



**STUDY ON PRICE ESTIMATING METHOD IN SELECTED ETHIOPIA  
ROAD ADMINISTRATION CONSTRUCTION PROJECTS**

**MSc. THESIS IN**

**CONSTRUCTION TECHNOLOGY AND MANAGEMENT**

**BY**

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## **ABBREVIATIONS**

ANN	Artificial Neural Network
CMS	Construction Method Statement
ERA	Ethiopian Road Administration
GDP	Gross Domestic Product
HCSS	Heavy Construction Systems
RF	Random Forest
ROW	Right of Way
SVM	Support Vector Machine
WBS	Work Breakdown Structure

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## Abstract

Road construction is a major sector for national income growth and generates employment within a country. Accurate road construction project price estimation solves the project finance problem for country by providing efficient resource allocation. Hence, identification and analysis of price estimation accuracy is important for successful project completion. Accordingly, this research attempts to identify the major shortcoming and limitation during price estimation, factors leading to price estimation inaccuracy road construction sector, computer price estimation software used for price estimation; which can serve as the way to provide structured approach for price estimation stakeholder. Literature review and desk study were done to investigate price estimation method in road construction projects. The questionnaire survey was conducted with stakeholders from contractors, client and consultants. The questionnaire include total of fourteen major factor affecting price estimation process. In addition, other questions which enable to achieve the objectives of the research were developed. The result of the desk study indicated that out of ten investigated road construction projects eight projects encounter price variance. All projects have encountered project delay. There is lack of database technique and advanced price estimating method like ANN and 74% of respondent indicates existence of price estimation inaccuracy. The survey result of respondent indicates project size, project location, market condition and external event are major factor affecting price estimation accuracy. In order to improve price estimation accuracy data availability and documentation should be improved; identify each factor affecting price estimation accuracy and document it; implement advanced computer price estimating software. In addition, use specialized group for each road work and finally check estimate with independent estimator.

**Keywords:** Accuracy, Computer program, Price estimation, ERA, Method

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## CHAPTER ONE

### INTRODUCTION

#### 1.1. Background to the Research

The construction industry's GDP contribution in Ethiopia has increased to 5.6%, approaching the average of 6% for sub-Saharan countries. Apart from its national contribution the industry ranks sixth in terms of important contributions to the country infrastructure development next to Nigeria, South Africa, Egypt, Morocco and Algeria (Ayalew, et. al 2016). Construction industry GDP contribution in Ethiopia and sub-Saharan countries was 7.95% and 8.3% respectively (<https://tradingeconomics.com/ethiopia/gdp-from-construction>). Even if road construction requires big investment, it benefit society based on a price–benefit analysis in the case of road projects or purely based on financial considerations in the case of private projects (Yadessa, 2015). So, it is important to estimate price of road construction project accurately to get high amount of GDP contribution. Price estimation is the process of forecasting the price of the resources used in construction project to determine overall price of project (Fanny, 2018). Price estimation can be conceptual or detail estimation. Conceptual price estimation is a greatly experience-based process that involves the assessment of several multifaceted relationships of price-influencing factors. Detailed price estimation requires close attention to detail. The ability to pay attention to details and simultaneously see the bigger picture of how construction items interface that is the connection between construction details, specifications and actual construction processes benefits those who prepare price estimates particularly for processes that aren't usually illustrated and detailed in construction documents like excavation and drainage work items (Danit, 2015). Although there are numerous approaches to price estimating, they all require determining the project's or operation's scope, divide it into smaller components, calculate the estimated price of each component, sum the total price of all the components to get the estimated overall price and then figure in a contingency (Tijanac, et. al, 2020).

The research attempts to identify the major shortcoming and limitation during price estimation, evaluates factor affecting price estimation process, asses computer-based price estimating software used for price estimation and suggests well-structured approach to improve the existing price estimating method in contracting parties.

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## 1.2. Statement of the Problem

The road construction industry in Africa still struggles with issues like lack of professionalism, employment prospects and poor performance in terms of price, schedule and quality. In Ethiopia, schedule slippage varies from 61–80%, while planned prices and other factors like risk, quality, resource utilization and safety deviate from predetermined requirements or initial expectations by 21–40% as a result of inaccurate price estimation (Ayalew, et. al.,2016).

According to Jennifer, (2009) and Thillai, (2013) cited in Holm, et. al., (2012) an academic study on 24 projects showed that 80% of the projects were experiencing cost overrun in Ethiopia that means more than 80% of the construction projects are run over budget and delayed. For road infrastructure projects the minimum, maximum and average cost overruns were found to be 1%, 61%, and 18% respectively and also the minimum, maximum and average schedule delay recorded were 3%, 312% & 110% respectively (Melaku, et. al, 2021).

Wakjira, T (2011) found that the price estimating method in local road construction industry varies greatly and it requires standardization and proper database. This shows that the estimating practice itself is contributory to the problem of cost overrun. Moreover, according to the findings of Abebe & Girmay (2003), in road projects there has been a financial claim reaching up to 300% of the project price. They also observed that the project's completion is well behind schedule. The data on Ethiopian road project completed in the past 5 years also showed that there was cost overrun and project delay. These academics study on road projects indicate that among other issues cost overrun is one of the issues related to financial claims. In addition, it also indicates that poor construction and price estimation techniques had a negative influence on both the growth of the local road construction sector and country economy. It is clear that one of the causes for cost overrun and project delay in road construction project is inaccurate price estimation.

The above problem has been identified through preliminary literature review and data gathering, which has led to the formulation of the research hypothesis that states there is a weakness in the price estimation of highway projects with some shortcomings, such as being conventional, outdated, slow and uncertain.

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## **1.3. Objectives of the Study**

### **1.3.1. General objectives**

The general objective of the study was to study on price estimating method in Ethiopian federal road construction projects. It has been carried out through detail study on selected Ethiopian federal road construction projects and identifies factors that are considered during price estimation method.

### **1.3.2. Specific Objectives**

The research has the following specific objectives:

- To assess the major shortcomings and limitations of the price estimating method used on road construction projects in Ethiopia.
- To identify factors that have impact on the accuracy of price estimating and evaluate agreement between different project stakeholder on ranking those factors on road construction projects in Ethiopia.
- To assess the level of computer-based price estimating software usage on road construction projects in Ethiopia.
- To recommend contracting companies i.e., client, contractor and consultant with a structured approach to minimize the problems that occur due to improper price estimating method.

## **1.4. Research questions**

- 1) What are major shortcomings and limitations of price estimating method in Ethiopia road projects?
- 2) What are the factors affecting price estimation method on road construction in Ethiopia federal road projects?
- 3) What types of computer software were used for price estimation method on road construction in Ethiopia federal road projects?
- 4) What are ways to minimize price estimation inaccuracy on road construction in Ethiopia federal road projects?

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## **1.5. Significance of the research**

The problem of inaccurate price estimating technique due to the use of inadequate information and improper system mainly results in cost overrun, poor quality, stakeholder dissatisfaction as well as project delays. Previous studies show that most of the road construction projects in Ethiopia encounter considerable delays, cost overruns and quality related issues. Therefore, paying close attention to the methods and process of price estimation will be crucial to completing a project on schedule, within budget and with the desired level of quality. Price estimation should perform in detail in order to achieve the main objective of road construction projects. In addition to that the findings of the research will benefit industry stakeholder, researchers and scholars. It may also act as a reference to those interested in this area or other related topics for further research.

## **1.6. Research scope and limitation**

The research was limited to the evaluation of price estimating method of road construction in Ethiopian federal road projects. It was also limited to project types cover a range from gravel road construction to road upgrading, such as asphalt concrete. Thus, the researcher believes that these projects are well organized for carrying out research in evaluating price estimating method. Therefore, the research was focused on evaluating price estimating process with the aim of identifying the shortcomings, factor affecting price estimation and provides structured approach to the current price estimating method.

## **1.7. Overview of the Research Process and Study**

This thesis is organized in five chapters with the following brief description about each chapter:

Chapter I: This chapter provides a concise overview of the research including its scope, limitations, significance, reasons for conducting the research and the primary goal that motivated its development.

Chapter II: The definition of price estimate, type of price estimate, price estimating method, road construction price estimating process, accuracy of price estimate, factor affecting price estimation, problem resulting from inaccurate price estimation and computer aid price estimating method are briefly discussed in the literature review section that goes into detail about the road construction industry.

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Chapter III: The research methodology covers research strategy, research design, data analysis and research paper writing.

Chapter IV: The discussion and analysis of price estimate techniques used in Ethiopia's road construction industry are included in this chapter. It also provides an overview of the factors influencing price estimation practice, the type of price estimating techniques and the price estimating software employed in federal road projects in Ethiopia.

Chapter V: This section focuses mostly on the research's final product which includes recommendations and conclusions drawn from the discussion and analysis sections. This section provides way to improve price estimation accuracy for clients, consultants and contractors.

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1. General**

Mohamed & Moselhi (2022) indicate that even though construction industry provide job for almost 7% of the world's working population only 2.5% of construction firms complete all their projects successfully without delays and/or cost overruns. Wubishet (2004) in his work indicated that the construction industry accounts even for more than 50% of the capital budget in developing countries. According to Wubishet (2004), for instance, in Ethiopia (1997/98 to 2001/02), the capital budget was made up of 58.2% for the construction and also the capital budget for construction is 68.4% in 2023. It should be highlighted that the industry in both situations needs to be grown because it pays for a sizable amount of government capital expenditures. Therefore, to achieve successful road construction the price estimation process is a major part of construction projects because price is one of main criteria for decision making at early phase of construction process. So, price estimation is particular interest to all project participants. However, calculating construction prices is difficult because of inconsistencies that result from a lack of information and data during the conceptual stage of construction projects (Tijanic, et.al, 2020). In order to reduce those challenges, the work packages must be assigned and the price must be tracked throughout the project (Hunter, 2014).

A correct price estimate ensures project success in design-consultancy firms; erroneous estimates will lead to project failure. In addition to having an impact on the current project the failure could force the associated company out of business (Tadesse & Dinku, 2017). In addition to that Yadessa, (2015) indicate that unreliable project price estimates cause serious issues with the planning, budgeting and programming processes which in turn affects the final budgetary decisions and efficient use of funds. As a result, one of the key elements of a successful construction project is an accurate price estimate. Although estimating is crucial for construction projects, it is not an easy or uncomplicated operation. This study therefore set out to evaluate price estimation method for selected road projects in the Ethiopian construction industry.

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## 2.2. Definition and Purpose of price estimate

Cost estimating has been defined in different ways by different researchers. Hatamleh, et. al (2018) defined it as the predictive process of quantifying the financial resources depending upon the scope of investment to establish the project budget. Cost estimation is a process of predicting the total cost of construction project such as materials, labor, equipment, permits, and contingencies. It is an essential part of project planning and budgeting, as it helps to ensure that projects are completed on time and within budget (Alumbugu, et. al 2014). Price estimation is process of estimating total price of project including profit margin to estimated cost. It is a tool used to make informed decisions about construction projects. By accurately estimating the price of a project, decision-makers can compare different options and choose the most price-effective solution (Othman, 2016). The estimated project price enables decision-making regarding project completion or termination as well as tracking the development of the project. Therefore, project price estimation is essential to project success. Otherwise, inaccurate price estimation causes the project to run behind schedule. Additionally, Bademosi, et. al (2018) state that Project managers can identify appropriate options and avoid making poor judgments about technical and financial solutions by using accurate price estimating. Nonetheless, price estimation is a projection of the total price of a construction project. Price estimates are used to evaluate projects, determine project feasibility, evaluate concepts, and approve preliminary budgets (Birhanu, et.al.,2024).

Fanny (2018), explains the objective of price estimating is to develop estimates and measurement of prices needed to complete project tasks and activities. In addition to that Alumbugu., et. al (2014) outlines the purpose of a price estimate to:

- provide an estimate of the capital price of a certain project.
- provide fundamental data including labor, material and equipment needs, required for the creation of a schedule such as resources, tasks and durations.
- provide the financial data required to create cash flow curves.
- provide a substantial amount of relevant project information in a straightforward document.
- specify the extent of the work and the projected price involved so that planning and control may be established.

Furthermore, according to Serbanoiu, et. al, (2000) the goal of price estimating is to ascertain the projected expenses necessary to finish a project in compliance with the contractual plans and

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requirements as well as to produce an accurate and economical estimate of project prices. The estimation of cost is the basic component of all project-related engineering fields, which greatly affects planning, bidding, design and implementation (Birhanu, et.al.,2024).

### **2.3. Precondition for preparation of road construction price estimation**

Price estimating in road construction requires preparation to achieve accurate price estimates and thus the following are requirement for price estimating based on reviewed literature.

#### **a) Planning**

According to Dagostino & Peterson, (2011) cited in Danit (2015) planning for the preparation of price estimating method in road construction is an important aspect of project management. Since the preparation of an estimate is performed by many parties, all parties involved in road construction must have input regarding when specific commodities are needed and must be aware of the relationships between the relevant parties. As a result, one of the first things that has to be done while establishing the estimate is assembling the members of the estimate team to create the overall estimate schedule. The details of how to accomplish the project's objectives within the restrictions are assembled in the project planning process (Danit 2015). Common estimating and scheduling techniques will lay out just how much work the project entails, who will do the work, when it will be accomplished and how much it will price. The detailed strategy laid out in the plan becomes a reality check for the price-schedule-quality equilibrium developed during project definition.

#### **b) Construction method statement**

The way and when is to be completed are specified in a method statement and a construction schedule, respectively. A method statement usefulness or success depends on one's capacity to recognize and specify the job that must be done. Any possible hazards or dangers associated with the pertinent project component should be described in the method statement along with the precautions that will be taken to lower those risks and manage the work safely. It should also list the main risks to safety and explain how they will be mitigated (Clough,2000). Construction method statement helped in identifying potential risks and minimizing the impacts of unforeseen events on the project's price. Construction method statement also helped in improving communication and coordination among various stakeholders which led to more accurate price estimate (Project management institute,2000).

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## **c) Work Breakdown Structure**

A work breakdown structure (WBS) is a result-oriented grouping of project works that arranges and defines the overall scope of the project. It is frequently employed to create or validate a shared understanding of the project scope. Every level that descends signifies a comprehensive explanation of the project's outputs (Project Management Institute, 2000).

According to Flanagan & Jewell, (2018) WBS can be viewed from specialty and general contractor that projects are broken down with bid packages handled either by the general contractor with directly employed labor or by specialty contractors. The specialist contractor may charge for labor only or labor and materials. A supply with a set price or a supply-only service is provided by certain specialist suppliers. In general, work breakdown structures are a great way to identify which processes require pricing and they may also be used as the basis for the resource and time scheduling in the method statement.

According to Clough, et. al. (2000) construction work breakdown structure consist of five steps:

1. A determination of the general approach to the project.
2. Dividing the project into tasks or activities that need to be completed.
3. Determining the order in which certain activities are performed.
4. Graphic presentation of this planning information in the form of a network.
5. Support from the project group.

## **d) Type of road construction price**

Based on USA Department of energy, (2011) cited in Danit (2015) each construction task requires unit price so unit price is developed to increase the accuracy of the estimating process. According to Flanagan, (2018) unit price is a calculation of price items in one particular quantity and quality. Construction prices, design or planning prices, land acquisition and damage prices, construction supervision prices and geo technical investigation prices can all be computed based on unit prices. Direct price, indirect price and contingency are typically considered basic price aspects.

### **i. Direct price**

Serbanoiu, et. al, (2000) stated direct prices are those prices that can be attributed to a single task of construction work. These prices are usually associated with a construction work crew that performs a task using specific equipment and materials or subcontracted work and according to Dagostino & Peterson, (2011) cited in Danit (2015) direct price includes labor, equipment and

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material price. According to ERA specification project price element includes site clearance, drainage, earthwork, sub base and base course and also ancillary improvements.

### **ii. Indirect price**

Serbanoiu, et. al, (2000) also stated that Indirect prices are those prices that cannot be attributed to a single task of construction work. It is not an element of the actual construction work but it is incurred by the contractor for support of the work. According to Dagostino & Peterson, (2011) cited in Danit (2015) Indirect prices include home office and field office indirect prices.

### **iii. Contingency**

It is customary to add a markup to a project's construction price to account for uncertainties in quantity and unit price as well as small risk events that frequently arise during construction. (WSDOT, 2015). The different interests of project participants increase the complexity and dynamics of risk in construction projects. Risk exposure affects important project goals in terms of price, time and quality. So, it must be managed and minimized (Agyekum-Mensah, 2019).

Moreover, the primary objective of contingency and allowance is to mitigate unanticipated risks that may arise during the construction or maintenance phase. Generally, the contingency appears in a project during the construction phases and traditionally 10% to 15% of the project price is set aside for contingencies. A more realistic approach to managing the contingency during the construction or maintenance phase of the project would be possible if a mathematical model could be created to estimate the contingency price (Shrestha, 2016). In general contingency can be set by expert judgment, some percentage of whole project price, risk analysis and regression analysis.

## **2.4. Type of price estimating**

It is known in relevant literature that there is different type of price estimating based on project development level, function and level of accuracy.

### **2.4.1. Type of price estimating based on project development level**

It's very important that projects follow a thoughtful and clear process when developing project price estimates. There may be differences in the estimating inputs, methods, strategies and tools needed for each phase of the estimate. By its very nature price estimation tasks necessitate the use of sound judgment from inception to conclusion (WSDOT, 2015).

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In relevant literature on road infrastructure price estimation type are divided into four phases of project development level as discussed below:

### **i. Planning**

Planning estimates are used to estimate the funding required for projects and to prioritize highway projects. These estimates are made with few details about the project definition (Shihunegn, 2014). This estimate is typically prepared before beginning the design process and it is used to develop a proposed project budget based on historical data from similar projects. This initial price estimate is rough providing the client with only a general indication of the project budget (Dandan, et. al, 2020). According to Yadessa, (2015), the general results of resource planning serve as important information for price estimation. Project operations are broken down to the number of resources required at certain unit rates. These resources consist of equipment capabilities, personnel skills and material capabilities or quality.

Many researches on the study area also indicate that at the planning stages price estimation is generally based on expert judgment, industry standards and historical data. Consequently, when there is little information accessible on the project this technique is frequently erroneous and untrustworthy.

### **ii. Scoping**

Scoping estimates are important because they represent the baseline that the uses to set budget and they are compared against all future estimates. All changes, assumption and data source should be clearly documented; estimate should be careful about inaccurate information; right unit price should be chosen and its change due to inflation should be considered (Shihunegn, 2014). Estimates benefit from conceptual plans, sketches, schematic drawings, sections, elevations and early specifications for work that are based on a more precise scope of the project. Since there are frequently few data available, the estimator must rely on a variety of synthetic and parametric methodologies to create price estimates. Using a customized checklist to ensure the completeness of price estimate items was identified as a significant factor affecting price estimate accuracy (Dandan, et. al, 2020).

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## **iii. Design**

According to Dandan, et. al, (2020) during design stage, the scope and design are finalized and final materials are selected. Based on the available detailed design documents, the detailed design estimate offers a better level of accuracy. Changes in the project timeline and phasing the requirements were the main element influencing the accuracy of the price estimate during project design stage. Examine how the project's expected completion price has changed in comparison to the present budget by using design estimates produced at various design stages, such as geometric review, general plan review and preliminary contract review. Clearly document each of these updates in relation to previous quotes and include that documentation in the price estimation file and also the engineer's final estimate must be submitted with supporting documentation in the design document summary (Shihunegn, 2014).

Washington state department of Transportation, (2015) enumerate during design project development phase review risks identified earlier in the project development process and update the Risk Management Plan to reflect the current design phase and risks and configuration of project is known during design approval. This will solidify many items in the scope such as Right of Way needs, likely permit conditions, environmental mitigation and quantities of major items and outside stakeholders. As scope definition improves, the accuracy of the estimate will likewise improve (Shihunegn, 2014).

Several researchers have indicated that at the design stages price estimating is more detailed and accurate as more information becomes available about the project. However, price estimating practices at this stage still face several challenges, such as the lack of integration between design and price estimating, insufficient attention to risk management and the tendency to underestimate prices.

## **iv. Plans, Specifications, and Estimate**

According to Dandan, et. al, (2020) the project data used at this phase shall be identical to the project data provided to potential bidders.

Concerns at this level of estimate should include:

- The key quantities and price drivers should be investigated and accurately estimated.

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- Reviewing scope and price estimates for specialty groups.
- The effects of the Contract Special Provisions on prices and schedule should be considered.

Beside the above literature, problems still exist during implementation of above strategies due to lack of skill and experience. So, to address these problems several solutions have been proposed. These include the use of parametric and probabilistic price estimating techniques, the integration of price estimating with project management processes and the adoption of risk management practices. Furthermore, as the estimation is utilized to assess contractor bid amounts and request construction funds, it should be thoroughly examined. Thus, its premise needs to be independently confirmed (Shihunegn, 2014).

Price estimate perform at different project development level and when percentage of design completion increase accuracy of estimate will increase due to availability of information about project. The design completion percentage increases progressively throughout project development stage as shown in figure 2.1. The minimum and maximum percentage of design completion that have effect on price estimation process vary across various project development stages in road construction. Planning has the least design completion ranging from a minimum of 0% to a maximum of 10%. Design completion increases steadily throughout project progress. Scoping has minimum of 10% to maximum of 30% design completion. During design stage percent of design completed was minimum of 30% to maximum of 90%. This showed most of the project design is performed at design project development level. The percent of design complete at plan, specification and estimate is minimum of 90% to maximum of 100%. This shows that while some design work occurs early in the project the majority of the design occurs in the later stages.

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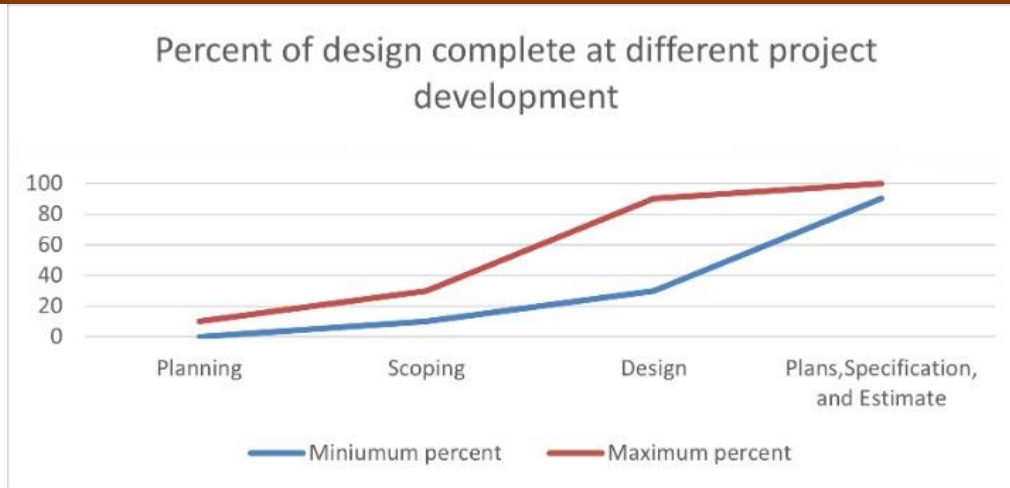


Figure 2.1 Percent of design complete at different project development level stage

(Source: WSDOT, 2015)

The overall success of a project generally depends on accurate price estimating method at various project development levels. Project managers should take into account a variety of price factors and use cutting-edge methods and digital tools to improve the accuracy and speed of the price estimating process.

### 2.4.2. Type of Price estimating based on function

In addition to the many types of price estimates at different stages of a project, price estimates can be classified into three major categories according to their functions that are design, bid and control estimate.

#### i. Design estimate

Design estimate is early stage estimate with projection of price of project at design phase and it serve as foundation for financial support decision and price control but it is vulnerable to inaccuracy because they are frequently prepared within a narrow time frame and often devoid of finalized project scope (Alumbugu, et. al 2014). Bademosi, et, al (2019) confirmed that in the early stages of a road project a design estimate serves as a guide for the most likely price of construction. And following design, there are two crucial phases that must be completed: quantity takeoff and pricing of the resources needed to finish the project. These are difficult and time-consuming processes that require a lot of data.

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According to Molla A. (2021) The process of a design team meeting frequency and the process of written reporting of design phase progress were found to be statistically significant in reducing design phase costs. If not, it was discovered that employing project management training and having an organizational structure centered on project management were statistically significant ways to reduce expenses associated with the design phase.

### **ii. Bid estimate**

According to Manfredonia, et al. (2016) cited in Danit (2015) it estimates the potential prices of preparing and bidding for a contract with the client. These price estimates are used for subcontractor bid evaluation and change orders throughout the construction process. If the tender documents are prepared, a comprehensive statement detailing the scope of the estimate, assumptions, tolerances and reference documents used in the estimate and contingent amounts should be prepared.

Dandan, et. al, (2020) state that in the final design stage, a bid phase price estimate is created to support the development and submission of bids for the client contract as well as the assessment of contractor bids and change orders during the building phase. At this stage, the design is 100% complete and price estimates are most accurate. Bid estimate often reflects the desire of the contractor to secure the job as well as the estimating tools at its disposal. In most bidding, the lowest bidder will win the contract therefore any effort made to estimate prices will be lost by the bidder who does not win (Othman, 2016).

### **iii. Control estimate**

It is the estimate at construction and operation stage that is based on more accurate information such as detail project plans, schedule and actual price data from similar project. However, problem exists at this stage such as lack of integration between design and construction poor project management and insufficient risk management (Dandan, et. al, 2020). A control estimate is created using the facts at hand to monitor the project throughout construction: Both the client and the contractor must adopt some base line for price control during the construction. For the owner, a budget estimate must be adopted early enough for planning long term financing of the facility (Alumbugu, et. al, 2014).

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### **2.4.3. Type of Price estimating based on level of accuracy**

Price estimation can be conceptual or detail at various stage of construction based on accuracy, speed of completion and amount of project information.

#### **i. Conceptual estimate**

The conceptual price estimation of highway construction uses known data at early stage of a project. It only relies on the high-level project features and it does not require detailed information about the project such as the items quantities (Mohamed & Moselhi,2022). In addition, it is important to attain future good price estimation and improve project model (Meharie, et. al, 2019). Beside the above literature Bademosi, et. al. (2019) also state that conceptual estimate is used to finalize price of project before the graphic representation is fully created even though there is lack of complete design and construction documents.

Elmousalami, (2019) discussed that conceptual price estimate should perform at 0%–2% of the construction project execution. Even though conceptual estimate is with minimum information, it is crucial to asses' alternative projects in feasibility study. At this stage, the estimated accuracy is between  $\pm 25\%$  and  $\pm 50\%$  due to less defined project details (Ibrahim, 2013).

Furthermore, Serbanoiu, et. al, (2000) identified reason for the occurrence of less accuracy during conceptual price estimation. Firstly, planning takes place in the early phases of a project, when there is a lack of information and a great deal of unknown elements influencing the project's price. Secondly, it is regarded as an activity with the limited resources due to limited available of time and money to prepare an estimate. This is because there wasn't enough time or money to prepare an estimate. Establishing a more realistic and accurate cost estimate for a certain project at its preliminary phase is one of the most difficult tasks. Because preparation of preliminary cost estimation must be done before the detail design of the project is completed as there exist lack of detail information, high complexity, and uncertainty, therefore, it is required to have a systematic way of exploring the cost-estimate accuracy factors which can be used for preliminary cost estimation of construction projects (Meharie, et.al 2019).

The level of detail in decomposing the facility into tasks depends on the type of price estimate to be prepared. Conceptual estimation involves less detailed breakdown of task. A preliminary

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estimate is made on the basis of the layout of the selected bridge form on the basis of the preliminary or conceptual design (Othman, 2016).

### **ii. Detail estimate**

Detailed estimates are prepared from clear and fully developed design and construction documents. It has been believed to be accurate as they have been prepared based on available information derived from complete construction documentation and subcontractor price quotes (Bademosi, et. al., 2019).

According to Dandan, et. al, (2020) error percentage is 20 and 5 % for conceptual and design estimate respectively. For detailed estimates, the level of detail of quantity is very high. A thorough estimate is prepared based on the well-defined project scope once the detailed design has advanced to the point where all pertinent details are known. Since the detailed estimate is available for earlier than the engineer's estimate and sufficiently definitive to reflect the project scope, it is frequently chosen as the budget estimate (Othman, 2016).

Detail estimate are frequently used for bidding, change orders, permits and approvals (Sabol 2008). Each task is logically and methodically broken down during the creation of a comprehensive estimate. The price of each task is then calculated based on past performance or data from a database and combined to estimate the project's overall price (Butcher and Demmers, 2003).

### **2.5. Price estimating Methods**

Price estimation is one piece of information that will influence client decision to engage on project. Therefore, it is important to properly prepare these estimates to avoid incorrect estimates that can lead to improper project starts. In the past years a number of techniques such as parametric, bottom-up and analogous estimation have evolved for creating construction price estimates. The methods chosen for creating a price estimate are determined by a number of factors, including the amount of time and information at hand. Therefore, the degree of knowledge and the amount of time available to produce it define the accuracy of estimation (Mahamid & Bruland, 2010). Price estimating methods can be performed by manual or computer to ensure accuracy of estimation. Depending on project scope, estimate purpose and availability of price estimating resource there are many types of prices estimating methods.

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## **i. Parametric price estimation**

It is an approach of estimating the value of a project primarily based on one or more project-based price factors. Historical bid statistics is regularly used to define parameters related to the price of road infrastructure facilities, such as price per lane mile, price per interchange or price per square foot. Additionally, based on historical price data, percentages can be utilized to determine the worth of endeavor aspects (WSDOT, 2015).

According to Flanagan, et.al. (2018) the purpose of parametric estimation techniques is to support planning or estimation development during the early scoping phase when minimal project information is available. To calculate the price of different items of construction, like center lane miles or square feet of bridge deck area, historical data and other project factors are compared using statistical relationships, non-statistical ratios, or both.

USA Department of Energy, (2011) list advantage and disadvantage of the price estimate as follow:

Advantages of parametric estimating methods include:

- Versatility: when data are available, parametric relationships can be derived even during design changes.
- Sensitivity: simply varying input parameters will produce a sensitivity analysis.
- Statistical output: the information can be used to supply a self-assurance stage.

Disadvantages of parametric estimating methods include:

- Database requirements: it is time consuming to collect and normalize data correctly.
- Currency: amount of currency required to be updated periodically.
- Complexity: it is difficult to recognize relationship between price and its independent variables.

## **ii. Analogous price estimation**

Analogous estimation methods rely on analogy with similar past projects to estimate price of the current project during its early stages. This is done via combining historical information and expert judgment by the project manager. It may also rely on bids for similar project rather than just historical data. However, this method is questionable, as it assumes a linear relationship between the project price and its basic design variables such as the location, size, type and capacity of the

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structural components (Mohamed & Moselhi, 2022). Makovsek (2014) states that common feature of those methods is the inclusion of a contingency for unplanned events or risk. In this instance, the contingency is chosen either subjectively or based on prior project experiences and anticipated project unpredictability. Older project data is less trustworthy because of differences in prices, standards, and technology and labor practices. This technique is most effective when used to establish general pricing ranges for easy-to-understand projects or as a means of verifying prices determined through the use of another technique (Shihunegn, 2014).

### **iii. Bottom-up price estimation**

Bottom-up price estimates methods are typically the most definitive of the estimating methods and it use information down to the lowest level of detail available. The accuracy of bottom-up price estimation techniques depends on the accuracy of available information, assets spent to improve the price estimate and the validity of the bases of the estimate. set of drawings or specification may additionally be used to get more accurate data. Additionally, the work breakdown structure, crew input and the work announcement may be used to discover work flow in project (Flanagan, 2018).

According to USA Department of Energy, (2011) Bottom-up price estimating method have the following advantage and disadvantage.

Advantages of using Bottom-up price estimating methods include:

- A greater level of confidence;
- More information that can be utilized for more manipulation;
- Expanded definition of particular activities and their extent;
- Detailed amounts to create measurements that are more accurate; and
- Better resource basis for the schedule.

Disadvantages of using Bottom-up price estimating methods include:

- It can be time-consuming and requires significant number of resources.
- It can be less accurate for project with high level of uncertainty or complexity.

### **iv. Three-point price estimation**

It uses best-case estimate, most likely estimate and worst-case estimate to determine range for an activity (Yadessa, 2015). One of the advantages of three-point price estimating is that it accounts

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for the uncertainty associated with each component of a project. An estimate of the estimated price that is more reasonable can be obtained by estimating the worst-case, most likely and best-case situations. Its ability to provide a variety of estimations is an additional benefit. Its disadvantage is that it is more time consuming than other methods (Flanagan, 2018).

### **v. Risk based price estimation**

Washington state department of Transportation, (2015) stated Risk-based estimating makes use of historic records and/or price-based estimating methods and an expert's fantastic judgment to advance the mission. It consists of intricate probabilistic analyses that pinpoint possibilities and risks related to project expenses, timelines and events (Dinku & Tadesse, 2017).

According to Flanagan & jewell, (2018) contingency price estimating method can be classified as:

**i) Traditional percentage:** These represent a project-wide percentage to the base estimate based on the estimator's expertise and experience as well as historical data.

**ii) Expected value:** individual risk occurrence has an expected value that is:  $\text{impact} \times \text{probability}$  of occurrence, that need to be calculated.

**iii) Monte Carlo simulation:** It involves building a probabilistic model of the undertaking and estimating the likelihood of different outcomes using random sampling.

Furthermore, this estimation method combines all other estimation methods and risk analysis techniques attempt to quantify the uncertainty in construction price estimates. This method establishes upper bounds on the total project expenses and specifies the distribution of contingent liabilities among essential project components (Danit, 2015).

### **vi. Artificial Neural Networks (ANN)**

Artificial Neural Networks have gained popularity in multiple fields due to their superiority compared to other AI techniques for many reasons. One of the main reasons is it can process massive volumes of complex non-linear data quickly and accurately in real time, while avoiding assumptions like linearity and normality. This makes it an excellent fit for the construction data that is gathered from the project. Even in cases when the causal linkages are unclear, it can achieve excellent predicted accuracy by identifying complex associations and patterns. It can also handle small datasets with independent features successfully (Mohamed & Moselhi, 2022).

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The neural network model consists of three basic layers which are connected between successive layers. The three layers include input nodes, hidden nodes and output nodes. The data sent to the network is accepted by the input nodes. The output nodes generate the network results, while the hidden nodes internally evaluate or analyze the relationships in the data. The development and application of such a technique would assist in removing human error from the price estimation procedure (Othman, 2016). According to Dinku & Tadesse (2017) the network learns from the samples by constructing an input-output mapping for the problem at hand and it have a built-in capability to adapt their synaptic weights to changes in the surrounding environment.

The main benefits that occur from using neural networks are easier access, uniformity and storage of data and use of data. In addition to that Othman, (2016) indicate the first advantage for using the neural network is the uniformity of the model along with the ease of access. The second benefit is the capability to store. Finally, the ability to use the knowledge through mathematical tools may produce a constant and reliable answer to price estimation. Cost estimation approaches using neural networks have an advantage over traditional cost estimation techniques using regression because, unlike linear regression (LR), neural networks are able to represent interdependencies between input data, which will almost certainly occur when evaluating factors that affect the construction process (Teferi, et.al. 2021). Despite the above benefit Turochy, et., al (2001) indicates the main problems encountered when using the neural network price estimation mathematical models are the complexity of this initial setup and learning curve.

### **2.6. Road construction price estimating process**

It is the project team task to determine the quality and quantity of price estimates that match with the project type and expected quality so price estimating process is important part of project life cycle (Hatamleh, et. al, 2018). However, regardless of its importance the price estimating process is very cumbersome. Quantification that determines the number of resources required to complete a construction project is also considered the most inefficient part of price estimating (Bademosi, et. al, 2019). Alumbugu p., et. al (2014) recommended that Clients should always engage the services of skilled professionals to undertake the consultancy services in price estimating process. Several literatures that deal about price estimating indicate following price estimating process:

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## **I. Prepare Base Estimate**

Creating a baseline estimate involves creating estimated prices for all components of the project without future escalation. Depending on the project's size, complexity and degree of scope definition many estimation methods can be used for these components. And also, the number and details of estimated components may vary depending on the stage of project development. Pre-engineering, ROW and construction are all included in the scoping phase price estimate. Some of the estimates will become more detailed as the design progresses (Shihunge, 2014).

According to Serbanoiu, et. al, (2000) price estimation can be performed with these stages:

- i. Examining the construction project's technical design which takes into account the project's size, scope, location and construction time.
- ii. Identification of the elementary construction processes such as excavation, backfill and assembly of reinforcement, etc.
- iii. Defining the specific unit of measurement and determining the quantity for each item.
- iv. Calculating the unit price of the supplies, labor and machinery for the project.
- v. Determination of direct and indirect price.
- vi. Perform risk and uncertainty analysis.

There are several steps in developing price estimate of a project as shown in figure 2.2. The first step is defining the purpose of the estimation. This involves understanding benefit of the project and the level of detail required for estimation. The second step is to develop an estimating plan, which involves determining the structure of the estimate. This includes deciding how the estimate will be broken down and what level of detail will be included in each section. Estimating plan is essential to create accurate estimation as it creates better communication between stakeholders. The next step is defining Project Characteristics that involves understanding exactly what the project requires. Defining project characteristics is essential to create accurate estimation as it provides better scope definition and resource allocation. Once the project characteristics are clearly defined the estimating structure is determined. This involves deciding how the estimate will be broken down. The fifth step is to identify ground rules and assumptions. This involves documenting any background information or specific decisions that will be used throughout the estimating process. The fifth step can improve project decision making and price control. After

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identifying ground rule and assumption data will be obtain and estimation performed. During price estimation specialized software used to improve the accuracy of estimation.

According to USA Department of energy, (2011) base estimate preparation also involves the following stages as shown in Fig 2.2

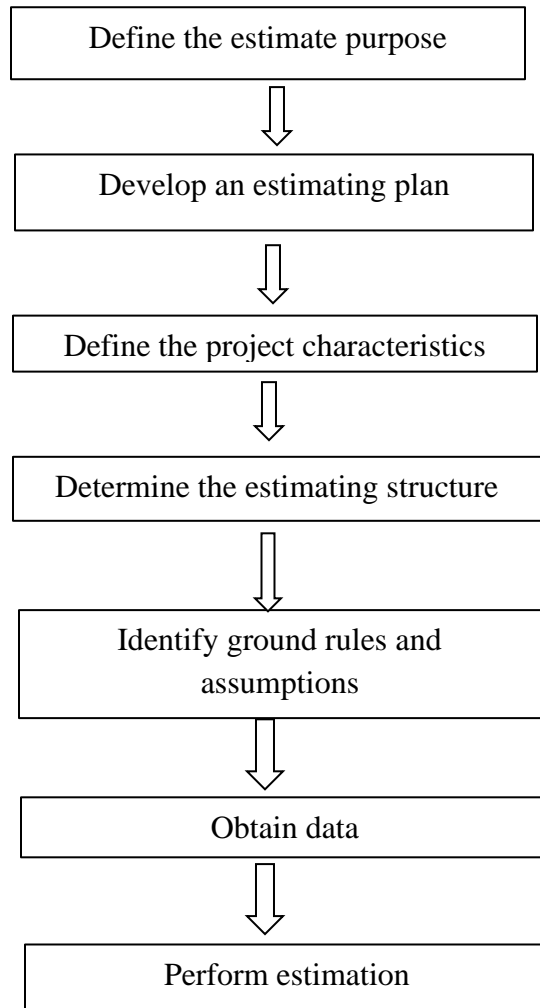


Figure 2.2 Base estimate preparation stages (Source: USA Department of energy,2011)

### II. Review Base Estimate

It involves cross-checking price check, validating the estimate by looking for errors like double counting and omitted prices, comparing the estimate against the independent price estimate and examining where and why there are differences and also comparing results against previous estimates (Hatamlen,2018).

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Washington state department of Transportation, (2015) recommended to apply the following while reviewing base estimate

- When reviewing total estimate use knowledgeable and experienced individuals who are independent from the project.
- Perform reviews at every stage of the project's development.
- Use the tools and documents that have been prepared by others to your advantage.
- Examine estimates from related projects and utilize them as a basis for goods and expenses.
- When creating your estimate use databases and spreadsheets that others have created as templates.
- Ensure that the right technical and human resources are used in the estimation process.

### **III. Document the estimate**

It involves recording each step taken in the estimate development process so that a price analyst who is not familiar with the software may rapidly replicate it and get the same outcome. The estimate goal, the person who approved it, its timeframe, the technical baseline from which it was created, a detailed description of the estimating technique, the outcome of the risk uncertainty and sensitivity analysis are all included in the document (Danit, 2015).

Future estimate assumptions can be eliminated with a well-documented basis of estimate. This document provides an overview of the project's knowledge base. This permits the identification of both knows and unknowns in the estimate. This document is necessary because estimator to complete estimation within short period of time (WSDOT, 2015).

### **IV. Conduct Independent Review of estimated price and Obtain Management Endorsement**

Due to importance of price estimation all estimates should be independently verified, adjusted and revised as necessary to respond to comments from independent auditors. Once sufficient independent review comments have been incorporated the estimation should be submitted to management for approval (Shihunge, 2014). The goal is to ensure that the estimate's important metrics match those of projects that are comparable to it. If there is a significant difference, it must be explicable using the particular examples of the estimated challenge in comparison to the similar completed projects (Peng M., 2006)

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In general, the price estimation process can be divided into multiple parts based on the researched literature. Data must first be acquired from a range of sources including stakeholder input and historical data. The data must be reviewed once it has been gathered in order to spot patterns and possible threats to the project's finances. From this analysis estimates that account for labor, material and overhead expenses may be created. In order to increase accuracy over time project managers should also include a feedback system in the price estimation process.

### **2.7. Accuracy of price estimation and its importance for road construction projects**

Accuracy of price estimate indicates major shortcoming and limitation during estimation. According to Akinradewo, et., al (2020), Accuracy can be defined as having no errors. This can be interpreted to mean that less error means more accuracy. In order to determine whether there is an error, there must be an actual worth which is compared with the inaccurate value. These errors can be made as small as possible but it can still be inaccurate. In other words, an inexact value can be an approximation of an exact value.

Serbanoiu, et. al, (2000) describe the accuracy of the estimate depends on the completeness of the documents provided by the contract and by the experience of an estimator. Agyekum-Mensah (2019) also explains the degree of accuracy is claimed to be a prediction. It means an approximation that provides information for decision-making and guidance. However, he argued that it is considered accurate if it is close enough to or equal to the actual performance.

The accuracy required for construction price estimates varies at different stages of project development level and it can range from approximate figures in the early stages to fairly reliable figures for pre-construction budgeting. Design decisions made early in the project life cycle are more preliminary than decisions made later in the life cycle, so early price estimates can be less accurate. Accurate estimates at early stages are very difficult due to the inadequate or a very little information about the forthcoming of the project, but it is necessary in some cases, i.e., for bidding a project or getting a contract. Accurate cost estimation in early-stage of the project development is an important concern where detailed information does not exist. Road projects typically have a large number of incomplete data sets and little historical cost data accessible in developing nations like Ethiopia. Those difficulties were among the difficulties in accurately estimating costs during pre-feasibility investigations (Teferi, et.al. 2021). In addition to the above determinate accuracy

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can be achieved with regression analysis in the preliminary price estimate for road projects. In general, the accuracy of a price estimate will reflect the information presented at the time of estimation (Shihunegn, 2014). Arif, et. al (2015) indicates various studies have developed evaluation systems for estimates resulting in the development of software to measure the accuracy of estimates. They found that there were four determinants of the accuracy of the initial estimates as stated in the following:

1. Who was involved in formulating the estimate?
2. How the estimate was prepared;
3. What was recognized about the project; and
4. Other factors considered while preparing the estimate.

Preliminary estimates that are inaccurate may result in project cancellations, missed opportunities to secure contractors for next projects, or lower-than-expected revenues, all of which may cause development activity to stand (Akinradewo, et., al, 2020). And also, Fanny (2018) suggest that in order to provide precise estimates, project managers should become experts in a number of estimating-related areas, including communication, being realistic, uncertainty, big-picture thinking and technique.

Accurate price estimates are important for both estimator and customers. They can be used for request of proposal, contract negotiations, scheduling, monitoring and control. In price estimation both under estimation and over estimation have effect. Underestimating prices can lead to management approval of a proposed system that has underdeveloped features, with poor quality and may not be completed on time. Overestimation can result in too many resources being put into a project or a contract not being awarded during a contract tender that leading to job loss (Hatamlen, 2018). Accurate cost estimates are essential for the effective execution of any construction project. Achieving accurate cost estimates requires comprehensive knowledge, comprehensive information, extensive expertise, and continuous improvement (Meharie, et.al 2019).

According to Washington state department of Transportation, (2015) the need to solidify the estimation process can be seen in four areas:

- Financial plan: price estimates are used to obtain and allocate funding for projects.

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- Public trust: to deliver transportation projects in a timely manner and within budget for stakeholder satisfaction.
- Project controls: the baseline project price estimate keep projects within the appropriate fiscal boundaries.
- Project resilience: as projects encounter problems estimates are examined. The quality of the estimate and the documentation provide critical support to project success.

In general, accurate price estimate is important to increase project efficiency, better price control and better project outcomes.

### 2.8. Factors affecting price estimation method of road construction projects

According to Washington state department of Transportation, (2015) factors affecting price estimation method includes project location, method of work, project size, material availability, project size constraint and inflation.

Several reviewed literatures classify factor affecting price estimation in different ways from those Peng, M. (2006) classify it as follow:

- A. Internal Factors:** are elements under the direct control of a project team that can significantly impact the accuracy of price estimates. It also related to project characteristics and execution process and also it includes Project size, Project type, Project duration, Project location, Construction site conditions, Construction methods, Subcontractor-related factors, estimation tools and techniques and price estimator experience.
- B. External Factors:** are elements outside the direct control of a project team that can significantly impact the accuracy of price estimates. It includes Market Conditions i.e., labor, material and equipment price; Regulations and permits such as environmental regulation and permitting process delay; Logistics and Supply Chain like material availability and delivery price; External Events such as political instability and force majeure and also bidding competition.

So, to identify the above factor affecting price estimation Arif, et. al (2015) indicates three step analysis procedures that include:

- Concentrated on determining the price bias from the respondent's data on the actual project expenses. To ascertain whether the data were appropriate for regression analysis the normality of price bias was also evaluated.

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- Conduct an exploratory factor analysis with the goal of determining the factors by examining the correlations between the various sets of data.
- Regression analysis produced a list of the actual significant factors among all the influencing factors that had an impact on the projects' price estimates' accuracy.

Similarly, Meharie, et. al, (2019) perform various factor selection techniques including both statistical and nonstatistical for estimating the preliminary price of projects in the highway construction from that optimal data transformation combined with least angle regression for input variable selection/dimensional reduction as alternative approach for preliminary price estimation.

Zegye, (2019) indicate that Construction price fluctuation has impact on cost estimation. It is changes in price levels of construction input resources driven by underlying economic conditions. The unpredictable high cost of fuel and building supplies has increased the risk associated with construction work contracts for both the employer and the contractor. The primary source of risk is the fluctuation in labor and material costs. Both parties will be exposed to unforeseen risk at different points in the business cycle due to significant cost fluctuations that resulted in either an underestimation or an overestimation of construction expenses.

A study conducted in Ghana by Akinradewo, et. al (2020) on the factors affecting the accuracy of Ghanaian road construction project indicates the following factor have effect price estimation:

**Estimator unprofessional practices:** When estimators make inaccurate volume measurements, equipment/labor productivity inaccuracies coupled with omission errors, road projects will inevitably experience resource fluctuations resulting in price estimation inaccuracy.

**Economic factors:** the project price will be impacted by a greater inflation rate if the road project is projected before the execution phases.

**Project peculiarity factors:** the degree of accuracy is determined by the available project information. This suggests that in order to obtain a precise preliminary estimate for the road project, the project team must take into account all relevant project aspects.

Ibrahim & Elshwadfy (2021) indicate the top 10 factors that affect the accuracy of construction project price estimates such as construction project clear and detailed drawings, specifications and project documentation; experience and skill level of estimators; completeness of price information,

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accuracy, quality and details; prices, availability, quality of material; experience on similar project; accuracy of Bill of quantity; suitability, experience, performance of Management team; Financial capability. Alumbugu, et. al (2014) also states the experience and skill level of the estimator is the factor that most influences the accuracy of the pre-bid price estimate. Birhanu, et.al., (2024) indicate that cost influential parameter of road project include Project location, Length and width of the road, Project type and scope, Contract type, Project delivery method, Number of lanes, Terrain type, Climatic condition, Bridges and culverts, Grade of the contractor, Inflation rate, Contract duration, Numbers of control points. The reviewed literature showed that factor affecting road construction project price estimation vary from project to project and this study aims to identify major factor affecting price estimation process in Ethiopia federal road construction projects.

### **2.9. Problems due to inaccurate price estimation in road construction projects**

Alumbugu, et. al (2014) indicates that the problem of inaccurate price estimates is reflected in many numbers of projects not being completed on time and within budget. Several researchers state the following problem occurs due to inaccurate price estimation.

#### **i. Cost overruns**

Price over-runs in publicly financed projects usually receive a substantial attention of the public in road construction projects. It could be argued that cost overruns have received much more media attention than price under runs. Estimated prices and estimated benefits in construction decisions are important to the investment selection process (Makovsek, 2015).

Site location and type of project affect accuracy of price estimation and Ahady, et, al (2017) presented that the magnitude of the cost overruns vary depending on the size, location and the type of the project and the overruns were reported to be more frequent in large projects than small projects. He also mentioned that the medium sized firms are more prone to cost overruns in comparison to large and small firms as the main reason for this being that they are in the transitional phase and they need to take more risk to get more business and establish them.

Akinradewo, et. al, (2020) indicate Cost overruns of highway projects have impact on program budgeting from the view of the owner. Under estimating a project will lead to under staffing it, under scoping the quality assurance effort and setting too short a schedule. That in turn can lead

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to staff burnout, low quality, loss of credibility as deadlines are missed and ultimately to inefficient development effort that takes longer than nominal.

According to Ahady, et. al., (2017) to mitigate the risk of cost overrun due to inaccurate price estimation in road construction projects and it is essential to:

- Perform a thorough price assessment process that takes into account all variables.
- Apply knowledge gained from previous projects to increase estimate accuracy.
- Make sure the budget has enough contingencies to cover unforeseen circumstances and uncertainties.
- Continuously monitor project prices during execution.

### **ii. Project delays**

Delays in road construction project can be caused by several factors including inaccurate price estimating. When prices are underestimated that lead to funding gaps that will result in project delays. Delay can have significant impact on the project stakeholders including increased prices reduced quality and loss of revenue (Kassa, 2020). Construction delays are often a result of mismanagement and it can be seen as a risk for infrastructure projects, which if identified, analyzed and managed in a systematic process of various phases of the project life cycle could be managed, minimized and mitigated. Delay in construction project has a negative impact to key stakeholders in terms of growth in adversarial relationships, claims, litigation, arbitration and cash-flow challenges which also affect price estimation (Melaku, et, al, 2021).

According to Gadisa & Zhou (2021) cited by Olawale and Sun, 2010, The top five factors impeding effective project time control in descending order are: design modifications; imprecise assessment of project duration and time; intricacy of works; project risk and uncertainty; and subcontractor and nominated supplier underperformance, which impacts the price estimation process and project schedule. Most of the road construction projects in Ethiopia exposed to extreme time and cost overruns. From the investigation it is found that 88% of the road suffered time performance and most of the reason for those project delays is inaccurate price estimation (Kassa, 2020).

### **iii. Project quality**

Another problem associated with improper price estimating is less project quality. Underestimate construction price can lead to sub-standard materials being used or insufficient supervision which

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can compromise the quality of final product. Poor quality can increase maintenance prices and affect the road durability and safety (Mahmaid, 2010). Generally, from the reviewed literature the relationship between project quality and price estimation inaccuracy is tangled. The degree of quality that is wanted for a project can affect accuracy of price estimation. Key instruments for managing this connection and guaranteeing successful project outcomes include effective communication, risk management and continuous monitoring during price estimation.

### **iv. Stakeholder dissatisfaction**

When the actual price of construction exceeds the estimated price stakeholders such as taxpayers and funding agencies can be left with a negative impression of the project. This can lead to a lack of trust in the project's stakeholders and decreased support for future projects. So, improper price estimating can result in stakeholder dissatisfaction (Wakjira, 2011). The client-consultant relationship in Ethiopian construction projects is not smooth due to inadequate Engineer's price estimate submitted for purpose of budget allocation to the project. Mainly variations due to increase of work volume that has impact on budget of the client which result stakeholder dissatisfaction (Bekele,2005).

Wakjira (2011) indicate that problem due to inaccurate price estimation such as cost overrun and project delay can be reduced with:

- The client must set aside a suitable budget that accounts for contingencies in price estimate.
- Planning resources such as labor and equipment should be done in accordance with the scope and milestones of the project.
- Provide a comprehensive design and price estimate in accordance with the owner's specifications.

### **2.10. Computer-Aid price estimation of road construction project**

Computer based software can generate automatic quantities from 3D models as well as producing quantities from 2D systems. Areas, lengths and all the basic measurements can be exported into an estimating system. There is growing take up of digital 3D design and even 4D models that integrate the spatial and temporal aspects of a project to understand, predict, evaluate and manage

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even the most complex projects. The majorities of these IT systems enable advanced pricing techniques like feature-based estimating and support estimation software in addition to supporting project price estimation (Project management institute, 2000).

Even though computer system preferred there are many responsibilities of an estimator which computer systems can't replace such as discussions with sub-contractors, interpretation of ground conditions and high-quality use of resources.

Flanagan & jewell, (2018) indicate the following advantage of computer-based estimation

- To provide the estimator with a set of tools that will allow him to perform more efficiently.
- To give contractors the opportunity to outperform their rivals in the marketplace.
- To manage data electronically speed up data access and generate price summaries.
- To standardize and implement company practices.

So, to get above benefit Akinradewo, et. al, (2020) indicates that spreadsheet, word processor package, database programmed and specialty package are used for price estimating of road construction project. In spite of those benefits disadvantage of using computer-based software tools includes the price of the software can be expensive for small construction companies making it difficult for them to invest in the software. Another disadvantage is the need for regular software updates to ensure that the software remains up to date with the latest industry trends and standards. This regular update can be time consuming and it may require additional expenses.

Serbanoiu, et. al, (2000) also indicate computer software package have several advantages providing electronic records that can be shared, saving on printing and hard-copy storage prices. Some of the packages allow estimates to be created from scheduling tools such as Primavera and MS Project. Construction estimating software is cloud or desktop technology designed to streamline and improve the process of creating detailed price estimates for construction projects. It comes in a variety of forms from straightforward spreadsheet templates to web-based collaboration software with functionalities that enhance much beyond the estimation process. Either open-source software or the free version of a paid alternative can be used to get free estimating software. <https://constructioncoverage.com/estimating-software> (Accessed in Sep, 2023)

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Some benefits of construction estimating software are improved job price estimation; Better accuracy; Consistent estimates; better project management and Improved efficiency. In order to get the above advantage numerous computer aided price estimation software systems are now available. These range in sophistication from simple spreadsheet calculation software to integrated systems involving design and price negotiation over the Internet. Even though there are expenses associated with the purchase, training and computer hardware for this program, significant efficiency is frequently achieved. In particular, price estimates can be prepared more rapidly and with less effort (Turocky, et. al, 2001).

Computer program like excel are limited to basic calculations, formulas and chart; accuracy depend on user expertise and formula and also limited sharing and collaboration features. Construction industry use different type of price estimation software. HCSS offers heavy bid highway and road construction software to help contractors of all sizes in the transportation industry to go paperless, minimize the possibility of price mistakes and increase accuracy. Heavy Bid is designed to develop estimated prices and produce proposals that span across all civil construction industries including highways. Because of Heavy Bid's adaptability estimators specializing in road construction can deconstruct complicated issues into manageable amounts that precisely account for expenses. HCSS can import takeoff data into Heavy Bid in order to swiftly assign prices to asphalt and/or concrete paving bid elements that are frequently encountered in heavy highway construction. It helps to determining and monitoring material prices, making last-minute adjustments to the estimate quickly and efficiently and also decomposing work activities into extremely fine-grained detail without making the estimating process more difficult.<https://www.hcss.com/who-uses-hcss/heavy-highway-road-construction-software/> (Accessed in Sep, 2023)

Heavy Bid by HCSS is an estimating and bidding software for crew-based infrastructure construction. It has been used for estimates in earthwork, underground, highway, pipeline, mining, plants and other heavy construction. <https://softwareconnect.com/estimating/> (Accessed in Sep, 2023)

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PlanSwift utilizes Artificial intelligence to automate the process of measuring quantities and dimensions from digital plans, significantly reducing manual work and errors. It boasts a claimed 92% reduction in takeoff time and improved project price control. Its automated takeoff reduces manual calculation and minimizes errors and prebuilt assemblies ensure consistency to industry standards. In addition, compressive reporting capabilities with detailed breakdowns and analysis; generate proposal and bid document directly from project data is its functions. <https://www.planswift.com/> (Accessed in Sep 2023).

AASHTOWare project estimation utilizes powerful algorithms that account for complex factor like terrain and drainage integrated with pavement design software for precise calculations. Advanced features for detailed price breakdown and scenario analysis integrate with external software for additional functionality and high level of customization for project workflows and reporting prove its customization and flexibility relative to other price estimation software. Its limitation includes higher upfront price and ongoing subscription fees due to advanced features. <https://www.aashtoware.org/products/project/project-estimator/> (Accessed in Sep 2023). In general, from the reviewed literature even if price estimation program like Heavy bid, Stack, plan swift and AASHTOWare require subscription fee they provide more advanced features and functionality than Excel.

Ethiopian road administration use ERAMS for price estimation of road construction projects. ERAMS is used on a computer server at the ERA data center and it can be accessed via a secure website on the Intranet or the Internet. It is available to assist with project and contract management at all levels, from project engineers responsible for individual contracts to senior management reporting to the General Manager. Centrally linked data storage is a feature of ERAMS, which enables other systems to connect to previously stored data (ERA,2017).

ERAMS is web-based unlike excel template. Instead of estimating the overall cost of any work item, equipment, manpower, etc., ERAMS establishes the unit rate for each of these items. The total cost of the project or part of it will be estimated by the designer based on ERAMS unit rates. However, the Excel template estimates both unit costs and total costs. The Excel template is available for anyone to use, but ERAMS can only be used by ERA. Factors considered in cost estimating using ERAMS include current market prices for construction, materials, machinery,

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rent, labor, transportation, project site location, asphalt and concrete plant, ERA specifications and AASHTOO (ERA,2017).

According to Ethiopia road administration ERAMS function include:

- Providing a single source of trusted information
- Providing management information from a single source for better management, responsibility and accountability giving better assurance in budget allocation by validating estimates through the Estimate Validation System (EVS),
- Review bids for construction and maintenance contracts more efficiently and appropriately by analyzing bids with a Tender Analysis System (TAS). TAS allows authorized personnel to analyze bidders' rates and compare them with engineer's estimates.
- Monitoring of construction progress and maintenance work through a Work Monitoring System (WMS).
- Improving the performance of contractors and consultants through the performance appraisal system (PAS).

### **2.11. Summary of literature review**

The literature section attempts to cover previous studies that serve as a background for research on the price estimation process. This part shows that price estimation is an important stage in any road construction project. Several studies have been conducted related to accuracy of price estimates for construction projects. On many occasions researchers have attempted to assess factors influencing accuracy of construction project price estimates (Alumbugu, et. al,2014; Arif, et. al,2015; Dandan, et. al, 2020; Hatamleh, .et. al, 2018; Ibrahim, & Elshwadfy, 2021) and also other researcher conduct Preliminary price estimating models and system (Bademosi, et. al,2019; Elmousalami, 2019; Mahamid, & Bruland, 2010; Peng, M.,2006).

Shiunegn, (2014) perform Testing Regression Models to Estimate Prices of Road Construction Projects. He shows the significant variables or bid quantities can be used to develop regression models as tools in forecasting future road construction price that carry much greater reliability than the previous estimated value. Tadesse, N., & Dinku, A. (2017) conducted Conceptual price estimation of road projects in Ethiopia using neural networks. They identified the influential parameters for conceptual stage include construction duration, location, wearing surface class,

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project scope, terrain classification, structural intensiveness, road length and year of construction and the application of this price estimation tool increases accuracy of the price estimates.

Danit, (2015) conducted evaluation of the price estimating system of building contractor in Addis Ababa. She recommended encouraging local contracting companies to have better awareness and attitude to use proper price estimating systems. Wakjira, (2011), Identified Risk factors leading to cost overrun in Ethiopian federal road construction projects and its consequences. He found that the price estimating method in local road construction industry varies greatly and needs proper database; this shows that the estimating method itself is contributory to the problem of cost overrun. The study presented in this paper considered above mentioned studies and try to fill the gap that was not studied in the past researches.

### **2.12. Gap identified**

Upon reviewing different literatures, it was observed that the price estimation inaccuracies exist in road construction sector. Even though, it's natural to think through all technological advancements, new and advanced methods of estimation techniques, price estimation process inaccuracies of estimation are still a critical issue in the construction industry. Many research works have been done in different country globally on identifying significant factors causing inaccuracies of estimation but factors affecting price estimation accuracy may different from project to project. And also studies on price estimation of road construction projects in Ethiopia have been limited to conceptual price estimation using Artificial neural network and testing regression models to estimate price of road construction project. In addition to that this study will also explicitly point out computer aid tool to estimate accurately. Finally, the study recommends well- structured approach for future price estimation method in road construction in Ethiopia to contractors, consultants and client. So, this study will perform step by step analysis of price estimation method in ERA with identified factor affecting price estimation accuracy.

### **2.13. Conceptual framework**

The conceptual framework for price estimation method presented in figure 2.3 outlines factor that cause price estimation inaccuracy, effect of inaccurate price estimation and ways to mitigate price estimation inaccuracy. The factors are grouped into two main categories i.e internal and external factors. Internal factors are directly related to the project itself, such as project size, type, duration,

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location, construction methods, and estimation tools used. External factors are related to factor outside the project that include market conditions, regulations and permits, logistics and supply chain issues and political instability. Inaccurate price estimation can result a number of negative consequences in construction project such as cost overruns, project delays, poor project quality and stakeholder dissatisfaction. Construction professional can improve project outcome by understanding the cause of inaccurate price estimation and implementing strategies to mitigate those causes.

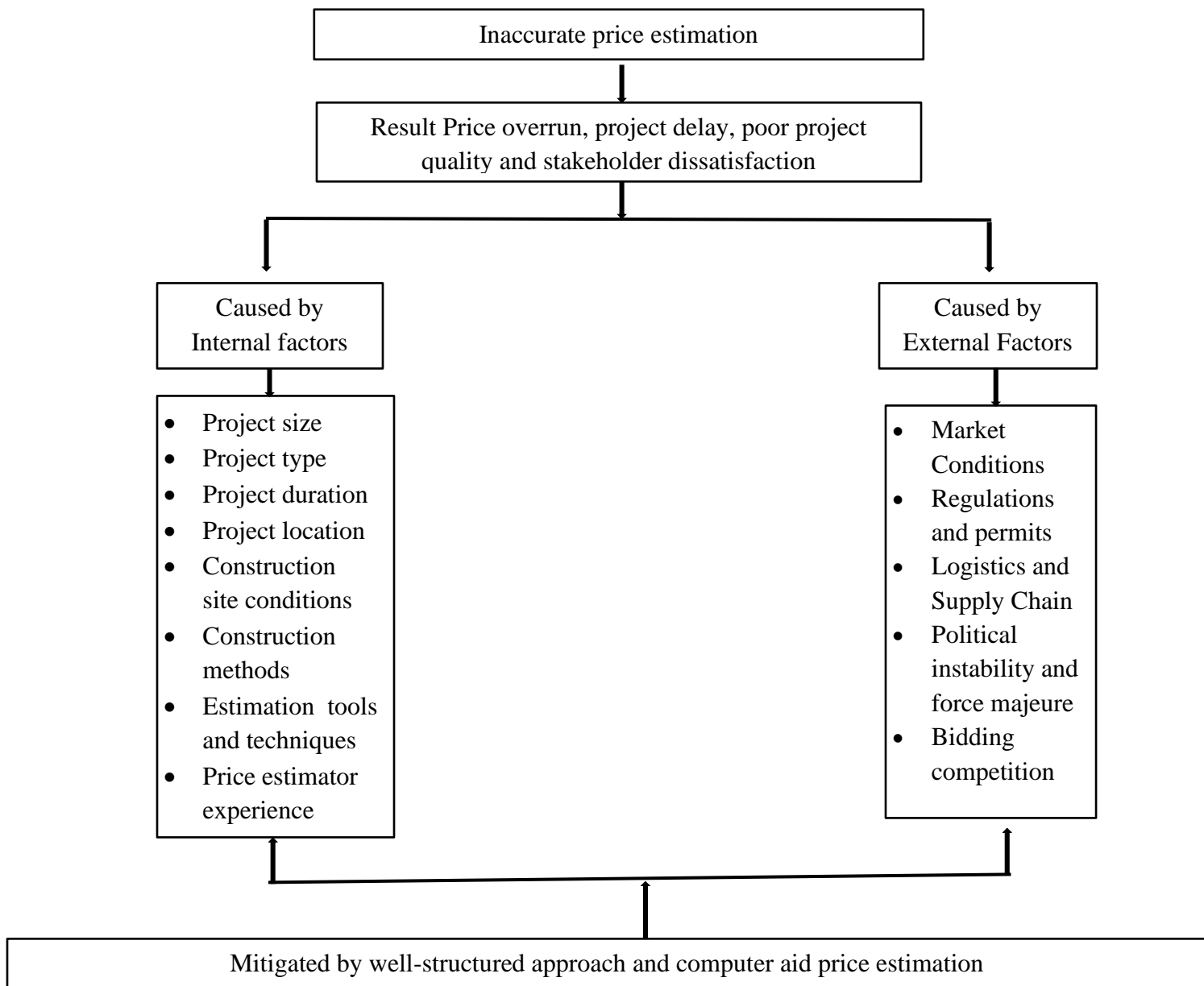


Figure2.3 Conceptual framework (source: the author)

**CHAPTER THREE**

**MATERIALS AND METHODS**

**3.1. Introduction**

According to Wubishet (2004), research is a method of critical investigation for analyzing the different aspects of the issue at hand, comprehending and creating guiding principles to direct the research process and putting to the test theories aimed at improving the current circumstance, condition, or method. The research methods will be covered in this chapter. It outlines the methodical process that was employed to collect data for the study in order to address the goals of the investigation and produce research results and conclusions. This chapter will also cover the study area, research methodologies, data collection process, target population and sample, sampling and sample size determination. The chapter concluded with discussion and summary of data analysis methodologies.

The goal of the study is to examine the current price estimation method as well as the main factors that affect price estimation accuracy. Computer-aided estimation will be studied to improve price estimation accuracy. Finally, it provides a well-structured approach to reduce price estimation inaccuracy and strategies for enhancing the price estimation method in ERA.

**3.2. Study Area**

Ethiopian Road Administration (ERA) performs different tasks like constructing new roads, upgrading existing roads, rehabilitant existing roads, administering design and supervision works and also performing different studies about the sector. The study area of this research work was road construction projects that are completed with ERA in the past 5 years that means from 2018 up to 2023 G.C to get accurate result from the study.

**3.3. Research type**

The study was descriptive and exploratory in nature to understand price estimation issues related to federal road projects in Ethiopia. It was studied the major shortcomings and limitation of Ethiopia road sector price estimating method, identify the factors influencing its accuracy, evaluate

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the computer aid estimation system used in ERA and offer a structured approach for enhancing the method.

### **3.4. Research Approach**

In consideration of the nature of the research, a combination of quantitative and qualitative research designs is chosen in order to achieve the goal of the study. This mixed research approach is sometimes called a triangulation. In scientific research or investigation quantitative approach which is predicated on quantity measurement is utilized. Qualitative research is concerned with qualitative phenomena and it is employed in philosophical, educational and historical investigations. However, the mixed method approach is better than either method alone since it eliminates the drawbacks of each strategy while gaining the benefits of each and it offers more information with higher quality (Singh, 2006).

In order to get accurate price estimation in federal road construction project of Ethiopia one needs to deal with the identification of the possible causes of inaccurate price estimation in Ethiopia. As a result, the research would have to take into account several aspects of the issue including cost overruns, project delays and stakeholder dissatisfaction. To obtain an accurate price estimate in Ethiopia certain variables relating to frequency and degree of influence in each of the aforementioned concepts must be determined. Descriptive and explanatory studies are combined using a mixed method approach in this research to obtain information about price estimation process.

The study implements research approach as shown in figure 3.1. The first approach is problem identification that involves identification of research problem that is relevant to investigate the study. The second approach is to set objective which outlines aim to achieve the research goal. The third approach literature review that involves critically analyzes relevant articles, journals, books and other source. The next approach is setting research method that is crucial for gathering data to achieve research objective. The fifth approach is analysis and discussion that involves analyzes the data using appropriate method and then discusses the finding of the result. The other approach is conclusion and recommendation which involves drawing conclusion and recommendation based on finding of study.

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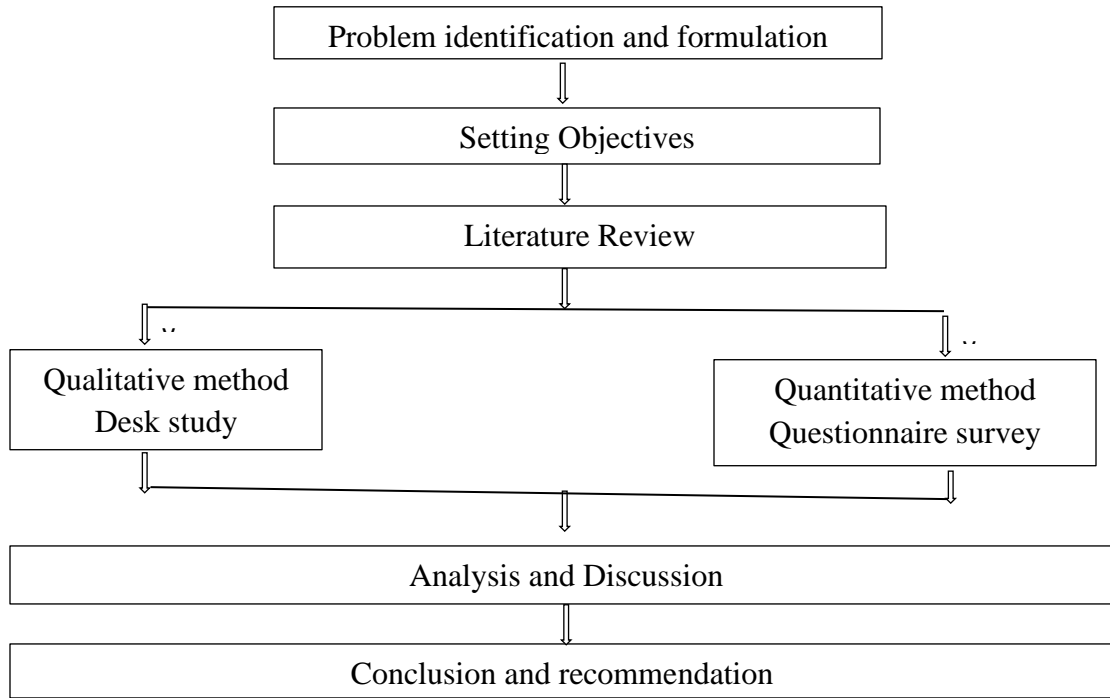


Figure 3.1 Research approach flowchart (Source: compiled by author)

## 3.5. Methods of Data Collection

Data collection is generally difficult in developing country because there is lack of technology so it is time consuming and tiresome. During data gathering there are primarily two difficulties. One potential obstacle could be inadequate documentation and fragmentation of readily available data. Low practitioner knowledge on the advantages of documentation utilizing inexperienced and unskilled labor in documentation and it has been noted that a lack of managerial resources and modern information technology contributes to difficulty in data collection. Data access is also sometimes exceedingly difficult and biased (Wubishet, 2004).

Through the literature review factors that could cause inaccuracy to the estimated price, price estimation methods, general techniques of price estimation of road projects and computer software-based package used for price estimation were identified. In this study, more than one type of data collection instrument and triangulation method were used to increase the precision of the result in estimation. The data collection approach used for conducting this research includes basic

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documents, archival documents and respondents. Besides desk study as the primary data source for this research closed ended questionnaires were distributed to client, contractors and consultants that participate in selected road project.

### **3.5.1. Questionnaire**

For this study, a structured questionnaire was used to gather the actual, perceptive and attitudes of the respondents. The questionnaire was used as a quantitative approach to gather information and gain insights on major shortcoming and limitation in price estimation method factor that have impact on accuracy of price estimation and computer-aid price estimation software used in ERA project. The questionnaire was chosen because it is a quick and somewhat easy way to collect data and it yields better results when processing and evaluating the data. It was developed with closed ended questions. Pilot study was performed with respondents in the construction field that helps to eliminate possible misunderstandings and inconsistencies from the questionnaire and to improve its form, design, structure of the statements and the overall content. Finally, with in-depth review of literature, pilot study and desk study the designed questionnaire was distributed to contractors, consultants, client (ERA) to get their professional opinion based on their experience.

The main objective of the study is to identify price estimation methods in road projects in Ethiopia. Respondents are then asked about their agreement on price estimation of federal road projects in Ethiopia. The first section of the questionnaire asked about the respondents' general background and the organization. It covered topics including years of experience, educational background, job classification and the work experience of the organization. This information helped the researcher to validate the outcome of the survey. The second part to recognize the major shortcomings and limitations of the price estimating system. The third part asked professionals who are working for contractors, consultants and clients to explore factors that have impact on the accuracy of price estimating and to evaluate agreement between different project stakeholders on ranking those factors. The fourth part to Asses computer-based price estimating software used on road construction projects price estimation. The fifth part of the questionnaire in the research concentrates on to provide the contracting companies i.e., client, contractor and consultant with a well-structured approach or techniques to minimize the problems. The original questionnaire is in (Appendix 1).

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Accordingly, the respondents would choose one of the following based on their outlook. They will be expressing their agreement and/or disagreement on the variables of price estimation. The answers for some of the structured parts of the questionnaire were based on Likert's scale of five ordinal measures of agreement towards each statement (from 1 to 5).

Client, contractor and consultant were chosen for questionnaire response in order to gain their relevant knowledge and expert information about price estimation process that help to draw reliable conclusion and recommendation. The questionnaire was distributed to two professional engineers one from top level management and one from medium level management who was participating from contractor and consultant on 28 road constructions projects. Client of federal road construction project is only ERA so only 26 questionnaire is distributed to both top and medium level management professional in ERA but 112 questionnaires were distributed to both contractor and consultant equally. So total of 138 questionnaires was distributed to the respondent. After that response of respondent was collected and then analysis was done in Excel.

### **3.5.2. Desk study**

During the desk study, various documents such as contract documents, claim documents, correspondences, progress reports, completion reports and payment certificates were the main source of desk study to implement finding of research and price estimation inaccuracy are critically evaluated and the root factors causing price estimation inaccuracy in projects was identified. Interviews with pertinent parties in contracting companies will yield additional explanations or information in cases where the primary data collected for the desk study was unclear. The goal of the desk study is to examine the price estimation method used in Ethiopian road construction projects.

Desk study was performed on 10 new road construction projects out of 28 new road construction project completed from 2018 to 2023 G.C. The numbers were determined to gain a deep understanding on price estimation; on the basis of the time available for conducting the research work; and the reliability of data.

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## 3.6. Population and Sampling

### 3.6.1. Population

Population means the entire mass of observations which is the parent group from which a sample is to be formed. The sample observations provide only an estimate of the population characteristics (Singh, 2006). In this research, the population of the study has comprised of new road construction project for further investigation of price estimation method in ERA. The construction industry's clients, contractors and consultants were selected for their direct engagement in price estimating preparation and exposure to specific road construction project will provide research samples for the study.

### 3.6.2. Sample Size Determination and Sampling

Sampling is indispensable technique of behavioral research; the research work cannot be undertaken without use of sampling. It is both impractical and impossible to research the entire population. The practical restriction is that examining the entire population is disadvantaged by time, money and other variables that are typically present in the circumstance (Singh, 2006). In Purposive Sampling units of sampling are selected according to the purpose. This technique can be used for specific purposes (Ralph, et. Al., 2002).

In this study the number of samples was determined with purposive sampling method and Yamane formula was used to determine minimum number of responses as shown in Eq.3.1

$$n_o = \frac{N}{1+Ne^2} \quad (\text{Eq.3.1})$$

Where            no= sample size  
                     N= population size  
                     e = precision or error limit

Assumption     N= population size  
                     e = precision or error limit =+ or – 0.05  
                     Confidence level =95%

The number of populations for study is 31 new road construction projects that were completed in the past 5 year in ERA. In this study the number of samples was determined with purposive sampling method and Yamane formula was used to determine minimum number of responses.

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So, according to equation 3.1 the number of samples will be

$$n_o = \frac{31}{1 + 31 * (0.05)^2} = 28$$

From those 28 new road construction project 10 new road construction projects was used for desk study. The number was determined in order to gain detail information about price estimating process and considering available time for research that demonstrate reality purposive sampling.

### **3.7. Data Analysis Method**

#### **3.7.1. Processing of Data**

Raw data is meaningless without processing and analysis so after data is collected, it is processed and analyzed according to established research methods. After the data have been collected it must be organized and analyzed to draw proper inferences. While the vast amount of data gathered using a variety of instruments is authentic, trustworthy and sufficient, it is still in its raw form. It must be edited, categorized and tabulated in order to be systematized and ordered. Editing is verifying that the information gathered is accurate, useful and comprehensive. Classifying refers to the dividing of the information into different categories, classes or heads for the use. Tabulating denotes the recording of the classified material in accurate mathematical terms i.e., marking and counting frequency tallies for different items on which Information is gathered. Before tabulating all raw data should be tested on the basis of the purpose for which they are gathered and only the useful and usable data should be tabulated (Singh, 2006). These are an essential part of any research and thus, in this subsection discussion was made about how collected data are processed and analyzed.

In this study, questionnaires that are thought insufficient for analysis or incomplete were eliminated from the data collection. As a result, certain surveys were eliminated as being significantly incomplete following inspection. This is done to ensure that the data are correct, compatible with other information obtained, consistently input and organized in a way that makes coding and tabulation easier.

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## 3.7.2. Analysis of Data

The study was analyzed based on descriptive statistical analysis. The mean, standard deviations, frequency or mode were used to statistically characterize the variables using descriptive statistics. The standard deviation was employed to characterize the degree of divergence of the factors from the mean. The data collected through questionnaire will be analyzed and presented in the form of diagrams, charts and tables using Microsoft Excel sheet.

The Kendall coefficient of concordance (W) is used to measure the community of ranks for M observers as shown here under.

$$W = \frac{12 * S}{m^2 * (n^3 - n)} \quad (\text{Eq.3.2})$$

Where S is the sum of squares of deviation of the ranking

$$S = \sum (R_i - R_{\text{mean}})^2 \quad (\text{Eq. 3.3})$$

M is the number of groups of respondents, n is the number of variables being ranked,  $R_i$  is the sum of ranks for  $i^{\text{th}}$  variable and  $R_{\text{mean}}$  is mean of sum of the ranks. W ranges between 0 and 1, when  $W=1$  indicates a perfect agreement among the three respondent groups.

The significance level (P) of the hypothesis (confidence level of more than 95%) is checked using CHIDIST, which returns the one-sided probability of the chi-squared distribution. The  $\chi^2$  distribution is associated with a  $\chi^2$  test. Using the  $\chi^2$  test to compare observed and expected values. By comparing the observed results and the expected ones, it can be determined whether the original hypothesis is valid or not. The Syntax for CHIDIST (P) in Excel spread sheet is; CHIDIST (x, degrees \_ freedom) where; x - is the value at which you want to evaluate the distribution and Degrees \_freedom is the number of degrees of freedom i.e. (n-1).

$$X^2 = m * (n - 1) * W \quad (\text{Eq. 3.4})$$

This research was use Kendall coefficient of concordance (W) to show the degree of agreement between the different parties involved in the survey i.e., contractors, clients and consultants. It also uses CHIDIST to check the significance level (P) of the hypothesis.

## **CHAPTER FOUR**

### **ANALYSIS AND DISCUSSION**

#### **4.1. Introduction**

This section of the study focuses on the analysis and discussion. It was composed of four primary sections in accordance with the study objectives. The first section of analysis and discussion is about the major shortcomings and limitations of the price estimating method. The second section is about factors that have impact on the accuracy of price estimating and also the third section is about computer-based price estimating software used on road construction projects. Finally, the fourth section is about providing well-structured approaches to contracting companies to improve price estimating method. In this research questionnaire survey and desk study were performed. A questionnaire survey has been carried out in order to obtain the necessary data from experts working on behalf of contractors, consultants and clients involved in the construction of ERA road projects. A desk study was also conducted in 10 selected new road projects that were completed in the past 5 years. The documents referred during the desk study include progress and completion reports, contract documents and claim submittal, variation orders, correspondences and other important documents of selected project. Hence, this chapter presents the results of data collected from professionals who are working for the contractors, consultants and client through questionnaire and desk study on selected 10 new ERA road construction projects.

#### **4.2. Questionnaire Data and Analysis Results**

##### **4.2.1. General Information about the respondents**

In this sub section the response rate including number of questionnaires distributed and collected were discussed. In addition, the quality of respondent such as educational status, experience level and job position were discussed.

##### **4.2.1.1 Response Rate**

In this study total of 138 questionnaires were distributed to client, contractors and consultants. The questionnaires were distributed equally i.e., 56 for contractor, 56 for consultant and 26 for client. Out of the 138 questionnaires that were distributed, 96 were returned; of those 7 were rejected because the responses were incomplete and hence invalid. As a result, 89 questionnaires were

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correctly filled out and approved for analysis. Generally, table 4.1 shows contractor had the highest response rate followed by consultant and clients.

Table 4.1 Questionnaire distributed

Description	Contractor	Client	Consultant	Total
Questionnaire distributed	56	26	56	138
Response collected	39	23	27	89
Percentage of response	70	88	48	64

### 4.2.1.2 Quality of the respondents

In order to achieve the research objective, it is important to know percentage of respondents with their job position. So, the respondents were asked to mention about their current roles within their respective organizations. Project coordinator, resident engineer, site engineer, office engineer and contract administrator work as project price estimator in contractor, consultant and client office. As shown in table 4.2 from the respondent's, majority (27%) were project coordinators, contract administrators (24%), office engineers (19%), resident engineers (17%), and site engineers (13%).

Table 4.2 Role of respondents in their organization

Job position	Frequency	Percent
Project Coordinator	24	27
Resident Engineer	15	17
Site Engineer	12	13
Office Engineer	17	19
Contract Administrator	21	24
Total	89	100

In order to achieve the research objective, it is important to know the educational status of respondents. So, in addition to their job position the respondents were asked to state their greatest level of education. As shown in table 4.3 out of the respondents the majority 69% (61) has a BSc

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or bachelor's degree, 31% (28) have an MSc, and 0% has a Ph.D. This shows that all of the respondents have bachelor and master degree educational status.

Table 4.3 The Educational status of respondents

Education status	Frequency	Percent
B.sc	61	69
M.Sc.	28	31
Total	89	100

To achieve the research objective the respondents' years of experience in the road construction sector was another crucial factor in the categorization process. As shown in table 4.4 most of the respondents 43% have 11 to 15 years of experience in the road construction industry. Next in line are 28%, who have 6 to 10 years of experience. Finally, 15% have 16 to 20 years of experience. 13% have less than 5 years of experience while holding M.Sc. degree and 4% have more than 20 years of experience.

Table 4.4 Experience level of respondents

Experience level	Frequency	Percent
Less than 5 years	9	10
6-10 years	25	28
11-15 years	38	43
16-20 years	13	15
More than 20 years	4	4
Total	89	100

In addition to job position, educational status and year of experience the respondents' position in the road construction project was another crucial factor in the categorization process. Most of the respondents 61% are at top management level and 39% are at middle management level which is considered appropriate for the study.

Table 4.5 Position of respondents in the project

Respondent position	Contractor	Client	Consultant	Total in No.	Total in Percent
Top management	28	12	14	54	61
Middle management	11	11	13	35	39
Total	39	23	27	89	100

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The validity of responses in terms of comprehending questions and possessing greater technical abilities in the construction industry are significantly impacted by one's educational background and experience level. And also, the reliability and accuracy of the response is thought satisfactorily accurate as 61% of the respondents are from top management level in Client, Contractor and Consultant with job position of Project Managers, Resident Engineers and Contract administrators that are directly involved in project with more than 11 years of experience. Therefore, relevant knowledge and expert information are believed good for the analysis in order to draw reliable conclusions and recommendations.

### 4.2.2. Major shortcomings and limitations in price estimating method

#### A. Existence of accurate price estimation

To achieve the first objective of this thesis the existence of accurate price estimation was checked and as shown in table 4.6 most of the respondent i.e., 74% indicates there is no accurate price estimation, 26% of the respondent also indicates there is accurate price estimation. So, the finding of this study based on respondent indicates there is problem during price estimation process for road project. In order to solve those problem well structure approach should be developed in each organization as price estimation inaccuracy have effect on project success.

Table 4.6 Existence of accurate price estimation

Response	Frequency	Percent
Yes	23	26
No	66	74
Total	89	100

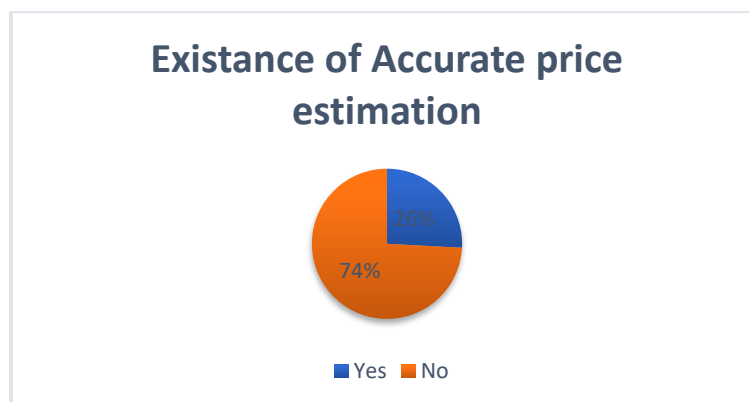


Figure 4.1 Existence of accurate price estimation

## Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects

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### B. Frequent type of inaccurate price estimation

Price underestimation is the most frequent type of inaccurate price estimation with average mean of 3.64 than within range and overestimation (3.27, 2.77 respectively) as shown in table 4.7. This could be due to a natural tendency for people to be optimistic and underestimate the challenges they might face, incomplete or inaccurate data and also complex and unpredictable factors like terrain, underground utilities and environmental regulations. Underestimation could occur by different internal and external factor in road construction project even if underestimation occur mostly, it is essential to focus on overestimation for successful road construction.

Table 4.7 Frequent type of inaccurate price estimation

No	Statement	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Final project price exceeding detail price estimation range (Underestimation of prices)	4.03	1	4.11	1	2.80	2	3.64	1
2	The project's total price falls within the detail price estimate range (Price estimated within the range)	3.33	2	3.23	2	3.24	1	3.27	2
3	The project's completion price is less than its detail price estimate (Overestimation of prices)	2.81	3	2.76	3	2.71	3	2.77	3

### C. Limitation during price estimation

The analysis result for degree of effect of limitation during price estimation from survey indicated that almost the entire respondent agrees the existence of limitation during price estimation. Although, the existence of those limitation is agreed by almost all respondent the degree of effect of those limitation on price estimation is different. It can be seen from table 4.8 lack of data collection and documentation was ranked first with high mean value as limitation during price estimation. Lack of data could result underestimation of price due to missing data. The other limitation is inadequate availability of data ranked second with high-range significance in causing inaccurate price estimation. Inadequate availability of data could result inability to consider all

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relevant data point during the estimation process potentially leading to overestimation or underestimation. The rank of other limitation is also indicated in Table 4.8. Therefore, from the respondent response the need to mitigate this limitation is essential to enhance accurate price estimation.

Table 4.8 Limitation during price estimation

No.	Statement	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Lack of data collection and documentation	4.03	1	3.89	3	3.71	1	3.88	1
2	Inadequate availability of data	3.97	2	3.88	3	3.67	2	3.84	2
3	Insufficient interaction and cooperation between project participants	3.96	3	3.90	1	3.61	5	3.83	3
4	Inadequate expertise and training of estimators	3.91	4	3.90	1	3.66	3	3.82	4
5	Inadequate systems for monitoring and tracking price	3.90	5	3.88	5	3.59	7	3.79	5
6	Inadequate tools or software for price estimation	3.69	6	3.64	6	3.65	4	3.68	6
7	Absence of uniform methods for price estimation	3.66	7	3.64	6	3.60	6	3.67	7

This section's main goal is to understand how price estimating limitations affect the accuracy of road construction estimates in Ethiopia. In order to determine the difference in ranking between the three groups of respondents, the correlation of the respondents' responses as assessed using the Kendall coefficient of concordance is summarized in this portion of the thesis.

The Null Hypothesis (H<sub>0</sub>) is: There is no agreement between respondent in ranking effect of price estimation limitation in its accuracy.

The Alternative Hypothesis (H<sub>A</sub>) is: There is agreement between respondent in ranking effect of price estimation limitation in its accuracy.

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Kendall coefficient of concordance (W) is calculated using excel. A level of significance 95% (P = 0.05) is considered in order to resolve whether to accept or reject the null hypothesis in order to conform whether or not there is "agreement" between respondents' response.

Table 4.9 Kendall coefficient of concordance result for effect of price estimation limitation its accuracy

m	n	df	w	p	X <sup>2</sup>
3	7	6	0.744	0.036	13.41

m = No. of group of respondents, n = No. of variable being ranked and w= Kendell's coefficient of concordance p = significance level df = degree of freedom

The values of Kendall coefficient of concordance (W) and the significance level (p) are found out to be 0.744 and 0.036 respectively. As the coefficient of concordance (W) is more than 0.5 and significance level (P) is less than 0.05, the agreement among the parties is found acceptable with confidence level of more than 95%.

### D. Precondition for price estimation process

The survey from respondent affirmed Road construction price considered during estimation is the most frequent precondition considered for price estimation method with mean value of 3.41 than work breakdown structure, Planning and Construction method statement 3.34, 3.11, 2.99 respectively. This could be due to identifies all work activities and by identifying every activity, it minimizes the risk of omitting expenses during estimation leading to more accurate and realistic budgets than WBS, planning and construction method statement as shown in table 4.10.

Table 4.10 Precondition for price estimation method

No.	Statement	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Road construction price considered during estimation	3.41	1	3.45	1	3.39	1	3.41	1
2	Work breakdown structure	3.33	2	3.35	2	3.33	2	3.34	2
3	Planning	3.00	3	3.06	3	3.29	3	3.11	3
4	Construction method statement	2.97	4	2.94	4	3.00	4	2.98	4

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## E. Susceptible stage of roadwork for price estimation accuracy

During the study susceptible stage of road work for inaccuracy of price estimate was checked and based on the respondent response 32% of the respondent indicates that earthwork is affected mostly during price estimation that occurs due to the fact high dependence on unpredictable ground conditions and significant impact of weather events. In order to minimize price estimation inaccuracy at earthwork stage project stakeholder should develop detailed earthwork plan. Base and sub base course work, Ancillary & Miscellaneous, Asphalt work and Site clearance were susceptible to inaccurate price estimation respectively as shown in table 4.11.

Table 4.11 Susceptible stage of roadwork for inaccurate price estimation

Item	Frequency	Percent
Site clearance	9	10
earthwork	28	32
Base and sub base course work	19	21
Asphalt work	15	17
Ancillary & Miscellaneous	18	20

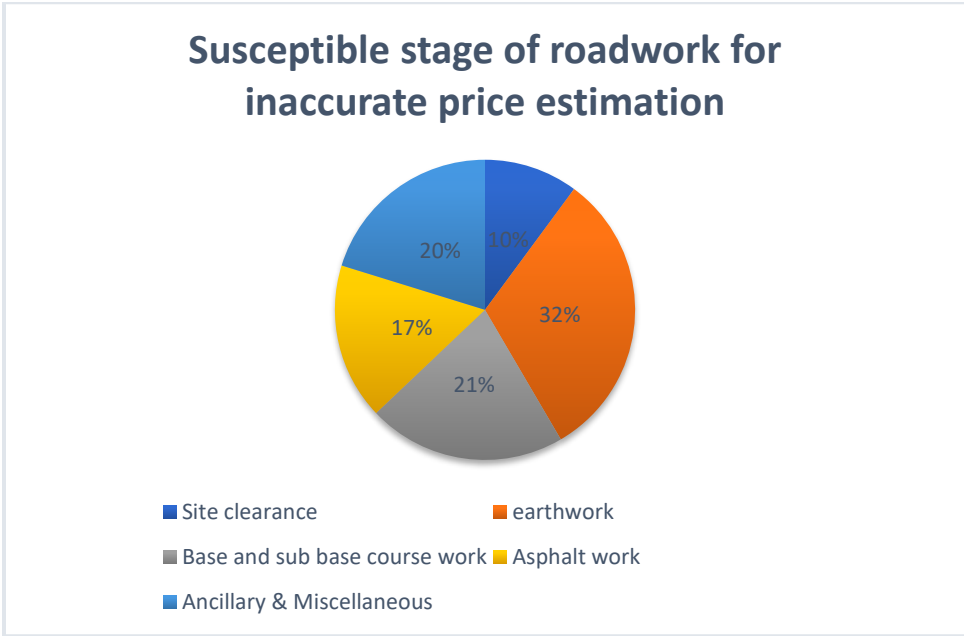


Figure 4.2 Susceptible stage of roadwork for inaccurate price estimation

## Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects

### F. Problem occurred due to inaccurate price estimation

This section deals with the analysis of the information gathered from questionnaire survey about the rate of occurrence of different problem due to inaccurate price estimation and from the survey result cost overrun is the most frequently occur problem due to inaccurate price estimation than other problem with average mean of 4.08. This could be due to its Direct Financial Impact. The second problems that occur due to inaccurate price estimation is project delay with average mean of 4.05. Poor project quality, Contract dispute& Stakeholder dissatisfaction are problem ranked third and fourth due to inaccurate price estimation. In order to mitigate price, overrun, project delay, poor project quality and stakeholder dissatisfaction contracting parties should focus on accuracy of price estimation because it is necessary to maintain price, quality and time of road construction projects.

Table 4.12 Problem occurred due to inaccurate price estimation

No.	Statement	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Cost overrun	4.06	1	4.17	1	4.00	2	4.08	1
2	Project delay	4.03	2	4.11	2	4.05	1	4.05	2
3	Poor project quality	3.33	3	3.35	3	3.14	3	3.28	3
4	Stakeholder dissatisfaction	2.33	4	2.35	4	2.33	4	2.34	4

### 4.2.3. Factors that have impact on the accuracy of price estimating

#### A. Internal factors

The second objective in this study is recognizing factors affecting accuracy of price estimation and in order to achieve this objective respondent were asked to give their response. From the survey result it can be seen in table 4.13 that project size is the first factor affecting price estimation with average mean of 4.00. This could be due to unforeseen and management Challenges as project size grows the probability of encountering unforeseen challenges like ground conditions, weather events, or material availability increases and it is very difficult to manage those challenges. The second ranked factor is project location with average mean of 3.98. This could be location of project have effect on delivery of material, equipment and labor. It is observed from table that respondent give rank for Project type, Construction methods, Construction site conditions, Project

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duration, Price estimator experience, Estimation tools and techniques and Sub-contractor related factor in chronological order that have effect on price estimation accuracy.

Table 4.13 Internal factors based on degree of argument

No.	Statement	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Project location	4.21	2	3.70	1	4.09	1	4.00	1
2	Project size	4.33	1	3.58	4	4.04	3	3.98	2
3	Project type	4.12	3	3.64	2	4.04	3	3.93	3
4	Construction methods	4.09	5	3.59	3	4.00	5	3.89	4
5	Project duration	4.10	4	3.52	6	4.05	2	3.88	5
6	Construction site conditions	4.00	6	3.56	5	3.85	8	3.81	6
7	Price estimator experience	3.67	7	3.49	8	3.90	7	3.68	7
8	Estimation tools and techniques	3.56	8	3.51	7	3.91	6	3.66	8
9	Sub-contractor related factor	3.51	9	3.45	9	3.85	8	3.60	9

This section's main goal is to understand factors that have effect on Ethiopian road construction sector. In order to determine the difference in ranking between the three groups of respondents, the correlation of the respondents' responses as calculated using the Kendall coefficient of concordance is summarized in this portion of the thesis.

The Null Hypothesis (H<sub>0</sub>) is: There is no agreement between respondent in ranking of internal factor affecting price estimation.

The Alternative Hypothesis (H<sub>A</sub>) is: There is agreement between respondent in ranking of internal factor affecting price estimation.

Kendall coefficient of concordance (W) is calculated using excel. A level of significance 95% (P = 0.05) is considered in order to resolve whether to accept or reject the null hypothesis in which it would be possible to conform whether or not there is "agreement" between respondents' response.

Table 4.14 Kendell coefficient of concordance result for internal factor affecting price estimation

m	n	df	w	p	x <sup>2</sup>
3	9	8	0.839	0.009	20.15

## Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects

$m$  = No. of group of respondents,  $n$  = No. of variable being ranked and  $w$  = Kendall's coefficient of concordance  $p$  = significance level  $df$  = degree of freedom

The values of Kendall coefficient of concordance ( $W$ ) and the significance level ( $p$ ) are found out to be 0.839 and 0.009 respectively. As the coefficient of concordance ( $W$ ) is more than 0.5 and significance level ( $P$ ) is less than 0.05, the agreement among the parties is found acceptable with confidence level of more than 95%.

The study has also identified the respondent opinion about degree of influence of those internal factors and from the survey result it can be seen in table 4.15 that project size is the first factor influencing price estimation with average mean of 4.26. The second ranked factor is project location with average mean of 4.22. It is observed from table respondent give rank for construction method, construction site condition, project duration, project type, price estimator experience, estimation tools and techniques, sub-contractor related factor in chronological order that have effect on price estimation accuracy.

Table 4.15 Internal factors based on degree of influence

No.	Statement	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Project size	4.30	1	4.28	1	4.22	2	4.26	1
2	Project location	4.21	2	4.24	2	4.21	3	4.22	2
3	Construction methods	4.18	3	4.15	3	4.20	4	4.18	3
4	Construction site conditions	4.15	5	4.09	4	4.27	1	4.17	4
5	Project duration	4.12	6	4.06	6	4.12	5	4.10	5
6	Project type	4.18	3	4.08	5	3.97	6	4.07	6
7	Price estimator experience	3.61	7	3.69	8	3.79	8	3.69	7
8	Estimation tools and techniques	3.45	8	3.71	7	3.81	7	3.65	8
9	Sub-contractor related factor	3.43	9	3.63	9	3.74	9	3.60	9

This section's main goal is to understand influence level of each factor that have effect on Ethiopian road construction sector. In order to determine the difference in ranking between the three groups of respondents, the correlation of the respondents' responses as assessed using the Kendall coefficient of concordance is summarized in this portion of the thesis.

## Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects

The Null Hypothesis (H<sub>0</sub>) is: There is no agreement between respondent in ranking of influence level of internal factor affecting price estimation.

The Alternative Hypothesis (H<sub>A</sub>) is: There is agreement between respondent in ranking of influence level of internal factor affecting price estimation.

Kendall coefficient of concordance (W) is calculated using excel. A level of significance 95% (P = 0.05) is considered in order to resolve whether to accept or reject the null hypothesis in which it would be possible to conform whether or not there is "agreement" between respondents' response.

Table 4.16 Kendell coefficient of concordance result for internal factor affecting price estimation based on degree of influence

m	n	df	w	p	X <sup>2</sup>
3	9	8	0.920	0.004	22.08

m = No. of group of respondents, n = No. of variable being ranked and w= Kendell's coefficient of concordance p = significance level df = degree of freedom

The values of Kendall coefficient of concordance (W) and the significance level (p) are found out to be 0.920 and 0.004 respectively. As the coefficient of concordance (W) is more than 0.5 and significance level (P) is less than 0.05, the agreement among the parties is found acceptable with confidence level of more than 95%.

### B. External factors

This section attempts to briefly examine external factor affecting price estimation accuracy and its degree of influence. From the survey result it can be seen in table 4.17 Market Conditions is the first factor affecting price estimation with average mean of 3.56. This could be due to fact highly fluctuation of material price in the country. External Events i.e., political instability and force majeure is the second ranked factor with average mean of 3.46. As force majeure will result termination of project that led to cost variance and project delay the respondent give second rank for external event. It is observed from table that respondent give third rank for logistics and supply

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chain for estimation that has effect on price estimation accuracy and also bidding competition, Regulations and permits ranked fourth and fifth respectively.

Table 4.17 External factors based on degree of argument

No.	Statement	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Market Conditions	3.67	1	3.65	1	3.33	3	3.56	1
2	External Events i.e., political instability and force majeure	3.52	2	3.29	3	3.52	1	3.46	2
3	Logistics and Supply Chain	3.36	3	3.58	2	3.33	3	3.40	3
4	Bidding competition	3.32	4	3.26	5	3.26	5	3.34	4
5	Regulations and permits i.e., environmental regulation and permitting process delay	3.29	5	3.26	4	3.26	5	3.27	5

This section's main goal is to understand factors that have effect on Ethiopian road construction sector. In order to determine the difference in ranking between the three groups of respondents, the correlation of the respondents' responses as assessed using the Kendall coefficient of concordance is summarized in this portion of the thesis.

The Null Hypothesis (H<sub>0</sub>) is: There is no agreement between respondent in ranking of external factor affecting price estimation.

The Alternative Hypothesis (H<sub>A</sub>) is: There is agreement between respondent in ranking of external factor affecting price estimation.

Kendall coefficient of concordance (W) is calculated using excel. A level of significance 95% (P = 0.05) is considered in order to resolve whether to accept or reject the null hypothesis in which it would be possible to conform whether or not there is "agreement" between respondents' response.

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Table 4.18 Kendell coefficient of concordance result for external factor affecting price estimation

m	n	df	w	p	$\chi^2$
3	5	4	0.835	0.039	10.02

m = No. of group of respondents, n = No. of variable being ranked and w= Kendell's coefficient of concordance p = significance level df = degree of freedom

The values of Kendall coefficient of concordance (W) and the significance level (p) are found out to be 0.835 and 0.039 respectively. As the coefficient of concordance (W) is more than 0.5 and significance level (P) is less than 0.05, the agreement among the parties is found acceptable with confidence level of more than 95%.

The study has also identified the respondent opinion about degree of influence of factor affecting price estimation accuracy and from the survey result it can be seen in table 4.19 Market Conditions is the first factor influencing price estimation with average mean of 4.34. As market condition have effect on material, equipment and labor price it has major influence on overall final completion price of project that could show price estimation inaccuracy. The second ranked factor is External Events i.e., political instability and force majeure with average mean of 4.04. It is observed from table 4.19 that respondent give rank third for Bidding competition in order that have effect on price estimation accuracy and also Regulations and permits i.e., environmental regulation and permitting process delay, Logistics and Supply Chain ranked fourth and fifth respectively.

Table 4.19 External factors based on degree of influence

No.	Statement	Contractor		Client		`Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Market Conditions	4.36	1	4.24	1	4.38	1	4.34	1
2	External Events i.e., political instability and force majeure	3.67	3	4.18	2	4.29	2	4.04	2
3	Bidding competition	3.81	2	3.88	3	4.05	3	3.91	3
4	Regulations and permits i.e., environmental regulation and	3.61	4	3.71	5	4.01	4	3.77	4

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	permitting process delay								
5	Logistics and Supply Chain	3.53	5	3.77	4	3.98	5	3.76	5

This section's main goal is to understand influence level of each factor that has effect on Ethiopian road construction project. In order to determine the difference in ranking between the three groups of respondents, the correlation of the respondents' responses as assessed using the Kendall coefficient of concordance is summarized in this portion of the thesis.

The Null Hypothesis (H0) is: There is no agreement between respondent in ranking of influence level of external factor affecting price estimation.

The Alternative Hypothesis (HA) is: There is agreement between respondent in ranking of influence level of external factor affecting price estimation.

Kendall coefficient of concordance (W) is calculated using excel. A level of significance 95% (P = 0.05) is considered in order to decide whether to accept or reject the null hypothesis in which it would be possible to conform whether or not there is "agreement" between respondents' response.

Table 4.20 Kendell coefficient of concordance result for external factor affecting price estimation based on degree of influence

m	n	df	w	p	X <sup>2</sup>
3	5	4	0.911	0.027	10.93

m = No. of group of respondents, n = No. of variable being ranked and w= Kendell's coefficient of concordance p = significance level df = degree of freedom

The values of Kendall coefficient of concordance (W) and the significance level (p) are found out to be 0.911 and 0.027 respectively. As the coefficient of concordance (W) is more than 0.5 and significance level (P) is less than 0.05, the agreement among the parties is found acceptable with confidence level of more than 95%.

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### 4.2.4. Computer-based price estimating software used on road construction projects

#### A. Price estimating method

Bottom-up estimating is the most frequent used type of price estimating tools than other type of price estimating method with average mean of 3.62 as shown in table 4.21. The second method of estimation used is analogous estimating that indicates estimator sometimes used comparison method with previous project to estimate current project price and based on the response the next price estimating method used is Risk based price estimation with average mean of 2.66. This result show risk and uncertainty were considered during price estimation. Three-point estimation and parametric estimation are given fourth and fifth rank by respondent. This show that mathematical relationship is not properly implemented to estimate price in projects. So, from this the Bottom-up estimating is mostly used price estimation method for road project in Ethiopian federal road projects.

Table 4.21 Traditional price estimating method

No.	Methods of price estimation	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Bottom-up estimating	3.76	1	3.71	1	3.33	1	3.62	1
2	Analogous estimating	2.94	2	2.94	2	2.75	3	2.86	2
3	Risk based price estimation	2.64	3	2.65	4	2.67	4	2.66	3
4	Three-point estimate	2.36	4	2.82	3	2.76	2	2.59	4
5	Parametric estimating	2.33	5	2.35	5	2.33	5	2.34	5
6	Artificial neural network	1.00	6	1.00	6	1.00	6	1.00	6

The finding of this study from questionnaire response showed that less emphasis was given to Machine Learning Algorithms type of price estimating like Artificial neural network as respondent indicate they never used those method to estimate road project price. This could be due to limited data availability i.e., ANNs rely heavily on large datasets of past projects and their associated prices and also maintaining ANN-based price estimation systems can be expensive and require ongoing updates and refinements.

# Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects

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## B. Excel computer program implemented for price estimation

From the survey result the usage of excel computer program was asses during questionnaire survey. Almost all of the respondent indicate there is excel computer program implemented for price estimation. This shows that the organizations worked to enhanced accuracy and efficiency of estimation and improve data management system.

Table 4.22 Excel computer programs implemented for price estimation

Response	Frequency	Percent
Yes	88	99
No	1	1
Total	71	100

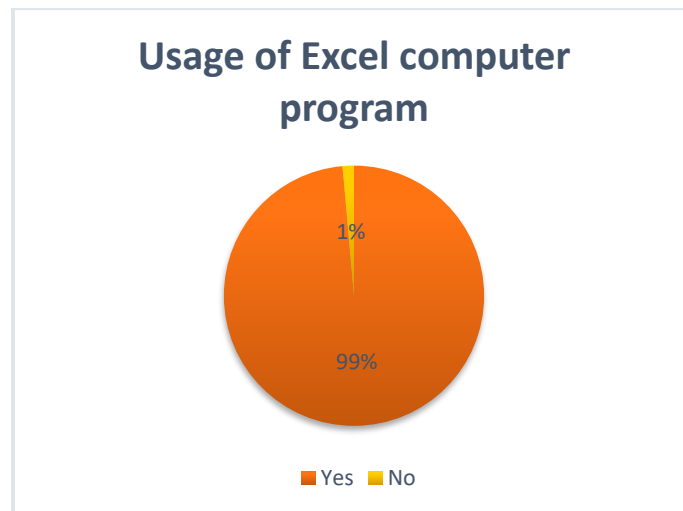


Figure 4.3 Usage of Excel computer program for price estimation

## C. Degree of application of computer program

In addition to examining the implementation of computer program for price estimation this section checked degree of application of computer program and based on respondent response excel is the only computer program used to estimate price in ERA project. This indicates that there is lack of using computer package program such as Heavy bid, stack, procure to estimate project price. This could be due to limited awareness about computer program package.

## Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects

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### D. Advantage of using computer program

After examining degree of application of computer program respondent requested to indicate the advantage, they gain by using computer program in their organization. Almost the entire respondent agrees effectively handles complex calculations and formulas required for accurate price estimation ranked first with mean value. It provides tool for data exchange ranked second with moderate mean value. In addition to those the analysis shows rank of other advantage of computer program in table 4.23.

Table 4.23 Advantage of using computer program

No.	Statement	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	It includes complex formulas required for accurate price estimation.	4.09	2	3.70	6	3.85	3	3.98	1
2	It provides tools for continuous data exchange.	3.93	5	3.82	4	3.76	4	3.88	2
3	It is possible to assess risks and uncertainties in price estimation.	3.97	3	3.94	3	3.95	1	3.87	3
4	It includes databases with resources and price information.	4.12	1	3.95	2	3.47	6	3.84	4
5	It provides Reporting tools for presenting price estimates	3.72	7	3.64	7	3.66	5	3.73	5

This section's main goal is to understand advantage of using computer program on Ethiopian road construction sector. In order to determine the difference in ranking between the three groups of respondents, the correlation of the respondents' responses as assessed using the Kendall coefficient of concordance is summarized in this portion of the thesis.

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The Null Hypothesis (H<sub>0</sub>) is: There is no agreement between respondent in ranking Advantage of using computer program.

The Alternative Hypothesis (H<sub>A</sub>) is: There is agreement between respondent in ranking of Advantage of using computer program.

Kendall coefficient of concordance (W) is calculated using excel. A level of significance 95% (P = 0.05) is considered in order to decide whether to accept or reject the null hypothesis in which it would be possible to conform whether or not there is "agreement" between respondents' response.

Table 4.24 Kendell coefficient of concordance result for advantage of using computer program

m	n	df	w	p	X <sup>2</sup>
3	5	4	0.942	0.023	11.30

m = No. of group of respondents, n = No. of variable being ranked and w= Kendell's coefficient of concordance p = significance level df = degree of freedom

The values of Kendall coefficient of concordance (W) and the significance level (p) are found out to be 0.942 and 0.023 respectively. As the coefficient of concordance (W) is more than 0.5 and significance level (P) is less than 0.05, the agreement among the parties is found acceptable with confidence level of more than 95%.

### 4.2.5. Structured approach to minimize inaccurate price estimation

#### A. Usage of specialized group for price estimation

The respondent also asked about usage of specialized group for price estimation and from survey result it can be seen that respondent more than 50% indicate there is no specialized group for price estimation that could be due to Organizational structure established practices.

Table 4.25 Usage of specialized group for price estimation

Response	Frequency	Percent
never used	53	60
rarely used	18	20
sometimes used	11	12
often used	7	8
always used	-	-

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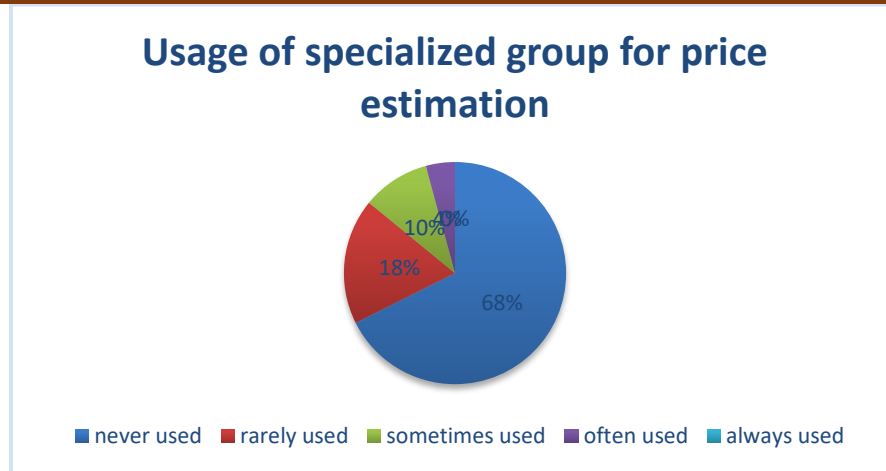


Figure 4.4 Usage of specialized group for price estimation

### B. Existence and Source of price estimating database

From the survey result the usage of price estimating database was assessed during questionnaire survey. Almost the entire respondent as shown in table 4.26 indicates there is price estimating database implemented for price estimation. This shows that organization work to enhance price estimation accuracy and better price control and tracking. 57% of respondent also indicates primary source of price estimation database is historical project data. This indicates importance of past project experience and data for price estimation practice. And also, construction price handbook and government agency are 30, 13% source respectively.

Table 4.26 Existence and source of price estimating database

Existence of price estimating database		
Response	Frequency	Percent
Yes	54	60
No	35	40
Total	89	100
Source of price estimating database		
Response	Frequency	Percent
Historical project data	51	57
Government agency	12	13
Specialized price estimation software	-	-
Construction price handbook	26	30

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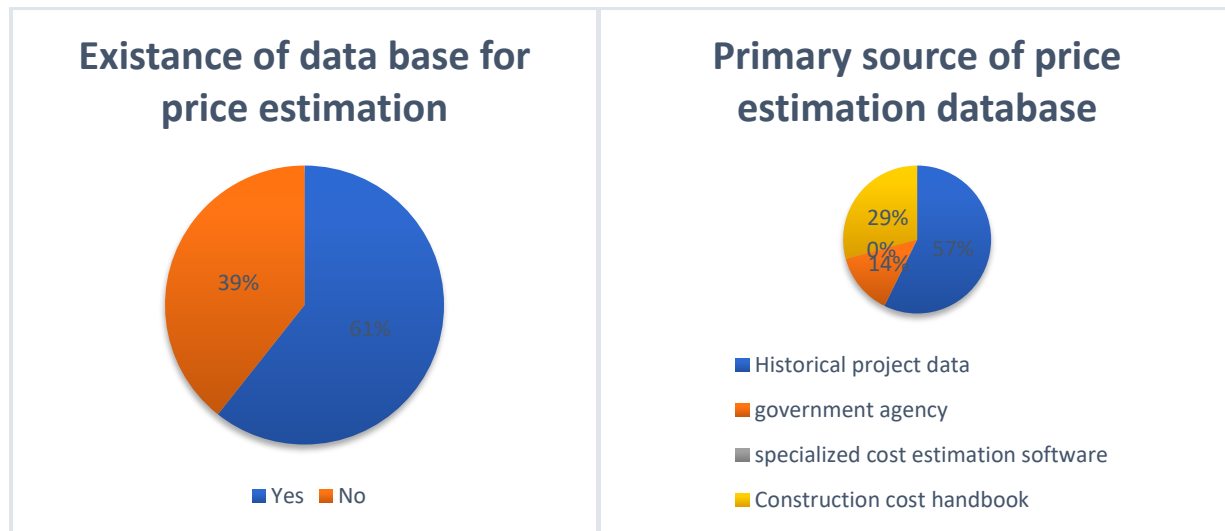


Figure 4.5 Existence and source of database for price estimation

### C. Importance of database techniques in price estimation process

In addition to source of price estimation database importance of database technique used for price estimation was studied in this research and based on response of respondent from table 4.27 Local market survey is the most important database technique than other with an average mean of 4.32. This could be due to fact inflation is one of top factor that affect price estimation accuracy. The second important database technique in price estimation process is standardize price database. The analysis also indicates analyzing historical data and financial indices are ranked third and fourth respectively.

Table 4.27 Importance of database techniques in price estimation process

No.	Database technique	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Local market survey	4.36	1	4.18	1	4.38	1	4.32	1
2	Standardize price database	4.30	2	4.18	1	4.00	2	4.18	2
3	Analyzing historical data	3.67	3	3.65	3	3.67	4	3.66	3
4	Financial indices	3.58	4	3.59	4	3.81	3	3.65	4

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### D. Way to increase accuracy of price estimation

According to the analysis result of table 4.28, application of checklist and template for standard price estimation was ranked first with high mean value as way to increase accuracy of price estimation. Frequent price estimators' professional development and training programs ranked second with high mean value to increase accuracy of price estimation. In general, the following table indicate the respondent agree about the way to increase accuracy of price estimation.

Table 4.28 Way to increase accuracy of price estimation

No.	Ways	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	The application of checklists and templates for standard price estimation	4.09	2	4.29	1	4.26	2	4.21	1
2	Frequent price estimators' professional training programs	3.99	1	4.11	2	4.24	1	4.17	2
3	Creating effective channels of communication between project stakeholders and price estimators.	4.10	6	4.13	4	4.27	4	4.12	3
4	Conducting comprehensive risk assessments and contingency planning.	4.00	5	4.12	3	4.22	5	4.11	4
5	Developing an extensive database relevant to road construction projects.	4.05	3	4.00	6	4.25	3	4.10	5
6	Using advanced software tools specifically designed for price estimation.	4.03	4	3.94	7	4.21	6	4.06	6
7	Implementing quality control measures and conducting regular audits of price estimation.	3.95	7	4.01	5	4.09	7	4.01	7

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This section's main goal is to understand way to increase accuracy of price estimation in road construction of Ethiopia. In order to determine the difference in ranking between the three groups of respondents, the correlation of the respondents' responses as assessed using the Kendall coefficient of concordance is summarized in this portion of the thesis.

The Null Hypothesis (H0) is: There is no agreement between respondent in ranking way to increase accuracy of price estimation.

The Alternative Hypothesis (HA) is: There is agreement between respondent in ranking of way to increase accuracy of price estimation.

Kendall coefficient of concordance (W) is calculated using excel. A level of significance 95% ( $P = 0.05$ ) is considered in order to decide whether to accept or reject the null hypothesis in which it would be possible to conform whether or not there is "agreement" between respondents' response.

Table 4.29 Kendell coefficient of concordance result for way to increase accuracy of price estimation

m	n	df	w	p	$\chi^2$
3	7	6	0.761	0.032	13.71

m = No. of group of respondents, n = No. of variable being ranked and w= Kendell's coefficient of concordance p = significance level df = degree of freedom

The values of Kendall coefficient of concordance (W) and the significance level (p) are found out to be 0.761 and 0.032 respectively. As the coefficient of concordance (W) is more than 0.5 and significance level (P) is less than 0.05, the agreement among the parties is found acceptable with confidence level of more than 95%.

### E. Degree of price estimating application at different stage

The survey from respondent affirmed Prepare Base Estimate is the most frequent type of price estimate stage with average means of 4.13 than document the estimate, Review Base Estimate and Conduct Independent Review and Obtain Management Endorsement (3.80, 3.32 & 3.31 respectively) as shown in table 4.30. This could be due to organizational structure of company.

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Table 4.30 Degree of price estimating application at different project stage

No.	Price estimating stage	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Prepare Base Estimate	3.94	1	4.29	1	4.29	1	4.13	1
2	Document the estimate	3.67	2	3.76	2	4.05	2	3.80	2
3	Review Base Estimate	3.30	3	3.35	3	3.33	3	3.32	3
4	Conduct Independent Review and Obtain Management Endorsement	3.27	4	3.35	3	3.33	3	3.31	4

### F. Degree of price estimation type application

In this study degree of application of price estimation type based on project development level, accuracy and function was responded by respondent as shown in table 4.31 and based on their response plan specification ranked first followed by design and planning price estimation type based on project development due to fact organization want to estimate finally to minimize expense for estimator. Based on accuracy detail estimation is performed than conceptual estimation in road construction sector. And also bid estimation is ranked first with price estimation type based on function that could be due to interest of contracting party to win project bid.

Table 4.31 Degree of price estimation type application

Degree of price estimation type application based on project development level									
No	Price estimation stage	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Plan, specification estimation	4.15	1	4.18	1	4.67	1	4.31	1
2	Design	3.67	2	3.65	2	3.67	2	3.66	2
3	Planning	3.33	3	3.35	3	3.33	3	3.34	3
4	Scoping	2.00	4	2.06	4	2.14	4	2.06	4
Degree of price estimation type application based on accuracy									
No	Price estimation stage	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Detail estimation	4.42	1	4.29	2	4.67	1	4.46	1
2	Conceptual estimation	4.33	2	4.35	1	4.33	2	4.34	2
Degree of price estimation type application based on function									

## Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects

No	Price estimation stage	Contractor		Client		Consultant		Average	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Bid	4.33	1	4.29	1	4.29	1	4.31	1
2	Control	2.33	2	2.35	2	2.33	2	2.34	2

### 4.3 Desk study Analysis & Discussion

This section deals with the analysis of desk study gathered from selected 10 new road construction projects that were completed during the past 5 year in Ethiopia.

#### 4.3.1. Major Shortcoming and Limitation in Road construction project

To identify factor affecting price estimation inaccuracy and to provide well-structured approach for price estimating method first it is importance to check existence of price estimation inaccuracy. The existence of price estimation inaccuracy in selected road project was investigated by comparing project contract cost with final completion cost, project planned duration with project completion duration, investigate computer program used for price estimation, precondition considered during price estimation and method of price estimation implemented.

During desk study on selected road project, it is observed there is cost variance and project delay as shown in table 4.32 and table 4.33 those selected project also uses excel as computer program tool rather than heavy bid, stack, Plan swift and AASHTOware. In addition to that all project use Bottom-up price estimation method rather than advanced price estimation method like artificial neural network. Using road construction price type together with work breakdown structure, planning and construction method statement during price estimation provide advantage such as increased accuracy, improved transparency and communication, enhanced risk management and provide better decision making. Instead of using road construction price type together with work breakdown structure, planning and construction method statement as precondition for price estimation those project give more emphasis for road construction price type.

Achieving the planned detail price estimation during completion of project provide advantages such as improved cash flow, client satisfaction, reduced risk, improved decision-making, project completion on time and enhanced reputation. Achieving the planned project time during

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completion of project provide advantages such as project delivery as promised, reduced client risk, stronger risk management, increased revenue potential, reduced prices and improved resource allocation. Instead of those benefit in the studied project there is project delay.

According to several literature review and questionnaire response from this study to achieve accurate price estimation construction contracting companies should implement advanced price estimation method such as ANN instead of bottom-up price estimation method because using advanced price estimation method like artificial neural network provide learning and adaptability; data-driven insights: efficiency for large projects and consider complexities and non-linearities of project. Bottom-up estimating remains a valuable tool, especially for smaller projects or when a clear understanding of price breakdowns is crucial. It is also better to use computer program like heavy bid, stack, plan swift and AASHTOware rather than excel because they provide more specialized features for quantity takeoff, material databases, price databases, proposal generation, industry standards integration, bid price data and provide collaboration features for estimator. Excel is sufficient for very basic price estimation but, for large road construction projects, HeavyBid, stack, Planswift and AASHTOWare offers significant advantages in terms of automation, efficiency, accuracy, and collaboration features. The price and learning curve associated with HeavyBid need to be weighed against the time saved and increased accuracy it provides.

Planning and construction method statement should also be considered in addition to work breakdown structure as precondition for price estimation. The desk study on selected road project showed that there is lack of implementing the above-mentioned technique to increase price estimation accuracy and there is also significant cost variance and project delay in selected project. These show that existence of challenges to achieve price estimation accuracy in selected road construction projects.

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Table 4.32 Selected project cost information

No.	Name of projects	Project Contract cost	Cost of Addition or omission in project	Project Actual completion cost	Cost overrun	Cost overruns (In percent)
1	Koka Adula - Debre Zeyte	613,165,000.00	49,338	710,788,012.18	97,573,674.18	15.91
2	Belta – Otololo	623,018,347.29	No	792,759,126.55	169,740,779.26	27.24
3	Dicota Galafi Megenteya Elidar Belho	1,731,381,614.00	-262,293,348	1,290,638,408.74	-178,449,857.26	-10.31
4	Morcho – Dimtu – Bitna – Dilbo - Sodo/con 1	995,018,921.34	No	1,045,318,921.34	50,300,000.00	5.06
5	Sugar factory project 2-1 Hana	651,111,223.66	No	670,924,450.59	19,813,226.93	3.04
6	Babilye - Fike (Lote - 4)	447,937,109.98	No	493,104,693.70	45,167,583.72	10.08
7	Jara Gedo – Debre Tabor	1,256,390,355.02	-66,002,661.01	1,223,385,491.01	32,997,797.00	2.63
8	Sanja- kera kere	1,352,642,535.82	140,294,284.56	1,632,936,820.37	139,999,999.99	10.35
9	Ddigsa –Yalo	1,146,340,445.02	-67,142,748.01	1,457,387,694.01	378,189,997.00	32.99
10	Dima- Rad Bridge	926,796,267.00	No	889,573,230.00	-37,223,037.00	-4.02

Source: Compiled by Author

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Table 4.33 Selected project duration information

No.	Name of projects	Planned completion time (in days)	Actual completion time (in days)	Project delay	Project delay (in percent)	Status completed or in complete
1	Koka Adula - Debre Zeyte	648	857	209	32.25	Completed
2	Belta – Otolu	721	794	73	10.12	Completed
3	Dicota Galafi Megenteya Elidar Belho	1170	1305	135	11.54	Completed
4	Morcho – Dimtu – Bitna – Dilbo - Sodo/con 1	913	1114	201	22.02	Completed
5	Sugar factory project 2-1 Hana	742	901	159	21.43	Completed
6	Babilye - Fike (Lote - 4)	715	925	210	29.37	Completed
7	Jara Gedo – Debre Tabor	1096	1247	151	13.78	Completed
8	Sanja- kera kere	1096	1375	279	25.46	Completed
9	Ddigsu –Yalo	1024	1078	54	5.27	Completed
10	Dima- Rad Bridge	1036	1047	11	1.06	Completed

Source: Compiled by Author

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Table 4.34 Selected project information

No.	Name of projects	Method of price estimation i.e., parametric, analogous or other	Name of price estimation software used	Factor affecting price estimation accuracy
1	Koka Adela-Debre Zeyte	Bottom- up	Excel	Market condition, Project location, Political instability
2	Belta - Otolu	Bottom- up	Excel	Abnormal Market condition, Project location, Project size
3	Dicota Galafi Megenteya Elidar Belho	Bottom- up	Excel	Political instability, Market condition, Project location
4	Morcho – Dimtu – Bitna – Dilbo - Sodo/con 1	Bottom- up	Excel	Project location, Market condition and Project size
5	Sugar factory project 2-1 Hana	Bottom- up	Excel	Market condition, Political instability, Project location
6	Babilye-Fike (Lote- 4)	Bottom- up	Excel	Political factor, Project location, Market condition
7	Jara Gedo – Debre Tabor	Bottom- up	Excel & Civil 3D	Unable to know material type, Abnormal Market condition
8	Sanja- kera kere	Bottom- up	Excel & Civil 3D	Abnormal Market condition, Project location, Project size
9	Ddigsa –Yalo	Bottom- up	Excel	Project location, Market condition and Project size
10	Dima- Rad Bridge	Bottom- up	Excel	Market condition, Political instability, Project location

# Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects

## i. Investigation of extent of cost overrun

During the desk study, 10 selected road construction project contract cost and actual completion cost was investigated to know extent of cost overrun. Based on the study 8 out of 10 project encounter cost overestimation and 2 out of 10 project encounter cost underestimations. There are factors that cause those cost overrun and those cost overrun is one of cause of price estimation inaccuracy. So, it is important to consider cost overrun factor while performing price estimation. In addition, price management strategies should be improved to mitigate financial risks in future road construction projects.



Fig 4.6. Project contract cost Vs Project completion cost for surveyed projects

## ii. Investigation of extent of project delay

During the desk study, 10 selected road construction project contract duration and actual completion duration was investigated to know extent of project delay. Based on the study all project encounter project delay. There are factors that cause those project delay and those project delay is one of cause of price estimation inaccuracy. So, it is important to consider project delay factor while performing price estimation. In addition, project delay management strategies should be improved to mitigate financial risks in future road construction projects.

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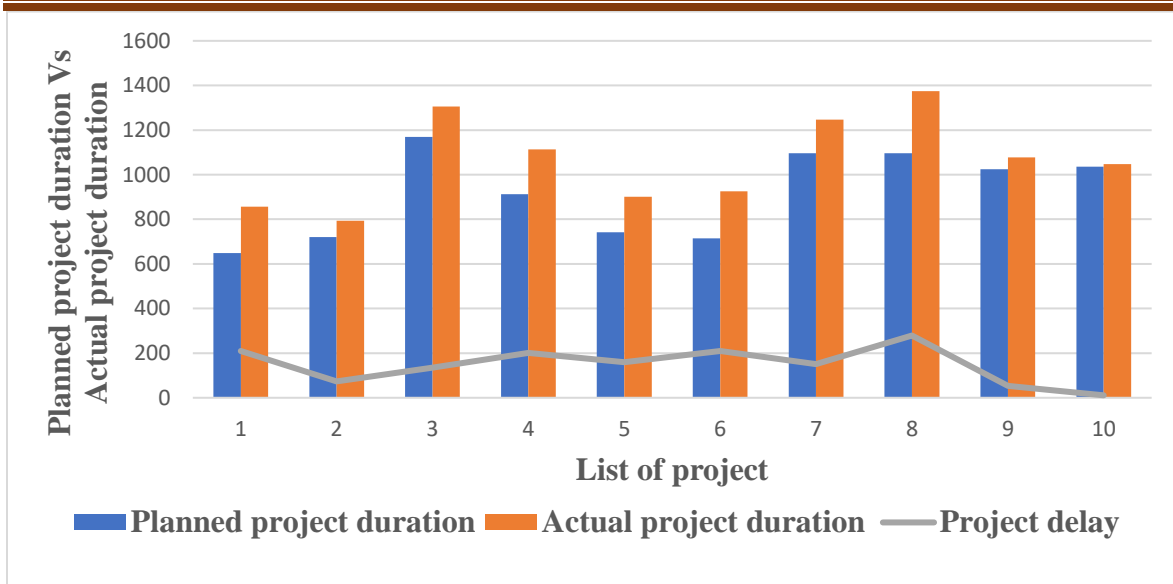


Fig 4.7. Project contract duration Vs Project completion duration for surveyed projects

### iii. Correlation between cost overrun and project delay

The correlation between cost overrun and project delay help to focus on specific area such as inefficient project management, inadequate planning, unforeseen challenges or inadequate estimation method that contribute to both cost overrun and project delay. In addition, correlation between cost overrun and project delay help to identify and quantify project risk more effectively. As cost overrun and project delay cause inaccurate cost estimation knowing those factors causing cost overrun and project delay help to propose specific adjustment to price estimation methodologies that account potential cost and time variation and also to recommend development of more accurate and reliable price estimation model.

The result in Table 4.35 indicates that there is positive correlation between cost overrun and project delay with significance value ( $p$ ) of 0.983 and Pearson correlation ( $r$ ) = 0.008 show positive correlation. Positive correlation between cost overrun and project delay in Table 4.35 indicate that internal and external project factor are causing both cost overrun and project delay. So, price estimation should be focused on both cost and time related factor to increase accuracy of estimation.

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Table 4.35. Correlation coefficients of variable

		Cost overrun	Project delay
Cost overrun	Pearson correlation	1	0.008
	Sig. (2- tailed)		0.983
	N	10	10
Project delay	Pearson correlation	0.008	1
	Sig. (2- tailed)	0.983	
	N	10	10

The correlation between cost overrun and project delay can be also illustrated with rate of cost overrun versus rate of project delay as shown in Fig 4.8. As Fig 4.8 illustrates a positive relationship between the rate of cost overruns and the rate of project delays, as indicated by the R-squared value. This suggests that changes in one variable significantly predict changes in the other. The regression line ( $y = 0.0063x + 17.171$ ) suggests a slightly positive slope, its minimal impact is evident in the overall distribution of the data.

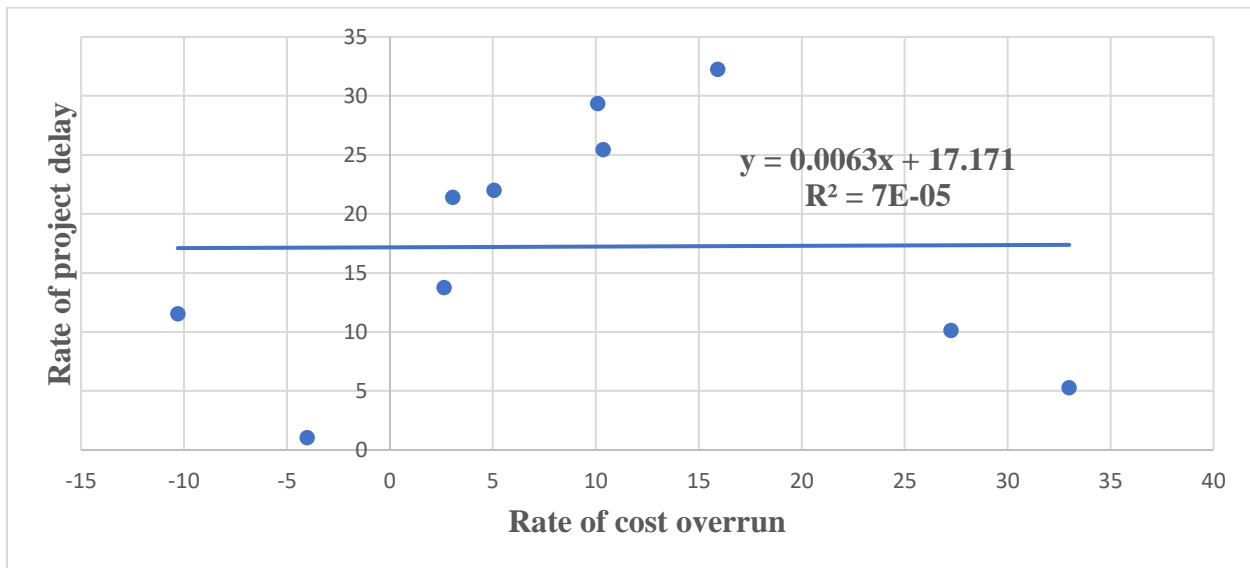


Fig 4.8. Rate of cost overrun Vs Rate of project delay for surveyed projects

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### **4.3.2. Price estimation process**

In order to assess computer program implemented for price estimation and factor affecting price estimation accuracy and then to provide well-structured approach for contracting parties desk study was performed on price estimating process in selected DBB road projects. So, the desk study identifies price estimation process in those selected project that include price estimation method, source of price estimation, computer program used for price estimation, database technique for price estimation and application of price estimating stage.

Based on desk study as shown in table 4.34 there's no Machine learning method used for price estimation in these selected projects. Even if the choice of method should depend on project characteristics and available data most of project under study use bottom-up estimation. While implementing bottom-up type of price estimation method excel is used as computer program instead of modern software package like heavy bid, stack, plan swift and AASHTOware. This indicate there is lack of implementing new technology and due to that the occurrence of price estimation inaccuracy is not minimized since excel do not have better features as those of latest software packages. As Heavy bid, stack, plan swift and AASHTOware provide more features with pre-built library material, labor and equipment price; integration with other software and also bidding and reporting tools.

The desk study also indicates that considering type of road construction price given emphasis rather than using type of road construction price together with work breakdown structure, planning and construction method statement as precondition for price estimation method. Even if WBS provide Structured hierarchy to identify and estimate individual price components easily, using WBS together with CMS and planning provide Comprehensive understanding about the project, Enhanced accuracy of estimation, Improved risk identification, promotes better communication and alignment among project stakeholders, as they share a common understanding of project scope, methods and price implications. Historical database was used as source of price estimation software on studied projects. Even if Historical databases contain actual project price data from completed projects using historical database together with construction price handbook provide accuracy, improved risk assessment, increased efficiency and confidence, improved communication and collaboration between stakeholder that means using both resources foster

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better communication and collaboration among project stakeholders by providing a shared understanding of price drivers and potential risks. Database techniques used in price estimation process was also studied and based on the study local market survey i.e., updating the database when there is noticeable price change within Ethiopia was used instead of financial indices. Even if financial indexes such as construction price indices published by international organizations might not accurately reflect local market conditions in developing countries using local market survey together with financial index provide accuracy, improved Risk Management and scenario planning for better understanding inflation and economic impacts and to Increased Transparency and Credibility.

Moreover, the project studied in this research are estimated with all price estimating stage that include prepare base estimate, review base estimate, document estimate, conduct independent review and obtain management while independent review is conducted by highly experience expert within company. Even though it is important to identify and document major factor affecting price estimation as those factors affect the next project price estimation process. Professional who involved on project response there is no clear and well-organized document that state those factors.

### **4.4 Comparison of Questionnaire response and Desk study Analysis and Discussion**

The study used both questionnaire response from professional and comprehensive desk study and then by triangulating response from questionnaire with desk study comprehensive understanding of price estimation method was gained in Ethiopian road construction.

#### **A. Major shortcoming and limitation during price estimation**

- From desk study most of studied project encounter cost overrun and project delay that was due to inaccurate price estimation and respondent response from questionnaire strength desk study by indicating existence of price estimation inaccuracy in federal road projects.
- The frequent type of price estimation from the respondent response is price underestimation and desk study on ten projects showed that eight project encounter price underestimation that was due to giving less emphasis for extra work.
- Price estimation inaccuracy in federal road project was due to limitations such as lack of data collection and insufficient cooperation between road projects participate as indicated in the

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questionnaire analysis. During desk study professional that was participated in studied project mentioned existence of lack of data collection and insufficient cooperation between project stakeholders that strength questionnaire response.

- In order to estimate price respondent response, they give more emphasis for construction price type than WBS, CMS and planning and also desk study showed road construction price type and WBS is considered rather than planning and CMS that was by considering CMS and planning have not much influence but it is better to use all together because as project size increase the effect of CMS and planning on price estimation become high.
- The respondent indicates cost overrun and project delay are major problem due to price estimation inaccuracy. Desk study also showed that all project understudy encounter cost overrun and project delay. So, it is better to mitigate limitations that have effect on price estimation inaccuracy to minimize cost overrun and project delay.

### **B. Factor affecting price estimation accuracy**

- The study also identify project size and project location are major internal factor affecting price estimation accuracy; market conditions and external event like environmental conditions are major external factor affecting price estimation accuracy from respondent response. During desk study professional who was participate on project mentioned project size and market condition are major factor affecting price estimation but those factors affecting price estimation accuracy are not well-documented. So, to achieve accurate price estimation in the future project road construction contracting parties should study factor affecting price estimation at each project in detail and document it for future project price estimation.

### **C. Computer aid price estimation**

- In this study the respondent indicates bottom-up price estimation was used instead of machine learning price estimating method. The desk study also showed that all project understudy use bottom-up price estimation.
- The respondent response and desk study indicate excel is used as price estimation program rather than advanced program like heavy bid and plan swift. This indicates that there is lack

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of computer package program. Even though Ethiopian Road Administration use ERAMs that is online program to estimate price in the past, ERA is not currently using ERAMs due to some modification for better accuracy. So, to achieve accurate price estimation implement advanced price estimation method as they have many features to get accuracy.

### **D. Well-structured approach for price estimation**

- The desk study indicates existence of price estimation database with historical project data source. The respondent also mentioned historical project data is major source for price estimation that strength desk study result.
- The study shows there is no specialized group for price estimation but there should be specialized group because estimator will give more emphasis for each work that increase accuracy of price estimation.
- From desk study independent review is conducted within company and also respondent response indicate independent review is not performed always during price estimation.

**CONCLUSIONS AND RECOMMENDATIONS**

**5.1. Conclusions**

In conclusion, this research work has comprehensively investigated the shortcomings and limitations of price estimation method in road construction projects, identified key factors affecting accuracy of price estimation, explores available computer program for price estimation and ultimately proposes a well-structured approach for minimizing future price estimation problems for construction parties.

1. The finding of study showed existence of project price underestimation than overestimation; lack of data collection and documentation as major limitation; earthwork as more susceptible stage of road work than other to price estimation inaccuracy. In addition, cost overrun is a major problem than project delay, poor project quality and stakeholder dissatisfaction. The result of desk study also showed existence of significant cost overrun and project delay.
2. The other finding of study showed that project size and project location are major internal factor; market condition and external event like environmental change are major external factor affecting accuracy of price estimation. Hence more attention should be given to those factors as they affect accuracy of price estimation. Furthermore, desk study indicates there is no clear and well-organized document about factor affecting price estimation accuracy of selected projects.
3. The finding of study showed that usage of bottom-up price estimating method rather than advanced price estimation like ANN in Ethiopia. It also indicates excel is used for price estimation instead of computer program like heavy bid, stack, plan swift and AASHTOware. In addition, the study indicates advantage of using computer program to perform accurate price estimation for project that required complex formula.
4. The finding of study from respondent showed that there is no specialized group for each road work activity price estimation process. There is also positive correlation between stakeholders about ways to increase price estimation accuracy. In addition, the desks study

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also strength the respondent response on lack of using advanced price estimation method and latest computer program.

### **5.2. Recommendations**

Based on finding of study the following recommendation was given to stakeholder involved on price estimating process in road construction project to increase price estimation accuracy.

1. To alleviate major shortcoming and limitation occur during price estimation it is essential to implement all precondition for price estimation i.e., WBS, Planning and CMS; perform price estimation in each project development from planning to bid submission; increase availability of data and documentation; improve cooperation between estimators and also provide training for estimator.
2. Identify each factor affecting price estimation accuracy and document each factor for other future project price estimation to minimize problem such as cost overrun, project delay, poor project quality and stakeholder dissatisfaction that occur due to inaccurate price estimation.
3. In order to increase accuracy of price estimation implement advanced price estimation method such as ANN, use latest computer program such as Heavy bid, stack, plan swift and AASHTOware instead of excel as they provide more features with pre-built library of material, labor and equipment price; integration with other software and also bidding and reporting tools.
4. All stakeholders should implement well-structured approach to increase accuracy of price estimation by using specialized group for price estimating each type of road work; performing independent price estimation check; perform all price estimating stages i.e. prepare base estimate, review base estimate, document estimate and independent review the estimate

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## **Appendix A**

### Questionnaire

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construction Projects**

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**ADDIS ABABA UNIVERSITY  
SCHOOL OF GRADUATE STUDIES  
ADDIS ABABA INSTITUTE OF TECHNOLOGY  
SCHOOL OF CIVIL AND ENVIROMENTAL ENGINEERING**



**Study on price estimating method in selected Ethiopian Road  
Administration Construction projects**

**BY: GEDIYON ADDIS**

**ADVISOR: Prof. (Dr. ing.) Abebe Dinku**

**FOR PARTIAL FULFILLMENT OF M.Sc. DEGREE IN CIVIL  
ENGINEERING**

**(MAJOR CONSTRUCTION TECHNOLOGY AND MANAGEMENT)**

Date of filling the questionnaire\_\_\_\_\_

# **Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects**

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## **Survey Questionnaire**

**Addis Ababa University**

**Addis Ababa institute of technology**

**Masters in construction technology and management**

Dear Respondents this is a deliberate survey for Masters Research work, on study on price estimating method in selected Ethiopia road administration construction projects, in the Department of construction technology and management in Addis Ababa University and your responses are used only for academic purposes, i.e., for writing the thesis. Please note that your personal details or affairs are not required in the survey. Your responses will be secured with a code number only. Please complete all questions because missed responses cannot be included in the analysis.

### **Research objectives**

- To recognize the major shortcomings and limitations of the price estimating method used on road construction projects in Ethiopia.
- To explore factors that have impact on the accuracy of price estimating and evaluate agreement between different project stakeholder on ranking those factors on road construction project in Ethiopia.
- To assess the level of computer-based price estimating software usage on road construction projects in Ethiopia.
- To provide the contracting companies i.e., client, contractor and consultant with a structured approach or techniques to minimize the problems such as cost overrun, project delay and delivering poor quality that occur due to inaccurate price estimating process.

Thank you in advance for your heartfelt cooperation

Instruction for completing the Questionnaire

- Please put “√” mark on the space provided to indicate your response where applicable

Post Graduate Student, Construction Technology and Management

A.A University, Institute of Technology, School of Civil and Environmental Engineering

Gediyon Addis

Phone No.: 0921029015

Email: gediyone@gmail.com

# Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects

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## Section 1: General Information about Respondents

1.1. Company Name (optional): \_\_\_\_\_

1.2. Type or origin of your organization (where applicable, please mark with a "√")

A. Client  B. Contractor  C. Consultant

1.3. Year of establishment of the organization you have been working in:

A. 5-10 years  B. 11-15 years  C. 16-20 years  D. >20 years

1.4. What is your role in organization that you have been working?

A. Project Manager  B. Resident Engineer

C. Site Engineer  D. Office Engineer  E. Contract Administrator

1.5. What is your educational status?

A. B.Sc.  B. M.Sc.  C. Ph.D.

1.6. For how many years you have been involved in the road construction projects?

A. Less than 5 years  B. 6-10 years  C. 11-15 years  D. 16-20 years

E. More than 20 years

## Study on Price estimating Method in Selected Ethiopian Road Administration construction Projects

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### Section 2: To recognize the major shortcomings and limitations of the price estimating method used on road construction projects in Ethiopia.

1. Do you believe there is accurate price estimation method in company you have been working?

Yes                       No

2. How would you compare the project's completion price to its detail price estimate based on your experience with road construction projects? Rate the degree of occurrence the following using a 5-point scale.

Where 1= never occurred 2= rarely occurred 3= sometimes occurred 4= often occurred  
5= always occurred.

No.	Final project price Vs. Detail price estimation	1	2	3	4	5
1	Final project price exceeds Detail price estimation range (Underestimation of prices)					
2	The project total price falls within the Detail price estimate range (Price estimated within the range)					
3	The price to complete the project is less than the detailed price estimate (Overestimation of prices)					

3. What is your argument on the effect of following limitation during price estimation in your organization?

1= strongly disagree    2= disagree    3= neutral    4= agree    5= strongly agree

No.	Limitations	1	2	3	4	5
1	Inadequate availability of data					
2	Absence of uniform methods for price estimation					
3	Inadequate tools or software for price estimation					
4	Inadequate systems for monitoring and tracking price					
5	Inadequate expertise and training of estimators					
6	Insufficient interaction and cooperation between project participants					
7	Lack of data collection and documentation					

4. How do you rate usage of the following precondition for price estimation method in your organization?

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1=less frequent 2= moderate frequent 3=frequent 4=high frequent 5= very high frequent

No.	Precondition for price estimation	1	2	3	4	5
1	Planning					
2	Construction method statement					
3	Work breakdown structure					
4	Road construction price considered during estimation					

5. Which stage of work frequently or most of the time be susceptible for inaccuracy of estimated price because of inaccurate quantity variation and omission of some item?

- A. Site clearance                      B. Earthwork                      C. Base and subbase course work  
 D. Asphalt work                      E. Ancillary & Miscellaneous work

6. What is degree of application of following price estimation type based on project development level, accuracy and function in your organization?

1= never used 2= rarely used 3= sometimes used 4= often used 5= always used

Criteria for price estimation	Type of price estimation	1	2	3	4	5
Project development level	Planning					
	Scoping					
	Design					
	Plan, specification					

Criteria for price estimation	Type of price estimation	1	2	3	4	5
Accuracy	Conceptual estimation					
	Detail estimation					

Criteria for price estimation	Type of price estimation	1	2	3	4	5
Function	Bid					
	Control					

7. How do you rate occurrence of following problem due to inaccurate price estimation?

- 1= never occurred 2= rarely occurred 3= sometimes occurred 4= often occurred  
 5= always occurred

No.	Problem due to inaccurate price estimation	1	2	3	4	5
1	Cost overrun					
2	Project delay					

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3	Poor project quality					
4	Stakeholder dissatisfaction					

**Section 3:** To explore factors that have impact on the accuracy of price estimating and evaluate agreement between different project stakeholder on ranking those factors on road construction project in Ethiopia.

1. What is your response about following factor that have impact on price estimation method?

Degree of argument 1= strongly disagree 2= Disagree 3= Neutral 4= Agree 5= Strongly agree

Degree of influence 1= very low 2= low 3= moderate 4= high 5= very high

No.	Major factor	Factor	Degree of argument					Degree of influence				
			1	2	3	4	5	1	2	3	4	5
1	Internal factors	Project size										
		Project type										
		Project duration										
		Project location										
		Construction site conditions										
		Construction methods										
		Subcontractor-related factors										
		Estimation tools and Techniques										
		Price estimator experience										
3	External factors	Market Conditions										
		Regulations and permits i.e., environmental regulation and permitting process delay										

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		Logistics and Supply Chain											
		External Events i.e., political instability and force majeure											
		Bidding Competition											

**Section 4:** To Assess computer-based price estimating software used on road construction projects in Ethiopia and also recommend to use computer-based software if do not used.

1. How do you rate degree of application of the following price estimation methods?

Where 1 never used, 2 rarely used, 3 sometimes used, 4 often used, 5 always used.

No.	Major price estimating type	Methods of price estimation	1	2	3	4	5
1	price estimating type	Analogous estimating (applying values from comparable previously finished projects)					
		Parametric estimating (using mathematical relationships between relevant variables)					
		Bottom-up estimating (Estimating every component in detail)					
		Three-point estimate (using formulas to account for variability and uncertainty to increase accuracy)					
		Risk based price estimation (taking potential risks into account)					
		Artificial Neural Network					

2. From your point of view are there any computer programs implemented in your company for price estimation?

Yes

No

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3. If the answer for above question is yes what is degree of application of following program for price estimation?

1= never used 2= rarely used 3= sometimes used 4= often used 5= always used

No.	Programs	1	2	3	4	5
1	Excel					
2	Heavy Bid					
3	Stack					
4	Planswift					
5	AASHTOWare Project Estimation					

4. What is your argument about the following advantage gain by using computer-aid price estimating program used in your organization for road construction price estimation process?

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

No.	Advantage gain by using computer-aid price estimating program	1	2	3	4	5
1	It includes databases with resources and price information unique to road construction.					
2	It effectively handles complex calculations and formulas required for accurate price estimation.					
3	It is possible to assess risks and uncertainties in price estimation.					
4	It provides tools for continuous data exchange.					
5	It provides Reporting and visualization capabilities for presenting price estimates to stakeholders.					

**Section 5:** To provide the contracting companies i.e., client, contractor and consultant with a structured approach or techniques to minimize the problems such as cost overrun, project delay and delivering poor quality that occur due to improper price estimating method.

1. Based on your experience working on road construction projects, does road construction company used specialized groups—such as structural, right-of-way, environmental, geotechnical, etc.—that provide particular portions of estimates rather than having one group of teams complete the entire estimation process?

A. Never used       B. Rarely used       C. Sometimes used

D. Often used       E. always used

2. Does your company have a price estimating database? Yes       No

3. If yes, what is the primary source of your company estimation database?

A. Historical project data       B. government agency

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C. specialized price estimation software

D. Construction price handbook

4. How do you suggest importance of following database techniques in price estimation process?

1= less important 2= moderate important 3= important 4= highly important 5= very high important

No.	Technique	1	2	3	4	5
1	Standardize price database (Road materials labor and plant database)					
2	Local market survey (updating the database because there has been a noticeable price change)					
3	Analyzing historical data (updating the database when project estimates are updated)					
4	Financial indices (Directly updating the database in response to any price changes)					

5. What is your argument about following techniques or ways statement to increase accuracy of price estimation?

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

No.	techniques	1	2	3	4	5
1	The application of checklists and templates for standard price estimation					
2	Frequent price estimators' professional training programs					
3	Creating effective channels of communication between project stakeholders and price estimators.					
4	Conducting comprehensive risk assessments and contingency planning.					
5	Using advanced software tools and technologies specifically designed for price estimation.					
6	Implementing quality control measures and conducting regular audits of price estimation.					
7	Developing an extensive database					

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6. What is degree of application of following price estimating stage in your organization?  
1= never used 2= rarely used 3= sometimes used 4= often used 5= always used

No.	Price estimating stage	1	2	3	4	5
1	Prepare Base Estimate					
2	Review Base Estimate					
3	Document the estimate					
4	Conduct Independent Review and Obtain Management Endorsement					