ Market price fluctuations: ☐ Very significant ☐ significant ☐ Neutral ☐ insignificant ☐Very insignificant

○ Lack of skilled personnel: ☐ Very significant ☐ significant ☐ Neutral ☐ insignificant ☐ Very insignificant

○ Outdated data like productivity: ☐ Very significant ☐ significant ☐ Neutral ☐ insignificant ☐Very insignificant

○Inadequate resources: ☐ Very significant ☐ Significant ☐ Neutral ☐ insignificant ☐ Very insignificant

○ Use of advanced estimation software/tools: ☐ Very significant ☐ Significant ☐ Neutral ☐ Insignificant ☐ Very insignificant

○Methodology used: ☐ Very significant ☐ Significant ☐ Neutral ☐ Insignificant ☐ Very insignificant

15. What specific elements of the unit rate estimations do you find most accurate? (Please indicate with "ے" and select all that apply)

○ Material costs ○ Overhead and profit margins

○ Labor costs ○ Equipment costs

○ Other (Please specify):

16. What specific elements of the unit rate estimations do you find least accurate (Please indicate with "ے" and select all that apply)

○ Labor costs ○ Material costs

○Equipment costs ○ Overhead and profit margins ○ Other (Please specify)

17. How do the bid unit rates compare with the published unit rates, especially for the major work items of public construction building projects? (Please indicate with "ے")

○ Higher ○ Similar ○ Lower

18. How often do you find differences between the estimated unit rates and the actual unit rate? (Please indicate with "ے")

○ Very often ○ Often ○Sometimes ○ Rarely ○ Never

19. In your opinion, which of the following had the greatest impact on the difference between bid rates and published rates? (Select the most one)

○ In accurate data input and analysis ○ Labor market fluctuations

○Rapid changes in material prices ○ Supply chain issues

○ Other (please specify): _____

20. How frequently does the Bureau involve stakeholders (e.g., contractors, project managers) in revising SUR estimation practices?

○Regularly ○ Occasionally ○ Rarely ○ Never

Section 4: Impact on Projects

21. How do inaccurate unit rate estimations impact your projects? (Please indicate with "ے" and select all that apply)

○ Project delays ○ Cost overruns

○ Quality compromise ○Client dissatisfaction ○ Other (Please specify)

22. How do you compare the unit rate estimations from the construction, road, and transport bureau of Tigray with those from other regions or bureaus? (Please indicate with "ے")

○Much better ○Better

○ About the same ○ Worse ○ Much worse

23. How does the use of SUR estimation practices influence project quality?

○ Significantly improves quality ○ Slightly improves quality

○ No impact on quality ○ Slightly reduces quality ○ Significantly reduces quality

24. Do you believe the least bidder mechanism used by the Bureau impacts project outcomes? (Please indicate with "ے")

○ Positively ○ Negatively ○ Neutral

25. If negatively, how does it affect the project? (Please indicate with "ے" and select all that apply)

○ Encourages shortcuts by contractor ○ Leads to lower quality work ○ Causes project delays

○ Other (please specify)

Section 5: Suggestions for Improvement

26. What improvements would you suggest to enhance the accuracy of unit rate estimations? (Please indicate with "ے" and select all that apply)

○ use updated productivity and costs ○ Improved data collection methods and methodology

○ Increased transparency in the estimation process ○ Training and development for personnel

○ Better stakeholder engagement ○ Use of advanced estimation software/tools

27. How effective do you think the following measures would be in improving the accuracy of unit rate estimations? (Please indicate with "ے")

○ an accurate market surveys, productivity and methodology used: ☐ Very effective ☐ Effective ☐ Neutral ☐ Ineffective ☐ Very ineffective

○ Enhanced data analytics: ☐ Very effective ☐ Effective ☐ Neutral ☐ Ineffective ☐ Very ineffective

○ Stakeholder feedback mechanisms: ☐ Very effective ☐ Effective☐ Neutral ☐ Ineffective ☐Very ineffective

○Training and development for personnel: ☐Very effective ☐ Effective ☐ Neutral ☐ Ineffective ☐ Very ineffective

○ Collaboration with academic institutions: ☐ Very effective ☐ Effective☐ Neutral ☐ Ineffective ☐ Very ineffective

28. What metrics or indicators do you suggest the Bureau should use to measure the success of improvements in unit rate estimation practices? (Please indicate with "ے")

○ improvement in budget ○ Improvement in project completion times

○ Stakeholder satisfaction levels ○ Accuracy of cost forecasts

○ Other (Please specify)

29. Do you have any additional comments or suggestions regarding the unit rate estimation practices of the Tigray Bureau of Construction?

Appendix 2-Standard unit rate for the major work items

	Standard unit rate for the major work items					
Project ID	**Excavation and earth work(birr/m3)**	**Concrete work(birr/m3)**	**Masonry and HCB work(birr/m3)**	**Reinforcement work (birr/kg)**	**finishing work (birr/m2**	**Average SUR**
p1	146.18*	2978.22	1858.16*	33.36	807.37	**1164.658**
p2	135.6*	1446.78	1683.3*	31.02*	770.35*	**813.41**
p3	110.75*	1436.3	1286.41	30.57	669.65	**706.736**
p4	243.35*	1285.65*	1108.1*	28.37	493.91*	**631.876**
p5	137.6	2854.4	1788.56*	33.51*	885.17	**1139.846**
p6	130.46	1271.88*	1133.34*	26.45	523.05*	**617.036**
p7	157.69*	1320.6*	1258.9*	27.86*	527.78*	**658.566**
p8	123.95*	1455.08	1556.48*	31.68*	968.63*	**827.164**
p9	118.29*	1541.99	1604.67*	32.31*	587.88	**777.028**
p10	98.15*	1053..49*	990.5*	25.43*	381.38*	**373.865**
p11	136.7	1067.31	1457.38	29.55*	475.4*	**633.268**
p12	151.81*	1387.53*	1169.27*	25.05*	482.95	**643.322**
p13	164.81*	1567.06*	1536.88*	23.09	388.96*	**736.16**
p14	127.8*	1126.83*	1326.96	25.89*	488.3*	**619.156**
p15	120.15*	1280.3*	933.57*	22.82	580.4	**587.448**
p16	161.21*	1965.68	1208.3*	33.5	564.55	**786.648**
p17	126.91*	1299.18*	1705.68*	31.71*	790.87*	**790.87**
p18	124.79*	1238.98*	1056.07	26.29*	431.69*	**575.564**
p19	156.8*	1569.44*	1135.85	28.53	577.75*	**693.674**
p20	234.07*	1789*	1217.19*	28.99*	224.95*	**698.84**
p21	126.15	1393.62*	1186.7*	23.72	628.07	**671.652**
p22	175.77*	1687.16*	1214.45	29.56	284.4*	**678.268**
p23	129.9*	1195.08	846.24	28.81	96.95*	**459.396**
p24	127.32	1410.8	1338.16*	30.44	439.64*	**669.272**
p25	108.66	1563.59	1067.62	30.51	371.88*	**628.452**
p26	215.32*	1802.6*	1337.87*	53.56	634.44*	**808.758**
p27	122.02*	3251.36	1481.47*	33.99	72.49	**992.266**
p28	130.13*	1997.32	1481.46	33.99	72.5	**743.08**
p29	211.51*	1189.32*	1469.46*	26.48	512.91*	**681.936**
p30	147.34*	1713.45*	1235.22	25.23*	466.58*	**717.564**

*SUR indicates unit rate higher than bid unit rate

Appendix 3 - Bid unit rate for the major work items

	Bid unit rate for the major work items					
project ID	**Excavation and earth work(birr/m3)**	**concrete work(birr/m3)**	**masonry and HCB work(birr/m3)**	**Reinforcement work(birr/kg)**	**finishing work (birr/m2**	**BUR AVERAGE**
p1	140	3333.33	1373.33	40	1364.05	**1250.142**
p2	68.18	1700	1430	30	709.32	**787.5**
p3	39.55	1812.5	1420.5	45	813.95	**826.3**
p4	229.45	1251.67	1005.2	33.25	394.19	**582.752**
p5	145	3377.78	1373.33	33.5	1379.91	**1261.904**
p6	144.1	1206.26	737.67	27.67	482.08	**519.556**
p7	90.93	1278.02	750.16	27.28	488.84	**527.046**
p8	65.26	1700	1341.61	30	668.69	**761.112**
p9	105.3	2086.67	1447.67	38	724.04	**880.336**
p10	61.78	1511.11	759.1	22.5	279.69	**526.836**
p11	141.36	1310.25	1547.22	29.18	424.61	**690.524**
p12	73.33	1100.33	1009.6	24.8	484.84	**538.58**
p13	89.63	1203.03	520	25.8	379.28	**443.548**
p14	87.14	786.39	1346.41	22.1	362.56	**520.92**
p15	62.15	1186.67	339	40.82	793.96	**484.52**
p16	89	4303.33	129	45	680.84	**1049.434**
p17	59.38	1102.85	750	18.36	231.94	**432.506**
p18	80.17	1053.93	1205.88	22.1	340.67	**540.55**
p19	133	1304.76	1250	29	487.85	**640.922**
p20	87.14	1480	800	24	132.5	**504.728**
p21	148.09	1010.75	686.3	25	713.65	**516.758**
p22	94	1636	1500	29.56	172.25	**686.362**
p23	107.5	1503.33	908.33	31	92.78	**528.588**
p24	161.25	2462.85	1195	31.18	346.45	**839.346**
p25	129.87	1966.67	1733.33	37	338.82	**841.138**
p26	57	1196.18	1030	57	566.42	**581.32**
p27	121.67	4268.57	1333.33	35	100	**1171.714**
p28	107.5	2401.9	1853.33	42	107.7	**902.486**
p29	10	724.42	187.22	35.88	194.9	**230.484**
p30	120.5	1624.24	1383.33	25	448.55	**720.324**

Appendix 4 - projects cost, Time and Average Unit Rates

P.ID	EE(Birr)	CP(Birr)	AC(Birr)	CT (day)	AT(Day)	SURave	BURave	SURave - BURave
p1	29501046.5	30393430.6	33560197.4	566	1001	1164.85	1250.34	-85.484
p2	25644811.5	16810576	16840621.1	494	983	813.41	787.5	25.91
p3	18938298.2	18726383.2	18381004.5	386	892	706.736	828.3	-119.564
p4	22379127.9	15894591.3	17304490.8	561	1125	631.876	584.752	49.124
p5	44344322.7	43053186.7	47582508.9	566	1095	1139.84	1261.90	-122.058
p6	22398563.2	16933671.3	20208608.9	561	792	617.036	519.556	97.48
P7	23626990.7	16599859.9	18275268.8	561	715	658.566	527.046	131.52
p8	25337393.0	16986891.2	18666494.6	494	890	807.164	761.112	66.052
p9	24600329.7	23990672.3	26233513.7	494	1037	777.028	880.336	-103.308
p10	22002046.3	16998055.6	18688977.8	751	1150	373.865	566.836	-152.971
p11	45074021.9	36791087.1	45962406.6	561	1570	633.268	690.524	-57.256
p12	10040167.5	6440066.7	6995065.9	379	686	639.322	538.58	104.742
p13	17438334.6	13103209	18677049.9	561	1339	732.16	443.548	292.612
p14	20526486.3	15295714	18831315.3	751	1146	605.156	528.92	98.236
p15	21623414.0	15490163.4	16874880.6	561	837	587.448	484.52	102.928
p16	18801714.1	17823977	17011921.0	501	437	782.648	1055.43	-272.786
p17	21153022.4	14277356.2	17244174.7	751	1116	790.87	432.506	358.364
p18	20265084.4	14958547.5	15239868.1	751	1165	571.564	540.55	35.014
p19	28521016.7	21452389.4	23595587.8	561	1381	685.674	640.922	52.752
p20	7462506.7	3929589.88	3372383.0	254	945	698.84	504.728	194.112
p21	15456765.5	9499570.57	11364381.7	386	938	671.652	522.758	154.894
p22	3952185.4	2839269.12	2425883.8	175	723	678.268	686.362	-8.094
p23	14633944.7	14901953.7	11234322.5	386	651	459.396	534.588	-69.192
p24	27145160.9	27736228.1	23787416.2	386	984	661.272	839.346	-170.074
p25	23870437.7	22810946.7	21679671.6	386	881	622.452	841.138	-212.686
p26	7586417.2	3,693,604.6	3489184.8	379	517	808.758	581.32	227.438
p27	9647331.9	9200343.39	8666747.0	134	173	988.266	1183.71	-179.448
p28	20485150	21386426.9	20034733	134	258	743.08	904.486	-159.406
p29	15032981.2	10208419	12759903.5	495	599	681.936	230.484	451.452
p30	12963314.4	11291071.2	11,613,332	582	617	717.564	720.324	-2.76

Appendix 5- List of selected Public Construction Building projects with project IDs

project ID	Public Construction Building Projects
p1	Tsegede Primary Hospital
p2	Atsbi Wenberta Hospital
p3	Edaga Arbi Expansion Hospital
p4	Asgede Tsnbla Hospital
p5	Welkayt Adi Remets Hospital
p6	Tahtay Maychew Mebaetawi Hospital
p7	SaesieTsaedaenba Hospital
p8	Medebay Zana Selekleka Hospital
p9	Hntalo Wejerat Hospital
p10	Abi Adi Administration building
p11	Adigrat Administration building
p12	Abi Adi prison building
p13	Ofla Administration building
p14	Tanqa Abergele Administration building
p15	Hntalo wejrat secondary School
p16	Asgede Tsnbla Techniquen moyan meselteni
p17	Kola Tenben Administration building
p18	Tahtaty Machew Administration building
p19	Naeder Adet Technichn.Moyan
p20	Shre Endaslase Edaga Enssat
p21	Mdre Genet Mehebhebi Aregawiyan
p22	Humera Ranch
p23	Bora Secondary School
p24	Maycadra Secondary School
p25	Adi Awala Secondary School
p26	Shre Police Collage

p27	Korarit Elementary School
p28	Korarit Secondary chool
p29	Atsbi Adminstration building
p30	Qafta humera kum Hntsa