**Ethiopian Institution of Architecture, Building Construction, and City Development (EiABC)**

**Chair of Construction Management**

# Assessing the Current Management Practice of Price Escalation and Its Effects on Cost Performance for Federal Public Building Projects

Saron Gebeyaw

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This thesis is submitted to the Graduate Programs Director of the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC), Addis Ababa University, in partial fulfillment of the requirements for the Master of Science Degree in Construction Management.

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Author: Saron Gebeyaw Alemu

Advisor: Dr. Solomon Sertse Desta

June 2025

Approved by the Board of Examiners:

| Department | Signature | Date |
|---|---|---|
| _____ | | _____ |
| _____ | | |
| Advisor | Signature | Date |
| _____ | | _____ |
| _____ | | |
| External Examiner | Signature | Date |
| _____ | | _____ |
| _____ | | |
| Internal Examiner | Signature | Date |
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# DECLARATION

I declare that I have prepared this thesis, "Assessing the Price Escalation Management Practice and Its Effects on Cost Performance for Federal Public Building Projects," to partially fulfill the requirements for the Masters of Science in Construction Management degree. It is my original research work, prepared independently by my effort with the close guidance and supervision of my advisor. Furthermore, I confirm that this thesis has not been presented for a degree in any university and that every source I cited or used was properly cited.

Declared by: Saron Gebeyaw Alemu

Signature: _____

June 2025

## CERTIFICATION

Here, I state that Saron Gebeyaw Alemu has carried out this research work on the topic entitled "**Assessing the Current Management Practice of Price Escalation and Its Effects on Cost Performance for Federal Public Building Projects**" under my supervision and it is sufficient for submission for defense.

Dr. Solomon Sertse Desta

Signature: _____

Date: _____

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# ABBREVIATIONS

| | |
|---|---|
| CSFs: | Critical success factors |
| DBB: | Design-build delivery method |
| ECSA: | Ethiopian Central Statistics Agency |
| ENA: | Ethiopian news agency |
| KPI: | Key performance indicators |
| PM: | Performance measurement |
| UK : | United kingdom |
| ECA: | Ethiopian construction authority |
| AADCWB: | Addis Ababa design and construction works bureau |
| IMF: | International monetary fund |
| UNECA: | United nation economic commission for Africa |
| MoWUD: | Ministry of Works and Urban Development |
| PMBOK: | Project Management Body of Knowledge |
| PPA: | Public procurement Agency |
| FIDIC: | Fédération Internationale Des Ingénieurs-Conseils |
| GDP: | Gross domestic product |

# ABSTRACT

*In a country like Ethiopia, the construction sector is one of the major contributors to national growth. Despite its importance in one country growth its performance, the industry has faced many challenges during the last few years. One of the major reasons identified by different researchers is price escalation in the inputs of the construction projects. This study assesses the management practice of price escalation and its effect on the cost performance of federal public building projects. The research is descriptive and explanatory in nature and employed a mixed-method approach (both qualitative and Quantitative) with case study methodology. Four suitable cases from Universities located in Addis Ababa city were selected, and document review was used as a data collection instrument and utilized both primary and secondary data. For analyzing the collected data, the researcher used content and thematic analysis with within case analysis and cross-case analysis. In addition to these, the researcher uses four themes for analyzing the data: a description of the case, identifying the increment of major materials, labor, and equipment, assessing the effect of price escalation on each project's cost performance, and identifying the price adjustment techniques, source of price, and weightage for each project. The study investigates the impact of material price escalation on the cost performance of selected construction projects. Price increment were analyzed across various activities in both substructure and superstructure elements. In Project A, the maximum increment in the substructure was 49% for the 500 mm thick mat slab, while the superstructure's 180 mm thick floor and roof beams experienced an escalation of 89%. For Project B, the substructure's 200 mm thick suspended ground floor slab showed the highest increase at 85%, with a similar escalation of 88% seen in the superstructure's 270 mm thick flat roof slab. Project C recorded an 84% increment in the foundation pad for the substructure, while the 180 mm thick roof slab led in the superstructure with an 87% increase. And also in Project D, the footing in the substructure had the greatest escalation at 91%, alongside the superstructure's elevation column, which increased by 88%. And also, the results showed that there were different management practices used by contractors to overcome the challenges of price escalation. To enhance effectiveness, the study recommends early implementation of contractual adjustments and proactive cost management strategies in building projects. In the future, studies should focus on regularly developing construction resource price indices, analyzing the influence of finishing material cost fluctuations on project outcomes, and evaluating the contractor's cost structure to better address non-adjustable contract elements.*

*Key word: construction; Cost Performance; Price escalation*

# CHAPTER ONE: INTRODUCTION

## 1.1. Background of the Research

A country's development is considerably dependent on the construction industry. Studies conducted on the construction industry in developed and developing countries generally emphasize its role in economic growth (IMF, 2013; World Bank, 2022; UNECA, 2020). In Ethiopia, the construction industry is expected to be a key driver of the country's economic growth, with Ethiopia's GDP expected to grow by 5.2% (World Bank, 2022).

The construction industry transforms a wide range of resources into the physical, economic, and social infrastructure needed for socioeconomic advancement. Moreover, it is known for being complex because of the involvement of many parties and professionals (including architects, engineers, contractors, suppliers, financiers, and others), the requirement of many resources, the fact that each project is unique by itself, etc. UNECA (2018) published that despite having a big impact on the country's economic growth, the industry still has many performance problems. Maintaining high performance in each project is essential for project success.

Measurement of performance is crucial to all projects and provides the basis for continuous performance improvement. Critical success factors and Key Performance Indicators (KPIs) are a collection of measurements used to assess how well a construction process is performing. Many KPIs are used to measure overall performance in construction projects, and different scholars in construction studied them for several years.

Iron Triangle criterias are the the first and most commonly mentioned key performance indicators of project performance throughout all industries (Barnes, 1996). However, addition to cost, quality, and time, many other researchers have looked into a variety of other performance indicators for construction projects (Chan, 2003; Enshassi, et al., 2009; Dawood et al., 2006; Cheung et al., 2004).

From literature, the most commonly used KPIs that are used to measure the performance of construction projects in Ethiopia are cost, time, quality, client satisfaction, and health and safety (Tadesse et al., 2016; Solomon et al., 2021; Tagess,

2017; Benti & Hong's, 2021). Moreover, in studies, the results show that performing construction projects within the allocated cost, time, and quality that have been stated is poor and getting increasingly difficult (Solomon et al., 2021).

The study conducted by Tadesse et al. (2016) mentioned that Ethiopia is a second last followed by Mozambique which indicates that the management practice in Ethiopia is even far behind those poor- performing developing countries in Africa. How effectively these projects worked in comparison to expectations was measured and evaluated using a wide variety of performance indicators that might be related to several dimensions (groups), including time, cost, quality, client satisfaction, business performance, health and safety. There are different factors, which contribute to the problem.

According to Benti & Hong's (2021) study, ten factors (inadequate performance of contractors, poor site management, poor project management skills, delayed payment, poor project plan, incomplete design, poor project schedule, poor cost management, the rising market price of construction inputs, and devaluation of currency) are sated as the reasons for poor performance in public construction of Ethiopia.

From KPIs (time, cost, quality, client satisfaction, business performance, health and safety etc) of project performance, this study focuses on cost and its performance-related issues.

Cost is a crucial factor and is seen as one of the most critical parameters of a project and the driving force of project success throughout the project management life cycle (Azhar et al., 2008)

Cost of construction refers to the total expense incurred by a project from its beginning to its completion, including any costs associated with variations, modifications made during construction, and costs associated with legal claims, such as those associated with litigation and arbitration (Chan & Chan, 2004). To keep the health of the projects cost, maintaining cost performance of the project in each phase is mandatory. It is the critical issue that needs great attention in construction project which is reported as one of the major problems for project performance globally (Zarina et al, 2014; Chen et al, 2016).

Cost performance defined as finding no difference between projects' budgeted or initial cost estimate and, in some situations, spending less than the estimate. The cost difference between the final contract amount and the initial contract sum may be express as a percentage (Mckim, 2000). However, finding differences between projects' budgeted or initial cost estimate is not clearly indicating the performance of projects so it should be measure with different cost performance indicators. Some of the indicators are; cost estimation accuracy, project design cost, cost of rework level, cost of variation orders controlling mechanism, regular project budget update etc. They are used to determine whether the project is proceeding within the allocated budget or whether it is in line with the real cost. To ensure that the cost of construction remains within the budget and achieve good cost performance, it is crucial in the construction sector to control project costs. To keep the project within the allocated budget, project cost management is therefore required.

Major cost management processes are cost management plan, cost budgeting, cost estimate, Managing cost and cost control interact, with one another and with the other project management pillars of construction projects. Unless the construction management team develops an effective cost management plan and completes all tasks as outlined in the plan, the project will face a cost overrunning issue. Cost overrun arises when the project's actual cost or expenditure exceeds its planned budget (Avots, 1983). It is a problem that both developed and developing countries may face.

Construction cost overrun defined as the difference between forecasted and actual construction costs (Lee, 2008). Abdulkadir, et al., (2020) found that construction cost overrun is a common concern in the construction industry, with constant increases in project costs causing major problems with the efficiency of work contracts and their performance in construction projects.

In building construction, inaccurate or poor estimation of the original cost; escalation of project costs; improper planning fluctuation in raw material price; poor project management; lack of experience; unforeseen site conditions; a design error; insufficient funds; poor contract management; high cost of machinery; construction cost underestimation; various elements that contribute to cost overruns (Angelo & Reina, 2002). Similarly, Ibrahim & Nabil's (2013) study result showed that the top five factors that experts believe have the most impact on cost overruns in building

construction projects are: the political climate, changes in the cost of materials and labor, the intensity of competition, the state of the currency market, and economic instability. The reasons for cost overruns are varied in countries, even though some of them are universal, such as poor management, fluctuating material prices, inaccurate material estimates, and contractor financial health (Shambalid et al., 2017).

Significant cost overrun factors have been detected in Ethiopia public building construction projects by different researchers. From survey study of contractors, the top five variables that lead to cost overruns in construction projects are, in descending order, poor planning, fluctuating material prices, low productivity, inflationary pressure, and project financing (Zinabu & Getachew, 2015). Other research found that material price strike, poor cost escalation, late raw materials delivery, and ambiguous contract documents were the top sources of cost overrun (Ashebir et al., 2017). Additionally, Nege (2008) in his research stated that, poor planning and coordination, change orders due to client-requested additions, excess quantity during construction and a rise in the cost of building materials, labor, and machinery are some of the consequences. The first five most critical cost factors agreed upon by all stakeholders, according to Aschalew (2017) study, are an escalation of material price, completeness of design, variation order, and speed of decision-making and initial budget estimate.

Generally, from different studies in different countries the causes for cost overrun inaccurate or poor estimation, escalation of project costs due to construction materials and labor, poor contract management and poor planning the most mentioned ones.

From the factors studied by local and foreign researchers, increasing (escalation) in the price of construction inputs that leads to an overrun of project costs is mentioned as a major cause.

Price escalation is a term that describes a steady increase in the price of a certain product, goods, or service because of a combination of inflation, supply/demand, and other factors. Construction price escalation is referred to as unexpected increases in the cost of construction inputs like material, labor, and equipment (Williams, 1999).

Different scholars like, Gangwar (2020), Jennifer et al. (2009) have emphasized the risk of price escalation that occurs in construction projects and it is the major phenomenon that is almost associated with all construction projects all over the world. In Ethiopia scholars like, Andualem (2020), Teshome (2021), and Yuzu (2008), have underlined the risk of price escalation that occurred in construction projects.

Generally, different scholars and early attention to its cause's state price escalation as major problem and effect on project performance will help to reduce cost rise throughout the bid process or during construction. Its management should be used throughout the project life cycle. To manage the problem of price escalation contract related issues, bulk material purchase, buyer-supplier partnership, and use of local materials are some of the major mechanisms mentioned by different scholars. Nevertheless, price adjustment clauses are the most used mechanisms in most countries regarding price escalation problems. The situation in Ethiopia in terms of price adjustment has evolved from MoWUD1994 to PPA 2011. Each type of price adjustment comes with its own set of constraint.

## 1.2. Research Problem Statement

Price escalation is the concept that the estimated cost during project planning or constructing will rise when the cost of materials, labor, equipment, and other building inputs rises in future periods (Chen & Zhang, 2020; Love et al., 2016; Gangwar & Kalidindi, 2020; Jaeger, 1996; Lock, 2003).

Many scholars like Gangwar (2020), Arditi et al. (1985), Jennifer et al. (2009) from aboard; Andualem (2020), Teshome (2021), and Yuzu (2008) from local researchers emphasize that the major cause of cost overrun is escalation in the price of construction inputs (materials, labor, and equipment).

- Gangwar (2020) stated that, price escalation (in materials, labor, and machinery) is a common issue in the construction industry and it becomes the cause increasing of construction cost overruns claims, and disputes in some projects it is also the cause of time overruns.
- Jennifer et al. (2009) have highlighted the risk of price escalation in building projects; it is a significant phenomenon that is almost always associated to all construction projects globally.
- Similarly, a study conducted in Turkey by Arditi et al. (1985) shows that increase in material costs and labour costs were one of the major causes of cost overruns.

Ethiopian construction's current situation is changed by the price increases for all construction-related inputs. In addition, it is mentioned as an external economic risk that affects the performance of construction (Andualem, 2020).

Habtemariam (2019) mentioned that the escalation of construction input (labour and material) prices ranked fourth, with a shorter completion period given for the contract, the unavailability of skilled workers, and an insufficient supply of materials ranking from first to third. Additionally, Yehulum and Jain (2023) stated that the main causes of escalation are the demand (consumer indices), shortage of supply (production indices), and monopoly of materials, labour, or machinery, which have a direct and indirect impact on construction projects.Abraham, (2008), Andom (2015), and Mossa (2013) also conducted research on the issue and the following key observations:

- The financial and economic risk, which is associated with the escalation of construction direct costs, is the major risk item that should have been seriously considered by the contractors to get accurate cost estimates. Underestimation of direct costs in cost estimation contributes 25% to cost overruns (Andom, 2015).
- Price escalation is one of the many issues that the construction industry is dealing with, the following consequences: project delays, cash flow (project finance) issues, project termination, and reduced project quality (Mossa, 2013).
- Price escalation is the first ranking factor in the order of influence on contractors' profitability (Abraham, 2008). Since it cuts the contractor's profit leading to higher losses, leaving the project in a bad situation it shall be managed properly.

Ethiopia's construction industry has been struggling with a number of issues with its performance because of the rapid growth in the price of labor, materials, and equipment (Wakjira, 2018; Abebe, 2020; Tessema, 2022). The use of local materials (Skitmore, 1997), the inclusion of price escalation clauses in contracts (Potts and Ankrah, 2008), bulk material purchases (Arditi and Chotibhongs, 2005), buyer-supplier partnerships (Love et al., 2004; Winch, 2000), and material substitutions (Ballard, 2000) are some of the main mechanisms mentioned by scholars to manage the problem of price escalation.

In market assessment & procurement procedure management mechanism, when contractors know that there will likely be a cost escalation, they have options when it comes to purchasing supplies. In order to purchase and prepare supplies in advance, they might want to create a planned delivery and storage plan.

On the other hand, escalation clauses may include in contracts because they are a common way for contracts to control price adjustments. Contractors frequently base their offers on set rates or include estimates of future expenditures in their bids. Nevertheless, the contractor may still bear some financial risk if these modifications are unable to completely cover all cost increases. The cost increases in construction inputs force most contractors to shoulder a substantial additional load, which leads to serious problems during project execution and disputes during contract administration. A risk like price escalation, are usually assigned to the contractor by contract, usually with escalation clauses controlling price-related increases to the contract amount. Furthermore, these provisions may differ from project to project. Price adjustment provisions may not be included in contracts with short delivery periods.

Conditions of Contract for Construction FIDIC (1st Edition, 1999) prescribe that the amounts payable to the contractor shall be adjusted for rises or falls in the cost of labor, goods and, other inputs. The FIDIC's conditions also recommend that the accepted contract amount shall be considered to have included an amount to cover the contingency of other rises and falls in costs. In USA, the escalation clauses are different according to state; the construction price includes a foretasted escalation cost in the bidding stage (Lee, 1998 & Knight, 2000). Full compensation for any rise or fall in costs is not covered. ADB (Asian Development Bank) prescribed that the bidding document indicate whether price adjustments are allowed in the event changes occur in the major cost components of the contract such as labor, equipment, and materials, over which the contractor has no control. Most of the developing countries also have legislation for terms of price adjustment to be followed even when FIDIC is used.

In **Ethiopia**, in government contracts, price adjustment provisions have evolved from MoWUD 1994 to PPA 2011. Each type of price adjustment comes with its own set of

constraints. Except its formula for adjustment, PPA 2011 is the contract that used is currently in most state funded constructions of Ethiopia.

From different scholars' perspectives, like Gangwar (2020), Arditi et al. (1985), Jennifer et al. (2009), and from local researchers like Andualem (2020), Teshome (2021), and Mossa (2013), the researcher concluded that price escalation is a critical issue that requires serious attention and resolution; focusing early on price escalation factors will reduce cost overruns during construction. Although previous research has explored the causes and effects of price escalation and the use of price adjustment clauses, there is a critical gap in recent studies addressing, how these ongoing issues continue to affect the construction industry (Wakjira, 2018; Abebe, 2020; Tessema, 2022). The problem became more significant than ever, highlighting the need attention and effective strategies to reduce cost overruns during construction (EMF, 2023; EMUDC, 2023; ECA, 2023; Ethiopian Herald, 2023; Addis Fortune, 2023). Additionally, there isn't any research that has focused on projects' cost performance and the effect of price escalation on it. Therefore, this research fills the gap by assessing the extent of the price escalation, its effect on the cost performance of projects at the federal university of Ethiopia, the mechanisms and management practices that have been applied to solve it, in addition to the challenges that occur during this process in the case of federal university building projects.

## 1.3. Research Questions

- What is the extent of price escalation in federal building construction projects?
- What management practices are currently used to address price escalation in federal building construction projects?
- How does price escalation affect the cost performance of construction projects?
- How do the current management practices for price escalation compare to recognized best practices in mitigating its major negative impacts?

## 1.4. Objectives of the study

### 1.4.1. General objective

The aim of the research is to assess the price escalation management practice for federal public building projects and its impact on cost performance.

### 1.4.2. Specific objectives

- To investigate the price escalation extents and management practices on federal building construction projects
- To assess the impact of the price escalations on the construction projects' cost performance
- To assess current management practice against best practices for mitigating the major negative impacts

## 1.5. Significance of the Research

Construction industry pricing escalation has badly damaged unprepared suppliers, subcontractors, contractors, and owners financially. The efforts of participants in the construction sector to mitigate, shift, or recover the financial effects of these unexpected and significant price increases resulted in contract losses, projects being delayed, or serious disagreements (Mossa, 2013). The study would be helpful by "assessing the price escalation management practice for federal public building projects and its effects on cost performance". Specifically, the findings of this study have the following implications for, contractors, consultants, and other stakeholders to let them know about the effects of construction price escalation and the gap in current market conditions and it determines how federal building projects face challenges in dealing with this issue. Identifying the major impact of construction price escalation and assessing its management practice helps in improving awareness among different stakeholders (clients, consultants, contractors, and other stakeholders) in facing these problems that may arise in building construction projects. Finally, serves as a benchmark for further studies in related research areas.

## 1.6. Scope and Limitation of the Study

### 1.6.1. Scope of the Study

The study was specifically restricted to price escalation management practice and its effects on cost performance. Despite the fact that the construction projects that contractors undertake might range from simple residential buildings to complicated and heavy ones, the scope of the study has been restricted only to federal public building projects that are engaged in selected ongoing university projects and recently

delivered ones. The study has certain de-limitations in terms of topic, geography, and time.

### 1.6.2. Limitation of the Study

The lack of professional willingness to provide the necessary documents was a major limitation of the research. Another challenge that the researcher faced was the absence of full data on the base price in Ethiopia against which to compare the current price.

## 1.7. Structure of Research Paper

The research paper has studied the assessment of management practices and their effects on cost performance. The paper organized into five chapters, including references and appendices.

**Chapter one: Introduction**: Composed of general information (background of the study) about the study construction, and project performance including its key indicators, cost performance, cost overrun, and price escalation. It also contains the research questions and objectives, significance, scope, and limitations of the study.

**Chapter two: Literature review**: This chapter includes the theoretical background of the subject by reviewing different articles and stating an explanation about the studied area. Mainly, it includes definitions of keywords, reviews of related articles in the area of the study, conceptual framework, and research gap.

**Chapter Three: Research Method:** this chapter is the methodology of the research. It describes the research paradigm, research type, data sources, and analysis techniques developed for the research following the nature of the study.

**Chapter Four: Result and discussion**: presented the data analysis and related discussion. The research's questions as conceptual framework used to discuss the findings.

**Chapter Five: Conclusion and Recommendations:** will present the study's conclusions and recommendations. Following the research questions and objectives, it contains a conclusion from the analysis and discussion of the research.

# CHAPTER TWO: LITERATURE REVIEW

## 2.1. Overview of construction overview

### 2.1.1. Construction Industry

The construction industry, in both developed and developing countries, is defined as the sector of the economy that transforms various resources into constructed facilities through the planning, design, construction, maintenance and repair, and operation (Ofori, 2015; Hillebrandt, 2000). Residential and non-residential buildings, as well as heavy construction, are examples of public and private facilities produced, and these physical facilities play an important and visible role in the development process (World Bank, 2020; UN Habitat, 2021).

Architects, engineers, management consultants, general contractors, heavy construction contractors, special trade contractors or subcontractors, and construction workers are among the major participants in the construction industry, as are the owners, operators, and users of the constructed facility (Oyewobi et al., 2011; Turner & Townsend, 2022). Building finance and insurance companies, land developers, real estate brokers, material and equipment suppliers and manufacturers, and others are all involved in construction as a purchaser, financier, regulator, and adjudicator, the government engages with the industry. Building and related codes, licensing requirements, safety regulations, and financial institution operating norms are examples of the regulatory environment in which the construction industry performs (Wells, 2001; Cheung et al., 2008).

The complexity of the construction industry is the most difficult aspect of doing or executing it. This is due in large part to the industry's diversified nature, which includes its huge size, fragmentation, geographic and product-type dispersion, reliance on a labor force, materials, and equipment that are widely utilized by other industries, and affiliation with various ancillary industries (Hosseini et al., 2018; Eadie et al., 2013).

Even so, the success of construction projects has a significant impact on the country's economic growth. There are many problems with the construction industry as it now

stands, and it is unusual for projects to be completed on time, under budget, and to the stakeholders' desired quality standards.

### 2.1.2. Overview of Construction Sectors Growth in Ethiopia

Over the previous years, Ethiopia's construction sector has seen remarkable progress, with increased investment in the creation and expansion of major infrastructure projects. Road infrastructure construction, real estate developments, and condominium housing projects are among the significant developments. More specifically, the Ministry of Education and Health's public infrastructure development projects and road infrastructure projects account for a significant portion of the investment outlay on construction activities (MoWUD, 2012).

Different segments may be found in Ethiopia's construction industry. These are Sewage and Energy Projects, Real Estate and Building Construction, Railway and Aviation, Road Construction, and Industrial parks. These components of the construction industry make up one of the fastest expanding areas of the Ethiopian economy (Mordor Intelligence, 2020).

The construction building growth of the country is one of the fastest growing sectors in the industry. It includes public, private, and federal buildings. The federal building projects currently have 13 projects that are in different stages of construction, among them National Meteorology Agency, Documentation and Authentication Registration Agency and Ethiopian Leather Industry Development Institute was new (yewondwossen, 2021). The other part of the federal building in Ethiopia is university construction most universities in Ethiopia are building their capacity.

UNECA (2018) published that despite having a big impact on the country's economic growth, the industry still has a lot of performance.

From report on the IRJET (2017), more than 80% of building projects in Ethiopia are delayed and over budget. Improper cost planning and monitoring during the pre- and post-construction phases, improvements to standard drawings during the construction stage, design modifications, inaccurate quantity take-off, changes in the cost of building materials, and a lack of planning and coordination are mentioned as primary causes.

## 2.2. Construction Project Performance

The term "performance" usually refers to the completion of work by the terms of a contract. Performance can be considered as an evaluation of how well individuals, groups, or organizations have done in pursuing a particular goal (Ankrah & Proverbs, 2005).

Successful performance has traditionally been outlined in terms of the delivery of projects on time, under budget, and to specifications, as well as the achievement of affordable life-cycle costs (Hobday, 2000). Measuring the project's development is essential for figuring out if it will succeed or fail. Performance in the construction industry has its own measures.

Performance of construction projects has primarily been evaluated on the basis of cost, time and quality criteria, famously described as ‘iron triangle’ (Atkinson, 1999; Chan et al., 2001). But these traditional criteria have faced criticism due to their inadequate coverage of performance measurement Gardiner, (2000); the perceived relationship among themselves and their short-term focus (Shenhar et al., 2002).

The most effective way to monitor a project's performance is by identifying key performance indicators (KPIs) and continuous process improvements (CSFs). They found that there are many factors that can influence a project's performance (Almahasneh & Emsley, 2018).

### 2.2.1. Performance measurement process

It is the process of evaluating how well successful individuals or groups have performed in achieving their goals (Sinclair and Zairi, 1995).

Assessing performance in relation to a specified objective is a critical aspect of project management. Measuring performance is essential in determining a project's condition and direction. According to Willis and Willis (1996), a project's condition and direction can be determined through measuring performance. The process of measuring performance helps to give project managers a sense of where they are and where they are heading.

Horonec (1993) emphasized that performance measures are strong determinants of an organization's health and indicate if a process's activities or results meet the desired

goals. Eccles (1991) also noted that performance measures can be used to translate an organization's strategy into a set of goals and objectives, and the outcomes of the measurements show how successfully the plan has been implemented. Furthermore, Neely (2002) pointed out that performance measures show the organization's top priorities and how employees should act to maximize results for the company. It serves as a tool for fast and accurate feedback on the effectiveness and efficiency of operations as well as for focusing emphasis on ongoing improvement (Amaratunga & Baldry, 2002).

According to Cheung, et al., (2004) various performance indicators may be used to measure how well a project is performing across a variety of dimensions (groups), including time, cost, quality, client satisfaction, client changes, and business performance, health, and safety.

Performance indicators, by Kingsley, (2010) define the measurable evidence required to demonstrate that a planned effort has achieved the expected outcome.

## I. Key Performance Indicators in Construction

The construction procedures needed to be continuously monitored and evaluated to reach the specified performance indicators (Kamau & Mohamed, 2015). On construction sites, being able to foresee how something will turn out before it happens or as it is happening would help employees prepare sufficiently for potential problems and, in the end, succeed (Elattar, 2009).

To ensure successful project performance, it is crucial to define metrics (performance indicators) for benchmarking projects during the project selection phase. However, construction is dynamic in nature, indicating that the risks and uncertainties involved in the industry change with each new project Gudiene et al. (2013), causing key performance indicators to differ from one project to another (Alumbugu, et. al., 2015).

Key performance indicators in construction from different literature:

The Iron Triangle criteria are the most commonly mentioned indicators of project success throughout all industries (Bryde, 2008). Dr. Martin Barnes first used the phrase "Iron Triangle" in about 1969.

White & Fortune (2002) found that the Iron Triangle was primarily used by project managers to define project success in their research of project managers' experiences with projects. Both experienced and inexperienced project managers respect the Iron Triangle (Müller & Turner, 2007). According to Berssaneti & Carvalho (2015), the Iron Triangle and project management maturity are related. The simplicity of the Iron Triangle construction may be the reason for its enduring popularity. Declaring a project successful when it is completed according to these standards is not difficult (Judgev & Müller, 2005).

"Iron Triangle" is an outdated paradigm that project managers use to oversee and evaluate a project's success from three angles with the project's delivery date in mind. Recent research works have shown that measuring project performance cannot be adequately justified with these three (3) indicators alone (Enshassi, et. al., 2009; Babu, 2015).

So, addition to cost, quality, time, and client satisfaction, many other researchers have looked into a variety of other performance indicators for construction projects and have identified the following: regular and community satisfaction, health and safety, and environmental factors (Chan, 2003; Enshassi, et. al., 2009; Dawood, Sikka, Marasini & Dean, 2006; Alumbugu, Abdulazeez, Saidu, Ola-awo & Tsado, 2015).

- According to Omran et al. (2012), a building project's performance determines whether it is successful or not and evaluated based on client satisfaction, on-time completion, projected quality standards, and cost estimations.
- In response to the Egan report, the UK working groups on KPIs have established 10 criteria for benchmarking projects to achieve good performance (UKWG, 2000). The majority of these indicators, such as construction time and cost, defects, customer satisfaction with the product and service, profitability, and productivity considered as result-oriented thinking. On other hand, predictability of design cost and time, predictability of construction cost and time, and safety can all be viewed as indicators of process-oriented thinking.

Takim and Akintoye (2002) divided the key performance indicators defined by the UK working group on key performance indicators into three orientations: procurement, process, and result orientations. Construction cost, construction time,

cost predictability, time predictability, defects, customer satisfaction with the product, customer satisfaction with the service, and three company performance indicators, namely safety, profitability, and productivity, are the performance indicators proposed by the UK working group.

Mahmoud & Scott (2002) stated that, the measurement of construction projects is primarily dependent on seven KPI groups.

The study by Dawood et al. (2006) concentrated on the 4D planning of construction projects. The research found that time, safety, client happiness, planning effectiveness, and communication are the most important performance metrics. The novel indicators found in this study are planning effectiveness and communication, but cost and quality, which were previously recognized as important factors in determining project success, were not included.

Various scholars have introduced different key performance indicators (KPIs) over time, and these KPIs have been implemented in different parts of the world. To provide an overview of some of the most commonly used KPIs, the following table has been summarized.

Table 1. Summary of some of previous studies on performance indicators at project level

| No. | Author and year | Country | Performance indicators |
|---|---|---|---|
| 1 | Jastaniah (1997) | Saudi Arabia | • Client satisfaction<br>• Closeness to budget<br>• Planning period<br>• Profitability<br>• Staff experience<br>• Payment<br>• Communication<br>• Claims<br>• Safety |
| 2 | Egan (1998) | UK | • Predictability – time, cost<br>• Profitability |

| | | | |
|---|---|---|---|
| | | | • Construction cost<br>• Safety<br>• Construction time<br>• Defects<br>• Productivity<br>• Client satisfaction |
| 3 | Department of the Environment, Transport, and the Regions (DETR), 2000 Department of the Environment, Transport, and the Regions (DETR) (2000) | UK | • Time<br>• Client changes<br>• Cost<br>• Business performance<br>• Quality<br>• Health and safety<br>• Client satisfaction |
| 4 | Pillai et al. (2002) | India | • Benefit<br>• Cost effectiveness<br>• Risk<br>• Customer commitment<br>• Project status<br>• Stakeholders<br>• Decision effectiveness<br>• Project management<br>• Production |
| 5 | Cheung et al. (2004) | China | • People<br>• Safety<br>• Cost<br>• Client satisfaction<br>• Time<br>• Communication<br>• Quality<br>• Environment |
| 6 | Wong (2004) | UK | • Staff experience<br>• Contractor experience |

| | | | |
|---|---|---|---|
| | | | • Resources<br>• Time<br>• Site management<br>• Cost<br>• Safety<br>• Quality |
| 7 | Constructing Excellence (2005, 2006, 2009) and Roberts and Latorre (2009) | UK | • Client Satisfaction<br>• Profitability<br>• Defects<br>• Productivity<br>• Predictability cost, time<br>• Safety<br>• Construction cost, time<br>• Social indicators<br>• Variance cost, time<br>• Environment<br>• Contractor satisfaction |
| 8 | 8 Rankin et al. (2008) and Canadian Construction Innovation Council (CCIC) (2007 | Canada | • Cost<br>• Scope<br>• Time<br>• Innovation<br>• Quality<br>• Sustainability<br>• Safety<br>• Client Satisfaction |
| 9 | Skibniewski and Ghosh (2009) | USA | • Construction cost<br>• Defects<br>• Construction time<br>• Client satisfaction product<br>• Predictability cost and time |
| 10 | Construction Industry Institute (CII) (2011) | USA | • Cost<br>• Accident<br>• Schedule<br>• Rework |

| | | | |
|---|---|---|---|
| | | | • Changes and Productivity |

From the above reviewed KPIs of construction, cost, time, quality, client satisfaction, and health and safety are used in the Ethiopian construction industry performance measurement process (Tadesse et al., 2016; Solomon et al., 2021; Tagess, 2017; Benti & Hong's, 2021).

**I. Time performance**

As clients, users, stakeholders, and the general public typically perceive project performance from a macro perspective, where their primary criterion for project success appeared to be the completion time (Lim and Mohamed, 2000), it is crucial that construction projects are completed on time. Time variance has been listed as one of the strategies for evaluating project performance in construction projects by Salter and Torbett (2003) and Odeh and Battaineh (2002). Project managers can notice that the project was not progressing as smoothly as anticipated due to the aspect of time.

**II. Quality performance**

Quality in the construction sector is defined as the combination of the features that must be included in a good or service in order to meet a certain requirement, or as being suitable for the intended use (Parfitt and Sanvido, 1993). In other words, the capacity to conform to specified specifications is what the construction industry emphasizes as quality. A characteristic is any specification or quality that determines the essence of those items, processes, or services, which are initially decided by the client. Requirements are the established characteristics of a product, process, or service as specified in the contractual agreement.

All parties to a project must gain an awareness of the owner's quality expectations, include them into the contract pricing and other contract agreements to the extent practicable, and promise in good faith to maintain them in order to complete a project that meets those benchmarks (Ganaway, 2006).

**III. Client satisfaction**

A person's perspective of a result and their expectation for that outcome are compared to determine whether they are satisfied (Locke, 1970). Client satisfaction has been a tricky and difficult problem in the construction industry for a long time.

Customers in the construction industry frequently express dissatisfaction, which can arise from a variety of factors but is primarily due to overrunning project costs, delayed completion, pretty poor quality, and incompetent service providers, including contractors and consultants.

Client satisfaction is therefore a crucial concern for construction industry participants who, in order to succeed in the global market, must always attempt to enhance their performance. In the construction sector, assessing client satisfaction frequently involves evaluating performance and quality in relation to the goods or services the client has received (Parasuraman, 1988; Soetanto and Proverbs, 2004). Typically, the client's expectations are to have their building needs translated into a design that specifies characteristics, performance standards, and compliance to specifications, in addition to having the facilities constructed quickly and affordably ( Ahmed and Kangari, 1995 ).

**IV. Health and safety**

The degree to which general conditions encourage the execution of a project without major accidents or injuries is what is meant by "health and safety" (Bubshait and Almohawis, 1994). The construction phase is where most accidents occur, hence this phase is where safety is primarily measured. The construction industry is regarded as one of the highest - risk industries worldwide. Each year, industrial accidents result in the death or permanent disability of thousands of people. Construction workers worldwide have three times more chances of dying and two times of getting injured than any worker of other economic activity (Sousa and Teixeira, 2004).In comparison to other employees, construction workers have a globally risk of death and injury that is three times higher (Sousa and Teixeira, 2004). The main purpose of measuring health and safety performance is to give information on the development and current state of the strategies, processes, and activities used to control health and safety risks. Effective measurement reveals not only the levels but also the reasons why they are there, allowing for the implementation of corrective measures.

**V. Cost performance**

Cost is defined as the extent to which the overall constraints used to completing a project within the projected budget (Bubshait and Almohawis, 1994). The total cost of

a project, including any costs resulting from changes, modifications made during construction, and expenditures associated with legal claims, such as litigation and arbitration, is not just limited to the tender amount. It can be calculated using unit costs and the net difference over final costs (Chan and Tam, 2000). Due to the fact that it shows how much the project is over or under budget, cost variance is a critical part in evaluating the performance of a project. Cost variance was utilized by Andi and Minato (2003) to assess how poorly designed projects performed in Japan's building sector. Georgy (2005) proposed using the cost component to measure how well engineering projects are performing.

This study focused on cost as a result of those performance criteria. Cost is one of the most essential indicators to consider when evaluating contractor performance.

## 2.3. Construction Cost performance

Cost is a critical factor, one of the most important project characteristics, and the main driver of project success throughout the project management life cycle (zhar, N., Rizwan U. Farooqui & Ahmed, S.M., 2008).

The term "cost" does not only refer to the amount of the tender but also all expenses incurred from the beginning to the end of a project (Chan, 2003), incidents that result in cost overruns or poor cost performance are frequently linked to the construction phase because of the many uncertainties that are inherent in this phase of a project.

Cost performance is essentially a measurement of how much the overall situation supports completing a building project within the projected budget. It is calculated by comparing the actual costs to the budgeted costs for the work that has been done so far (Vyas & Kulkarni, 2013). Several elements that affect project success in terms of cost should be tracked to achieve satisfactory cost performance on a construction project. Market share, liquidity, cash flow, profit rate, overhead percentage, project design cost, material and equipment cost, project labor cost, project overtime cost, motivation cost, cost of rework, cost of variation orders, waste rate of materials, regular project budget update, cost control system, and escalation of material prices are factors that measures (Enshassi, et.al., 2009; Auma, 2014; Babu, 2015).

Gido and Clements (2003) state that four cost-related measures are used in cost performance analysis to assess the cost performance of a project. The measure is used

to evaluate the project and determine whether it is being carried out by the actual ( planned )cost or within the allocated budget. The four cost-related metrics (cumulative earned value) they discuss are TBC (total budgeted cost), CBC (cumulative budgeted cost), CAC (cumulative actual cost), and CEV.

The cost performance of construction projects is determined by how disputes and conflicts, changes in client or project specifications, and other unforeseen occurrences are managed because these are likely to result in exceeding the project's target or budget (Chan & Chan, 2012).

Cost overruns are a clear indicator of a badly performed project in terms of cost, and the causes attributed to their occurrence fall into four categories: site-related, human-related, project-related, and technical concerns (Shibani & Arumugam, 2015).

Several factors contribute to cost overruns in construction projects. These include inadequate safety measures at the job site, unpredictable weather conditions, unexpected ground conditions, political instability, unrealistic project schedules, delays in accessing designs, revisions due to design or execution errors, poor management and supervision, shortages of skilled workers for specialized tasks, inadequate coordination among project participants, and various direct costs such as labor, and equipment and machinery, transportation (Mahamid & Dmaidi, 2013; Shittu et al., 2013; Shibani & Arumugam, 2015; Tejale, Khadenkar, & Patil, 2015).

### 2.3.1 Cost Overrun in Construction Projects

Cost overruns are a highly common phenomenon, and they affect the majority of construction projects. Cost overrun occurs when the project's actual cost or expenditure exceeds its initial budget (Avots 1983).

Cost overrun is a major problem in project development and a common occurrence in the construction sector (Angelo and Reina 2002). Construction projects frequently experience situations where the budget exceeds the budget estimate, and the settlement exceeds the budget. Uncontrolled construction costs increase investment pressure, raise construction costs, influence investment decision-making, and waste national resources, which may lead to corruption or criminal activity. Therefore, it is critical to identify the causes of cost overrun to prevent and deal with the issues.

From the researchers' analysis, various elements contribute to cost overruns in the building business. The following are the factors:

**i. Poor or Inaccurate Original Cost Estimation**

According to Peeters and Madauss (2008), underestimating the original or starting cost of a project is the main cause of budget overruns. It is due to a technological issue with estimating project costs as well as a lack of project information at the project's early stages.

**ii. An increase in project costs**

Harrison (1981) stated that, rising expenses are a result of project cost inflation. Costs for supplies, equipment, and labor may increase or decrease depending on where in a nation they are used, and contracts between subcontractors and suppliers, and clients may include varying inflation protection clauses. Interest rates will rise along with inflation, raising costs overall.

**iii. Improper Planning**

According to Frimpong (2003), poor management and planning limitations resulted in technological failures. The production of a product slows down, adding time to the project's completion and increasing the estimated cost.

**iv. Increase in Raw Material Prices**

In most instances, cost overruns result from price fluctuations because the cost is objective and difficult to correctly anticipate. This resulted from excessive price inflation in developing nations or supplier speculation (Long et al., 2008).

**v. Poor Project Management**

Poor Project Management Ineffective site management exposed the frailty and ignorance of contractors. Insufficient skilled and experienced human resources are used for site management (Long et al., 2008).

**vi. Lacking experience**

According to Chan and Park (2005), the majority of contractors lack experience, particularly in financial management. The cost distribution of projects is not adequately planned. Budgeted costs could go over because of it.

**vii. Outdated or inadequate construction equipment and methods**

Construction projects develop more slowly when using outdated and inappropriate tools and techniques. Some nations make an effort to import or transmit advanced technologies within their borders. However, the technique doesn't work because there aren't enough skilled people to use the technology (Long et al., 2004a).

**viii. Underestimating the cost of construction**

Some parties have intentionally underestimated their project's expenses to obtain project approval. The incident that occurred on some projects is very serious (Fetene, 2008).

**ix. Inappropriate project financing and costing**

According to Kaliba et al. (2009), customer organizations' complicated financial processes might cause delays in payments, which can lead to schedule delays. Payment delays would put contractors in a tough financial situation and therefore push back the deadline for finishing the tasks on the job site. Interest could be added to late payments, leading to project cost overruns.

**x. High Machinery Costs**

High machine costs have been identified by Chan and Park (2005) as one of the market-related issues. The market is primarily what drives the construction sector, which is influenced by current market trends. For instance, the cost of renting equipment increases when the amount of oil required operating it rises.

**xi. Foreign Exchange Market**

The foreign exchange market has a very significant impact on Ethiopia's construction industry, which is heavily dependent on imports.

Generally, Cost performance has been cited as an industry and literature-proven effective strategy for project management efforts (Gido & Clements, 2003). In construction project management, effective risk and cost management is one of the pillar that is used to achieve project cost performance. Those risk and cost management practices interact with one another and with the other project management pillars of construction projects can play significant role in the cost overrun mitigation strategies.

### 2.3.2. Construction project risk management and its Processes

Risk defined as "*the possibility of an occurrence that will have a negative impact on a project's objectives*" (PMI, 2021).

By nature, construction projects are complex endeavors filled with uncertainty (Flanagan & Norman 1993). It encompasses unforeseen incidents, changes in stakeholder needs, pricing fluctuations, etc. Strong processes for managing risks, such as qualitative and quantitative assessments, minimize cost overruns resulting from unexpected circumstances by enabling informed decision-making and contingency planning (Long et al., 2008). Therefore, risk management is an important step in project success and it includes the process of identifying, classifying, quantifying and responding of inherent risks in a project.

Risk management is one of the key knowledge areas of Project Management, which play a great role in managing the project cost during cost estimation and cost forecasting so as to prevent project cost from cost overrun.

**The benefits of effective risk management for mere cost minimization:**

- Enhanced Project Performance
- Informed Decision-Making
- Increased Transparency and Accountability
- Reduced Conflict and Disputes

### 2.3.3. Construction project Cost management and its Processes

It encompasses the processes involved in cost planning, estimation, budgeting, and control in construction projects. The goal of cost management is to finish the project

on time and within budget. In construction, the cost management plan is largely concerned with the cost of the numerous resources required to fulfill project tasks.

Cost estimation, budgeting, monitoring, and control are all part of project cost management in construction, as is controlling day-to-day project costs. This is distinct from financial management, which is concerned with the construction project's revenue sources, return on investment, cash flow, and investment payback analysis, to mention a few.

Early scope determination is crucial since an owner's potential to affect the cost is highest during the early stages of a project. Early in the project planning process, the cost management planning effort, which includes estimating and budgeting, establishes the structure for efficient and coordinated cost management. Cost control is a method of monitoring and controlling project costs to complete a project on time and within budget. Project cost management is vital to a project's success since it influences, among other things, organizational profitability.

According to (PMBOK, 2016) and the Ethiopia Construction Project Management manual series (EPMI, 2019), four processes are included in the construction cost management they are:

**Cost Management Plan:** Depending on the project delivery method, it should consider the project's life cycle cost and may include operating costs. Life cycle costing, value engineering, and constructability analysis are all utilized in the early stages of building construction projects planning to:

- Reduce cost and time,
- Improve quality and performance,
- Optimize design-to-cost facility performance, and
- Optimize the decision-making process.

**Cost Estimating:** the process of estimating the approximate cost of the resources required to fulfill the project's activities. The cost estimate is created by breaking down the work items into standard formats and estimating the cost of each item based on previous experience and a database of current construction cost data.

**Cost Budgeting:** It is the process of grouping the anticipated costs of various operations to produce allowed cost baselines.

**Cost control:** The process of monitoring and controlling the project's progress to update the project budget and stay on budget.

#### 2.3.3.1. Cost estimation practice in construction

The practice of determining the estimated cost of a building or physical structure is known as construction cost estimates. Cost estimates are used by project managers to establish the scope and feasibility of a project and to allocate budgets. They are used by contractors when considering whether or not to bid on a project. Architects and engineers are generally consulted when preparing estimates to guarantee that a project's financial feasibility and scope requirements are met.

**Steps of cost estimation** (EPMI, 2019)

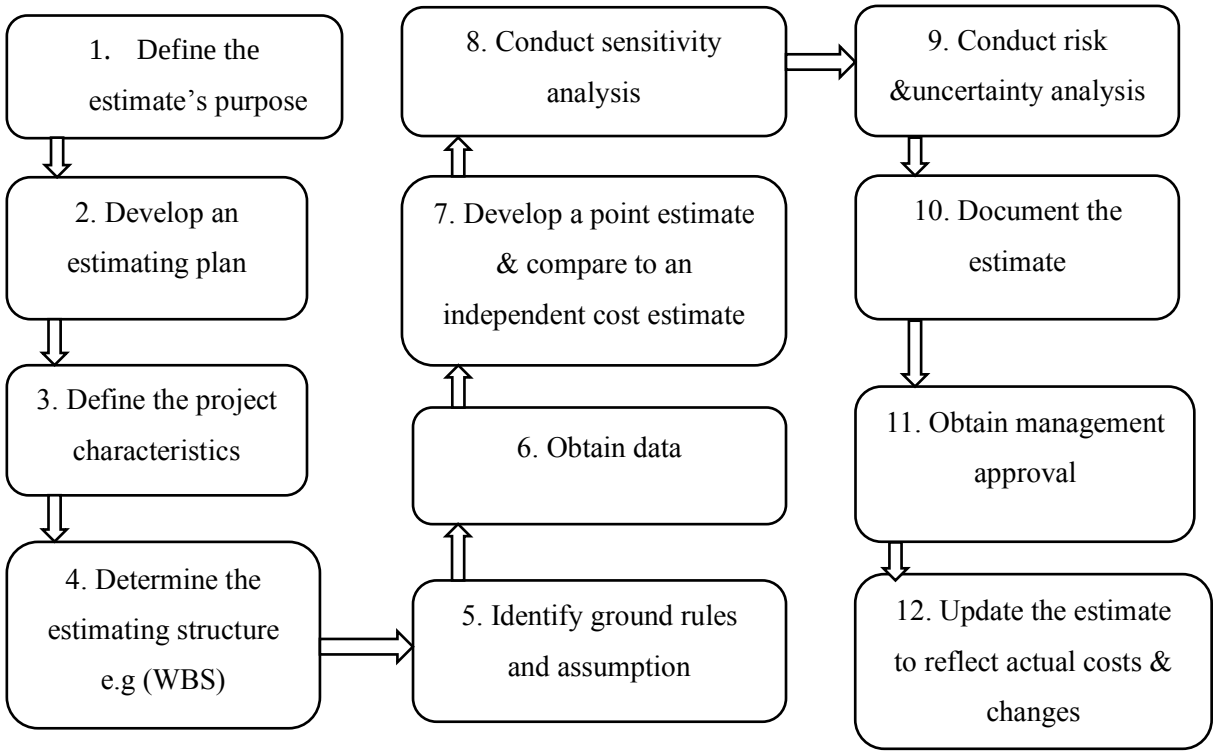



Figure 1. Steps of cost estimation

**There are different most prevalent techniques of cost estimation and they are**:

a. **Analogous:** It makes an estimate based on previous performance and requires precise data from similar situations. It estimates the same parameter or measure for a current project using the values of parameters such as scope, cost, budget, and duration, or scale measures such as size, weight, and complexity, from a previous, similar project (Archer, 2012).

b. **Parametric:** It calculates an estimate for activity factors such as cost, budget, and duration using a statistical relationship between historical data and other variables. Depending on the model's sophistication and underlying data, this technique can generate higher degrees of accuracy. In conjunction with other estimating approaches, parametric cost estimates could be applied to the entire project or specific project segments.
c. **Bottom-up: i**t is a method that begins with the most precise breakdown of the project and then estimates the cost of each activity in great detail. It necessitates the creation of a well-defined job breakdown framework. The size and complexity of the individual activity or work package often influence the cost and accuracy of bottom-up cost estimating. (Archer, 2012).
d. **Three-point estimating:** This method estimates the optimistic, pessimistic, and most-likely impacts to forecast risk and uncertainty. It determines optimistic (best-case scenario), pessimistic (worst-case scenario), and most-likely values for the present task (Simeonova, 2016).
e. **Monte Carlo simulation:** In project management, this is a technique that allows anyone to create random project estimates within a particular range as many times as they like. This simulation generates and is based on a probability distribution. Furthermore, the results with different values are vastly different (Simeonova, 2016).

The accuracy of cost estimation is a critical task on which the cost management team should focus. The estimation may become above or under the actual cost of projects due to negligence or insufficient data. This could result in a cost overrun on the project.

Cost overruns are a typical occurrence in the construction industry and are a key issue in project development. It's not uncommon for a construction project's budgetary estimate to exceed the estimation, the budget to exceed the budgetary estimate, and the settlement to exceed the budget. Out-of-control construction costs increase investment pressure, raise construction costs, influence investment decision-making, and waste national resources, potentially leading to corruption or criminal activity (A.S. Ali*, 2010).

To prevent or reduce the frequency of cost overruns in building projects, the elements that influence cost estimation accuracy must be identified.

**Factors Affecting Accuracy of Cost Estimation**

The term "accuracy" of an estimate can be defined in a variety of ways. It's the difference between the expected and actual figures.

The primary goal of cost estimation is to determine the project's estimated cost. This goal is critical for the client when making a construction selection (Ashworth, 2003).

Nonetheless, a variety of factors influence the accuracy of cost estimates for construction projects, which must be taken into account early in the process. Some factors can rapidly increase the estimated costs and the possibility of contractual disagreement between the different parties involved. From those factors, different scholars state the following.

(Chimwaso K.D., 2001) stated that Design changes, inadequate planning, unpredictable weather conditions, and variations in the cost of construction resources are all major causes of cost overruns, according to the report.

(Collier K., 1987) emphasized the importance of the building industry's demand "It would be incorrect to imply that all estimates and bids for construction work are made up of labor costs, materials cost, equipment costs, job overhead costs, and operating overhead costs,". All of this is based on established facts and calculated probabilities, with a profit margin calculated accurately based on current economic data." "There are other elements that may have a greater influence on the amount of a bid than any fluctuations in those expenses" plus "the most important of which is the demand for building work."

From different researchers' point of view, various factors influence the cost estimation of a construction project. From them following mentioned as a major influencer:

- Construction Site Conditions
- Project Schedule
- Reputation of Engineer
- Regulatory Requirements

- Size and Type of Construction Project
- Price of construction inputs

From the above factors, this paper focused on Price of construction inputs.

## 2.4. Price in construction

### 2.4.1. Definition

The term "price" is used to describe the sum of money that is exchanged between two parties in return for the provision of goods and/or services. Money is frequently used to make this payment. It reflects the sum of money required to purchase a certain number of different goods and services.

In construction contracts, the amount that was ultimately agreed upon may be referred to as the "contract sum" and the price that a supplier presented as a price may be referred to as a "tender" (Buildings, 2022).

**Cost vs. Price**

Cost: it refers to the expenditure of resources, including labor, materials, equipment, and overhead, required to complete a construction project (ASPE, 2019).

Price: The Construction Industry Institute (CII) defines price as the total amount charged to the customer, which includes costs plus profit margin, taxes, and other expenses (CII, 2016)..

There are different prices in construction contract. Those prices are:

**Tender prices**: A tender is a response to a request for tenders made by a prospective supplier (the'tenderer') (ITT). It provides a supply offer for goods or services. A tender price is the price set by the tenderer for the supply of certain goods or services to the client.

The tender price is usually determined by project information provided by the client in the ITT documents (a letter of invitation to tender, the form of tender, preliminaries, the form of contract, a tender pricing documents, a drawing schedules, design drawings, specifications).

**Resource costs:** 'Resource costs' are accruals reported in actual terms in resource accounting. 'Real goods and services excluding additional costs' are resources.

**Output prices:** In the construction sector, the term "output" refers to "the quantity of output chargeable to customers for building and civil engineering work completed during the relevant time."

## 2.5. Price escalation

### 2.5.1. Definitions of Price escalation in construction

The term "price escalation in construction projects" has been defined by several experts all around the world and some of them are:

- Construction price escalation is described as unanticipated increases in material, labor, and equipment costs. Due to the passage of time, the cost of any construction inputs of the initial contract and the base cost of a project increases (Williams, 1999).
- Price escalation is the provision in a cost estimate for escalating costs of equipment, material, labor, and other construction inputs over time due to ongoing price changes (Jaeger, 1996)
- Price Escalation is the increase in any element of project costs when the cost of that element is considered between two different periods (Lock, 2003).

Therefore, the consideration of increasing the expected cost due to increases in the price of materials, labor, equipment, and other construction inputs is known as price escalation. Price increases in construction projects are caused by a variety of variables.

**Escalation vs inflation**

**Inflation** is an increase in the prices of a basket of goods and services. In the construction sector, it means the general cost of materials, labor, and services goes up due to economic factors like money devaluation (Glen, 2016).

**Escalation**, on the other hand, is a continuous increase in the price of a specific commodity, good, or service over time. It is caused by a combination of inflation, changes in supply and demand, changes in technology, or even new environmental and engineering requirements (Smith and Hinze, 2020).

In fact, inflation is one of the factors that lead to escalation. While inflation is more general and economy-wide, escalation is often tied to specific project needs and market conditions that directly affect construction costs.

### 2.5.2. Factors Causing Price Escalation

The reasons for price escalation in construction projects are numerous, and some are not only difficult to foresee but also to control. Internal and external elements affect the estimate in each project development step by their very nature. The classified types are:

#### i. Internal Factors Causing Price Escalation

According to Warsame (2006), internal factors cost escalation factors that the project's sponsoring agency/owner can directly manage. During the planning and design stages of construction, a variety of internal factors might lead to an overestimate of project costs. The key internal components listed below are well-documented (Anderson et al. 2006). Some of the factors are:

**1. Delivery/Procurement Approach**

When the risk is passed to a party who is unable to control a specific risk, the delivery/procurement approach influences the division of risk between the agency/owner and the constructors; project costs are likely to rise. The transfer of project risks is influenced by the project delivery method, such as design-bid-build, design-build, or build-operate-transfer, and procurement methodologies, such as low bid, the best value, or qualifications-based selection.

**2. Project Schedule Changes:**

Even when the rate of inflation is accurately forecast, extensions arising from budget constraints or design problems might result in unanticipated increases in inflation cost effects. The time worth of money, as well as the rate of inflation and the timing of spending, must all be taken into account by agencies/owners.

**3. Engineering and Construction Complexities**

It can make early design work exceedingly difficult and lead to internal coordination problems and project component faults, depending on the project's geographical location, technology, or goal. Conflicts or problems amongst the various disciplines engaged in the planning and design of a project are examples of internal coordination issues.

**4. Scope change**

The agent/owner management should control this, which can lead to a cost underestimate of the project Changes in project construction limitations, design, and/or dimensions of important project elements such as adjustments in type, size, or location of project components are examples of such changes.

**5. Poor Estimation**

As a result, project expenses may be underestimated. Estimate documentation must be in an easily understandable, checkable, verifiable, and correctable format. The formats, procedures, and processes utilized to arrive at the cost are the cornerstone of a good estimate. General errors and omissions from plans and quantities, as well as general inadequacies and poor performance in planning and estimating procedures and methodologies, all contribute to bad estimation.

**6. Improper Planning and/or Improper Implementation of Proper Planning**

It is considered improper planning without knowing the facts on the ground. People who work in actual conditions will handle the implementation phase. Planners make sometimes-good plans, but they are not carried through because of the executioners. If the construction cost is predicted at the planning stage, it will escalate for a variety of reasons.

**7. Ambiguous contract provisions**

It confused accountability and leads to misunderstandings between the owner, the project design team, and the construction contractors. Providing insufficient information in the project documentation can result in cost overruns during the project's implementation.

**ii. External Factors Causing Price Escalation**

External cost escalation factors are those that the agency or owner has little or no direct control over.

**1. Effect of Inflation**

Inflationary effects play a significant role in many projects' cost underestimation.

a. The time value of money can have a negative impact on projects when project estimates are not communicated in year-of-construction costs

b. Project completion is delayed and thus the cost is subject to inflation over a longer period than anticipated, and/or

c. The rate of inflation is greater than anticipated in the estimate.

**2. Market conditions**

An incorrect assessment of market conditions might cause inaccurate project cost estimation. Market factors have an impact on project costs during execution as well as during planning. Changing market conditions that reduce the number of bids, impact the labor force, and other essential components during the building of a project can create delays in the project timeline and budget Infrastructure, and the Constructed Environment.

**3. Unforeseen events and Unforeseen conditions**

Floods, hurricanes, tornadoes, and other weather-related disasters are examples of unanticipated and, in most circumstances, uncontrollable by the project owner. The people refer to these as “acts of God”. Unexpected circumstances, such as unknown soil conditions, might affect excavation, compaction, and structural foundation, causing the predicted cost to escalate.

**4. Change in Legislation**

One reason for price variation is a change in legislation during the project's contract period. These additional expenditures incurred because of legislative changes are factored into the contract and approved as an extension of the contract's completion period.

5. **Fluctuation in Money Exchange Rates**: foreign currency is the other cause of price variation.
6. **Shortage of labor / skilled workers and Increase in Material Cost** also causes for construction price escalation.

### 2.5.3. Effects of Price Escalation

The effect is the outcomes that will be experienced when price escalation happens on a construction project. The common ones are listed below:

**1. High Project Cost**

Price escalation is an additional cost that will almost certainly result in a high project cost. The cost of the project may rise as a result of the gap between the estimated cost and the current market price.

**2. Disputes among Stakeholders**

According to Sambasivan and Soon (2007), the other effect of price escalation is Disputes among Stakeholders, which can result in schedule overruns, price increases, litigation, and project abandonment.

Many construction disputes, according to Mohammed (2013), develop as a result of disagreements and delays in the construction project, resulting in hardship and expense.

**3. Project Financing Problem (Budget Short Fall)**

Contractors and consultants may request an interest payment from the employer if the company fails to pay interim payment requests owing to financial difficulty.

**4. Delayed and Cancelled Projects**

Price escalation may cause delay and project termination.

### 2.5.4. Managing Price Escalation in Construction Projects

Many of the mechanisms will need new approaches to project design, procurement, and risk allocation. Price escalation can happen during the planning, design, and execution phases of a project. Price escalation management should be used throughout the entire project. Early attention to price escalation causes will help to reduce cost rise throughout the bid process or during construction. In different industries and contract types, different price escalation management strategies will be used. The following methods are some of them (Nasir, 2000).

**1. Contract Related Issues**

Price escalation clauses are difficult in price escalation management, both as part of the contract and the administration of the contract. Good contract negotiation and

contract administration in terms of price escalation are one of the management challenges. Price escalation clauses in a contract may be misunderstood, and the contract's inability to be implemented may lead to poor price escalation management.

2. **Bulk Material Purchase**

When contractors are aware that cost inflation is likely, they can choose from a variety of material purchase choices. They could wish to set up a strategic delivery/product storage plan so they can buy and stage products ahead of time.

3. **Buyer-Supplier Partnership**

Partnerships provide procurement leaders with the ability to save money. The buyer-supplier relationship has gotten a lot of attention, which makes sense considering that purchased goods and services account for the bulk of a company's overall costs.

4. **Market Assessment & Procurement Procedure**

Making an acceptable market assessment allows for the identification of the best possible market price at the time, and following procurement procedures formally and legally prevents mischief and purposeful market pricing transactions.

5. **Use of Local Materials**

Local raw materials are widely available and do not suffer such high transportation costs, which can account for up to 50% of overall prices. When using local building materials, price escalation from overseas shipping, currency exchange rate fluctuations, international inflation, and an increase in international construction materials demand will all be addressed. The cost of a construction project is significantly influenced by the use of locally obtained building materials.

### 2.5.5. Price Escalation Valuation Techniques

Research indicates that there isn't a universally superior method for valuing price escalations. Nonetheless, three common types of adjustment clauses are typically employed (Barthet, 2010; Clough, Sears, & Sears, 2008; Halpin & Woodhead, 2010).

#### 2.5.5.1. Invoice Method (Rise and Fall method)

This technique requires the contractor to provide documentation showing any increase in material costs that occurred from the time the contract was signed to when the

materials were actually purchased, thereby passing these increased costs onto the owner (Barthet, 2010; Clough, Sears, & Sears, 2008).

#### 2.5.5.2. Index Method

In this approach, certain material costs are linked to an index for the relevant commodity. This allows the contract price to adjust in line with regional or local changes to that commodity's price index. Unlike the invoice method, which transfers cost increases to the owner, the index method can result in a loss for the contractor if material costs decline (Barthet, 2010; Halpin & Woodhead, 2010).

There are different price indeice in construction and the following are some of them:

I. Input Price Indices

Input price indices measure changes in the price of inputs to the construction process by monitoring the costs of wages and materials separately. This involves calculating the labor hours and materials needed for a representative object and periodically multiplying these quantities by their corresponding prices. These indices do not reflect the entire range of market influences, such as productivity changes, profits, and trade margins. Therefore, input price indices provide information on production costs rather than production prices and may overstate the price rise of completed construction work (IMF, 2004).

Input price indices are often used in price adjustment formulas because they directly reflect the changes in the cost of construction inputs such as materials and labor. This ensures that contracts remain fair and equitable by accounting for inflation and cost fluctuations. Contractors and clients use these indices to adjust payments to reflect current market conditions and maintain the financial viability of construction projects (Eurostat, 2013; OECD, 2011).

**II. Output Price Indices**

Output price indices measure changes in the prices of what is produced by entities engaged in construction activities. They cover most items included in the price paid by purchasers, such as materials, labor, equipment hire, land preparation costs, fittings, overheads, profits, and trade margins. Techniques to compile these indices include incorporating individual factors involved in construction or basing

the index on the prices of actual finished constructions (Eurostat, 2013; OECD, 2011; IMF, 2004).

**III. Seller's Price Indices**

Seller's price indices measure changes in the prices of construction output paid by the purchaser or final owner, covering the total sales price of completed construction, including labour, materials, land, selling expenses, and seller's profits. This index distinguishes from the purchaser's price by including the land component in the ownership transfer (Eurostat, 2013; OECD, 2011; IMF, 2004).

#### 2.5.5.3. Hybrid Method

The hybrid method merges the invoice and index methods and is based on a certified bid cost. The contractor certifies their estimate of the costs for specific materials or fuel, using either current supplier prices or an index price listing. If the certified bid cost changes by a predetermined percentage, the contract can be adjusted accordingly (Barthet, 2010; Clough, Sears, & Sears, 2008)

## 2.6. Price adjustment in the Ethiopian construction industry

From MoWUD1994 to PPA 2011, the circumstances have changed. Each type of price adjustment comes with its own set of constraints. Contract provisions add their adjustment to the process of implementation. These initiatives have been a source of controversy, as the main players are still learning their trade. The primary premise of contract price adjustment is to protect the contractor or the owner from price variations that may occur between the contract signature and execution for one or more of the reasons listed below:

- Profit margins widening or narrowing (market effect)
- Direct cost decrease or rise
- Productivity changes
- Monitory value change (inflation)

Price adjustment was handled differently in MoWUD 1994, PPA 2006, and PPPAA 2011. The first takes into account the price difference, while the second and third take into account the index formula.

**i. BaTCoDA 1987 Contract Form**

**Clause 70: Changes in Cost and Legislation, Sub-clause (1) Increase or Decrease of Costs**

The only adjustments allowed are on the difference between the basic prices and market prices of the materials and goods listed in the appendix to the bill of quantities after the bid pricing date.

- The rates in the priced bill of quantities are based on market prices for the materials and items listed in the bill of quantities' appendix, which is current at the time of bid pricing (Basic Price).
- If the market price of any of the materials or items mentioned in the basic price rises or falls after the bid-pricing deadline, the contractor must pay the net amount of the difference between the basic price and the market price.

**ii. MoWUD 1994 Contract Form**

**Clause 70, Sub-clause (1) Changes in Cost and Legislation**

The contract price shall be considered to have been calculated in the manner set out below and shall be subject to the adjustment in the events specified here under:-

- The rates in the priced Bill of Quantities are based on the wages, other emoluments, and expenses in effect at the time of bid pricing on the job site.
- If any Act, Statute, Decree, Regulation, or the like increases or decreases the said rates of wages and other emoluments and expenditures after the said date of bid pricing, The net amount of the increased or decreased payments and expenses shall then be, after careful consideration
- By the Engineer, and shall be added to or subtracted from, as the case may be. The Contract Price must be paid to or permitted by the Contractor.

**iii. PPA 2006 Contract Form**

Clause 47: Price Adjustments

Prices shall be adjusted for fluctuations in the cost of inputs only if provided in the

Special Conditions of Contract of the contract document. If so provided, the amounts certified in each payment certificate, after deducting for Advance Payment, shall be adjusted by applying the respective price adjustment factor to the payment amounts due in each currency. It has its own formula stated in clause 47.

**iv. PPPAA 2011 Contract Form**

Clause 62: Price Adjustments

Adjustments of contract prices shall be allowed after twelve (12) months from the effective date of the Contract when it is verified that the performance of the contract requires more than 18 months. It also has its own formula stated in clause 62.

Since price escalation or adjustment contract provisions are different from county to country. The following are the escalation provisions that are prescribed in major contract guidelines and laws of such countries and organizations. in major contract guidelines and laws of such countries and organizations. (Kim, 2006).

Comparison of the price escalation provisions in major countries and FIDIC

| | FIDIC | Korea | Japan | United States |
|---|---|---|---|---|
| Preconditions that enables to request the price escalation | The adjustment by basic prices or base index figure | In case the construction cost index increases or decreases by 3% or more | In case the fluctuation rate increases or decreases by 1.5% or more | The price change during construction is forecasted in advance and reflected to the estimate or bidding price |
| Minimum elapsed period for price escalation | 28days prior to the bidding date | 60days since the signing date of a contract | 1 year (365days) since the signing date of a contract | - |
| Scope of adjustment in price escalation | The difference in cost between the basic price (index) | Adjust the total contract amount reflecting the price changes | Adjust only the contract amount over 1.5% of minimum | Increased cost due to delay arising from project owner's faults |

| | | | | |
|---|---|---|---|---|
| | and the current price (index) | | fluctuation rate (contractor bears the loss up to 1.5%) | |
| Escalation for the price change of the specified material due to sudden economic crisis | Possible (in case the specified materials stated in Appendix to Tender) | Impossible | Possible (compensate for 3/4 of losses) | Impossible in principle |
| Overheads and profits | Not adjusted | Included in price escalation | - | - |

Table 2. Comparison between price adjustment provisions of contract forms in Ethiopia and other countries.

| Issues | PPA 2006 | PPPAA 2011 | FIDIC 1987 |
|---|---|---|---|
| Necessary conditions for Price Adjustment | Fluctuation in cost of inputs | Change in cost of inputs for projects longer than 18 months | Change in cost and legislation |
| Base pricing or indexing date | 28 days prior to latest bid submission | Bid closing or Previous contract price Adjustment date | 28 days prior to latest bid submission |
| Starting date of | - | After a year | - |

| | | | |
|---|---|---|---|
| price adjustment | | | |
| Adjustment application | Certified amount less advance deduction | Contract value(contract Price multiplied by quantity) | BOQ value except items with actual price |
| Method(s) of adjustment | Index formula | Index formula | Index formula & Price difference |
| Overhead & profit in price adjustment | not explicitly stated | not explicitly stated | Overhead & profit excluded |

### 2.6.1. The challenges in price adjustment practices (PPA 2011)

- Constant weighting coefficients throughout the project lifetime
- Different estimators give rise to different weighing coefficients
- It does not consider actual labor work time
- Change in project cost
- Constant input material amounts
- Computation time
- Considering only extreme prices
- Complication of a price adjustment formula
- Adjustable amount
- Adjustment for non-used items
- Failure to make periodic payment

Generally, Price adjustment clause may be misunderstood, and the contract's inability to be implemented may result in inadequate price escalation management. In Ethiopia adjustment clauses of PPA 2011, includes only applies to works contracts after twelve months from the contract's effective date and to procurements performed under a framework contract after 3 months from the contract's effective date (MFED, 2010). Furthermore, there have been issues with the approach used to determine the adjusted quantity to be paid, including constant weighting coefficients throughout the lifespan of the project, changes in weighting coefficients as a result of using different

estimators, and similar quantities of input items (Emiru, 2020). But these problems may be resolved if the contract included special clauses like indices clauses (Ofori, 1990) or price adjustment clauses (Clough, Sears, and Sears, 2015).

## 2.7. Conceptual review

A conceptual review in research is vital. It establishes the theoretical foundation, identifies research gaps justifying the study, clarifies key variables, guides in analyzing and interpretation, and shows the unstudied part of the research for future researchers.

The document provides insights into several studies related to the assessment of price escalation and its effects on building construction projects in various regions of Ethiopia. These studies aim to identify the main causes and effects of price escalation, assess the present condition of price escalation, and recommend measures to mitigate its impact on construction projects. The scope of the studies varies, focusing on specific regions such as Adama, Hawassa, Jimma University, and the capital city of Ethiopia, as well as specific sectors like the road, the railway industry also in private and public sector construction.

The methodologies employed in these studies include a combination of descriptive (quantitative) and exploratory (qualitative) survey methods, involving surveys, interviews, literature review, archival study, and document review. The data collection techniques encompass the administration of questionnaires, interviews, and analysis of relevant documents and reports. Purposive sampling was used to determine the sample size for the studies, targeting a balanced representation of stakeholders involved in construction projects.

The findings of the studies highlight the significant factors causing price escalation, such as fluctuation in foreign currency exchange rates, increase in material costs, unbalanced demand and supply of construction materials, and project schedule changes. The adverse effects of price escalation on construction projects include delayed project progress, cash flow problems, higher construction project costs, disputes between contracting parties, and scope reduction or project cancellations.

Based on the study findings, recommendations were made to address the identified causes and effects of price escalation, such as establishing an economic environment conducive to inspiring investors, conducting detailed feasibility studies, and implementing efficient resource planning. The studies emphasize the importance of understanding and addressing the identified factors to mitigate the adverse impacts of price escalation on construction projects in the region.

In conclusion, the studies provide valuable insights into the causes and effects of price escalation on building construction projects in various regions of Ethiopia. They underscore the need for improved **project management practices and the implementation of effective mitigation strategies** to address price escalation in construction projects.

## 2.8. Conceptual Framework

A conceptual framework is a written or visual representation of an expected relationship between variables. Variables are simply the characteristics or properties that are going to be studied.

Managing construction projects effectively requires not only careful planning and execution but also an awareness of potential challenges and proactive strategies to mitigate them. One such challenge is price escalation, where unexpected cost increases can derail budgets, schedules, and overall project success.

This conceptual framework provides a valuable tool for understanding the various factors contributing to price escalation, its significant impact on different aspects of construction performance, and effective strategies to manage it.

The framework visually represents the key elements involved in price escalation. Firstly, 'Inputs' like project budget, along with external and internal factors, lay the groundwork for potential cost increases. These inputs directly influence the central theme, 'Price Escalation', highlighting how various factors intertwine to raise project costs. The consequences of this escalation are reflected in the 'Outputs' section, where impacts on cost performance metrics. Finally, the 'Management Strategies' section offers a ray of hope by outlining actionable strategies like contract negotiation, and risk management and experience from best practices to address and mitigate price escalation.

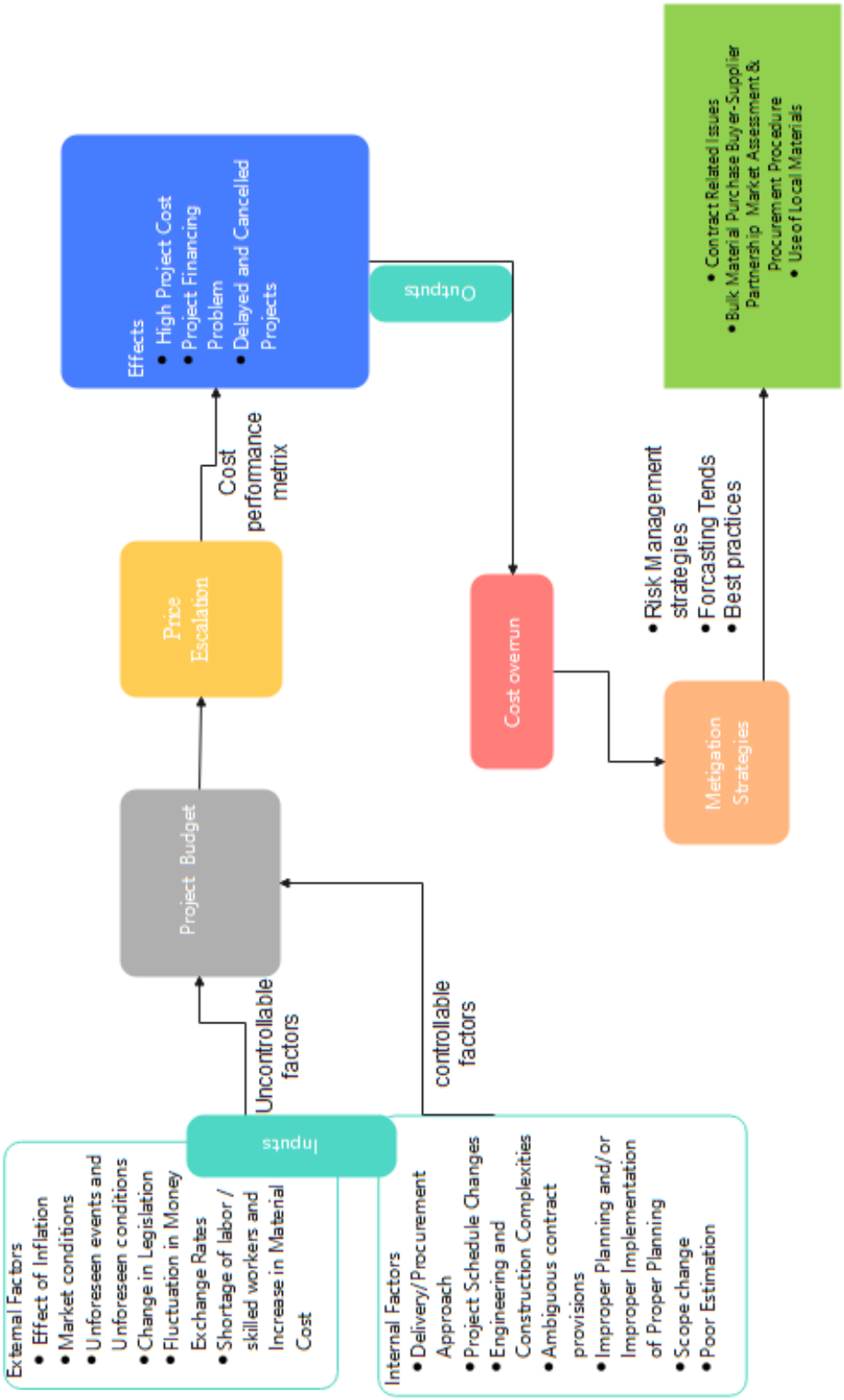



Figure 2. Conceptual framework of the study

## 2.9. Research Gap/Need for Study

Based on the previous researches, the gap in this research can be identified by considering the existing studies and their focus on specific regions and sectors in Ethiopia. The studies in the document primarily concentrate on construction projects in various cities, such as Adama, Hawassa, and Jimma University, as well as specific sectors like road, the railway industry and public sector construction. However, there is a gap in the literature regarding **implementation of effective mitigation** practices and **their effects on cost performance** specifically for federal public building projects in Addis Ababa, with a focus on the contractors' perspective.

Furthermore, the those researches do not explicitly mention a study that specifically **investigates the price escalation extents and implementation of effective mitigation practices** on federal building construction projects in Addis Ababa from the contractors' side. This presents a gap in the existing literature that this research can address.

Table 3. Previous researches related with price escalation in construction projects

| No | Title of Studies | Scholars Name | Scope of their research | Research Method | Their conclusion |
|---|---|---|---|---|---|
| **1** | Investigation of Price Escalation and Its Mitigation Mechanisms on Selected Building Construction Projects of Jimma University | Hamelmal Mekonen, Alemu Mosisa Legesse and Frikot Mulatu Ameya | The study focuses on four selected projects belonging to Jimma University, designated projects A to D and one of Jimma University's publicsector clients | Survey (research methodology) with Document review, Interview (data collection instrument) | The magnitude of escalation varies among the construction projects and project price escalation And the majority of the factors are highly preventable or controllable. |

| | | | | | |
|---|---|---|---|---|---|
| **2** | Price Escalation and Its Management In Turnkey Projects: The Case Of Ethiopian Railways Corporation (2017,Addis Ababa) | Dawit Tarekegn | The study considers the price escalation practice under EPC / Turnkey contracts only in the railway industry (excluding EPC / Turnkey projects in other construction sectors) and only railway projects in Ethiopian Railways Corporation | Survey (research methodology) with Questionnaire (data collection instrument) | The study has identified that there is a noticeable disagreement on the understandings of price escalation in the EPC/Turnkey projects among the employer, contractors and consultants. National and global inflation, late project launch & project schedule changes; and fluctuation in money exchange rates beyond the level predicted were among the main factors that cause price escalation in the EPC/Turnkey railway projects of Ethiopi |
| **3** | Causes of Price Escalation and Its Impact on Construction Contractors In Ethiopia (2015, Addis Ababa). | Hunde Hailu, Melese Mollaw and Yinchachu Mersha | Causes of price escalation and its Impact on construction contractors in Ethiopia in case of Addis Ababa | Survey(research methodology) with Questionnaire (data collection instrument) | The research result showed that the problem of price escalation occurs in an unpredictable manner with increase in price by more than 27.6% of cost and Contractors lose portion of their expected profit by at least 3.53% of contract amount. |

| | | | | | |
|---|---|---|---|---|---|
| **4** | Assessment of Price Escalation and Adjustment Problems on Federal Road Construction Projects (2013, Addis Ababa) | Mohammed Gashaw Mossa | The study is limited to cover only 33 federal road construction projects, South and West regions in Ethiopia, in which its construction work was commenced after June 2006. | close ended questionnaires, desk studies/archival records (four in number) and unstructured Interview | Price escalations are higher project costs, cash flow (project financing) problem of the projects, delay and dispute among parties. The study also identified uncompensated increase in cost of construction materials effect on their project. |
| **5** | Assessment of the cause & effect of Price Escalation on Public Sector Construction(2020, Addis Ababa) | Prashant Kumar Gangwar | the cause & effect of Price Escalation on Public Sector Construction in capital city of Ethiopia | Survey (research methodology) with Questionnaire (data collection instrument) | The study revised 25 internal factors result on price escalation. It also ranked the 10 most factors which affect the price escalation. |
| **6** | Investigating the effect of price Escalation on building construction project at Hawassa city(2018, Hawassa) | Melese Aschalew, Kurubel Yohanes, Mikiyas Birara | The study covered only in Hawassa city and based on stakeholders it's focused on contractors, clients, consultants. And this study focuses on Building construction sector. | Survey (research methodology) with Questionnaire and Interview (data collection instrument) | Higher Project Costs and delay are the most adverse effects of price escalation on building construction projects of Hawassa city and the study finds contractors are more responsible for the price escalation and also in order to minimize this effect the early material purchase, National Construction Price |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Indexes, Bid Contingencies and Contract Allowances are the main mitigate methods of price escalation on building construction industries in Hawassa city. |
| **7** | Assessment of the causes and effects of price escalation of federal road contracts in Ethiopia (2015, Addis Ababa) | Yadessa Dinsa | Only on East and Sub-Saharan African data exploration is only confined to survey from literature review, interview and personal contact with international consulting branch offices in Addis Ababa and through email contact with former colleagues operating in Uganda, Kenya and South Sudan | Survey (research methodolog ) with Questionnai re(data collection instrument) | Based on the findings of the research using simple statistical approaches, Likert's scale and Kendall coefficient of concordance, it's been possible to conclude that, cost inflation of construction materials, change in foreign exchange rate of imported materials, lack of proper budgetary planning and less emphasis given to planning by clients and financiers, cost of labor, equipment and material and the tendency of the client to stick to list bidder criteria rather than |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | analyzing the bid offer against the engineers estimate are the first top five causes in chronological order that triggered price escalation of road contracts in Ethiopia. |
| **8** | A Study on the Causes and Impacts of Price Escalation and Its<br>Improvement Mechanisms in Road Construction Projects in South<br>Nation Nationalities and People Region, Ethiopia | Tigist Getnet Wube | road construction sector particularly south nation<br>nationality and people region road construction projects | Survey (research methodology) with Document review, self-administered questionnaires, Interview (data collection instrument) | Causes and Impacts of Price Escalation are Inaccurate estimate, Unrealistic schedule and Sequence of activities<br>Owner level, Time required to make a decision by owner, Number of change/extra work orders<br>And Competence/know ledge of owner,<br>Laboure level; Subcontractors and suppliers, quality of work (by subcontractors) and availability of skilled labor,<br>Equipment and Material level; Material quality, Equipment availability and |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | Suitability |

By focusing on federal public building projects in Addis Ababa and considering the contractors' perspective, this research can provide valuable insights into the specific challenges and impacts of price escalation in this context. This will contribute to the existing literature by addressing the gap in knowledge related to the management practices and effects of price escalation on cost performance for federal public building projects in Addis Ababa, from the contractors' viewpoint.

Therefore, this research objectives align with the identified gap and aim to investigate the price escalation extents and management practices on federal building construction projects, assess the impact of price escalations on the construction projects' cost performance, and come up with recommendations to mitigate the major negative impacts. This research will provide valuable insights and contribute to the overall understanding of price escalation management practices in the context of federal public building projects in Addis Ababa.

Previous studies have reviewed the cause, impact, and management practice of price escalation in different construction sectors. But it was observed that there were discrepancies in the approaches adopted by those researchers, most especially in terms of the scope of the study and research methodology, including the types of data collected. This study focuses on the effect of price escalation on the cost performance of federal building projects. The previous studies used survey methodology and some of them reviewed necessary documents.

Whereas, this study seeks to fill the existing gap in knowledge by identifying the effect of price escalation on the cost performance of federal building projects and the management practice with its challenge. This will be done using factors identified from the reviewed literature. Secondly, assessing the effect of price escalation will be done by reviewing different documents.

# CHAPTER THREE: RESEARCH METHOD

## 3.1. Introduction

Research is the methodical process of gathering, analyzing, and interpreting data and information in order to better understand a phenomenon under the study (Leedy & Ormrod, 2015).

To conduct research, the first step is to understand what type of research is being conducted (Tayie, 2005; Creswell & Creswell, 2017).

### 3.1.1. Types of Research

As Fellows & Liu (2008) show, research can be classified into different types of categories based on its objectives, and approaches. Based on objectives, they can be classified as descriptive, explanatory, or exploratory; based on the approach used, research can be classified into quantitative and qualitative research.

To classify research into categories determining the research question is the first requirement.

This studies research questions are:

- What is the extent of price escalation in federal building construction projects?
- What management practices are currently used to address price escalation in federal building construction projects?
- How does price escalation affect the cost performance of construction projects?
- How do the current management practices for price escalation compare to recognized best practices in mitigating its major negative impacts?

Based on the above research questions, this research falls into the descriptive and explanatory research types (Creswell, 2014). The descriptive research answered the question "What is the extent of price escalation in federal building construction projects? And what management practices are currently used to address price escalation in federal building construction projects?". The explanatory research answered the questions "How does price escalation affect the cost performance of construction projects? And how do the current management practices for price

escalation compare to recognized best practices in mitigating its major negative impacts?".

From different types of research approaches (qualitative, quantitative, and mixed method), this study used mixed method research approach. The effect of price escalation on building projects' cost performance and its management practice requires both qualitative and quantitative data to provide a comprehensive understanding of the research problem. Therefore, mixed-method research is a well-suited approach to conduct this study. According to Creswell & Clark (2018), mixed methods research is appropriate for research problems were combining both quantitative and qualitative research methods in a research study is needed.

After deciding what type of research, the study is, the next step is determining the research methodology. Without appropriate determination of research methodology, the study cannot accomplish its destinations and reach to the fact.

### 3.1.2. Types of Research Methodology

Research methodology is the process of investigating and analyzing the different methods and basic principles that are used in any particular area of study to gather and draw conclusion. There are different methodologies used in researches, some of them are:

i. Survey (Descriptive survey, Longitudinal, Correlational and Ex post facto survey)
ii. Case study (Descriptive case study, Explanatory and Exploratory case study)
iii. Experiment
iv. Ground theory
v. Ethnography

## 3.2. Selecting Appropriate Research Methodology

Yin, (2009) stated that choosing a research strategy at random is not advisable. Instead, three crucial aspects should be taken into account:

i. The type of research question brought forward,
ii. The level of control an investigator has over actual behavioral events, and
iii. The level of emphasis on present rather than past events

Based on the above consideration case study is the appropriate research methodology for this research.

### 3.2.1. Case Study as Research Methodology

Case studies usually focus on unique or unusual situations that challenge assumptions, add complexity, or reveal something new about the subject under study. It can be particularly useful for gaining a deep understanding of a specific phenomenon or situation (Yin, 2014).

Yin (2003) notes that case studies are suitable for explanatory research where "how" and "why" issues over which the investigator has little control are addressed, when contemporary phenomena with a real-life context are sought. The more that the research questions seek to explain some contemporary circumstances, the more case study research methodology is relevant (Yin, 2018). They are also suitable for descriptive research where the "what? when? and how?" questions need to be answered.

The research questions of this study can be categorized into two types: explanatory and descriptive. The explanatory questions aim to understand how price escalation impacts the cost performance of federal public building projects and identify potential measures to minimize its impact. On the other hand, the descriptive question seeks to explore the current practices of price escalation management in these projects. However, it is important to note that the researcher may have limited control over the phenomena being studied due to external factors such as economic conditions, market forces, natural disasters, government policies, and global events like pandemics. These external factors can influence prices, project schedules, and overall project performance. Additionally, the nature of construction and building complexity, which involves multiple stakeholders including contractors, subcontractors, suppliers, and regulatory bodies, further adds to the complexity and lack of control in the research study. So due to the above reasons, a case study was chosen as the methodology for this study.

By using a case study methodology, the researcher has assessed a comprehensive understanding of the management practice, the challenges faced in the management

process of price escalation, and its effect on federal public building projects' cost performance.

The study utilized a mixed-methods approach, and a mixed-methods case study was selected from various types of case studies (Smith, 2017). Creswell & Clark (2018) define mixed-method case study research as a type of mixed-method study that uses both quantitative and qualitative data collection and results to provide detailed evidence for a case(s) or develop cases for comparative analysis. This research design is well suited for complex research questions that require a deep understanding of the research problem, and it is particularly useful when multiple cases need to be compared or contrasted.

The advantage of this approach in the case study research is (Cook & Kamalodeen, 2019):

- Allow multiple researchers to collect data in the cases at various times.
- Different research questions can be addressed.
- Allowed for greater understanding of the phenomena.

Based on the above reasons, a case study is selected as the research methodology, and its research design and different data collection methods with primary and secondary data sources are presented below.

### 3.3. Research Design

Research design refers to the overall plan or structure of the research study that outlines the research methods and techniques chosen by the researcher.

The selection of a research design is influenced by several factors, including the research question or problem, the nature of the data to be collected, the research setting, the population or sample to be studied, the available resources, and the intended audience or purpose of the study. In addition, the researcher's past experiences, knowledge, and skills may also influence their choice of research design (Creswell, 2014).

### 3.3.1. Case Study and Its Research Design

The purpose of a research design is to create a study plan that allows for proper evaluation of linkages between variables. It connects the research problem to the findings and conclusions (Creswell, 2014).

A study design must include a number of requirements, including a clearly stated research problem, the population to be investigated, methods for processing and interpreting data, and the processes and techniques to be employed for data collection (Kothari 2004).

Yin (2003) identifies the following five issues as being particularly important in case study research design:

**1. The nature of studying question:** The first task in research is to identify the type of research questions that are addressed in the study**.** In light of this, the aim of this study is to investigate and assess the effect of price escalation on the cost performance of building projects as well as their management practices with three research questions.

To answer those questions, a case study is chosen as a suitable research methodology for the following reasons:

What is the extent of price escalation in federal building construction projects? And also how does price escalation affect the cost performance of federal public building projects?

Case study research is well-suited for this question as it enables researchers to closely examine specific federal public building projects over time. By selecting multiple projects, researchers can compare and contrast how price escalation has impacted their cost performance and also to what extent it causes cost overrun. This approach allows for a detailed analysis of the external factors, project management strategies, and decision-making processes that influence cost performance. So, scholars like Yin (2009) emphasized the value of case study research in understanding complex phenomena in real-world situations.

**2.** What management practices are currently used in each projects to address price escalation in federal building construction projects?

Investigating current practices in price escalation management requires an in-depth examination of ongoing projects' performance, contractors, and decision-making processes. Case study research allows researchers to collect rich data from multiple sources, such as project documents of the practices on the ground. By adopting this approach, researchers can provide a detailed description of the current state of price escalation management in federal public building projects. Miles and Huberman (1994) highlight the importance of case study research in assessing current practices.

3. How do the current management practices for price escalation compare to recognized best practices in mitigating its major negative impacts?

To explore potential mitigations, case study research offers a valuable platform for identifying and analyzing different strategies and best practices in specific federal public building projects. Researchers can investigate projects that have successfully implemented mitigation measures and those that have faced challenges in this regard. This approach can uncover valuable understandings into what works, what doesn't, and why. Building theories from case study research can be particularly relevant when seeking to develop mitigation strategies based on empirical evidence (Eisenhardt, 1989).

**2. The proposition of the study:** in the event that it is articulated and needed, will help direct the research process and explain the variables that research ought to concentrate on. The general analytic strategy of the study was guided by the theoretical formulations and related research questions. The proposition of this study is to show that effective management practices and early mitigation measures significantly reduce the negative impacts of price escalation on the cost performance of building projects.

**3. Unit of analysis**: refers to the unit to which the research applies and from which data is collected. There are four types of units of analysis: individuals, organizations, groups, and data series.

A case study can be designed as a single-case study (holistic) or a multiple-case study (also known as a multi-case study). These two types can be further subdivided into two groups based on the inclusion of a single unit of analysis (a holistic case) or multiple units of analysis (embedded cases) (Yin, 1994). This study compared the approaches and methods used in the chosen case to the conceptual framework

developed and the suggested price escalation management practices from the literature.

In this research, the units of analysis were individual cases (projects) within federal universities' building projects. The researcher employed a multi-case selection, as recommended by Yin (2009), to ensure that replication enhances the precision, validity, and stability of the findings.

In addition, the subject of study (price escalation) is common across all projects with no significant uniqueness. Therefore, a single-case study was not selected. Instead, a multiple-case design on "price escalation," with embedded units of analysis focusing on the effect of price escalation and its management practices, was chosen.

**4. The logic linking the data to the proposition:** this study aims to establish a logical link between the data and the proposition that the price escalation has a significant impact on building projects' cost performance and management practice. To achieve this, the researcher has used multiple sources of evidence, establishing a chain of evidence, using pattern-matching logic, and using replication logic. This has helped to ensure that the data is comprehensive, reliable, and consistent across multiple cases and enabled the researcher to draw meaningful conclusions about the relationship between price escalation and building project cost performance, how the researcher had analyzed cost data, management practices, and mitigation strategies to draw conclusions.

**5. The criteria interpreting the finding:** Campbell's (1975) approach, the researcher seeks to establish a logical link between the data and the proposition by comparing the patterns in the data to the patterns in the proposition. This approach involves identifying cases that are relevant to the research question and comparing their practices to existing theories and suggested practices in order to identify common patterns that support the proposition.

In this study, the researcher has used a comparative approach to identify the factors that contribute to price escalation and their impact on building project cost performance. To do this, the researcher has used pattern-matching logic to identify common patterns across multiple cases that support the proposition that price escalation has a significant impact on building projects' cost performance and management practice. By comparing the patterns in the data to the patterns in the

proposition, it made it possible to identify the factors that contribute to price escalation and their impact on building project cost performance. This would help the researcher to establish a strong logical link between the data and the proposition and draw meaningful conclusions about the relationship between price escalation and building project cost performance.

The other issue in research is its flow. For this research, the research flow is shown in the figure below.

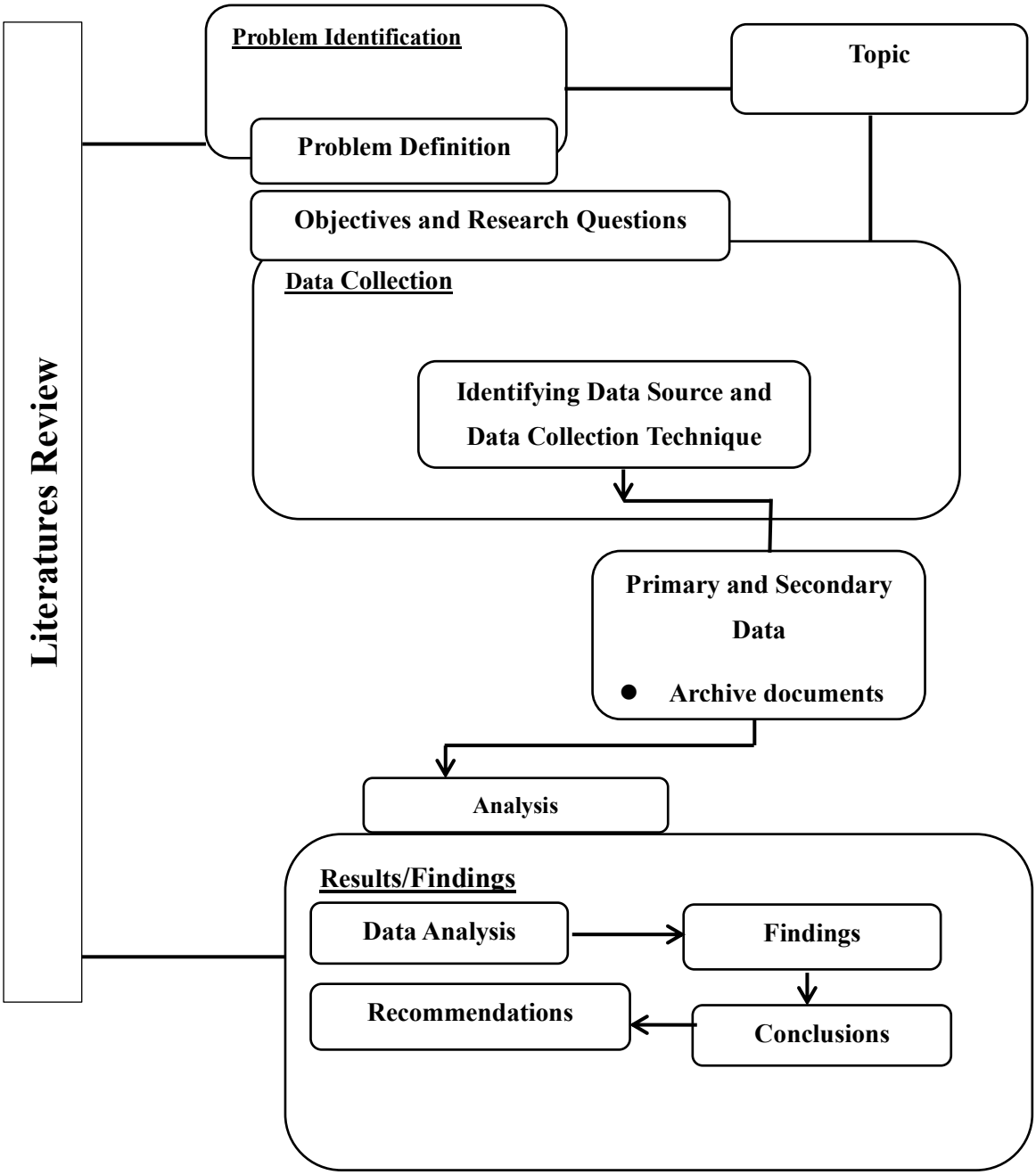


Figure 3. Research Flow

## 3.4. Selection of Case

Case selection refers to the intentional selection of one or more cases of a phenomenon as the particular subject of the research. To facilitate the generalization and protect the quality of the research, it is necessary to select the appropriate number and type of cases.

Yin (2018) recommends using a single case under a situation where a critical case is observed although multiple cases are recommended by Yin (2009) when replication is required because replication will strengthen the accuracy, validity, and stability of the findings.

It is very difficult to make a research study compromising all of them. So, it is important to select specific study areas that can represent the rest areas having sort of similarities.

In this regard, Eisenhardt (1989) recommends the use of four to ten cases for better external validity. However, Yin (2003) notes that while a larger case number may be needed for theoretical replication, when fit; even two cases may be enough for literal replication.

According to Seawright & Gerring (2008) case selection in case study research has twin objectives.

- A representative case and

It may be useful to try to select cases that are typical or strongly representative of other cases. The selected case studies are considered likely representative of the majority of other cases. Additionally, in order to fulfill this, there must be criteria for selecting representative case studies. The following are the criteria used for selecting the case study areas.

- Useful variation on the dimensions of theoretical interest

This research falls in the multiple case designs with multiple/embedded unit analysis (assessing the management practice and impact of price escalation on federal public building projects performance).

To address a particular interest or theoretical consideration, a case study requires selecting a best-fit case(s) based on predefined selection criteria. For the purpose of this research construction of buildings in universities, built under the federal government were selected based on the criteria of (Yin, 2018; Eisenhard, 1989; Mills, et al., 2010Hendrickson &Au, 2016; Brandon & Naoum, 2011):

1. Availability of data:
2. Relevant to the research objectives:
3. Degree of access and geographical location:

**1. Availability of full information**

According to the data that the researcher collected from the Ethiopian Construction Authority Office, which was studied in relation to price escalation problems, more than 600 building projects are being constructed in 45 federal universities. Only 63 projects had enough information to fully answer the research questions and be used for public use. From 63 of them, only 25 are ongoing or recently completed projects, and only 13 of them have active contractors (all the data presented in the table and shown in the appendix part of this paper).

**2. Relevant to the research objectives**

The cases being studied are appropriate and useful for answering the research questions or achieving the research goals.

**3. Degree of access for the data**

From 11 projects, the following four federal university public building projects that are registered under Addis Ababa Science and Technology University were selected for this study because of the degree of access needed for the data based on the researcher's time and location.

Table 4. Degree of access

| Universities | Buildings under construction | Address of the project | Contract Amount |
|---|---|---|---|
| Addis Ababa City | Commercial complex building construction | AASTU main campus | 490,179,128.52 |
| | Construction of administrative building | AASTU main campus | 601,374,007.00 |
| | Auditorium building construction | AASTU main campus | 230,213,081.70 |

| | | | |
|---|---|---|---|
| | Guest house buildings | AASTU main campus | 164,576,192.00 |

After the selection of projects to conduct the case study, the next important step was to choose how the price escalation issues in the selected projects would be assessed. Construction projects involve many activities, but due to the researcher's time constraints and access to data, activities were selected for assessment in the specific study. For this selection, there were some selection criteria:

- Importance in building projects:
- Vulnerability to price escalation:
- Availability of data:
- Industry significance

Therefore, after considering the above criteria, the researcher chose concrete work over the rest of the building construction activities. Concrete work is a critical component of building projects, particularly in the construction of foundations, columns, slabs, other structural elements, and various other components. It accounts for a significant portion of the overall project cost. It involves the use of raw materials such as cement, aggregates, and steel reinforcements, which are subject to price escalation. Additionally, the cost of concrete work can be influenced by various factors, such as labor costs, equipment costs, and site conditions etc. Price escalation, which refers to the increase in material and labor costs over time, is a prevalent challenge in construction projects. On the other hand, for the assessment of price escalation issues, availability of data is necessary, and concrete work is a well-documented aspect of construction projects, with extensive records available regarding material costs, labor expenses, and project budgets.

## 3.5. Data Source

According to Creswell (2013), data sources in research can be categorized into two categories: primary data sources and secondary data sources, based on their originality and the source accessed.

Under the case study approach, there are different data sources, which include documents, interviews, observations, physical artifacts, etc. Each of these could be used separately, but as much as possible, it is advisable to use a combination of them (Yin, 2003).

### 3.5.1. Data Source Selection

When conducting research, choosing an appropriate data source and data type is crucial. Creswell (2014), Neuman (2013), Patton (2014), and Yin (2014) have all discussed the importance of selecting an appropriate data source when conducting research. They have identified two main types of data source selection: purposive and probabilistic.

Purposive data source selection involves selecting a data source based on a specific goal or purpose.

In contrast, probabilistic data source selection involves selecting a data source randomly, usually with the goal of achieving statistical generalization.

The choice of data types depends on the broader methodology and philosophical orientation adopted by the researcher, as well as the purpose and nature of the research projects under study (Lochrie, 2015).

For this study, purposive data source selection was chosen because it is associated with extensive data-gathering procedures like observations, case studies, action research, and other techniques that are generally associated with analytical generalization.

Similarly, the selection of a data type can also affect the type of research conducted. There are two different types of data source that are, Primary and secondary data.

**Primary data:** is original data generated for the specific purposes of a research project.

The following list covers the main types of primary data each researcher can choose from:

- questionnaires
- transcripts of interviews
- field notes from focus groups

- Observations etc.

On other hand, secondary data includes all available data that are 'out there' for a researcher to collect and analyses.

They are resources that analyze, review, and assess the primary or first-hand data (Salkind, 2010; Kothari, 2004). Company archival documents, reference books, and journals that study and interpret any kind of primary data are all included.

This study employed secondary data sources. The data collected from the various construction documents, which were relevant for the issue under study; payment certificate, contract document, project progress report, Payment certificate, and input price etc.

The research used project-related documents and archives, as listed and discussed below and the needed data from these sources are collected through the different data collection techniques (stated below) and analyzed by using the method called document analysis.

- **Contract Documents**: - give the project description, scope, the requirements and agreements, which affect the decisions throughout the project lifetime.
- **Payment certificate**: - give the quantity that has been carried out in each month.
- **Monthly input price**: it shows the change of price for different construction with a month interval. It gives the information about the prices of materials and equipment used in the project, which can be used to assess the efect of price escalation on project costs.
- **Project budget related documents**: gives information about initial budget, cost estimation.
- **Suppliers related documents**: gives information where the materials price came from.
- **Cost estimation and forecasting documents**: These documents provide estimates of the costs associated with various aspects of the project, including materials, labor, and overhead. They also may include forecasts for potential price escalations and their impact on the project budget.

Table 5. Data sources

| Research Question | Data source | Description of document |
|---|---|---|
| • What is the current practice of price escalation Management in the Federal Public Building projects? | Secondary sources<br>•Document review | The documents collected from the contractor side, which include project contracts, forecasting estimation documents and supplier related documents. These documents are essential in studying the initial budget, monthly input price through project duration and forecasting trends. By analysing these documents, it will be possible to identify the the current practice of price escalation management in the federal public building projects. |
| How does price escalation affect the cost performance of Federal Public Building projects? | Secondary sources<br>• Document review | The documents had be collected from the contractor side, which include the budget report of the project in different time interval, any request of time extension and adjustment request related to price escalation. By analysing these documents, it would be possible to identify the effect of price escalation on the cost performance of federal Public building projects. |
| • What are the possible mitigations to minimize the impact of price escalation on the construction cost performance building | Secondary sources<br>✓ Document review | This can include reports, case studies, and literatures on effective strategies applied by previous building projects to lessen the effect of price increases on the performance of construction costs. By analysing these documents, |

| | | |
|---|---|---|
| projects'? | | it would be possible to identify possible mitigations to minimize the impact of price escalation on the construction cost performance building projects'. |

## 3.6. Research Instrument

A research instrument is a tool or technique used to collect data in a systematic and standardized manner for a research study. Research instrument designed for data is collected that enable to test the validity of the problem statement and in order to acquire the relevant data for answering the research question. To develop a research instrument, the researcher should determine the research questions and select the type of instrument that is most appropriate for the study.

**Document review instrument**

The data collection technique for this research is reviewing archival data. The archival data collection was relevant for this research because the focus of this study was to collect construction data and analyze correlations between the different variables mentioned in chapter two. The research questions, which were answered by reviewing selected document, are:

i. **What is the current practice of price escalation management in federal public building projects?**

Table 6. Documents used to assess the current practice of price escalation management in federal public building projects

| No | Data | Source | Purpose |
|---|---|---|---|
| 1 | Ccontract agreement between the owner and the contractor, and any addenda or amendments | Project Contracts and Agreements | The purpose of these documents is to establish any needed description of the project like; the scope of work, the terms and conditions of the contract, and the responsibilities of the parties involved. These documents provide insights into how price escalations are accounted for and managed within the project's budget |

| | | | |
|---|---|---|---|
| | | | (Smith, 2019).<br>These documents additionally outline the terms and conditions related to price escalation and provide insights into how price changes are managed. |
| | Contractual payment terms | | Review the payment terms and conditions, including the payment schedule, milestones, and other payment-related provisions. |
| | Price escalation clause | | Those clauses shows the current practice that related to price escalation, such as how price increases were handled and under what circumstances |
| 2 | Initial project budget, cost estimates for different project phases, cost control measures implemented | Project Budgets | This document provides information on the initial budget, cost estimates, and additionally the document allowing for an assessment of how price escalation is being managed through the project lifetime. |
| 3 | Estimation methods employed, factors considered for price escalation, ttechniques used for cost forecasting. | Cost estimation and forecasting documents | These documents outline the estimation methods used, factors considered for price escalation, and techniques for cost forecasting trend of the project.<br>Compare the actual cost of the project to the planned cost, taking into account any price escalations that have occurred. |

**ii. How does price escalation affect the cost performance of Federal Public Building projects?**

Table 7. Documents used to assess price escalation affect the cost performance of Federal Public Building projects

| No | Data | Source | Purpose |
|---|---|---|---|
| 1 | Ccontract amendments or Renegotiating contracts | Project Contracts and Agreements | The purpose of the document is to show if there have been revised pricing or cost adjustments made in response to price escalation. |
| 2 | The increment of material, labor and equipment price through project life time | Monthly input price reports | The document shows the fluctuations in input prices over time, and allowing the researcher to identify any patterns or trends in price escalation. |
| 3 | The difference of price of materials, labors and equipment through the project life time | Cost Estimation documents | This documents provides a prediction of the project's total cost based on the stated scope of work on the contract and current market conditions. If there are any changes to these estimates due to an increase in the price of materials or labor that document showed how the price escalation affects the cost performance of the project. |
| 4 | The percent increment of each month price from its contract amount | Payment certificates | This documents provides information about monthly executed amount to calculate in what percent iss the specific activity increase its contract amount |

## 3.7. Data Collection Methods

Case study research can involve various data sources, including documents, archival records, interviews, observations, and physical artifacts. While each of these can be used as a standalone data source, it is often recommended to use multiple data sources to ensure data triangulation. This approach can help to increase the accuracy and reliability of findings, as well as identify patterns and themes that may not be evident in a single data source (Yin, 2003; Patton, 1987). In order to collect relevant information and data, different data collection techniques were applied in this study.

After developing the research instrument, the researcher prepared the document review formats or templates to collect the data (Appendix I).

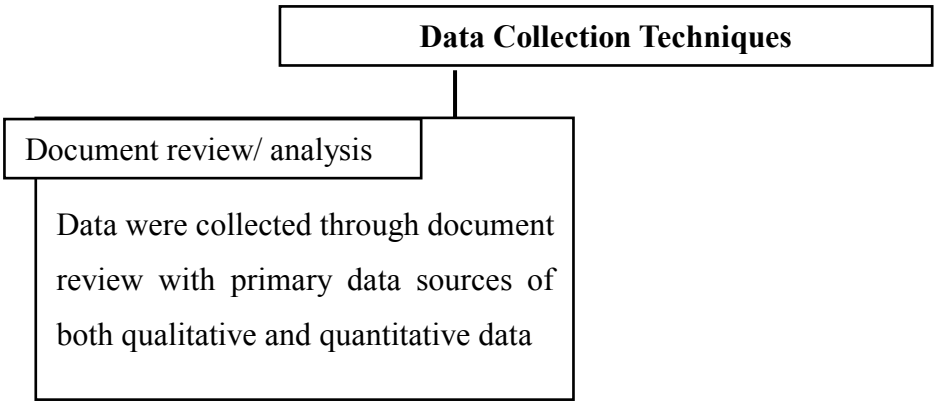



Figure 4. Data Collection technique

### 3.7.1. Secondary Data Collection Methods

Critical analysis and interpretation of archival data can also be a good source of research data. It is a better technique of data collection for case studies, which actually focus on specific characteristics of a construct for detail presentation. Such approaches demand a good skill in critical thinking and content analysis. Moreover, care should be taken about the authenticity and credibility of the source document, which perhaps, demands understanding the writing party's viewpoint.

* Secondary sources are utilized to investigate key issues related to specific research questions. These sources included proposals, library references, reports and minutes of meetings, letters, project evaluations, government policies/guidelines, newspaper articles, contract agreements, government census, video recordings, and maps. Information was obtained from various actors in the case areas, government officials, and internet databases such as books, articles, and journals. From those the researcher reviewed the following documents:

- Project Contracts and Agreements
- Monthly input price reports
- Suppliers related reports
- Cost estimation and forecasting documents
- Project Budgets

Addition to the above data, library references (books and previous researches), official reports (published and unpublished documents), internet databases (books, articles and journals), newspapers articles, radio programs and photographs will have direct or indirect connection to subject matters of this study in showing minimum reflections for analysis in relation to a particular research question.

### 3.7.2. Challenges of Data Collection Methods and Their Mitigation

The following table shows some challenges that may occur during data collection and their solutions.

Figure 5. Challenges and their Mitigation of data collection Techniques

| Technique | Weakness | Mitigation |
|---|---|---|
| Document Review | • Retrievability can be low<br>• Biased selectively, if collection is incomplete<br>• Reporting bias (reflects bias of authors)<br>• Access (may be deliberately blocked) | **1.** Use multiple evidence<br>  ✚ Triangulation types (Patton, 1987)<br>• Of data sources (data triangulation)<br>For this study, for triangulation, the findings from document reviews outputs were cross-referenced with reviewing different documents.<br>• Create a case study database<br>  ✚ Two collections<br>• The data or evidence base<br>• The report of the investigator, whether in article, report or book format<br>  • Uses notes, documents, tabular material, and narratives |

## 3.8. Data Analysis Techniques

### 3.8.1. Introduction

This study falls under the mixed-methods research, approach, so for analyzing the collected data, the researcher used both qualitative and quantitative data analysis techniques.

The study used document review as its main data sources and for triangulation by reviewing different documents. Content analysis is a research data analysis technique

used to analyze the content of written, verbal, or visual communication. It entails systematically classifying and coding the content of documents to identify patterns, themes, and relationships within the collected data (Bowen, 2009). In this research project contracts and agreements, project budgets, cost estimation and forecasting documents, suppliers' related reports and monthly input price reports were reviewed. The analysis used to assess the management practice of price escalation best practices and the effect of price escalation on the cost performance of federal building projects identified in chapter two as the main theme of the content analysis.

Pattern matching: the main concept of pattern matching logic, as described by Yin (2018), is to compare empirically based patterns with theoretically predicted patterns or to compare patterns across cases. In this study, both methods are applied. Each case study report is subdivided into three main key issues derived from the research questions, reflecting the theoretical predictions and descriptions:

- Cost Performance
- Effect of Price Escalation
- Managing Price Escalation

In multiple case study research analyzing data, Yin (2003) recommends a two-stage analysis within-case analysis and cross-case analysis. Several pieces of information about price escalation history were clarified from the cases with descriptive analysis, within case and cross-case analysis.

For assessing the cases' price escalation management practices, analytical analysis was conducted against best practices, which were mentioned in Chapter two.

The case analysis addressed the impact of price escalation on cost performance and their price escalation management practices in selected federal university building projects in Addis Ababa.

**Descriptive analysis:** The contextual information provides a broad understanding of the history of price escalation for each project.

**Within the case analysis:** it involves analyzing the collected qualitative and quantitative data of each case study independently after which the researcher concludes the findings of the research questions for each individual case.

**Cross-case analysis:** the four cases were compared in relation to the key issues. By grouping cases based on specific dimensions to identify similarities and differences within these groups.

### 3.8.2. Developing Themes

The following themes and sub-themes are developed by the researcher to analyze the collected data.

**Theme I:** description of the cases, in this theme the researcher described the basic contracting parties, contractual dates, type of contracts, delivery methods and cost related clauses of the cases from contract document; and forecasting type, trend and database issues from cost estimation and forecasting documents.

**Theme II:** identifying the increment of major materials, labors and equipment for each project.

**Theme III**: identifying the effect of price escalation on each project's cost performance.

**Theme IV:** identifying the price adjustment techniques, source of price and weightage for each project.

## 3.9. Reliability and Validity

### 3.9.1. Reliability

Stenbacka, (2001) viewed reliability as 'purpose of explaining' in quantitative approach and 'generating understanding' in qualitative approach to research.

Saumure & Given (2008) recommended that reliability could be addressed by providing a rich description of the research procedures and instruments used so that other researchers may be able to collect data in similar ways.

To address reliability issues in this research, the researcher focused on establishing the reliability of measurement tools and methods. This can be accomplished by incorporating established, validated measurement scales (Babbie, 2016). To ensure reliability in measurement, clear definitions of key variables such as price escalation, project costs, cost performance, etc. were established. This ensures consistency in the data collection process. Additionally, employing an appropriate case selection method can enhance the reliability and generalizability of the study findings (Babbie, 2016).

### 3.9.2. Validity Test

To make sure the research is valid; the study used reliable sources such as published books and recent articles, which are written by highly praised authors in the construction management field. Several measures employed to ensure that the results are free from different errors starting from the design of the templates used in gathering the data.

#### 3.9.2.1. External Validity

It emphasizes the generalization of the research findings. The study is a piece of mixed methods research in which the combination of qualitative and quantitative studies has the potential to achieve triangulation, which is one of the important ways to enhance external validity (Bryman, 1988). This study examines the management practice of price escalation and the relation between price escalation and the cost performance of construction projects by using both quantitative techniques and qualitative interpretation and description.

The external validity of this study can be enhanced through the following ways:

- Purposive sampling allows the researcher to select the cases that represent the feature the researcher is interested in (Silverman, 2001). To ensure to the validity of gathered data they were collected direct from related archival documents, which has reach information on the research theme.
- The study investigates data from multiple cases gathered from different construction building projects, which are constructed under federal universities. The case selection is done to incorporate different projects with different sizes, and types of federal buildings were considered.

#### 3.9.2.2. Internal validity

In quantitative researches, it is about conceptualized as the degree to which the researcher is confident about the conclusion/inferences of the causal relationship between variables/events (Tashakkori and Teddlie, 1998); where as in qualitative research refers to the extent to which the observations and measurement represent the reality (Lecompte and Goetz, 1982). It is concerned with the research methodology and data sources used to establish a high degree of harmony between the raw data and the researcher's interpretations and conclusions.

In this study, internal validity were ensured by controlling for confounding variables that may influence cost performance, such as changes in project scope, design modifications, or external economic factors. Statistical techniques can help establish causal relationships between price escalation management practices and cost performance. The researcher examined carefully the inferences drawn from the qualitative and quantitative data by adopting the content and thematic analysis to guide the discussion of results.

#### 3.9.2.3. Construct validity

Construct validity refers to whether the measures used accurately capture the concept being studied. To enhance construct validity, the research were established measures of the management practices of price escalation and cost performance that are commonly accepted in the field of construction and project management.

## 3.10. Summarized Research Method

The research methodology focused in search of answers to the research questions formulate based on logical problems. The methodology and methods were employed in designing the whole framework of this research and data collections, the types and selections of documents, application and timing of analysis and the role of literature in analysis present below as summery in this chapter.

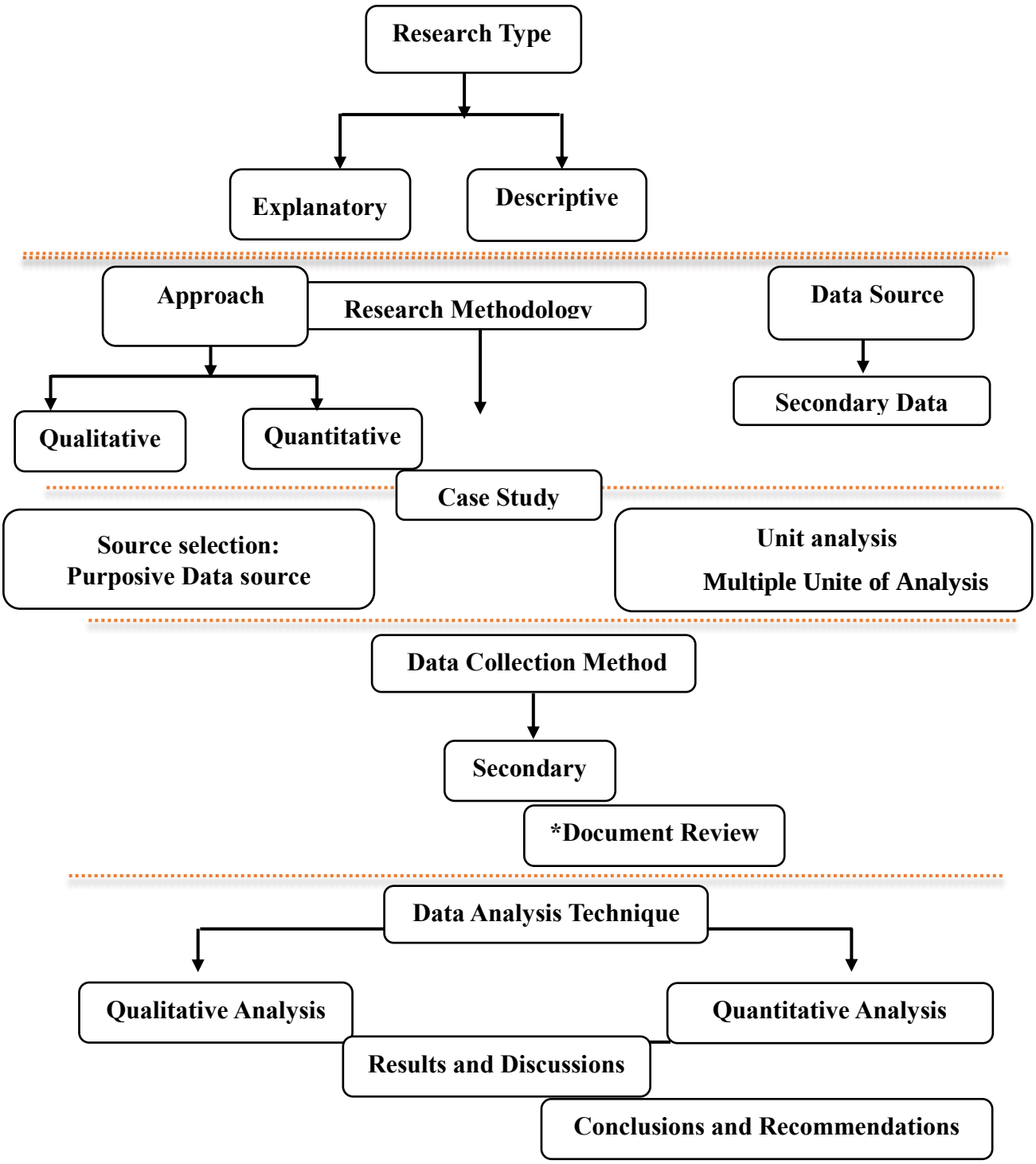



Figure 6. Summarized Research Method

# CHAPTER FOUR: RESULTS AND DISCUSSIONS

## 4.1. Introduction

The chapter presents the results of data collected through document review to assess the current management of price escalation and its effect on the cost performance of federal public building projects. The research employed a case study research methodology to gather data from various projects, specifically those located in Addis Ababa city federal universities. The findings will provide insights into the current management of price escalation and its impact on the cost performance of federal public building projects. The discussion will analyze the results obtained from the collected data.

## 4.2. Description of Cases

The selected cases for this research were federal public building projects found in Addis Ababa federal universities that are still under construction. The following table presents the four elected projects and their description.

Table 7. Selected Projects and their description

| **Description** | **Project A** | **Project B** | **Project C** | **Project D** |
|---|---|---|---|---|
| Client | Addis Ababa Science and technology university | | | |
| Building Type | commercial complex building | Construction of Administration Building | Construction of Guest house building | Construction of Auditorium Building |
| Date of contract signing: | 09-05-2018 | 01-08-2018 | 03-07-2018 | 14-05-2018 |
| Contact amount: | 418, 133,212.95 | 601,374,007 | 164,576,192.00 | 203,213,018.17 |
| Project delivery method | DBB | | | |
| Contract type: | Unit price | | | |
| Price adjustment clause availability | No | Yes | No | No |
| Base price sources | ECSA/ AADCWB | ECSA, AADCWB & well-known suppliers | ECSA/ AADCWB | ECSA/ AADCWB |

| | | | | |
|---|---|---|---|---|
| Progress until June 4-2024: | Above 95 % | Above 68% | Around 70 % | 99 % |
| Project duration: | 540 Days | 600 days | 540 Days | 540 Days |
| Original completion date: | November 30, 2019 | March 24, 2020 | December 25, 2019. | November 5, 2019 |

The first objective of this study is to assess the extent of price escalation on cost performance and the management practices used to mitigate this issue in selected projects. This is followed by an analysis of the impact of price escalation on project cost performance, and finally, recommendations for mitigation strategies based on best practices.

## 4.3. The extent of price escalation on their cost performance

A change in the price of direct inputs of construction during the life of a building project can affect initial cost forecasts, which result in major issues for project stakeholders. Understanding the extent of these increments is necessary to prevent problems with budget shortages, enhancements in cost management, and project success. The following graphs and tables showed the extent of price escalation in major materials and in each project, as well as how the project initial budget was affected.

### 4.3.1. The increment of price for major inputs of concrete, reinforcement, formwork and masonry activities

The following graphs and tables contained the main direct inputs of concrete, reinforcement, formwork, and masonry works/activities, with the increment they showed through the project lifetime.

#### A. For concrete work

For concrete work Project A and B used batching plant with 30 $m^3$/hr productivity rate. But the rest of two (Project C and D) used automatic mixer. The following graphs and tables will show the price increment of concrete inputs in different years and months throughout selected projects execution period.

### I. Price of cement

The three case studies reflect that the base price of cement for project A, C and D is from AADCB/ CSE and it is presented in the following graph.

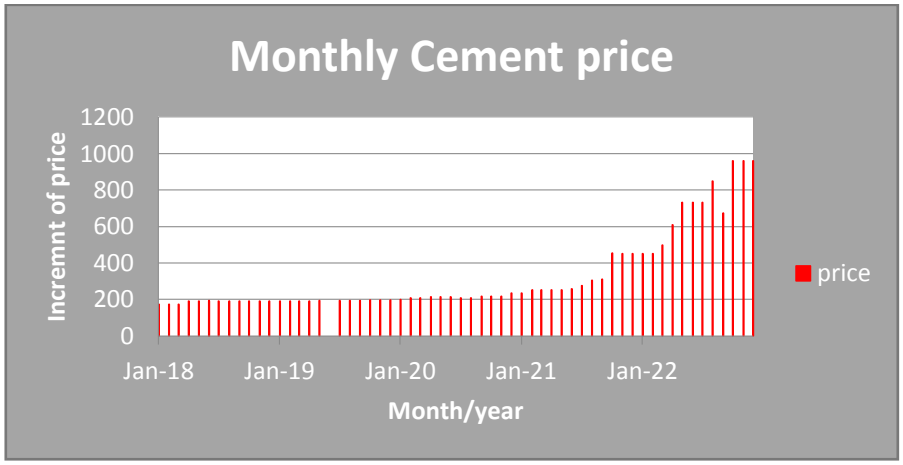



Figure 7. Price increment of cement

From January 2018 to December 2022, cement prices show a striking upward trend. Starting at 174.06 in early 2018, the price remained stable throughout the year before rising slightly to 194.66 by mid-2019 and increasing to 197.56 by the end of 2019. In 2020, prices continued to climb, reaching 216.94 by December. The increase became more pronounced in 2021, with prices reaching 310 by September and surging to 450 by December. This upward trend persisted into 2022, peaking at 960 by October and staying at this high level through December.

But for **project B** the suppliers of cement is Derba mediroc cement factory. In addition, the following table shows the price of cement in those factories from 2018-2021 G.c.

Table 8. Price (ETB) Cement

| No | Source of cement | Price (ETB) | |
|---|---|---|---|
| 1 | Derba Mediroc | 233.5 | October, 2018 |
| 2 | | 260 | August, 2019 |
| 3 | | 292 | September, 2019 |
| 4 | | 253.45 | October, 2019 |
| 5 | | 355 | February, 2020 |
| 6 | | 650 | September, 2020 |

| | | | |
|---|---|---|---|
| 7 | | 700 | February, 2021 |
| 8 | | 635 | June, 2021 |

## II. Price of Sand

Sand is one of the major ingredients in concrete. Increased in the price of sand may lead to higher expenses for concrete production, which may result in affecting the budget and profitability of construction projects. The following graph shows the increment of sand through the projects' life time.

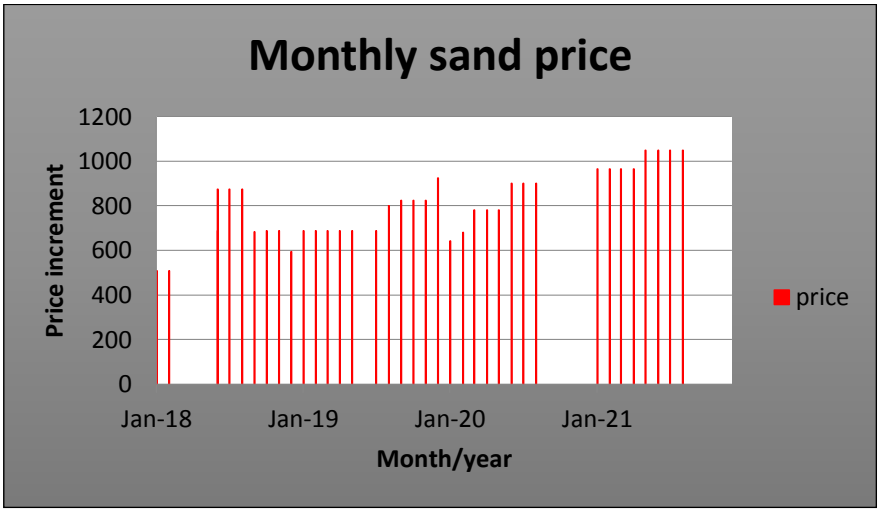



Figure 8. Price increment of sand

From January 2018 to May 2021, the price of sand exhibits a clear upward trend. Initially, in early 2018, prices were relatively low at 508.89 but surged significantly starting from June, reaching 875. Throughout 2018, prices fluctuated between 595 and 875. In 2019, the price remained stable at 687 for the first eight months before rising steadily to 925 by December. The year 2020 saw a notable price increase from January through May, with prices ranging from 643 to 780, and then spiking to 900 from June onwards. In 2021, prices continued to climb, reaching 1050 by May.

## III. Price of Coarse Aggregate

**Coarse Aggregate** is one of the major ingredients in concrete. Increased in the price of this material may lead to higher expenses for concrete production, which may result in affecting the budget and profitability of construction projects. The following graph shows the increment of sand through the projects' life time.

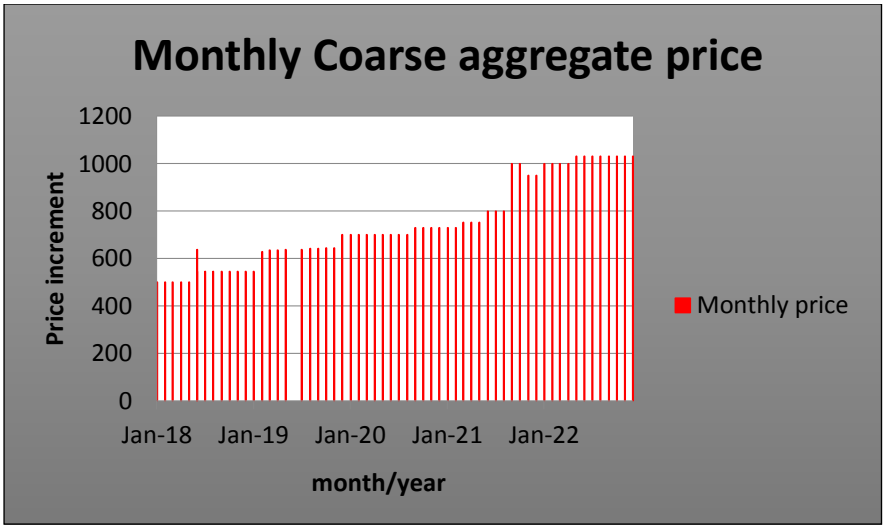



Figure 9. Price increment of coarse aggregate (source: Addis Ababa Design and Construction Works Bureau)

From January 2018 to December 2022, the price of coarse aggregate, a key component in concrete, shows a significant upward trend. Beginning at 500 in early 2018, prices remained stable until June 2018, when they increased to 546. Throughout 2018 and early 2019, prices gradually rose, reaching 700 by December 2019. In 2020, the price stabilized at 700 before climbing to 730 by September. The increase became more pronounced in 2021, with prices reaching 1000 by September and staying at this level until December. In 2022, prices continued to rise, peaking at 1031.75 by May and remaining at this high level for the rest of the year.

## IV. Price of scaffolding

The selected projects used two types of scaffolding. They are:

### 1. Wooden scaffolding

Table 9. wooden scaffolding prices at different time interval

| No | Material | Price (ETB) | Year |
|---|---|---|---|
| 1 | Scaffolding(wooden) | 3.00 | May, 2019 |
| 2 | | 4.00 | September, 2020 |
| 3 | | 8.00 | February, 2021 |
| 4 | | 15.00 | October, 2022 |

(Source: Addis Ababa Design and Construction Works Bureau)

**Projects C** and **D** used wooden scaffolding for their entire work. In 2019, it was 3 ETB but after three years it became 15 ETB by showing 80% increment in three years.

### 2. Steel scaffolding

The second type of scaffolding used in selected was steel scaffolding. The following table shows the price of steel scaffolding in different time.

Table 10. Steel scaffolding prices at different time interval

| No | Material | Price (ETB) | Year |
|---|---|---|---|
| 1 | Scaffolding(steel) | 1189 | 2018 |
| 2 | | 1278 | 2019 |
| 3 | | 1820 | 2020 |
| 4 | | 2022 | 2021 |
| | | 2800 | 2022 |

(Source: Addis Ababa Design and Construction Works Bureau)

Unlike **project C** and **D** Project A and B used steel scaffolding for during their work execution. And through the project execution time steel scaffolding showed more than 40% increment in the market.

### B. Price of Reinforcement Bar

There are several suppliers of reinforcement bars in Ethiopia, with many of them importing from Turkey, the base price for reinforcement bar for project A, C, D is from CSE/ AADCB, and it is presented in the following graph.

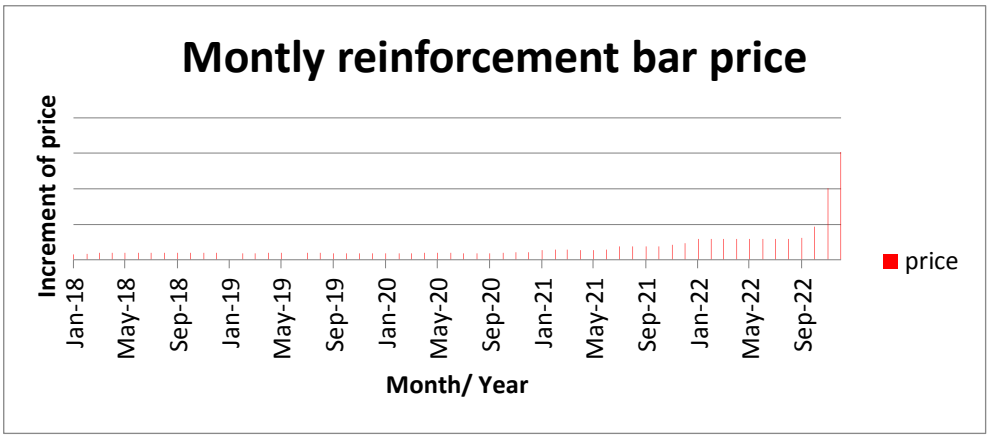



Figure 10. Price increment of reinforcement

From January 2018 to December 2022, reinforcement bar prices show a dramatic increase. Starting at 29.77 in early 2018, prices began to climb steadily, reaching

around 39.15 by the end of 2018. The price trend continued to rise in 2019, fluctuating between 36.5 and 40. By early 2020, the price stabilized at about 39.29 before dipping to 38 by mid-year. However, a sharp increase began in late 2020, with prices reaching 42.86 by December. In 2021, the price surged significantly, peaking at 95 by December. This upward trend continued into 2022, with prices soaring to 608 by December. This data reflects a substantial and ongoing rise in reinforcement bar prices, driven by factors such as market demand and supply chain disruptions.

However, for **Project B,** the base price of reinforcement bar came from C&E brothers, and for the entire project, the contractor used the average price from different suppliers.

### C. Formwork

Formwork is one of the activities used in concrete work for shaping and supporting the concrete until it reaches its final strength. The following table showed

| Price of Formwork For super-structure in different period of time | | |
|---|---|---|
| 2019 | March | 110 |
| | October | 200.32 |
| | January | 260.81 |
| 2020 | June | 280.5 |
| | September | 301.1 |
| 2021 | April | 304.56 |
| | September | 354 |
| | December | 381.69 |
| | May | 402.63 |
| 2022 | August | 417.04 |

Between 2019 and 2022, the price of formwork for superstructure construction saw a notable upward trend. In March 2019, the price started at 110 birr. By October 2012, it had risen to 200.32 birr, and continued to increase steadily throughout 2021, reaching 301.1 birr in September and 304.56 birr by April 2022. In September 2022, the price increase to 354 birr, reflecting a sharp increase in its costs. By December 2022, the price continues to increase and became 381.69 birr. In 2022, the price reaches to 402.63 birr in May and peaking at 417.04 birr by August.

### D. Masonry Work

One of the major activities that execute under the part of structural part of a building is masonry work. The following graph shows the price of stones used for masonry work at different period of time.

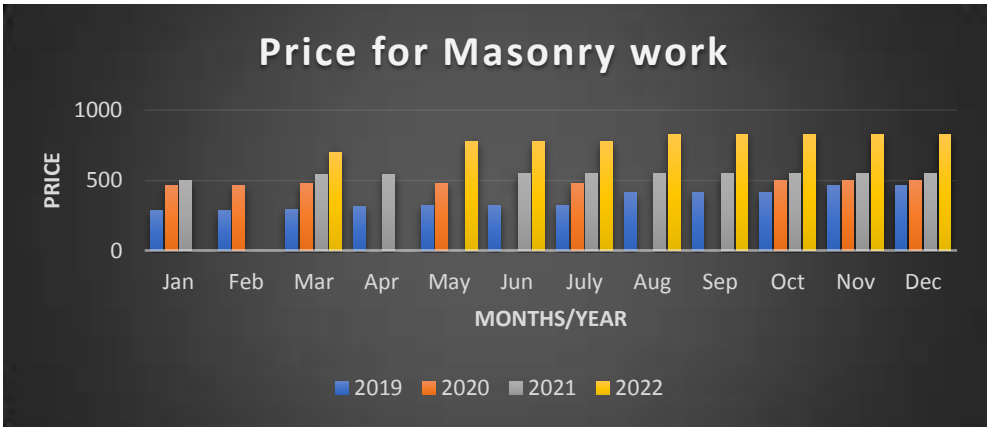



Figure 11. Price of Stone masonry (Source: Addis Ababa Design and Construction Works Bureau)

The above graph shows the price of masonry stone used in selected projects from year 2019 to 2022 across different months. In 2019, the prices were around 200 to 300 birr in most months. By 2020, prices increased, reaching around 400 birr by July and staying close to 500 birr by the end of the year. In 2021, the price reaches to around 500 and 600 birr throughout the year. In 2022, the prices peaked, reaching above 700 birr in April and hitting as high as 800 to 850 birr in July, October, and December.

### E. Cost of labor

The following graph shows the increments of labors through projects' lifetime.

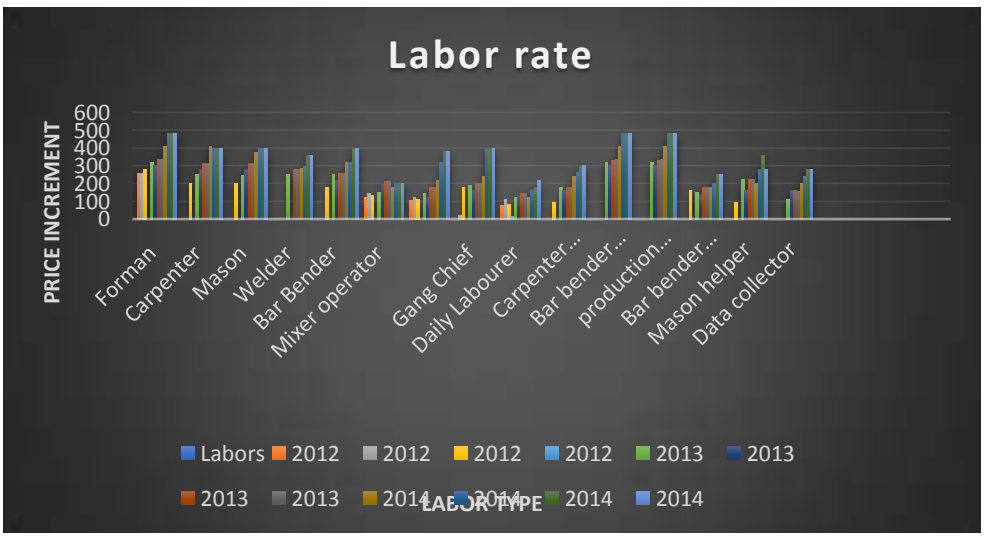


Figure 12. Cost increment of labors (Source: Addis Ababa Design and Construction Works Bureau)

From 2012 to 2014, labor costs across various trades show significant changes. The graph shows, the cost of a Forman started at 256 per quarter in early 2012, rising to 408 by the end of 2014. Carpenters saw a gradual increase from 200 in 2012 to 400 in 2014. Similarly, Masons began at 200 and reached 400 by 2014. The cost of Welders and Bar Benders showed more variability, with Welders increasing from 250 in 2013 to 360 by 2014, and Bar Benders rising from 180 in 2012 to 400 by 2014. Mixer Operators saw a rise from 120 to 200, while Vibrator Operators experienced a significant jump from 104 to 384. Daily Laborers had an increase from 76 to 220. Additionally, Bar Bender Foreman and Production Forman saw significant jumps, reaching up to 480 by the end of 2014.

Generally, the prices of inputs in construction, including concrete, masonry, reinforcement, formwork, scaffolding, and labor, have significantly increased over the years. These price increments have resulted in a high rise in project costs compared to the original contract amounts.

### 4.3.2. The extent of price escalation on projects A's cost performance

Table 11.The effect of price escalation on projects A cost performance in sub structure activities

| No | Item of work | | Contract amount | 2019 | | | | | 2020 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Jan | Feb | Apr | Oct | Dec | Feb | Apr | May | Aug | Oct | Dec |
| 1 | Lean Concrete (C-5) | under foundation pad | 150 | 56% | 21% | | | | | 33% | | | | |
| | | under beam | 150 | 56% | | | | | | | | | | 39% |
| 2 | C-30 | in foundation pad | 3040 | 17% | 17% | | | | | | 33% | | | |
| | | foundation column | 3040 | | 17% | | | | | | | | | |
| | | foundation beam | 3040 | | | | | 31% | | 33% | | | | 42% |
| | | 150mm thick basement slab | 3040 | | 17% | 26% | 29% | | 31% | 38% | | 42% | | |
| | | 250 mm thick shear wall for lift shaft and retain wall | 3040 | | 17% | 26% | | | | | | | 42% | |
| | | 20mm thick suspended ground floor | 2040 | | 15% | | | | | | 39% | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | slab | | | | | | | | | | | | |
| | | basement beam | 3040 | | 17% | | | 28% | | | | | | 46% |
| | | basement elevation column | 608 | | | 26% | | | 28% | | | | | |
| | | grade beam | 3040 | | 17% | | | | | | | | | |
| | | | 3040 | | | | | | | | | | | |
| | | in entrance steps | 3040 | | 17% | | | | | | | | | |
| 3 | Formwork | in foundation pad | 390 | 25% | | | | | | | | | | |
| | | foundation column | 390 | 25% | | | | | | | | | | |
| | | foundation beam | 390 | | | | | | | | | | | |
| | | 250 mm thick shear wall for lift shaft and raintain wall | 390 | | 25% | | 30% | | | | | | | |
| | | 20mm thick suspended ground floor | 390 | | 25% | | | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | slab | | | | | | | | | | | | |
| | | basement beam | 390 | 25% | 25% | | | | | 35% | | | | |
| | | basement elevation column | 390 | 25% | 25% | | | | | | | | | |
| | | grade beam | 390 | | 25% | | | | | | 47% | | | |
| | | 200mm thick ramp | 390 | | | | | | | | | | | |
| | | in entrance steps | 390 | | | 33% | | | | | | | | |
| | | Under foundation pad | 600 | | 41% | | | | | | | | | |
| 4 | Masonry work | Under beam | 680 | | 42% | | | | | 37% | | | | |
| | | dia 8 | 65 | 3% | 8% | 8% | | | | 49% | 28% | | | |
| | | dia 10 | 52 | 5% | 19% | 20% | | | | | 39% | | | |
| | | dia 12 | 62 | 3% | 8% | 12% | | | | 35% | 38% | | | |
| | | dia 14 | 62 | 3% | 8% | 12% | | | | 40% | 41.71% | | | |
| 5 | Reinforcement | dia 16 | 57 | 2% | 10% | 15% | | | | | 19% | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | dia 20 | 60 | 6% | 13% | | | | | 33% | | | | |
| | | dia 24 | 60 | 6% | 13% | | | | | | | | | |

The table above shows the percentage increase of each activity from the contract amount and the timing of their execution in **Project A's substructure activities.**

- For **lean concrete** under the foundation pad and beam, the contract amount was 150 birr. However, when executed, they showed a 56% increment in June 2019; a 21% increment for the foundation pad in February 2020, and a 33% increment in April 2020; and a 39% increment for the beam in December 2020.
- For **C-30**, which includes the foundation pad, foundation column, foundation beam, 150 mm thick basement slab, 250 mm thick shear wall for the lift shaft and retaining wall, 20 mm thick suspended ground floor slab, basement beam, and grade beam, the contract amount was 3040 birr. When executed, the foundation pad showed increments of 17%, 31%, 33%, and 39% in January and February 2019, December 2019, April 2020, and December 2020, respectively; the foundation beam showed a 17% increment in February 2019; the foundation column showed increments of 31%, 33%, and 42% in December 2019, April 2020, and December 2020, respectively; the 150 mm thick basement slab showed increments of 17%, 26%, 29%, 31%, 38%, and 42% in February 2019, April 2019, October 2019, February 2020, April 2020, and August 2020; the 250 mm thick shear wall for the lift shaft and retaining wall showed increments of 17% and 26% in February and April 2019; the basement beam showed increments of 17%, 28%, and 46% in February and May 2019 and December 2020; and the grade beam showed a 17% increment in February 2019. The 200 mm thick suspended ground floor slab, with a contract amount of 2040 birr, showed increments of 15% and 39% in February 2019 and May

2020, respectively. For the basement elevation column slab, with a contract amount of 608 birr, increments of 26% and 28% were observed in February 2019 and 2020, respectively.

- In **formwork**, the contract amount was 390 birr for all activities of sub-structures. The foundation pad, basement beam, basement elevation column, and foundation column showed a 25% increment in January 2019. The 250 mm thick shear wall for the lift shaft and retaining wall, 20 mm thick suspended ground floor slab, basement beam, basement elevation column, and grade beam showed a 25% increment in February 2019. The 250 mm thick shear wall for the lift shaft and retaining wall showed a 30% increment in October 2019, the basement beam showed a 35% increment in February 2020, and the grade beam showed a 47% increment in April 2020. Additionally, the entrance steps showed a 33% increment in April 2019. In masonry work, the contract amounts were 600 birr for the foundation pad and 680 birr for under the beam. When executed, these showed increments of 41% and 42% in February 2019, respectively.
- In **reinforcement bar**, the contract amounts for diameters 8, 10, 12, 14, 16, 20, and 24 were 65, 52, 62, 62, 57, 60, and 60 birr, respectively. When executed, diameter 8 showed increments of 3%, 8%, 49%, and 28% in January, February, April 2019, and April and May 2020, respectively; diameter 10 showed increments of 5%, 19%, and 20% in January, February, and April 2019, respectively, and 39% in May 2020; diameter 12 showed increments of 3%, 8%, and 12% in January, February, and April 2019, respectively, and 35% and 38% in May 2020, respectively; diameter 14 showed increments of 3%, 8%, and 12% in January, February, and April 2019, respectively, and 40% and 41.71% in April and May 2020, respectively; diameter 16 showed increments of 2%, 10%, and 15% in January, February, and April 2019, respectively, and 19% in May 2020; and lastly, diameters 20 and 24 showed increments of 6% and 13% in January and February 2019, respectively, and diameter 20 showed a 33% increment in April 2022.

Table 12. The extent of price escalation on projects A cost performance in super structure activities

| No | Item of work | | Contract Amount | 2020 | | | | | 2021 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Feb | Apr | Oct | May | June | Apr | May |
| | | for elevation columns | 3745 | 22% | 27% | | | | | |
| | | 250mm thick floor slabs | 936.25 | | | | | | | |
| | | for 180mm thick floor beam and roof beam | 674.1 | 17% | 20% | 23% | | | | |
| | | floor beam and roof beam | 3745 | 21% | 24% | 27% | | | | |
| | | stair case and landing | 3745 | | 4% | | 23% | | | |
| | | shear wall for lift shaft | 3745 | | 14% | | 23% | | | |
| | | concrete lintel | 3745 | | | | 23% | 26% | | |
| | | concrete gutter | 3745 | | | | 23% | | | |
| | C-30 | | 3745 | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | for elevation column, 250mm thick floor slabs, 180mm thick floor beam and roof beam, stair case and landing, floor beam and roof beam and shear wall for lift shaft showed 26% increment in April 2020 | 398 | 24% | 26% | | | | | |
| | | 250mm thick floor slabs | 398 | | | | | | | |
| | | for 180mm thick floor beam and roof beam | 398 | 24% | 26% | | | | | |
| | | floor beam and roof beam | 398 | 24% | 26% | | | | | |
| | | stair case and landing | 398 | | 26% | | | | | |
| | | shear wall for lift shaft | 398 | | 26% | | | | | |
| | | concrete lintel | 398 | | | | | | | |
| 7 | Formwork | concrete parapet wall | 398 | | | | | | | |
| | | dia 8 | 52 | 11% | 14% | 27% | | | 34% | 47% |
| 8 | Reinforcement | dia 10 | 65 | 13% | 16% | 20% | | | 40% | 40% |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | dia 12 | 65 | 13% | 16% | 20% | | | 40% | 40% |
| | | dia 14 | 57 | 15% | 19% | 22% | | | 41% | 44% |
| | | dia 16 | 60 | 13% | 16% | 21% | | | 39% | |
| | | dia 20 | 60 | 13% | 16% | 21% | | | 39% | |
| | | dia 24 | 60 | 13% | 16% | 21% | | | | |

The table above shows the percentage increase of each activity from the contract amount and the timing of their execution in the superstructure

- **For C-30**, including elevation columns, floor beams, roof beams, staircases and landings, shear walls for lift shafts, concrete lintels, concrete gutters, and concrete parapet walls, the contract amount was 3,745 birr. However, at the time of execution, increments of 22% and 27% were observed in February and April 2020. The 180 mm thick floor beams and roof beams showed increases of 17%, 20%, and 23% in February, April, and October 2020. The shear wall for the lift shaft showed increases of 14% and 23% in April and May 2020. The concrete lintel showed a 23% increase in May and June 2020. The concrete gutter showed a 23% increase in May 2020.
- In **formwork**, the contract amount for all activities was 398 birr. When executed, increases of 24% were observed for elevation columns, 180 mm thick floor beams, and roof beams in February 2020. For elevation columns, 250 mm thick floor slabs, 180 mm thick floor beams, roof beams, staircases, landings, and shear walls for lift shafts, a 26% increase was observed in April 2020.
- In **reinforcement bars**, the contract amounts for diameters 8, 10, 12, 14, 16, 20, and 24 were 52, 65, 65, 57, 60, 60, and 60 birr, respectively. When executed, diameter 8 showed increases of 14%, 27%, 34%, and 47% in February, April, October 2019, and April

and May 2020, respectively. Diameters 10 and 12 showed increases of 13%, 16%, 20%, and 40% in February, April, October 2019, and April and May 2020, respectively. Diameter 14 showed increases of 15%, 19%, 22%, 41%, and 44% in February, April, October 2019, and April and May 2020, respectively. Diameters 16, 20, and 24 showed increases of 13%, 16%, and 21% in February, April, and October 2019, with the exception of diameter 24, which showed a 39% increase in April 2021.

### 4.3.3. The extent of price escalation on project B's cost performance

Table 13.The effect of price escalation on project B cost performance on sub structure activities

| **Price increment through project implementation for each sub structure activity Project B** | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Activities | | | Contact Amount | 2019 | | | | | | | 2020 | | | | 2021 | | | | | 2022 | |
| | | | | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Sep | Nov | Feb | May | Aug | Sep | Dec | Feb | Jul |
| sub structure | C-5 | under mat slab | 98 | 50% | | 64% | | | 81% | | | | | | | | | | | | |
| | | under mat beam | 98 | 50% | | 64% | | | 81% | | | | | | | | | | | | |
| | | under top mat slab | 98 | 50% | | 64% | | | | | | | | | | | | | | | |
| | | under footing for dome | 98 | 50% | 54% | 64% | | | | | | | | | | | | | | | |
| | | under footing | 98 | | 54% | | 66% | 79% | | | | | | | | | | | | | |
| | | under basement slab and beam | 98 | | 54% | | 66% | | | | | | | | | | | | | | |
| | | under masonry | 98 | | 54% | | 66% | | | | | | | | | | | | | | |
| | C-30 | 500mm thick mat slab | 3040 | | 13% | 16% | | | 22% | 25% | | | | | | | | | | | |
| | | 100mm thick top mat slab | 3040 | | 13% | | | | 25% | | | | | | | | | | | | |
| | | in basement columns | 3040 | | | 16% | | | | 25% | | | | | | | | | | | |
| | | in mat beam | 3040 | | | 16% | | | 24% | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | in dome footing | 3040 | | | | 17% | | 24% | | | | | | | | | | | |
| | | in foundation shear wall for dome structure. | 2040 | | | | 16% | | | | | | | | | | | 94 % | | |
| | | in ground floor beams | 3040 | | | | 17% | | | | | | | | | | | | | |
| | | in 200mm thick suspended ground floor slab | 608 | | | 33% | 37% | | 85% | 40% | 69% | | | + | | | | | | |
| | | in 250mm thick retain wall | 3040 | | | | 17% | | | | | | | | | | | | | |
| | | in 250mm thick shear wall for lift shaft | 3040 | | | | | | 24% | | | | | | | | | | | |
| | | in stair | 3040 | | | | | | | 25% | | | | | | | | | | |
| | | in 200mm thick rump | 608 | | | | | | | | | 72% | | | | | | | | |
| | | in entrance staps | 3040 | | | | | | | | | | | 56% | | | | | | |
| | | in footing | 3040 | | | | | 24% | | | 30% | | | 56% | | | | | | |
| | | in foundation column | 3040 | | | | 17% | | | | | 32% | | | | | 57% | | | |
| | | in grade beam | 3040 | | | 16% | | | | | | | | | 56% | | 57% | | | |
| | FW | 500mm thick mat slab | 276 | | 3% | 21% | | | 49% | | | | | | | | | | | |
| | | in basement columns | 276 | | | 22% | | 43% | | | | | | | | | | | | |
| | | in mat beam | 276 | | | 22% | | | 49% | | | | | | | | | | | |
| | | in dome footing | 276 | | | | 31% | | 49% | | | | | | | | | | | |
| | | in ground floor beams | 276 | | | | | | | | | | | | | | | | | |
| | | in 200mm thick suspended | 276 | | | | 31% | 43% | 49% | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ground floor slab | | | | | | | | | | | | | | | | | | |
| | | in 250mm thick retain wall | 276 | | | | | 43% | 49% | | | | | | | | | | | |
| | | in 250mm thick shear wall for lift shaft | 276 | | | | | | 49% | | | | | | | | | | | |
| | | in stair showed | 276 | | | | 31% | | | | | | | | | | | | | |
| | | in 200mm thick rump | 276 | | | | | | | | | 68% | | | | | | | | |
| | | in entrance steps | 276 | | | | | | | | | | | 78% | | | | | | |
| | | in footing | 276 | | | | | 43% | | | 64% | | | 78% | | | | | | |
| | | in foundation column | 276 | | | | | | | | | 68% | | | | | | | | |
| | | in grade beam | 276 | | | 22% | | | | | | | | | 78% | | 78% | | | |
| | MW | 500mm thick hard rough dressed stone ratio (1:3) | 600 | | | 66% | | 67% | 68% | | 69% | | 73% | | 82% | | | | 81% | 81% |
| | | ditto for above ground level externally with fully dressed stone | 680 | | | 62% | | 65% | 65% | 66% | | | | | 81% | | | | | 79% |
| | Bar | dia 8 | 56 | | 39% | 45% | 45% | 59% | 59% | 60% | 65% | 71% | 79% | 85% | 86% | 86% | 86% | 87 % | 88% | 88% | 93% |
| | | dia 10 | 56 | | 39% | 45% | 45% | 59% | | 60% | | 71% | | 85% | 86% | | 86% | 87 % | 88% | 88% | 93% |
| | | dia 12 | 56 | | 39% | 45% | 45% | 59% | 59% | 60% | 65% | 71% | 79% | 85% | 86% | 86% | | 87 % | 88% | 88% | 93% |
| | | dia 14 | 56 | | 39% | 45% | 45% | 59% | 59% | 60% | 65% | 71% | | 85% | 86% | | | | 88% | | 93% |
| | | dia 16 | 56 | | 39% | 45% | 45% | 59% | 59% | 60% | 65% | | | 85% | 86% | | | 87 | 88% | 88% | 93% |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | % | | | |
| | | dia 20 | 56 | | 39% | 45% | 45% | 59% | 59% | 60% | 65% | 71% | 79% | | 86% | | | 87 % | 88% | 88% | 93% |
| | | dia 24 | 56 | | 39% | 45% | 45% | 59% | 59% | 60% | 65% | 71% | | 85% | 86% | | | | 88% | 88% | 93% |
| | | dia 28 | 56 | | 39% | 45% | | 59% | 59% | 60% | | 71% | | | 86% | | | | 88% | 88% | 93% |

The table above shows the percentage increase of each activity from the contract amount and the timing of their execution in the sub-structure

- For **lean concrete**, the contract amount for the mat slab, mat beam, top mat slab, footing for the dome, footing, basement slab, and beam was 98 birr. When executed, the mat slab, mat beam, and top mat slab showed a 50% increment in June 2019; footing for the dome, footing, basement slab, and beam showed a 54% increment in July 2019; mat slab, mat beam, top mat slab, and footing for the dome showed a 64% increment in August 2019; footing, basement slab, beam, and masonry showed a 66% increment in September 2019; in October 2019, lean concrete for the footing showed a 79% increment; and in November 2019, the mat beam and mat slab showed an 81% increment. For C-30, including the 500 mm thick mat slab, 100 mm thick top mat slab, basement columns, mat beam, dome footing, foundation shear wall for dome structure, ground floor beams, 250 mm thick retaining wall, 250 mm thick shear wall for lift shaft, stairs, entrance steps, footing, foundation column, and grade beam, the contract amount was 3,040 birr. Additionally, for
- **C-30**, the 200 mm thick suspended ground floor slab and 200 mm thick rump had a contract amount of 608 birr. In formwork, the contract amount for all sub-structure activities was 276 birr.
- When executed, **formwork** for their contract amount 276 birr, the 500 mm thick mat slab showed 3%, 21%, and 49% increments in July, August 2019, and November 2020, respectively; basement columns showed a 22% increment in August 2019 and 43% in November 2020; mat beam showed a 22% increment in August 2019 and 49% in November; dome footing showed 31% in

September 2019 and 49% in November; the 200 mm thick suspended ground floor slab showed increments of 31%, 43%, and 49% in September, October, and November 2019, respectively; the 250 mm thick retaining wall showed 43% and 49% increments in October and November 2019, respectively; the 250 mm thick shear wall for the lift shaft showed 49% in November 2019; stairs showed 31% in September 2019; the 200 mm thick rump showed 31% in February 2020; entrance steps showed 31% in September 2020; footing showed 43% in September and December 2019 and 78% in November 2020; and the grade beam showed 22% increments in May and September 2021. In masonry work, rough dressed stone with a ratio of 1:3 showed increments of 66% in August, 67% in October, 69% in December 2020, 73% in January 2021, 82% in September 2021, and 81% in February 2022; and externally above ground level with fully dressed stone showed increments of 62% in August, 65% in October, 66% in November 2019, and 81% in February 2020.

- In **reinforcement bars**, for diameters 8 through 28, the contract amount was 56 birr. When executed, all diameters showed a 39% increment in June 2019. In July 2019, all showed a 45% increment, and in November 2019, except for certain diameters, all showed a 59% increment; in December 2019, all diameters showed a 60% increment. Except for diameters 10 and 28, all showed a 65% increment in January 2020; in February 2020, except for diameter 16, all showed a 71% increment. Diameters 8, 12, and 20 showed a 79% increment in September 2020; unlike diameters 16 and 28, all showed an 81% increment in November 2020. All showed increments of 86% and 88% in February and December 2021, respectively; lastly, all showed a 93% increment in July 2022.

Table 14. The extent of price escalation on project B cost performance on super structure activities

| **Price increment through project implementation for each sub structure activity Project B** | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Activity | | | Contract amount | **2019** | **2020** | | | | **2021** | | | | | **2022** | | | | | | | **2023** | |
| | | | | Dec | Jun | Aug | Sep | Nov | Feb | May | Aug | Sep | Dec | Feb | Apr | Jun | Jul | Sep | Nov | Dec | Jan | Mar |
| **super structure** | C-30 | for elevation Column | 3100 | 42% | 46% | | 48% | | 49% | | 56% | | | 62% | | 68% | | | | | | |
| | | for floor beam | 3100 | 42% | 46% | | 48% | | 49% | | | | | | | | | | | | | |
| | | roof beam | 3100 | | 42% | | | | | | | | | 62% | | | | | | | | |
| | | roof gutter | 3100 | | | | | | | | | | | 62% | | | | | | | | |
| | | Lintels showed | 3100 | 42% | | | | | | | | | | | | | | | | | | |
| | | 270mm thick flat floor slab | 837 | | 47% | | 52% | | 55% | | 61% | 67% | 72% | 72% | | 79% | | | 81% | | | |
| | | 270mm thick flat roof slab | 837 | | | | 52% | | | | 61% | | | | | 79% | | | | | | |
| | | 150mm thick solid floor slab | 465 | 54% | | | 63% | | | | 74% | | | 82% | | 85% | | | | | | |
| | | 150mm thick solid roof slab | 465 | | 60% | | 72% | | 66% | | 74% | | 82% | | | | | | | | | |
| | | 200mm thick solid floor | 620 | 49% | 49% | | 63% | | 68% | | | 74% | | | | | | | | | | |
| | | 200mm thick solid roof slab | 620 | | | | 63% | | | | 69% | | | 73% | | 77% | | | | | | |
| | | in 200mm thick shear wall for lift shaft | 620 | | | | 63% | | | | | | | 73% | | 77% | | | | | | |
| | | Stair | 3100 | 42% | | | 46% | | | | | | 69% | | | | | | | | | |
| | Fw | for elevation column | 288 | 51% | 63% | | 73% | | 74% | | 84% | | | 88% | | | | | | | | |
| | | for floor beam | 288 | 51% | 63% | | 73% | | 74% | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | roof beam | 288 | | | | | | | | | | | | | | | | | | | |
| | | roof gutter | 288 | | | | | | | | | | | 88% | | | | | | | | |
| | | Lintels | 288 | 51% | 63% | | 73% | | | | | | | | | | | | | | | |
| | | 270mm thick flat floor slab | 288 | | 63% | | 73% | | 74% | | 82% | | | 88% | | | | | | | | |
| | | 270mm thick flat roof slab | 288 | | | | 73% | | | | 82% | | 82% | | | 88% | | | | | | |
| | | 150mm thick solid floor slab | 288 | | 63% | | 73% | | | | 82% | | | | | | | | | | | |
| | | 150mm thick solid roof | 288 | | 63% | | 73% | | | | 82% | | | | | | | | | | | |
| | | 200mm thick solid floor slab | 288 | 51% | 63% | | 73% | | 74% | | 82% | | | | | | | | | | | |
| | | 200mm thick solid roof slab showed an increment of 82% in August 2021; | 288 | | | | | | | | 82% | | | | | | | | | | | |
| | | in 200mm thick shear wall for lift shaft | 288 | | | | 73% | | | | | | | 88% | | 88% | | | | | | |
| | | Stair | 288 | 51% | | | 73% | | | | | | | | | | | | | | | |
| | Bar | dia 8 | 56 | | 65% | | 79% | | 86% | 86% | | 87% | 88% | 88% | 88% | 89% | 89% | 89% | 89% | 89% | 89% | 89% |
| | | dia 10 | 56 | 61% | 65% | 71% | 79% | 85% | 86% | 86% | | | 88% | 88% | | 89% | 89% | | 89% | 89% | | |
| | | dia 12 | 56 | 61% | 65% | 71% | 79% | 85% | 86% | 86% | 86% | | 88% | 88% | | 89% | 89% | | 89% | | | |
| | | dia 14 | 56 | 61% | 65% | 71% | 79% | 85% | 86% | 86% | 86% | 87% | 88% | 88% | 88% | 89% | 89% | | 89% | 89% | 89% | 89% |
| | | dia 16 | 56 | 61% | 65% | 71% | | 85% | | | 86% | 87% | 88% | | 88% | | | 89% | 89% | 89% | | |
| | | dia 20 | 56 | 61% | 65% | 71% | 79% | 85% | 86% | 86% | 86% | 87% | 88% | 88% | 88% | 89% | 89% | | 89% | 89% | 89% | |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | dia 24 | 56 | 61% | 65% | 71% | 79% | 85% | 86% | 86% | 86% | 87% | 88% | 88% | 88% | 89% | | 89% | 89% | 89% | 89% | 89% |
| | | dia 28 | 56 | | 42% | 71% | 79% | | 86% | 86% | 86% | | 88% | 88% | | 89% | | | | | 89% | |

The table above shows the percentage increase of each activity from the contract amount and the timing of their execution in the superstructure.

- **C-30** for elevation, floor beam, roof beam, roof gutter, and lintels had a contract amount of 3,100 birr. For 270 mm thick flat floor slab and 270 mm thick flat roof slab, the contract amount was 837 birr. For 150 mm thick solid floor slab and 150 mm thick solid roof slab, the contract amount was 465 birr. For activities like 200 mm thick solid floor slab, 200 mm thick solid roof slab, and 200 mm thick shear wall for the lift shaft, the contract amount was 620 birr. When executed, the elevation column showed increments of 42% in December 2019, 46% and 48% in June and September 2020, 49% and 56% in February and August 2021, and 62% and 68% in February and June 2022. The floor beam showed an increment of 42% in December 2019, 46% and 48% in June and September 2020, and 49% in February 2021. The roof beam showed an increment of 42% in December 2019 and 62% in February 2022. The roof gutter showed a 62% increment in February 2019. Lintels showed a 42% increment in December 2019. The 270 mm thick flat floor slab showed increments of 47% and 52% in June and September 2020, 55% in February 2021, 61% in August, 67% in September 2021, and 72% in December 2021, with an 81% increment in November 2022. The 150 mm thick solid floor slab showed increments of 54% in December 2019, 63% in September 2020, 74% in August 2021, and 82% and 85% in February and June 2022. The 150 mm thick solid roof slab showed increments of 60% in June 2019, 72% in September 2020, 66% in February 2021, and 74% in August 2021. The 200 mm thick solid floor slab showed increments of 49% in December 2019, 63% in September 2020, and 68% in February 2021. The 200 mm thick solid roof slab showed increments of 63% in September 2020, 69% in August 2021, 73% in February 2022, and 77% in July 2022. The 200 mm thick shear wall for the lift shaft showed increments of 63% in September 2020,

73% in February 2021, and 77% in July 2022. The stair showed increments of 49% in December 2019, 46% in September 2020, and 69% in September 2021.

- In **formwork**, the contract amount was 288 birr for all super-structure activities. When executed, the elevation column showed increments of 51% in December 2019, 73% in September 2020, 74% in February 2021, 84% in August 2021, and 88% in February 2022. The floor beam showed increments of 51% in December 2019, 63% in June and 73% in September 2020, and 74% in February and 84% in August 2021. The roof gutter showed an 88% increment in February 2022. Lintels showed increments of 51% in December 2019, 63% in June, and 73% in September 2020. The 270 mm thick flat floor slab showed increments of 63% in June and 73% in September 2020, 74% in February 2021, 82% in August 2021, and 88% in February 2022. The 270 mm thick flat roof slab showed increments of 73% in September 2020, 82% in August 2021, and 88% in June 2022. The 150 mm thick solid floor slab and 150 mm thick solid roof slab showed increments of 51% in June 2020 and 73% in September 2020, with 82% in August 2021. The 200 mm thick solid floor slab showed increments of 51% in December 2019, 63% in June, 73% in September 2020, 74% in February 2021, and 82% in August 2021. The 200 mm thick solid roof slab showed an increment of 82% in August 2021. The 200 mm thick shear wall for the lift shaft showed increments of 73% in September 2020 and 88% in June 2022. Lastly, the stair showed increments of 51% in December 2019 and 73% in September 2020.

- In **reinforcement bars**, for diameters 8 through 28, the contract amount was 56 birr. When executed, in December 2019, all diameters except 8 and 28 showed a 61% increment. In June 2020, all showed a 65% increment; in August 2020, all except diameter 8 showed a 71% increment. In September 2020, all except diameter 16 showed an 85% increment. By November 2020, all showed an 86% increment. Except for diameters 10, 12, and 28, all showed an increment of 87% in September 2021. Finally, all showed a 89% increment until the contractor finished the superstructure parts in March 2023.

### 4.3.4. The extent of price escalation on project C cost performance

Table 15. The effect of price escalation on project C's cost performance on sub structure activities

| **Price increment through project implementation for each sub structure activity** Project C | | | | | | | |
|---|---|---|---|---|---|---|---|
| **No** | **Activities** | | **Contract amount** | **2019** | **2020** | | **2022** |
| | | | | **Jun** | **Feb** | **Apr** | **Mar** |
| 1 | Lean Concrete (C-5) | under foundation pad | 100 | 52% | | | |
| | | under masonry | 100 | 52% | | | |
| | | under grade beam | 100 | | 65% | | |
| | | underground slab | 100 | | | 74% | |
| 2 | C-30 | grade beam | 2300 | | 9% | | |
| | | 150mm thick ground floor slab | 3000 | | | 65% | |
| | | Foundation column | 3000 | 6% | | | |
| | | Foundation Pad | 2300 | 9% | | | |
| 3 | Formwork | in foundation pad | 276 | 22% | | | 84% |
| | | foundation column | 276 | 16% | | | 84% |
| | | in grade beam | 276 | | 31% | | 84% |
| 4 | Masonry work | Under foundation pad | 600 | 64% | | | |
| | | Under beam | 680 | 69% | | | |
| 5 | Reinforcement | dia 8 | 56 | | 21% | 19% | 68% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | dia 10 | 56 | 16% | | 19% | 68% |
| | | dia 12 | 56 | 16% | | 19% | 68% |
| | | dia 14 | 56 | 16% | | 19% | 68% |
| | | dia 16 | 56 | 16% | | | 68% |
| | | dia 20 | 56 | 16% | | | 68% |

The table above shows the percentage increase of each activity from the contract amount and the timing of their execution in the sub-structure

- In **lean concrete** under a foundation pad, masonry, grade beam, and ground slab, the contract amount was 100 birr. However, when executed, they showed a 52% increment in June 2019, a 65% increment in February 2020, and a 74% increment in April 2020.
- In **C-30** for foundation column, foundation pad, grade beam and ground floor slab, the contract amounts were 3000, 2300, 2300 and 3000 birr, respectively. However, when executed, foundation column and foundation pad showed a 6% and 9% increment in June 2019; and grade beam and ground floor slab they showed a 9% increment in February 2020 and also ground floor slab showed a 65% increment in April 2022.
- In **formwork**, the contract amount was 276 birr for all activities of sub-structures. When executed, formwork foundation pad and foundation column showed a 22% and 16% increment in June 2019 respectively, and grade beam showed 31% increment in February 2020. In March 2022 all showed 84% increment from their initial contract amount.
- In **masonry work** under foundation pad and beam, the contract amount was 600 and 680 birr. When executed, they showed increments of 64% and 69% in June 2019.
- In **reinforcement bar**, from diameter 8 up to diameter 20, the contract amount was 56 birr. When executed, all diameters except diameter 8 showed a 16% increment in June 2019. In February 2020, diameter 8 showed a 12% increment, and diameters 8, 10, 12,

and 14 showed a 19% increment in April 2020. In 2022, all diameters showed a 68% increment from the original contract price of reinforcement.

Table 16. The extent of price escalation on project C cost performance on super structure activities

| Price increment through project implementation for each super structure activity | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **No** | **Item of Work** | | **Contract Amount** | **2020** | | | **2021** | | **2022** | **2023** | | |
| | | | | **Feb** | **Apr** | **Aug** | **Feb** | **Jun** | **Mar** | **Feb** | **Jun** | **Aug** |
| 1 | C-30 | for elevation column | 3745 | 16% | 22% | 26% | 43% | 49% | 51% | 52% | 57% | 55% |
| | | for 180mm thick floor beam & roof beam | 936.25 | | 68% | 70% | 76% | 80% | 86% | 87% | 87% | 89% |
| | | floor beam and roof beam | 674.1 | | 22% | 26% | 43% | 54% | 51% | 52% | 52% | 55% |
| | | Stair case and landing | 3745 | | | | | | 47% | 50% | 56% | 57% |
| | | Lintels | 3745 | | | | | | | | | |
| 2 | Formwork | for elevation column | 398 | 25% | | 74% | | 84% | | 85% | 86.5% | 87% |
| | | for 180mm thick floor beam & roof beam | 398 | 25% | 73% | 75% | | 82% | | 83% | 85% | 84% |
| | | floor beam and roof beam | 398 | 25% | 68% | 74% | | 84% | | 85% | 86% | 87% |
| | | Stair case and landing | 398 | 25% | | | | | | 75% | | 77% |
| | | Lintels | 398 | 25% | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | dia 8 | 52 | | 27% | 34% | 57% | 60% | 76% | | 79% | 81% |
| | | dia 10 | 65 | 35% | 27% | 34% | 57% | 60% | 76% | | 79% | 81% |
| | | dia 12 | 65 | | 27% | 34% | 57% | 60% | 76% | | 79% | 81% |
| | | dia 14 | 57 | 35% | 27% | 34% | 57% | 60% | 76% | | 79% | 81% |
| | | dia 16 | 60 | 35% | 27% | 34% | 57% | 60% | 76% | | 79% | |
| 3 | Reinforcement | dia 20 | 60 | 35% | 27% | 34% | 57% | 60% | 76% | | 79% | |

The table above shows the percentage increase of each activity from the contract amount and the timing of their execution in the superstructure.

- **For C-30**, the contract amounts were as follows: elevation column, 180 mm thick floor beam & roof beam, floor beam and roof beam, staircase and landing, and lintels were 3,745, 936.25, 674.1, 3,745, and 3,745 birr, respectively. When executed, the elevation column showed a 16% increment in February 2020; the elevation column, 180 mm thick floor beam & roof beam, and floor beam and roof beam showed increments of 22%, 68%, and 22% in April 2020, respectively, and a 74% increment in April 2020, respectively. The contractor executed C-30 for the elevation column, 180 mm thick floor beam & roof beam, and floor beam and roof beam, with contract amounts of 3,745, 936.25, and 674.1 birr, respectively. When executed, the elevation column and 180 mm thick floor beam & roof beam showed a 26% increment; on the other hand, the floor beam and roof beam showed a 70% increment. Additionally, for the elevation column, 180 mm thick floor beam & roof beam, and floor beam and roof beam, with contract amounts of 3,745, 936.25, and 674.1 birr, respectively. When executed, the elevation column and the 180 mm thick floor beam & roof beam

showed a 43% increment; on the other hand, the floor beam and roof beam showed a 73% increment. Additionally, all reinforcement bars showed a 57% increment from their initial cost. In June, the elevation column, 180 mm thick floor beam & roof beam, and floor beam and roof beam showed increments of 49%, 80%, and 54%, respectively.

- In February 2021, the contractor executed **C-30** for the elevation column, 180 mm thick floor beam & roof beam, and floor beam and roof beam, with contract amounts of 3,745, 936.25, and 674.1 birr, respectively. When executed, the elevation column and the 180 mm thick floor beam & roof beam showed a 43% increment; on the other hand, the floor beam and roof beam showed a 73% increment. Additionally, all reinforcement bars showed a 57% increment from their initial cost. In June, the elevation column, 180 mm thick floor beam & roof beam, and floor beam and roof beam showed increments of 49%, 80%, and 54%, respectively. And also In March 2022 the contractor executed the elevation column, floor beam and roof beam, and staircases with a contract amount of 3,745 birr. When executed, they showed increments of 51%, 51%, and 47%, respectively. For the 180 mm thick floor beam & roof beam, the contract amount was 936.25 birr, but when executed, it showed an 86% increment. On the other hand,
- In **formwork**, for the elevation column, 180 mm thick floor beam & roof beam, and floor beam and roof beam, the initial contract amount was 398 birr. When executed, the elevation column and the floor beam and roof beam showed a 74% increment, while the 180 mm thick floor beam & roof beam showed a 75% increment from their initial cost. Additionally, all reinforcement bars showed a 34% increment in August 2020.
- **All reinforcement bars** showed a 76% increment in March 2022.
- In 2023, the contractor executed **C-30, formwork, and reinforcement** in three different months. In February, under **C-30**, the elevation column, 180 mm thick floor beam & roof beam, floor beam and roof beam, and staircases and landings showed increments of 52%, 87%, 52%, and 51%, respectively. In **formwork**, for the elevation column, the 180 mm thick floor beam & roof beam, the floor beam and roof beam, and staircases and landings showed increments of 85%, 83%, 85%, and 75%, respectively.

- In June of the same year, under **C-30,** the elevation column, 180 mm thick floor beam & roof beam, floor beam and roof beam, and staircases and landings showed increments of 57%, 87%, 52%, and 56%, respectively. In **formwork**, for the elevation column, the 180 mm thick floor beam & roof beam, and the floor beam and roof beam showed increments of 86.5%, 85%, and 86%, respectively; all reinforcement bars showed a 79% increment in the same month. Lastly, in August of that year, under **C-30**, the elevation column, 180 mm thick floor beam & roof beam, floor beam and roof beam, and staircases and landings showed increments of 55%, 89%, 55%, and 57%, respectively.
- In f**ormwork**, for the elevation column, the 180 mm thick floor beam & roof beam, the floor beam and roof beam, and staircases and landings showed increments of 87%, 84%, 87%, and 77%, respectively;
- **All reinforcement** bars showed an 81% increment in that same month.

### 4.3.5. The extent of price escalation on project D cost performance

Table 17. The effect of price escalation on project D's cost performance on sub structure activities

| Activities | | | Contract amount | 2019 | | | | 2020 | | 2021 | | | | | | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Jun | Jul | Aug | Sep | Oct | Nov | Jan | Feb | Mar | Sep | Oct | Dec | Apr |
| **sub structure** | C-5 | under footing | 95 | 52% | | 53% | 59% | 90% | 91% | | | | | | | |
| | | underground slab and beam | 95 | 52% | | 53% | | | 91% | | | | | | | |
| | | under masonry | 95 | 52% | | 53% | | 90% | | | | | | | | |
| | C-30 | | 3675 | | 14% | 12% | | | 36% | | | | | | | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | foundation column | 3675 | | 14% | | | | 36% | | | | | | | |
| | | ground floor beam | 3675 | | | 12% | | 31% | | | | | | | | |
| | | 150mm thick ground floor slab | 3675 | | | 12% | 19% | 31% | 36% | 38% | 40% | 40% | 42% | 44% | 44% | |
| | | to steps | 3675 | | | | | | 36% | | 40% | | 42% | 44% | | |
| | | in retaining shear wall | 3990 | | | | 12% | | 28% | | | | | | | |
| | | footing | 276 | | 27% | 14% | | | 63% | | | | | | | |
| | | foundation column | 276 | | | 14% | | 62% | | | | | | | | |
| | | ground floor beam | 276 | | | 14% | | | 63% | | | | | | | |
| | | to steps | 276 | | | | | | 63% | | 65% | | 66% | | | |
| | FW | in retaining | 276 | | | | 68% | | 73% | | | | | | | |
| | | 500mm thick hard rough dressed stone ratio (1:3) shear wall | 1575 | | | 34% | | 44% | 46% | | | | | | | |
| | MW | dito for above ground level externally with fully dressed stone | 1575 | | | | | 46% | 44% | | | | | | | |
| | Bar | dia 8 | 74 | | 2% | 5% | 9% | 14% | | 14% | 16% | 16% | 18% | 19% | 19% | 21% |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | dia 10 | 68 | | 10% | 13% | | 19% | 20% | 21% | 23% | 23% | 25% | 25% | 26% | 27% |
| | | dia 12 | 63 | | 16% | 19% | 22% | 25% | 26% | 37% | 38% | 38% | 40% | 41% | 41% | 52% |
| | | dia 14 | 61 | | 19% | 22% | 25% | 27% | 28% | 29% | 31% | 31% | 32% | 33% | 33% | 54% |
| | | dia 16 | 61 | | 19% | 22% | 25% | 27% | 28% | 29% | 31% | | | | | |
| | | dia 20 | 61 | | 19% | 22% | 25% | 27% | 28% | 29% | 31% | | | | | 57% |

The table above shows the percentage increase of each activity from the contract amount and the timing of their execution in the sub-structure.

- In **lean concrete**, under foundation pad, underground slab and beam, and masonry, the contract amount was 100 birr. However, when executed, they showed the following increments: under footing, 52% and 53% in June and August 2019, respectively. On the other hand, C-5 under footing showed a 59% increment in September 2019, a 90% increment in October 2019, and a 91% increment in November 2020; underground slab and beam showed a 91% increment in November 2020, and masonry showed a 90% increment.
- In **C-30**, for footing, foundation column, ground floor beam, 150 mm thick ground floor slab, and steps, the contract amounts were 3,675 birr and 3,990 birr for retaining and shear walls. When executed, the footing showed a 14% increment in July 2019, a 12% increment in August 2019, and a 36% increment in November 2020; the foundation column showed a 14% increment in July 2019 and a 36% increment in November 2020; the ground floor slab showed a 1% increment in August 2019 and a 31% increment in October 2020; the 150 mm thick ground slab showed a 12% increment in August 2019, a 19% increment in September 2019, and a 31% and 36% increment in October and November 2020, respectively; the ground floor beam showed a 12% increment in August

2019 and a 31% increment in November 2020; the steps showed a 36% increment in November 2020, and throughout 2021, the 150 mm thick ground slab and steps showed increments of 40%-44% until April.

- In **formwork**, all activities were estimated at 276 birr as the contract amount. When executed, the footing showed a 27% increment in June, a 14% increment in August, and a 63% increment in November 2020; the foundation column showed a 14% increment in August and a 62% increment in October 2020; the ground floor beam showed a 14% increment in August and a 63% increment in November 2020; the steps showed a 63% increment in November 2020, 65% in February 2021, and a 66% increment in September 2021; retaining and shear walls showed a 66% increment in September 2019 and a 73% increment in November 2020.
- In **masonry work**, with 500 mm thick hard rough-dressed stone ratio (1:3) shear walls and similar above ground level externally with fully dressed stone, the contract amount was 1,575 birr. When executed, the 500 mm thick hard rough-dressed stone ratio (1:3) shear walls showed a 34% increment in August 2019, a 44% increment in October 2019, and a 46% increment in November 2020; similarly, above ground level externally with fully dressed stone showed a 44% increment in October 2019 and a 46% increment in November 2020.
- In **reinforcement bars**, the contract amounts for diameters 8, 10, 12, 14, 16, and 20 were 74, 68, 63, 61, 61, and 61 birr, respectively. When executed, diameter 8 showed a 2% increment in June, a 5% increment in July, a 9% increment in August 2019, a 14% increment in October, a 16% increment in November 2020, an 18% increment in September 2021, and a 21% increment in April 2022; diameter 10 showed a 10% increment in July, a 13% increment in August 2019, a 19% increment in October, a 20% increment in November 2020, a 21% increment in March 2021, a 25% increment in October 2021, a 26% increment in December 2021, and a 27% increment in April 2022; diameter 12 showed a 16% increment in July, a 19% increment in August, a 22% increment in September 2019, a 25% increment in October, a 26% increment in November 2020, a 37% increment in February 2021, a 38% increment in March 2021, a 40% increment from September to December 2021, and a 52% increment in April 2022; diameter 14 showed a 19% increment in July, a 22% increment in August, a 25% increment in September 2019, a 27% increment in October, a

28% increment in November 2020, a 31% increment in February 2021, a 37% increment in March 2021, a 33% increment from September to December 2021, and a 54% increment in April 2022; finally, diameters 16 and 20 showed a 19% increment in July, a 22% increment in August, a 25% increment in September 2019, a 27% increment in October, a 28% increment in November 2020, and a 31% increment in February 2021.

Table 18. The extent of price escalation on project D cost performance on sub structure activities

| | | for elevation column | Contract amount | 2019 | | | | | 2020 | | | | | 2021 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Aug | Sep | Oct | Nov | Dec | Feb | Mar | Sep | Oct | Dec | Apr | May | Sep | Nov | Dec |
| | | for floor beam | 4305 | | 16% | 21% | 25% | 28% | | 33% | | | | | 41% | | | |
| | | roof beam | 4305 | | 16% | 21% | 25% | 28% | | 33% | | | | | | | | |
| | | roof gutter | 4410 | | | | | 27% | | 31% | | | | | 39% | | | |
| | | Lintels | 4410 | | | | | | | 31% | | | | | | | | |
| **super structure** | | 180mm thick floor slab | 4725 | | | | | | | | | | | | 33% | | | |
| | | 200mm thick floor slab | 940 | | 14% | | 53% | 55% | | 59% | | | | | | | | |
| | | 180mm thick roof slab | 1045 | | 24% | | | 44% | | 50% | 61% | | 60% | 65% | 56% | | | |
| | | in steps | 940 | | | | | | | 55% | | 62% | 66% | 68% | 60% | 71% | 68% | |
| | C-30 | Stair | 4725 | | | | | 31% | | 32% | | | | | 33% | | | |
| | Fw | for elevation column | 4725 | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | for floor beam | 315 | | 38% | | 24% | 38% | | 38% | | | | | 63% | 65% | | |
| | | roof beam | 315 | | 38% | 18% | 24% | 38% | | | | | | | 63% | | | |
| | | roof gutter | 315 | | | | | 38% | | | | | | | 63% | | | |
| | | Lintels | 399 | | | | | | | | | | | | | | | |
| | | 180mm thick floor slab | 399 | | | | | | | | | | | | 56% | | | |
| | | 200mm thick floor slab | 420 | | 21% | 25% | 28% | 19% | 56% | 19% | | | | | | | | |
| | | 180mm thick roof slab | 420 | | 21% | | 28% | 19% | 45% | | 42% | | 48% | | 54% | | | |
| | | in steps | 420 | | | | | | | | | 46% | 48% | | 54% | 58% | | |
| | | Stair | 315 | | | | | | | | | | | | 63% | 65% | | |
| | Bar | dia 8 | 368 | 5% | | | | | | | | | | | | | | |
| | | dia 10 | 74 | 22% | 10% | 12% | 12% | 14% | | | | 19% | 19% | | 21% | 22% | | 40% |
| | | dia 12 | 61 | 22% | 26% | 27% | 28% | 29% | | | | 33% | 33% | | 35% | 36% | | |
| | | dia 14 | 61 | | 26% | 27% | 28% | 29% | | | | 33% | 33% | | 35% | 36% | 37% | |
| | | dia 16 | 0 | 22% | | | | | | | | | | | | | | 40% |
| | | dia 20 | 61 | 28% | 26% | 27% | 28% | 29% | | | | 33% | 33% | | 35% | 36% | 37% | |

The table above shows the percentage increase of each activity from the contract amount and the timing of their execution in the superstructure.

- **C-30** for elevation column, floor and roof beams with a contract amount of 4305 Birr, the increments began at 16% in August 2019 and climbed to 41% by October 2021. Roof gutters with a contract amount of 4410 Birr saw a steady increase, starting from no increment in August 2019 and reaching 39% by December 2021. The 200mm thick floor slab started with a 14% increment in August 2019, escalated dramatically to 53% by October 2020, and further to 55% in November 2020, finally peaking at 59% in March 2021. The 180mm thick roof slab showed increments starting at 24% in August 2019, rising to 44% by November 2020, reaching 50% in December 2020, and ultimately hitting 65% by April 2021. In steps, increments began at 55% in November 2020, escalated to 62% by February 2021, and peaked at 71% by December 2021.
- Formwork shows increments for elevation columns, floor beams, roof beams, roof gutters, lintels, and steps. Notably, floor beams, with a contract amount of 315 Birr, increased from 38% in August 2019 to 65% by October 2021. The increments for roof beams followed a similar pattern, while roof gutters incremented to 63% by October 2021.
- **For reinforcement bars**, diameter 8 began with a 5% increment in June 2019 and reached 40% by December 2021. Diameter 10 increments started at 22% in August 2019, moved to 19% by October 2019, and reached a high of 40% by December 2021. Diameter 12 increments began at 22% in August 2019, increased to 27% by October 2019, and peaked at 36% by December 2021. Diameter 14 showed an increment of 26% in August 2019, increased to 27% by October 2019, and reached 37% by December 2021. Diameter 16 started at 22% in August 2019 and peaked at 40% by December 2021. Diameter 20 showed a similar pattern, beginning at 28% in August 2019, moving to 29% by November 2020, and reaching a peak of 37% by December 202.

## 4.3. The Current Management Practice of Price Escalation used in Each Project

### 4.3.1. Proactive management strategy: Price escalation preventing/minimizing method used in selected cases in early stage of projects

Firstly, early attention to price escalation causes will help to reduce cost rise due to increase in price throughout the bid process or during construction. From them cost estimation forecasting practice is the major one. In each projects the researcher assessed how the responsible parties forecast and estimate the cost for each activity of the project. The following table shows how they predict the increment of price in the construction inputs.

Table 19. Price escalation preventing method in selected cases in early stage of projects

| Assessments | Project A | Project B | Project C | Project D |
|---|---|---|---|---|
| **Preparation of price for construction direct inputs** | | | | |
| Historical data: | Yes | Yes | Yes | Yes |
| Market assessment: | No | Yes | No | No |
| Base price source: | ECSA/ AADCWB | ECSA, AADCWB & well-known suppliers | ECSA/ AADCWB | ECSA/ AADCWB |
| **Forecasting on the increment of price in the inputs** | | | | |
| **Assessments** | **Project A** | **Project B** | **Project C** | **Project D** |
| Price data Base Availability: | No | Yes | No | No |
| Nature of the existence database: | Only historical data base | Market-analysis Databases | Only historical data base | Market-analysis Databases |
| Pricing/forecasting methods: | Time series | Time series and Market analysis | Time series | Time series and Market analysis |
| List of items for forecasting: | The whole items | Selected items | The whole items | The whole items |
| Benchmark for trend analysis: | Historical project data and cost database from ECSA/ AADCWB | Historical project data and cost database from ECSA/ AADCWB and market price | Historical project data and cost database from ECSA/ AADCWB | Historical project data and cost database from ECSA/ AADCWB |
| Trend analysis Method/tools: | Excel and Ms-project | | | |
| Cost estimation techniques: | Bottom-up and analog | Parametric and Bottom-up | Bottom-up | Bottom-up |
| Tools and techniques for | Ms-project and Excel | | | |

| | | | | |
|---|---|---|---|---|
| estimation | | | | |
| **Price Adjustment Clauses Agreement** | | | | |
| Price Adjustment clause availability | Previously not allowed (duration of the project was only 18months) | Available initially in the contract | Previously not allowed (duration of the project was only 18months) | Previously not allowed (duration of the project was only 18months) |
| **Bulk Material Purchasing** | | | | |
| Only for main structural materials | | | | |
| **Buyer-Supply relationships** | | | | |
| Suppliers certainty | Still available (Long-term agreement) | Still available (Long-term agreement) | For short period of time (Short-term agreemnet) | For short period of time |

(ECSA= Ethiopian central statistics Agency and AADCWB = Addis Ababa design and construction works bureau)

The above table consist how the contractors for selected cases prepare input price and forecast the future price. The first section considers preparation of price for inputs and under this section availability of historical data and market assessment practice are listed. All projects have their historical data but except **project B and D** the rest didn't assess the market regularly.

The second is forecasting on the future price increment of construction inputs. The base price source, Project all used ECSA and AADCWB as the first source but **project B and D** also consider price from well-known suppliers. Because of this nature of the existence database for **Project A and C** became only historical data base unlike **project B and D which have** historical data base and market-analysis databases. In pricing/forecasting methods section all used time series analysis but addition to this **project B and D** use Market analysis method. The next criteria which was assessed by the researcher was their list of items for forecasting and except **project B,** all forecast for the whole inputs of construction.

The sixth section specifies what data will be considered for forecasting. Project A will consider the whole item, while Project B, C, and D will use selected items.

The other criteria were Benchmark databases and Trend analysis methods, and the benchmarks for trend analysis are Historical project data and cost database from ECSA/ AADCWB but project B and D used market price for additional input for their trend analysis. The techniques used for estimating cost were, Bottom-up and analog for Project A, Parametric and Bottom-up for project B and D and only bottom up for Project c. finally the tools for trend analysis and estimation used by contractors for selected cases were excel and Ms-project.

Another approach that selected projects used to handle price escalation was purchasing materials in bulk. While all projects adopted this strategy, they applied it only to essential materials. Alongside bulk purchasing, developing strong relationships with suppliers was another strategy aimed at managing future price increases. For instance, Projects A and B maintained long-term partnerships with their suppliers, which helped mitigate risks. However, other projects had to terminate their agreements due to challenges such as supplier unreliability or payment issues.

The other mechanism was agreement on contract provision related to price escalation. The next topic covered it in detail.

### 4.3.1. Contract provision mechanisms

From the literature part of the paper (Chapter 2), three main price adjustment techniques are mentioned: the invoice method, the formula method, and the hybrid method. All the selected cases used price adjustments conducted using the **formula method**.

To mitigate the risks associated with price escalation, contracts typically include specific clauses that allow for the adjustment of prices in response to significant changes in cost factors. These clauses, often referred to as **price adjustment clauses**, are designed to provide a mechanism for both clients and contractors to share the cost impacts of market volatility. And the following table contains the practice of each project related with contact terms related price escalation.

Table 20. Contact terms related price escalation

| **Description** | **Project A** | **Project B** | **Project C** | **Project D** |
|---|---|---|---|---|
| **Contact terms related price escalation** | | | | |
| Price Adjustment clause availability | Previously not allowed but now included | Available initially in the contract | Previously not allowed but now included | Previously not allowed but now included |
| Price adjustment conditions: | include fluctuations in material prices, currency exchange rates, labor costs, legislation changes, unforeseen events and conditions | | | |
| Price Adjustment method: | Formula method: 2006 PPPA | | | |
| How they change the condition: | By amending the contract | Available initially in the contract | By amending the contract | By amending the contract |
| Weighting: | Activity quantity/the whole project quantity | | | |
| Index: | Price from ECSA then convert to index by them self | | | |
| Adjustable portion: | 69.06% (cement, rebar, fuel & ceramic) | 66% (cement, rebar, fuel & ceramic) | 64.8% (cement, rebar, fuel & ceramic) | 67% (cement, rebar, fuel & ceramic) |
| Non-adjustable portion: | 30.94% (overhead, stone masonry, hardcore, formwork, selected materials) | 34% (overhead, stone masonry, hardcore, formwork, selected materials) | 35.2% (overhead, stone masonry, hardcore, formwork, selected materials) | 33%(overhead, stone masonry, hardcore, formwork, selected materials) |
| **Other cost provisions** | | | | |
| Currency fluctuation | Increase in dollar exchange rate | | | |
| Unforeseen | Covid-19 and security issues | | | |

| | | | | |
|---|---|---|---|---|
| condition | | | | |
| Amendment: | Price adjustment clause | -------- | Price adjustment clause | Price adjustment clause |

For **Project A**, the price adjustment clause was initially not allowed but has since been included, allowing adjustments based on fluctuations in material prices, currency exchange rates, labor costs, legislation changes, and unforeseen conditions. The price adjustment method employed is the Formula method from the 2006 PPPA, and changes to conditions are made by amending the contract (When the contract was signed, the clause was based on the 2011 PPPA; however, due to some issues, it was changed to the 2006 PPPA). The cost adjustments focus on 69.06% of the contract value, covering cement, rebar, fuel, and ceramic, while 30.94% remains non-adjustable, attributed to overhead costs and selected materials like stone masonry and hard-core.

**Project B** has had the price adjustment clause available from the start, with similar conditions and adjustments methodology as project a, involving a 66% adjustable portion and 34% non-adjustable portion. **Project C**, like A, introduced the price adjustment clause later, with a adjustable portion at 64.8% and non-adjustable portion at 35.2%.

**Project D** mirrors the conditions of projects A and C, with the clause initially not included but added later, allowing 67% of costs to be adjustable. Across all projects, the index used for price adjustment calculations is derived from the ECSA and converted to an index internally.

Other common cost provisions include adjustments for currency fluctuations, notably an increase in the dollar exchange rate, and unforeseen conditions such as Covid-19 and security issues, which are standard across all projects. Each project except **project B** include the price adjustment clause by amending the contract. For the amendment of the clause, the government accepted the increase in construction material prices and intervened in the management practices for price escalation. This intervention allowed specific clauses for price adjustments, providing contractors with relief. The Ministry of Finance issued guidelines specifying which materials qualified for these adjustments, with the federal building sector among those eligible. Additionally, the public procurement body permitted the use of the clause from PPPA 2006 instead of PPPA 2011 due to issues with the formula.

The construction authority, and the Central Statistics Agency, provided the initial pricing and managed overall oversight on this matter. However, these authorized bodies did not provide guidance for projects with durations of 18 months and under, nor did they address the 12-month threshold for considering price changes, leaving such decisions to the clients. For the selected projects, the Ministry of Education, as the client, approved immediate adjustments for all federal university projects.

## 4.4. Effect of price escalation on cost performance of Selected Projects

In Chapter Two of this paper, it is discussed that price escalation in construction projects results in various effects, including increased project costs, stakeholder disputes, financing issues such as budget shortfalls, and project delays or cancellations. But specifically in cost performance of projects it leads projects to cost overrun by rising the project cost with unexpected increment. This study assesses the impact of price escalation on the cost performance of building projects by analyzing the rise in project costs due to increased inputs of structural elements such as concrete work, reinforcement, masonry, scaffolding and formwork. The following table shows the effects noticed in each project.

| | | **Selected projects** | | | |
|---|---|---|---|---|---|
| | | **Project A** | **Project B** | **Project C** | **Project D** |
| Effect of price escalation on cost performance | High in project cost | ✓ | ✓ | ✓ | ✓ |
| | stakeholder disputes | | | ✓ | |
| | budget shortfalls | ✓ | ✓ | ✓ | ✓ |
| | Contract renegotiation | ✓ | | ✓ | ✓ |
| | Difficulty in Maintaining Cost Baselines | ✓ | | ✓ | ✓ |

The above table remarks the effects shown in each selected project. From the listed effects, all faced high project costs and shortages in budget. With stakeholder disputes, only Project C faced it, and it may even end up in termination. Except for Project B, all renegotiated their contracts because of price escalation; contract renegotiation itself was not the effect, but because of it, projects faced delays of more than a year. Another effect noticed in the selected projects was the problem of maintaining their cost baseline.

## 4.5. Discussion of the result

### 4.5.1. Effect of price escalation on the cost performance of federal public building projects

From the above discussion of the effect of price escalation on the cost performance of the selected case, it is evident that price escalation significantly affects the cost performance of building projects. The data collected highlights a variety of increments across different construction activities, showing the uncertainty in construction costs and its implications for project budgets. The observed increments, especially those key construction materials, point to a critical issue in cost management. In Project A, the maximum increment in the substructure was 49% for the 500 mm thick mat slab, while the superstructure's 180 mm thick floor and roof beams experienced an escalation of 89%. For Project B, the substructure's 200 mm thick suspended ground floor slab showed the highest increase at 85%, with a similar escalation of 88% seen in the superstructure's 270 mm thick flat roof slab. Project C recorded an 84% increment in the foundation pad for the substructure, while the 180 mm thick roof slab led in the superstructure with an 87% increase. And also in Project D, the footing in the substructure had the greatest escalation at 91%, alongside the superstructure's elevation column, which increased by 88%. These show that while some projects experienced higher escalations in substructure elements, others saw greater increments in superstructure components. The varied percentages across projects indicate the universal effect of price escalation on both substructures and superstructures, regardless of the project phase. These escalations lead projects to poor cost performance, resulting in potential budget overruns and financial strain on the project. The variability in increments suggests that the effects of price escalation are major issues and can significantly impact project costs, warranting serious attention.

### 4.5.2. The current management practice of price escalation in each projects

From the detailed results and the management practices the researcher analyzed how different management strategies before and after the occurrence of price escalation have affected cost performance across Projects A, B, C, and D. This analysis considers how each project's preparation for and reaction to price escalation correlated with the observed cost increments.

After investigating the management practices and their subsequent impacts on price escalation across the selected projects, a distinct pattern arises, highlighting the effectiveness of various preventive and adaptive strategies. **Project A** initially did not implement a price adjustment clause, relying instead solely on historical data without incorporating regular market assessments. This reactive management approach significantly hindered the project's ability to preventively address rising costs. Consequently, **Project A** experienced notable cost increments in its later stages, underscoring the financial strain and budgetary challenges induced by delayed adaptive measures.

Contrariwise, **Project B** demonstrated a more strategic foresight by incorporating a price adjustment clause from the beginning, coupled with a strong combination of historical and market analysis data for forecasting. This proactive approach facilitated a more dynamic response to market fluctuations, ensuring that cost increments were managed more effectively compared to **Project A and C**. The comprehensive use of market analysis provided deeper insights into potential price changes, thereby assisting in more precise budgeting and mitigating severe cost escalations.

**Project C**, paralleling the strategy of **Project A**, implemented the price adjustment clause at a later stage and limited its forecasting to historical data only. This approach resulted in management problems similar to those observed in **Project A**, with significant cost performance issues emerging due to the delayed response to escalating prices, ultimately leading to substantial cost overruns.

**Project D**, while initially lacking a price adjustment clause, fixed this by including one later in the project timeline, together with integrating market analysis into its forecasting strategy. This adjustment, though later than ideal, allowed **Project D** to manage price escalation impacts more efficiently than **Projects A** and **C**, although not with the same level of foresight as **Project B**.

These findings recommend that the integration of comprehensive market analysis, proactive management practices and the early adoption of price adjustment clauses are critical in

managing cost escalations effectively. Projects that employed these strategies from the beginning, like **Project B**, demonstrated superior financial control and minimized the adverse effects of price fluctuations. This analysis not only emphasises the importance of adaptive project management practices but also provides a valuable blueprint for future projects to mitigate the risks associated with price escalation.

On the other hand, having long-term relationships with suppliers is really important for all projects, especially in places like ours where the market can be unpredictable. Research shows that changing suppliers often makes price increases harder to handle, especially in long projects, and this can mess up both budgets and schedules. It's also a good idea to buy a larger amount of materials upfront, not just the main ones, to keep costs under control.

## 4.6. Comparison of Selected Projects against Best Practice Mitigations

| Best Practices | Project A | Project B | Project C | Project D |
|---|---|---|---|---|
| Early Inclusion of Price Adjustment Clauses | Added later, not initially included | Included from the start | Added later, not initially included | Added later, not initially included |
| Comprehensive Market Analysis | No market assessments | Regular market assessments | No market assessments | Regular market assessments |
| Diverse Data Sources | Solely historical data | Historical & market data | Solely historical data | Historical & market data |
| Effective Cost Estimation Practices | Basic, reactive adjustments | Advanced, proactive estimations | Basic, reactive adjustments | Improved post-adjustment |
| Risk Pooling/aggregation Mechanisms | Moderate pooling | | Moderate pooling | Moderate pooling |
| Contingency Budget Allocation | Minimal contingency allocated | Adequate contingency allocated | Minimal contingency allocated | Improved allocation after adjustment |

| | | | | |
|---|---|---|---|---|
| Advance Bulk Purchasing and Material Reservation | Full bulk purchasing but only for major materials | | | |
| Collaborative Supplier Relationships | Strong, long-term partnerships | Strong, long-term partnerships | Limited and inconsistent | Improved relationships post-adjustment |
| Regular Contract Reviews and Updates | Occasional updates after adjustments | Regular updates and reviews | Occasional updates after adjustments | Occasional updates after adjustments |
| Adjustable and Non-Adjustable Portion Management | Not clearly defined based on MoF and ECA | Clearly defined adjustable and non-adjustable portions | Not clearly defined based on MoF and ECA | Not clearly defined based on MoF and ECA |
| Trend Analysis Practices | Lacking advance trend analysis | Advance trend analysis | Lacking advance trend analysis | Advance trend analysis post-adjustment |

For **Project A**, price adjustment clauses were added later in the project, which could have been more effective if included from the start, as best practices suggest. This would help manage unexpected price changes more smoothly. Additionally, no market assessments were conducted, which limited the project's ability to anticipate future price shifts. Adding regular market analysis and using diverse data sources would improve forecasting accuracy. From the cost estimation perspective, **Project A**'s approach was basic and reactive, lacking the proactive adjustments that could have better controlled the budget. Although moderate risk pooling was applied, which offers some protection, this practice could be strengthened further to reduce vulnerabilities. Furthermore, the contingency budget was minimal, leaving the project exposed to cost increases; increasing this allocation would improve financial resilience. Bulk purchasing was only partially implemented, and expanding it to include

critical materials could help secure costs more effectively. On the other hand, supplier relationships were strong, which is positive and aligns well with best practices. However, contract reviews were infrequent, limiting the project's ability to adapt to market changes. Regular updates to contracts would align better with best practices, and, additionally, clearer definitions of adjustable and non-adjustable portions would enhance financial management. Adding trend analysis would also help in anticipating future price changes.

**Project B** aligns well with best practices in many areas. Price adjustment clauses were included from the start, effectively managing unforeseen costs. Additionally, regular market assessments were conducted, using both historical and market data to support accurate forecasting. Cost estimation was advanced and proactive, contributing to stronger budget control. Moderate risk pooling was applied, which helps reduce project vulnerabilities, and an adequate contingency budget was allocated for unexpected expenses. From the purchasing perspective, bulk purchasing was used for major materials, and strong, long-term supplier relationships were established, providing stability. Regular contract reviews and clearly defined adjustable portions also align with best practices, and advanced trend analysis enabled better anticipation of price trends. Overall, **Project B's** approach aligns closely with best practice recommendations, enabling it to handle price escalation effectively.

**Project C** faced similar challenges to **Project A**, with price adjustment clauses added later in the project rather than from the start, which could have been more effective in managing costs. Additionally, no market assessments were conducted, and reliance on historical data alone limited the project's ability to respond to market changes. Introducing proactive cost estimation practices and conducting regular market analysis would improve the project's adaptability to price escalation. Although moderate risk pooling was used, the contingency budget was minimal, which could leave limited coverage for cost overruns. Bulk purchasing was partially implemented, but supplier relationships were limited and inconsistent, reducing stability. Establishing long-term supplier partnerships would improve alignment with best practices, while regular contract updates would help manage shifting conditions. Like **Project A**, **Project C** lacked clear definitions for adjustable portions and advanced trend analysis, both of which would support better financial planning and risk management.

**Project D** included price adjustment clauses later in the project, which isn't ideal, though regular market assessments helped track price trends. From a cost estimation angle, practices

were initially basic but improved post-adjustment; adopting proactive estimates from the beginning would further strengthen budget control. Additionally, moderate risk pooling provided some protection, and contingency budget allocations improved after adjustments, aligning more closely with best practices. Selective bulk purchasing was used to help manage costs, and supplier relationships were strengthened post-adjustment. However, more frequent contract reviews would align better with best practices, allowing the project to adapt more easily to changing market conditions. Defining adjustable portions would further enhance financial predictability. While trend analysis was conducted after adjustments, implementing it earlier would provide better foresight for managing price escalations.

In comparing all four projects, **Project B** stands out as the most aligned with best practices across multiple areas, such as early inclusion of price adjustment clauses, regular market assessments, diverse data sources, proactive cost estimation, and strong supplier relationships. These factors give Project B a clear advantage in managing price escalation and maintaining budget stability. **Project D** shows similar alignment, particularly in market analysis and improved practices post-adjustment. However, the delayed inclusion of price clauses and initial cost estimation limitations make its alignment with best practices slightly less effective than **Project B**. On the other hand, **Projects A and C** share similar gaps in alignment, such as late inclusion of price clauses, lack of market analysis, and reactive cost estimation methods, which expose them to higher risks in volatile markets. While Project A benefits from strong supplier relationships, **Project C's** limited supplier engagement. Overall, **Projects A and C** would benefit most from adopting practices seen in **Project B**, particularly in proactive risk management and regular contract updates, to improve their alignment with best practices and enhance cost control and adaptability. Additionally, regarding to contact clauses, the issue of managing price adjustments in the industry reveals key areas where best practices could improve stability and fairness. Effective price adjustment clauses are usually proactive, providing a structured, transparent way to handle cost fluctuations from the start of a project. Best practices in other industries suggest including clear terms for price adjustments in initial contracts to protect contractors from sudden financial strain, especially in volatile markets. Typically, these clauses define time thresholds and materials eligible for price changes, allowing everyone involved to anticipate adjustments rather than react to them.

# CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

## 5.1. Introduction

In this chapter, the researcher will conclude what has been found from the collected data and give recommendations on them based on literature review. In addition to these, the researcher will suggest some unstudied areas for further studies.

## 5.2. Conclusions

To achieve the objectives of the study, the researcher used case study methodology with a mixed-method approach, and four projects were selected as a sample of the study by using case selection criteria. The data were collected by a document review instrument, which included descriptions of cases, the extent of the effect, and management practices. And also themes were developed to analyze the data.

Based on the results from the data collection, the following conclusions have been stated.

- One of the objectives of the study was to investigate the price escalation extents on federal building construction projects; The data reveals extreme volatility in cost increments; the highest observed increment reaches 91% of the contract amount.
- The other objective was to assess the effect of price escalation in the cost performance of building construction projects. The dramatic range (91% of contract amount) shows how potentially price escalation can affect the cost performance of building construction.
- The other objective was to assess the current management practice of prices escalation. The findings of the study emphasize that the importance of flexibility and adaptability of price escalation management approaches, which are crucial for responding to changing market conditions, unforeseen events and conditions. And also the result of the paper showed, proactive and comprehensive cost management practices are essential in construction. They are critical for ensuring the successful completion of projects with allocated cost.
- Finally, the researcher determined how the current management of selected projects looked when they were compared with the best practices in the construction industry for managing price escalation.

Based on the findings of this study, the following conclusions are drawn in line with the research questions:

- The **first objective** was to assess the extent of price escalation in federal public building construction projects. The results reveal significant volatility in material and labor costs, with the highest observed increment reaching up to 91% of the original contract amount. This demonstrates the seriousness of price escalation and its unpredictable nature in Ethiopia's construction sector.
- The **second objective** was to examine how price escalation affects the cost performance of construction projects. The results show that extreme price hikes in core construction inputs such as cement, steel, and reinforcement directly contribute to major cost overruns. The data clearly indicates that price escalation significantly compromises the ability of projects to stay within budget.
- The **third objective** focused on assessing the current management practices used to address price escalation. The study found that while some projects included contract provisions and basic mitigation strategies, the overall approach was reactive rather than proactive. Effective price escalation management requires adaptability and forward planning—traits that were lacking in several of the reviewed cases.
- Finally, the research compared the **current practices** of managing price escalation with **internationally recognized best practices**. The results show a clear gap between local practices and global standards. While certain methods such as price adjustment clauses were used, their implementation lacked consistency, flexibility, and responsiveness to real-time market changes. Proactive and integrated cost control strategies are needed to better manage the effects of price escalation throughout the project lifecycle.

## 5.3. Recommendations

The following recommendations will emphasize addressing the major problems identified through the research processes. To minimize the impact of price escalation on the cost performance of building projects, the contractors should manage the problem effectively; from this, the following are some of the ways that they can apply in their project:

Based on the findings of the study, the following recommendations are proposed by the researcher:

- **Early Negotiation for Price Adjustment Clauses**: including price adjustment clauses in contracts against price volatility is one of the best solutions to face the challenge. Additionally, keeping detailed records of all costs and price changes is necessary to support claims for adjustments.
- **Adapt to Market Changes**: Based on the current market condition, updating the cost estimation with the price of construction inputs regularly is necessary. It is important for projects to appropriately factor in changes in labor and material prices, as these factors have a direct impact on price increases. Contractors can make up-to-date decisions and modify budgets by regularly conducting market research to stay informed about potential price changes.

Using real-time cost tracking softwares and the integration of construction-specific price indices published by national statistical agencies or industry bodies. Setting up a monthly price review cycle and involving procurement officers in early cost planning can help maintain budget accuracy and ensure timely responses to market volatility.

- **Adjust Weightage as Needed**: To ascertain when weighting changes are necessary, it is crucial to track and record the expenses related to each project component on an ongoing basis. Employers should be kept informed of any changes in costs and how they may affect the weighting of projects on a regular basis. Proposals for weightage modifications must be made in light of the current market conditions and this updated cost information. By using dynamic weighting, you can make sure that the project budget stays in line with real-world expenses. Keep thorough records of all weightage adjustments and the reasons behind them to support any claims or adjustments needed.
- **Comprehensive Risk Management:** Implementation of proactive risk management framework that included identifying potential risks early in the project lifecycle. This involved regular risk assessments and updates to the risk management plan as the project progressed.

Using a risk breakdown structure (RBS) combined with a **risk register** updated at each project milestone can help to reduce the impacts. For this contractors can a use tools like **Monte Carlo simulation** or **Qualitative Risk Assessment Matrices** to prioritize risks.

- **Detailed Cost Estimation**: The cost estimation process must be detailed, utilizing historical data from similar projects, market analysis, and expert input. This allowed for realistic budgeting and the establishment of contingency funds to address unforeseen issues.
- **Flexible Contract Terms**: Including clauses in contracts that allow for adjustments based on significant price changes can help manage the risks associated with price escalation. This may involve renegotiating terms if material costs exceed a certain threshold.
- **Bulk Material Purchase**: It is recommended to secure bulk purchases for critical materials early in the project to lock in prices and protect against future cost increases, helping maintain budget stability.
- **Supplier Relationships**: Establishing and maintaining strong, long-term relationships with reliable suppliers will provide better pricing, ensure consistent supply, and reduce risks associated with price fluctuations.

## 5.4. Recommendation for Further Study

- An Assessment of the Methodologies and Challenges in Preparing Construction Resource Price Indices in the Ethiopian Building Sector
- A Study on the Effects of Price Escalation in Finishing Materials on the Cost and Schedule Performance of Building Projects
- Examining the Management of Non-Adjustable Contract Items under Price Escalation Conditions in Public Building Projects

# REFERENCE

Almahasneh, H. and Emsley, M. (2018). Key performance indicators (KPIs) for construction projects: A literature review. Journal of Civil Engineering and Management, 24(6), pp. 1222-1238.

Amaratunga, D. and Baldry, D. (2002). Facilities management performance measurement: A review. Facilities, 20(6/7), pp. 206-220.

American Institute of Architects (AIA). (2017). AIA Contract Documents. Retrieved from https://www.aiacontracts.org/

American Society of Professional Estimators (ASPE). (2019). Cost in construction: The sum of all expenditures necessary to complete a project.

Amaratunga, D., and Baldry, D. (2002). Facilities management performance measurement: A review. Facilities, 20(6/7), pp. 206-220.

Ankrah, N. A. and Proverbs, D. G. (2005). Performance management in organizations: A review of the literature. Journal of Management Development, 14(1), pp. 1-24.

Avots, I. (1983). Causes of time and cost overruns in large industrial projects. International Journal of Project Management, 1(2), pp. 92-94.

Babu, G. (2015). A framework for assessing project performance using balanced scorecard. Procedia Engineering, 125, pp. 34-40.

Berssaneti, A. B. and Carvalho, M. M. de (2015). The iron triangle revisited: A balanced view of project success. International Journal of Project Management, 33(1), pp. 127-139.

Bryde, D. (2008). The project management body of knowledge (PMBOK guide) and its critics: A critical review. International Journal of Project Management, 26(1), pp. 20-28.

Chan, A. P. C. (2003). Strategic construction project management: A best-practice framework. Construction Management and Economics, 21(5), pp. 433-445.

Chan, A. P. C., Kwan, K. K. and Luu, G. T. M. (2001). Evaluating contractor performance using a performance index. Construction Management and Economics, 19(4), pp. 447-454.

Cheung, S. O., Li, B. and Skitmore, M. (2004). Benchmarking in construction: A critical review. Construction Management and Economics, 22(8), pp. 979-995.

Construction Industry Institute (CII). (2016).

Dawood, N., Sikka, V. K., Marasini, M. and Dean, A. (2006). 4D visualization for construction sequencing: A review. Automation in Construction, 15(3), pp. 423-434.

Egan, J. (1998). Rethinking construction. Task Force Report of the Inquiry into the Future of the Construction Industry. Department of the Environment, Transport and the Regions, London.

Elattar, H. M. (2009). The impact of risk management practices on project performance in construction. International Journal of Project Management, 27(4), pp. 423-431.

Enshassi, A., Mohamed, S. and Love, P. G. (2009). Improving construction contracts: The role of client expectations and risk management. Construction Management and Economics, 27(9), pp. 891-908.

Eurostat. (2013). Handbook on Price and Volume Measures in National Accounts. Retrieved from https://ec.europa.eu/eurostat/documents/

Fisher, J. D. (2015). Types of Construction Contracts. Construction Management and Economics, 33(7), pp. 561-576.

Gudiene, L., Navai, M. and Bryson, D. M. (2013). Project risk management in the construction industry: A review. International Journal of Project Management, 31(4), pp. 576-589.

Cheung, S.O., Suen, H.C.H. and Cheung, K.K.W., 2008. PPMS: a Web-based construction project performance monitoring system. Automation in Construction, 17(6), pp.715-721.

Hillebrandt, P.M., 2000. Economic theory and the construction industry. 3rd ed. London: Macmillan.

Ofori, G., 2015. Nature of the construction industry, its needs and its development: A review of four decades of research. Journal of Construction in Developing Countries, 20(2), pp.115-135.

Oyewobi, L.O., Ganiyu, B.A., Oke, A.E., Ola-Awo, A.A. and Shittu, A.A., 2011. Determinants of unethical performance in Nigerian construction industry. Journal of Sustainable Development, 4(4), pp.175-182.

Chen, Z. & Zhang, Y., 2020. Managing price escalation risks in construction supply chains. Journal of Construction Engineering and Management, 146(5), pp.1–10.

Love, P.E.D., Sing, C.-P., Wang, X. & Irani, Z., 2016. Understanding the dynamics of cost overruns in infrastructure projects. Engineering, Construction and Architectural Management, 23(4), pp.554–575.

Gangwar, M. & Kalidindi, S.N., 2020. Assessment of price escalation clauses in construction contracts: Current practices and recommendations. Construction Management and Economics, 38(7), pp.651–664.

Turner & Townsend, 2022. International construction market survey 2022.

Hobday, M. (2000). Dynamics of innovation: Competences, networks and industrial change. Edward Elgar Publishing.

International Federation of Consulting Engineers (FIDIC). (2017). FIDIC Contracts. Retrieved from https://fidic.org/

International Monetary Fund. (2004). Producer Price Index Manual: Theory and Practice. Retrieved from https://www.imf.org/external/np/sta/tegppi/

International Research Journal of Engineering and Technology (IRJET). (2017, March).

Judgev, D. and Müller, R. (2005). A theoretical framework for a project complexity assessment tool. International Journal of Project Management, 23(7), pp. 628-640.

Kaliba, C., Muya, K. and Mwangi, M. (2009). Factors affecting cost variation in water and sanitation projects in Kenya. Construction Economics and Building Management, 17(6), pp. 637-651.

Kamau, G. and Mohamed, S. M. (2015). A review of performance measurement systems in construction. Construction Management and Economics, 33(5-6), pp. 403-420.

Kingsley, A. (2010). The performance management revolution: Why the search for the perfect key performance indicators (KPIs) is a waste of time. Greenleaf Publishing.

Mahmoud, Y. and Scott, D. (2002). The use of performance measurement in construction. Construction Management and Economics, 20(7), pp. 6.

Moavenzadeh, F. and Koch, C. (1975). Project Management in Construction. New York, NY: McGraw-Hill.

Mordor Intelligence. (2020). Ethiopia Construction Market - Growth, Trends, COVID-19 Impact, and Forecasts (2022 - 2027).

Müller, R. and Turner, R. (2007). The project management body of knowledge (PMBOK guide) and the waterfall model: Influences on project management practice. International Journal of Project Management, 25(1), pp. 81-89.

Neely, A. (2002). Performance measurement in turbulent times. Business Strategy Review, 13(3), pp. 22-30.

OECD. (2011). Producer Price Indices – Comparative Methodological Analysis. Retrieved from https://www.oecd.org/

Shenhar, A. J., Dvir, D., Levin, G. and Maltz, R. A. (2002). Project success: A literature review. Project Management Journal, 33(3), pp. 8-16.

Sinclair, M. and Zairi, M. (1995). The statistical evaluation of performance measurement systems. Construction Management and Economics, 13(5), pp. 347-357.

United Nations Economic Commission for Africa (UNECA). (2018). Economic Report on Africa 2018: Transforming Africa, Mineral Wealth and Economic Diversification.

White, K. P. and Fortune, J. M. (2002). Current practices in project risk management. International Journal of Project Management, 20(1), pp. 1-10.

Willis, R. and Willis, J. (1996). Project management made simple. Addison-Wesley Publishing Company.

Yewondwossen, E. (2021, June 11). 13 federal building projects under construction.

# APPENDEX

## Appendix A: Publishable Manuscript

**Assessing the Price Escalation Management Practice and Its Effects on Cost Performance for Federal Public Building Projects**

By: Saron Gebeyaw, Advisor: Dr. Solomon Sertse

**Abstract:**

The objective of the study is to assess the management practice of price escalation and its effect on cost performance for federal public building projects. To assess the problem, four different university building projects were selected. The study used document review as a data collection instrument. For analyzing the collected data, the researcher used within the case analysis and cross-case analysis with different themes; and also it utilize both primary and secondary data. The findings of the study reveal that in the selected case of the research there was significant cost increases in construction activities because of the price increment in direct input of construction. Due to that the major activities like concrete, reinforcement and masonry work showed that increments reaching up to 91%. And also, the results showed that there were different management practices used by contractors to overcome the challenges of price escalation. To enhance effectiveness, the study recommends early implementation of contractual adjustments and proactive cost management strategies in building projects. In the future, studies should focus on price indices preparation for construction project resources, price escalation in construction finishing materials on different performance of construction projects, and consideration of the non-adjustable portion of the contract based on the contractors‟ detailed cost breakdown.

**Keywords:** construction; Cost Performance; Price escalation

1. **Introduction:** In Ethiopia, where the construction sector is a key driver of economic growth, projects face performance challenges due to different factors (ECA, 2018; Solomon et al., 2021).

The result from different studies showed that performing construction projects within the allocated cost, time, and quality is poor and getting increasingly difficult (Solmon et al., 2021; Tadesse et al., 2016).

According to Benti & Hong's (2021) study, ten factors are sated as the reasons for poor performance in public construction of Ethiopia. From them they mentioned the rising market price of construction inputs as significant factors which directly contributing to the poor cost performance. Cost performance in construction refers to the ability of a construction project to stay within the budgeted costs. It involves monitoring and controlling costs throughout the project lifecycle to ensure that expenditures are in line with the budget and that cost overruns are minimized.

To ensure that the cost of construction remains within the budget and achieve good cost performance, it is crucial in the construction sector to control project costs. To keep the project within the allocated budget, project cost management is therefore required.

To effectively address cost overruns in construction projects, accurate cost estimation, efficient project design, and robust cost control mechanisms are essential components.

Several studies in Ethiopia have identified key variables contributing to cost overruns in construction projects. Factors such as poor planning, low productivity, inflationary pressure, project financing issues, poor cost estimation, late raw materials delivery, ambiguous contract documents, poor planning and coordination, change orders due to client-requested additions, excess quantity during construction, completeness of design, speed of decision-making and rising costs of building materials, labor, and machinery have all been highlighted as significant sources of cost overruns (Zinabu & Getachew, 2015; Ashebir et al., 2017); Nege , 2008; Aschalew, 2017). Among these challenges, price escalation of construction inputs (rising costs of building materials, labor, and machinery), stands out as one of the major issue for cost overrun.

Additionally, Different scholars like, Gangwar (2020), Jennifer et al. (2009) have emphasized the risk of price escalation that occurs in construction projects and it is the major phenomenon that is almost associated with all construction projects all over the world. In Ethiopia scholars like, Andualem (2020), Teshome (2021), and Yuzu (2008), have underlined the risk of price escalation that occurred in construction projects.

Different scholars and early attention to its causes and effect on project performance will help to reduce cost rise throughout the bid process or during construction. Its management should be used throughout the project life cycle. To manage the problem of price escalation contract related issues, bulk material purchase, buyer-supplier partnership, and use of local materials

are some of the major mechanisms mentioned by different scholars. Nevertheless, price adjustment clauses are the most used mechanisms in most countries regarding price escalation problems. The situation in Ethiopia in terms of price adjustment has evolved from MoWUD1994 to PPA 2011. Each type of price adjustment comes with its own set of constraint.

**General objective:** The aim of the research to be conducted is to assess the price escalation management practice and its impact on cost performance for federal public building projects.

**Specific objectives: the first objective is i**nvestigate the price escalation extents and management practices on federal building construction projects, the second one is assess the impact of the price escalations on the construction projects' cost performance he last one is come up with recommendations to mitigate the major negative impacts.

**Statement of the problem:** Price escalation, the increase in the estimated cost of materials, labor, and equipment over time, is a major factor contributing to cost overruns in construction projects. Scholars such as Gangwar (2020), Arditi et al. (1985), and Jennifer et al. (2009) emphasize that price escalation in construction inputs is a common issue leading to cost overruns and disputes. In Ethiopia, the escalation of construction input prices is exacerbated by factors such as currency depreciation and shortages, impacting project completion. Research by Habtemariam (2019), Abraham (2008), Andom (2015), and Mossa (2013) highlights the financial and economic risks associated with price escalation, including project delays, cash flow issues, and reduced project quality. To manage price escalation, mechanisms such as contract-related strategies, bulk material purchase, and buyer-supplier partnerships are recommended. Additionally, market assessment and procurement procedures can help contractors anticipate and address cost escalation through strategic planning and contract terms that accommodate pricing changes. Price escalation is a significant issue in construction projects, leading to cost overruns and disputes. Various strategies, including contract-related mechanisms and market assessment, can help manage price escalation effectively.

Price adjustment provisions are considered essential in construction contracts, especially for long-term projects with potential cost escalation risks. FIDIC's Conditions of Contract for Construction (1999) recommend adjusting amounts payable to contractors for fluctuations in labor, goods, and other inputs, including contingencies for cost changes. In the USA, state-

specific escalation clauses vary, with some including forecasted escalation costs in bids. ADB requires bidding documents to specify price adjustment allowances for major cost components beyond the contractor's control.

In Ethiopia, price adjustment clauses have evolved from MoWUD 1994 to PPA 2011, with constraints and specific implementation timelines. The PPA 2011 contract is commonly used in Ethiopian construction projects. However, challenges such as constant weighting coefficients and varying estimators affect the accuracy of adjusted payments.

**Research gaps:** in addressing the identified research gap, this study uniquely focuses on the impact of price escalation on the cost performance of construction projects specifically within the Federal University of Ethiopia. By honing in on this specific context, the research aims to provide targeted insights and recommendations tailored to the challenges and dynamics present in the university construction projects of Ethiopia. This unique approach not only fills a critical gap in the existing literature but also offers practical solutions and management practices that are directly applicable to the construction projects within the Federal University setting. By shedding light on the specific challenges and implications of price escalation within this context, the study aims to enhance awareness among stakeholders and provide actionable strategies to improve cost performance and project outcomes in this particular sector.

## 2. Literature review:

**Project Performance:** Successful performance in construction projects has traditionally been defined in terms of the delivery of projects on time, under budget, and to specifications, as well as the achievement of affordable life-cycle costs (Hobday, 2000). Measuring a project's development is essential for determining if it will succeed or fail. Performance in the construction industry has primarily been evaluated based on cost, time, and quality criteria, famously described as the "iron triangle" (Atkinson, 1999; Chan et al., 2001). However, these traditional criteria have faced criticism due to their inadequate coverage of performance measurement (Gardiner, 2000) and the perceived relationship among themselves and their short-term focus (Shenhar et al., 2002).

The most effective way to monitor a project's performance is by identifying key performance indicators (KPIs) and continuous process improvements (CSFs). There are many factors that can influence a project's performance (Almahasneh & Emsley, 2018). Assessing performance

in relation to a specified objective is a critical aspect of project management. Measuring performance is essential in determining a project's condition and direction, providing project managers with insights into where they are and where they are heading. Iron Triangle" is an outdated paradigm that project managers use to oversee and evaluate a project's success from three angles with the project's delivery date in mind. Recent research works have shown that measuring project performance cannot be adequately justified with these three (3) indicators alone (Enshassi, et. al., 2009; Babu,
2015). So, addition to cost, quality, time, and client satisfaction, many other researchers have looked into a variety of other performance indicators for construction projects and have identified the following: regular and community satisfaction, health and safety, and environmental factors (Chan, 2003; Enshassi, et. al., 2009; Dawood, Sikka, Marasini & Dean, 2006; Alumbugu, Abdulazeez, Saidu, Ola-awo & Tsado, 2015).

Various scholars have introduced different key performance indicators (KPIs) over time, and these KPIs have been implemented in different parts of the world. To provide an overview of some of the most commonly used KPIs, the following table has been summarized.

Table 21. Summary of some of previous studies on performance indicators at project level

| No. | Author and year | Country | Performance indicators |
|---|---|---|---|
| 1 | Jastaniah (1997) | Saudi Arabia | Client satisfaction, closeness to budget, planning period, profitability, staff experience , payment, communication, claims and safety |
| 5 | Cheung et al. (2004) | China | People, safety, cost, client satisfaction, time, communication, quality environment |
| 7 | Constructing Excellence (2005, 2006, 2009) and Roberts and Latorre (2009) | UK | Client satisfaction, profitability, defects, productivity, predictability cost, time, safety, construction |

| | | | |
|---|---|---|---|
| | | | cost, time, social indicators, variance cost, time, environment, contractor satisfaction |
| 8 | 8 Rankin et al. (2008) and Canadian Construction Innovation Council (CCIC) (2007 | Canada | Cost, scope, time, innovation , quality, sustainability, safety , client satisfaction |
| 10 | Construction Industry Institute (CII) (2011) | USA | Cost , accident , schedule, rework, changes, productivity |

From the above reviewed KPIs of construction, cost, time, quality, client satisfaction, and health and safety are used in the Ethiopian construction industry performance measurement process (Tadesse et al., 2016; Solomon et al., 2021; Tagess, 2017; Benti & Hong's, 2021).

The reviewed KPIs of construction; cost, time, quality, client satisfaction, and health and safety are used in the Ethiopian construction industry performance measurement process (Tadesse et al., 2016; Solomon et al., 2021; Tagess, 2017; Benti & Hong, 2021).

**Cost Performance:** Cost is defined as the extent to which the overall constraints used to complete a project align with the projected budget (Bubshait and Almohawis, 1994). The total cost of a project includes not just the tender amount but also any costs resulting from changes, modifications made during construction, and expenditures associated with legal claims, such as litigation and arbitration. It can be calculated using unit costs and the net difference over final costs (Chan and Tam, 2000).

Cost variance is a critical part of evaluating the performance of a project, as it shows how much the project is over or under budget. Cost variance was utilized by Andi and Minato (2003) to assess how poorly designed projects performed in Japan's building sector. Georgy (2005) proposed using the cost component to measure how well engineering projects are performing.

Cost performance is essentially a measurement of how much the overall situation supports completing a building project within the projected budget. It is calculated by comparing the actual costs to the budgeted costs for the work that has been done so far (Vyas & Kulkarni,

2013). Several elements that affect project success in terms of cost should be tracked to achieve satisfactory cost performance on a construction project.

**Construction Project Cost Management and Its Processes:** Cost management encompasses the processes involved in cost planning, estimation, budgeting, and control in construction projects. The goal of cost management is to finish the project on time and within budget. Early scope determination is crucial since an owner's potential to affect the cost is highest during the early stages of a project:

**Construction Project Risk Management and Its Processes**

Proactive risk identification, assessment, and mitigation are fundamental (PMI, 2021). Implementing strong risk management practices allows for contingency planning and informed decision-making, minimizing cost overruns arising from unforeseen events (Long et al., 2008). Risks, if left unaddressed, can lead to not only cost overruns but also schedule delays, quality compromises, and ultimately, project failure.

**Price Escalation and Adjustment Practices:**

**Price Escalation Valuation Techniques:** Research indicates that there isn't a universally superior method for valuing price escalations. Nonetheless, three common types of adjustment clauses are typically employed (Barthet, 2010; Clough, Sears, & Sears, 2008; Halpin & Woodhead, 2010).

**Invoice Method (Rise and Fall Method):** This technique requires the contractor to provide documentation showing any increase in material costs that occurred from the time the contract was signed to when the materials were actually purchased, thereby passing these increased costs onto the owner (Barthet, 2010; Clough, Sears, & Sears, 2008).

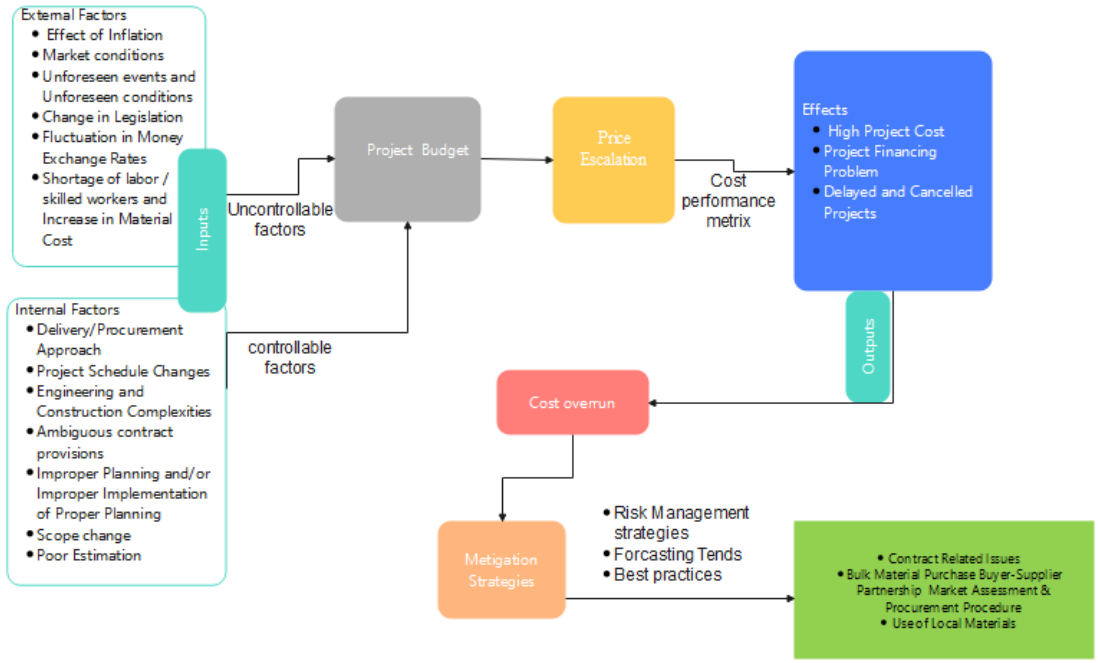
**Index Method:** In this approach, certain material costs are linked to an index for the relevant commodity. This allows the contract price to adjust in line with regional or local changes to that commodity's price index. Unlike the invoice method, which transfers cost increases to the owner, the index method can result in a loss for the contractor if material costs decline (Barthet, 2010; Halpin & Woodhead, 2010).

Challenges in price adjustment

- Constant weighting coefficients throughout the project lifetime.
- Different estimators giving rise to different weighing coefficients.
- It does not consider actual labor work time.

- Change in project cost.
- Constant input material amounts.
- Computation time.
- Adjustable amount.
- Adjustment for non-used items.
- Failure to make periodic payment (PPA, 2011).

**Conceptual Framework:** A conceptual framework is a written or visual representation of an expected relationship between variables. Managing construction projects effectively requires not only careful planning and execution but also an awareness of potential challenges and proactive strategies to mitigate them. This conceptual framework provides a valuable tool for understanding the various factors contributing to price escalation, its significant impact on different aspects of construction performance, and effective strategies to manage it.




**3. Research Methodology:** A case study approach with mixed research approach was chosen for this research. The case study method was chosen, due to its suitability for assessing descriptive and explanatory research type; it is helpful to investigate the phenomena under its real time context and a limited number of events in depth. The study used multiple unit analysis because, Yin (2009) recommends using multiple cases from those types since replication will improve the precision, validity, and stability of the findings.

So for this study the researcher chose four university projects which are located in Addis Ababa based on different criteria (Vulnerability to price escalation, availability of data, industry significance) by using purposive sampling technique. The data sources of the study were primary and secondary data. For the data collection the researcher used document review as a main data source. To analyze the collected data, the researcher used within the case analysis and cross-case analysis with developing themes.

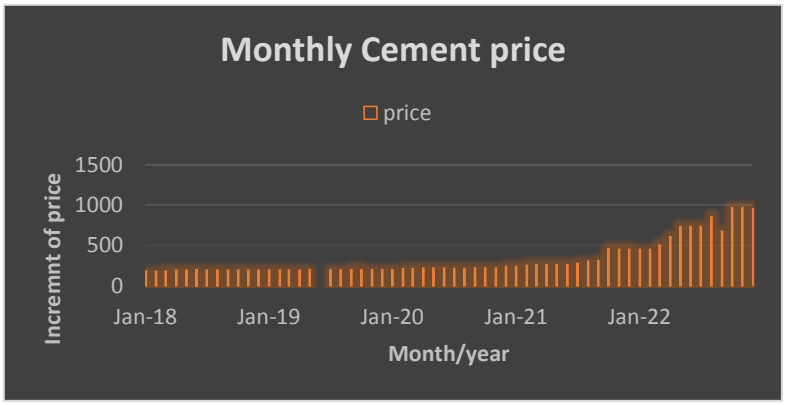
## 4. Result and Discussion:

**Description of Cases:** The selected cases for this research were federal public building projects found in Addis Ababa federal universities that are still under construction. The following table presents the four elected projects and their description.

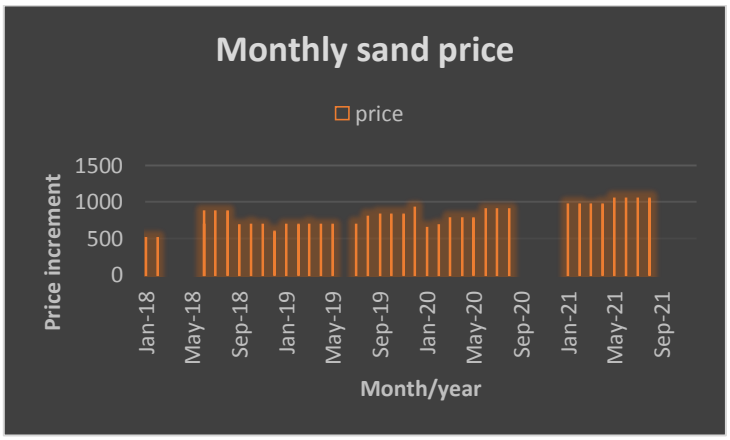
| **Description** | **Project A** | **Project B** | **Project C** | **Project D** |
|---|---|---|---|---|
| Client | Addis Ababa Science and technology university | | | |
| Building Type | commercial complex building | Construction of Administration Building | Construction of Guest house building | Construction of Auditorium Building |
| Date of contract signing: | 09-05-2018 | 01-08-2018 | 03-07-2018 | 14-05-2018 |
| Contact amount: | 418, 133,212.95 | 601,374,007 | 164,576,192.00 | 203,213,018.17 |
| Project delivery method | DBB | | | |
| Contract type: | Unit price | | | |
| Price adjustment clause availability | No | Yes | No | No |
| Base price sources | ECSA/ AADCWB | ECSA, AADCWB & well-known suppliers | ECSA/ AADCWB | ECSA/ AADCWB |
| Progress until June 4-2024: | Above 95 % | Above 68% | Around 70 % | 99 % |
| Project duration: | 540 Days | 600 days | 540 Days | 540 Days |
| Original completion date: | November 30, 2019 | March 24, 2020 | December 25, 2019. | November 5, 2019 |

**The extent of price escalation on selected projects' cost performance:** The following graphs and tables showed the extent of price escalation in some of the major materials and in each project, as well as how the project initial budget was affected.

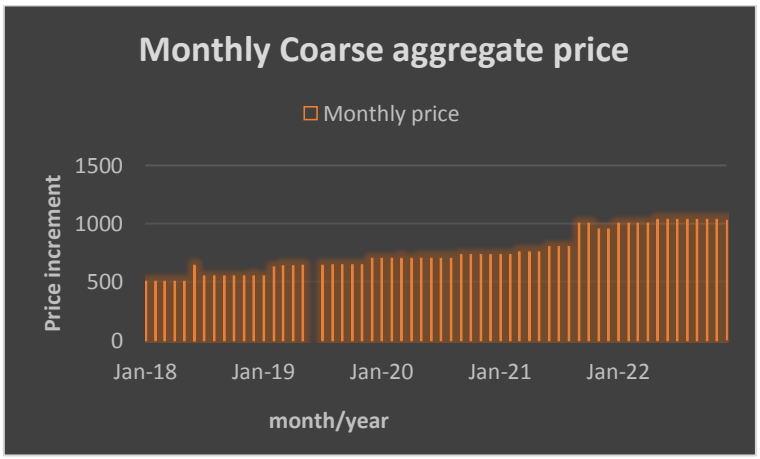
**I. Price of cement**




**I. Price of Sand**




**II. Price of Coarse Aggregate**



### III. Price of Reinforcement Bar

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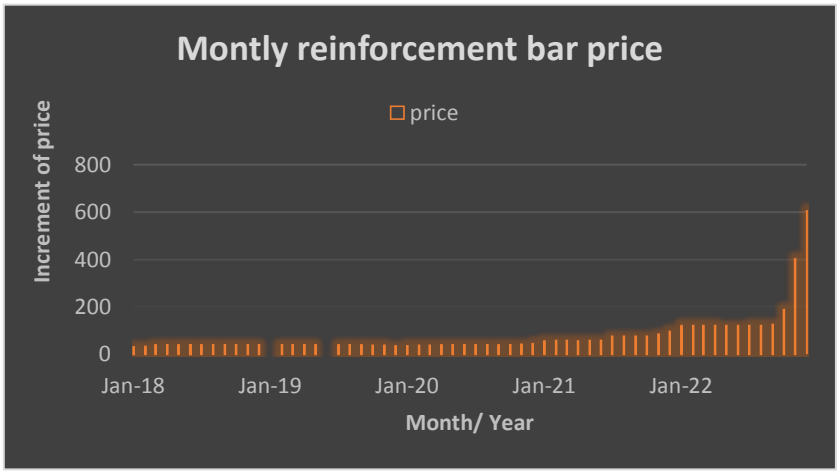


Because of the increment of price in different input of construction selected projects showed increment in their contract amount and the following explanation shows the extent of the increment in each projects.

**Project A:**

- **Concrete**: The largest increment was 23% for concrete lintels in April and May 2020.
- **Formwork**: The highest increment for formwork was 26% for elevation columns and floor beams in April 2020.
- **Rebar**: The largest increment for rebar was 47% for dia 8 bars in May 2020.

**Project B**:

- **Concrete**: The largest increment was 46% for the basement beam by the end of 2020.
- **Formwork**: The largest increment for formwork was 63% for foundation pads and basement beams in 2022.
- **Rebar**: The largest increment for rebar was 49% for dia 8 bars by mid-2020.

**Project C:**

- **Concrete**: The largest increment was 65% for the ground floor slab in April 2022.
- **Formwork**: The largest increment for formwork was 84% for foundation pads and grade beams in March 2022.

- **Rebar**: The largest increment for rebar was 68% for diameters 8, 10, 12, and 14 in 2022.

**Project D:**

- **Concrete**: The largest increment was 91% for underground slabs and beams by the end of 2020.
- **Formwork**: The largest increment for formwork was 87% for elevation columns and floor beams by August 2022.
- **Rebar**: The largest increment for rebar was 93% for all diameters by July 2022.

**Effect of price escalation on cost performance of Selected Projects: i**n Chapter two of this paper, it is discussed that price escalation in construction projects results in various effects, including increased project costs, stakeholder disputes, financing issues such as budget shortfalls, and project delays or cancellations. But specifically in cost performance of projects it leads projects to cost overrun by rising the project cost with unexpected increment. This study assesses the impact of price escalation on the cost performance of building projects by analyzing the rise in project costs due to increased inputs of structural elements such as concrete work, reinforcement, masonry, scaffolding and formwork. The following table shows the effects noticed in each project.

| | | **Selected projects** | | | |
|---|---|---|---|---|---|
| | | **Project A** | **Project B** | **Project C** | **Project D** |
| Effect of price escalation on cost performance | High in project cost | ✓ | ✓ | ✓ | ✓ |
| | stakeholder disputes | | | ✓ | |
| | budget shortfalls | ✓ | ✓ | ✓ | ✓ |
| | Contract renegotiation | ✓ | | ✓ | ✓ |
| | Difficulty in Maintaining Cost Baselines | ✓ | | ✓ | ✓ |

The above table remarks the effects shown in each selected project. From the listed effects, all faced high project costs and shortages in budget. With stakeholder disputes, only Project C

faced it, and it may even end up in termination. Except for Project B, all renegotiated their contracts because of price escalation; contract renegotiation itself was not the effect, but because of it, projects faced delays of more than a year. Another effect noticed in the selected projects was the problem of maintaining their cost baseline.

**Price escalation preventing method in selected cases in early stage of projects:** Firstly, early attention to price escalation causes will help to reduce cost rise due to increase in price throughout the bid process or during construction. From them cost estimation forecasting practice is the major one. In each projects the researcher assessed how the responsible parties forecast and estimate the cost for each activity of the project. The following table shows how they predict the increment of price in the construction inputs.

Table 22. Price escalation preventing method in selected cases in early stage of projects

| Assessments | Project A | Project B | Project C | Project D |
|---|---|---|---|---|
| **Preparation of price for construction direct inputs** | | | | |
| Historical data: | Yes | Yes | Yes | Yes |
| Market assessment: | No | Yes | No | No |
| Base price source: | ECSA/ AADCWB | ECSA, AADCWB & well-known suppliers | ECSA/ AADCWB | ECSA/ AADCWB |
| **Forecasting on the increment of price in the inputs** | | | | |
| **Assessments** | **Project A** | **Project B** | **Project C** | **Project D** |
| Price data Base Availability: | No | Yes | No | No |
| Nature of the existence database: | Only historical data base | Market-analysis Databases | Only historical data base | Market-analysis Databases |
| Pricing/forecasting methods: | Time series | Time series and Market analysis | Time series | Time series and Market analysis |
| List of items for forecasting: | The whole items | Selected items | The whole items | The whole items |
| Benchmark for trend analysis: | Historical project data and cost database from ECSA/ AADCWB | Historical project data and cost database from ECSA/ AADCWB and market price | Historical project data and cost database from ECSA/ AADCWB | Historical project data and cost database from ECSA/ AADCWB |
| Trend analysis Method/tools: | Excel and Ms-project | | | |
| Cost estimation techniques: | Bottom-up | Parametric and | Bottom-up | Bottom-up |

| | | | | |
|---|---|---|---|---|
| | and analog | Bottom-up | | |
| Tools and techniques for estimation | Ms-project and Excel | | | |

The table highlights how contractors in selected projects prepare input prices and forecast future prices. **Project A** and **C** only use historical data, without regular market assessments, while **Project B** and **D** incorporate both historical data and market analysis. All projects use ECSA and AADCWB as base price sources, but **Project B** and **D** also consider supplier prices. For forecasting, **Project A** uses time series analysis and includes all items, while **Project B**, **C**, and **D** focus on selected items and use both time series and market analysis. Trend analysis relies on historical data for **Project A** and **C**, while **Project B** and **D** also include market prices. **Project A** uses bottom-up and analog methods, **Project B** and **D** use parametric and bottom-up, and **Project C** relies solely on bottom-up. Excel and MS Project are common tools across all projects for trend analysis and estimation.

**Contract provision mechanisms:** From the literature part of the paper (Chapter 2), three main price adjustment techniques are mentioned: the invoice method, the formula method, and the hybrid method. All the selected cases used price adjustments conducted using the formula method.

To mitigate the risks associated with price escalation, contracts typically include specific clauses that allow for the adjustment of prices in response to significant changes in cost factors. These clauses, often referred to as **price adjustment clauses**, are designed to provide a mechanism for both clients and contractors to share the cost impacts of market volatility. And the following table contains the practice of each project related with contact terms related price escalation.

Table 23. Contact terms related price escalation

| **Description** | **Project A** | **Project B** | **Project C** | **Project D** |
|---|---|---|---|---|
| **Contact terms related price escalation** | | | | |
| Price Adjustment clause availability | Previously not allowed but now included | Available initially in the contract | Previously not allowed but now included | Previously not allowed but now included |
| Price adjustment | include fluctuations in material prices, currency exchange rates, labor costs, | | | |

| | | | | |
|---|---|---|---|---|
| conditions: | legislation changes, unforeseen events and conditions | | | |
| Price Adjustment method: | Formula method: 2006 PPPA | | | |
| How they change the condition: | By amending the contract | Available initially in the contract | By amending the contract | By amending the contract |
| Weighting: | Activity quantity/the whole project quantity | | | |
| Index: | Price from ECSA then convert to index by them self | | | |
| Adjustable portion: | 69.06% (cement, rebar, fuel & ceramic) | 66% (cement, rebar, fuel & ceramic) | 64.8% (cement, rebar, fuel & ceramic) | 67% (cement, rebar, fuel & ceramic) |
| Non-adjustable portion: | 30.94% (overhead, stone masonry, hardcore, formwork, selected materials) | 34% (overhead, stone masonry, hardcore, formwork, selected materials) | 35.2% (overhead, stone masonry, hardcore, formwork, selected materials) | 33%(overhead, stone masonry, hardcore, formwork, selected materials) |
| **Other cost provisions** | | | | |
| Currency fluctuation | Increase in dollar exchange rate | | | |
| Unforeseen condition | Covid-19 and security issues | | | |
| Amendment: | Price adjustment clause | -------- | Price adjustment clause | Price adjustment clause |

For **Project A**, the price adjustment clause was added later, allowing 69.06% of the contract value (cement, rebar, fuel, and ceramic) to be adjusted, with 30.94% non-adjustable for overhead and materials like masonry. **Project B** had the clause from the start, adjusting 66% of costs, with 34% non-adjustable. **Project C** introduced the clause later, adjusting 64.8% of costs, and **Project D** followed the same pattern with 67% adjustable. All projects use the

ECSA index for price adjustments and account for currency fluctuations, with common provisions for unforeseen conditions like Covid-19 and security issues.

**Discussion of the result**

**Effect of price escalation on the cost performance of federal public building projects:** From the above discussion of the effect of price escalation on the cost performance of the selected case, it is evident that price escalation greatly affects the cost performance of building projects, causing uncertainty and possible budget overruns. The data shows large increases, especially in reinforcement bars and key materials, making cost management difficult. These rising prices lead to poor cost performance, putting financial pressure on the projects and showing that price escalation is a major issue for project costs.

**The current management practice of price escalation in each projects:** The analysis shows how different management strategies impacted cost performance in Projects A, B, C, and D. **Project A** and **C**, which introduced price adjustment clauses later and relied only on historical data, faced significant cost overruns due to delayed responses to price increases. **Project B**, with a proactive approach, included price adjustments from the start and used both historical and market data, leading to better cost control. **Project D**, though late in adopting price adjustments, managed costs better than A and C. The findings highlight the importance of early price adjustment clauses and market analysis for effective cost management.

**Best practice vs selected projects:** The following table shows how the four projects align with best practices in managing price escalation. This approach allows for a clearer comparison and easier understanding of the extent to which each project follows to or diverges from recommended strategies. Below is a table that summarizes the discussion of best practices from chapter two against the actual management practices observed in each of the projects.

| **Best practices** | **Project A** | **Project B** | **Project C** | **Project D** |
|---|---|---|---|---|
| Early Inclusion of Price Adjustment Clauses | Added later, not initially included | Included from the start | Added later, not initially included | Added later, not initially included |
| Comprehensive market analysis | No market | Regular market | No market | Regular market |

| | assessments | assessments | assessments | assessments |
|---|---|---|---|---|
| Diverse data sources | Solely historical data | Historical & market data | Solely historical data | Historical & market data |
| Effective cost estimation practices | Basic, reactive adjustments | Advanced, proactive estimations | Basic, reactive adjustments | Improved post-adjustment |
| Adjustable and Non-Adjustable Portion Management | Not clearly defined based on MoF and ECA | Clearly defined adjustable and non-adjustable portions | Not clearly defined based on MoF and ECA | Not clearly defined based on MoF and ECA |
| Trend analysis practices | Lacking advance trend analysis | Advance trend analysis | Lacking advance trend analysis | Advance trend analysis post-adjustment |

**Conclusions and recommendations**

**Conclusions:** To achieve the objectives of the study, the researcher used case study methodology with a mixed-method approach, and four projects were selected as a sample of the study by using case selection criteria. The data were collected by a document review instrument, which included descriptions of cases, the extent of the effect, and management practices. And also themes were developed to analyze the data.

Based on the results from the data collection, the following conclusions have been stated.

- One of the objectives of the study was to investigate the price escalation extents on federal building construction projects; The data reveals extreme volatility in cost increments; the highest observed increment reaches 91% of the contract amount.
- The other objective was to assess the effect of price escalation in the cost performance of building construction projects. The dramatic range (91% of contract amount) shows how potentially price escalation can affect the cost performance of building construction.
- The other objective was to assess the current management practice of prices escalation. The findings of the study emphasize that the importance of flexibility and adaptability of price escalation management approaches, which are crucial for responding to changing market conditions, unforeseen events and conditions. And also the result of the paper showed, proactive and comprehensive cost management practices are essential in

construction. They are critical for ensuring the successful completion of projects with allocated cost.

- Finally, the researcher determined how the current management of selected projects looked when they were compared with the best practices in the construction industry for managing price escalation.

**Recommendations**: The following recommendations will emphasize addressing the major problems identified through the research processes. To minimize the impact of price escalation on the cost performance of building projects, the contractors should manage the problem effectively; from this, the following are some of the ways that they can apply in their project:

Based on the findings of the study, the following recommendations are proposed by the researcher:

- **Early Negotiation for Price Adjustment Clauses**: including price adjustment clauses in contracts against price volatility is one of the best solutions to face the challenge. Additionally, keeping detailed records of all costs and price changes is necessary to support claims for adjustments.
- **Adapt to Market Changes**: Based on the current market condition, updating the cost estimation with the price of construction inputs regularly is necessary. It is important for projects to appropriately factor in changes in labor and material prices, as these factors have a direct impact on price increases. Contractors can make up-to-date decisions and modify budgets by regularly conducting market research to stay informed about potential price changes.
- **Adjust Weightage as Needed**: To ascertain when weighting changes are necessary, it is crucial to track and record the expenses related to each project component on an ongoing basis. Employers should be kept informed of any changes in costs and how they may affect the weighting of projects on a regular basis. Proposals for weightage modifications must be made in light of the current market conditions and this updated cost information. By using dynamic weighting, you can make sure that the project budget stays in line with real-world expenses. Keep thorough records of all weightage adjustments and the reasons behind them to support any claims or adjustments needed.
- **Comprehensive Risk Management:** Implementation of proactive risk management framework that included identifying potential risks early in the project lifecycle. This

involved regular risk assessments and updates to the risk management plan as the project progressed.

- **Detailed Cost Estimation**: The cost estimation process must be detailed, utilizing historical data from similar projects, market analysis, and expert input. This allowed for realistic budgeting and the establishment of contingency funds to address unforeseen issues.
- **Flexible Contract Terms**: Including clauses in contracts that allow for adjustments based on significant price changes can help manage the risks associated with price escalation. This may involve renegotiating terms if material costs exceed a certain threshold.

**Recommendation for Further Study**

- Assessing the process of price indices preparation for construction projects resources
- Assessing the effect of price escalation in construction finishing materials on the performance of construction projects
- Consideration of non-adjustable portion of the contract based on the contractor's detailed cost break down

**Reference:**

**Almahasneh, H. and Emsley, M. (2018)**. Key performance indicators (KPIs) for construction projects: A literature review. *Journal of Civil Engineering and Management*, 24(6), pp. 1222-1238.

**Amaratunga, D. and Baldry, D. (2002)**. Facilities management performance measurement: A review. *Facilities*, 20(6/7), pp. 206-220.

**Berssaneti, A. B. and Carvalho, M. M. de (2015)**. The iron triangle revisited: A balanced view of project success. *International Journal of Project Management*, 33(1), pp. 127-139.

**Kaliba, C., Muya, K. and Mwangi, M. (2009)**. Factors affecting cost variation in water and sanitation projects in Kenya. *Construction Economics and Building Management*, 17(6), pp..

**Chan, A. P. C. (2003)**. Strategic construction project management: A best-practice framework. *Construction Management and Economics*, 21(5), pp. 433-445.

**Enshassi, A., Mohamed, S. and Love, P. G. (2009)**. Improving construction contracts: The role of client expectations and risk management. *Construction Management and Economics*, 27(9), pp. 891-908.

**Shenhar, A. J., Dvir, D., Levin, G. and Maltz, R. A. (2002)**. Project success: A literature review. *Project Management Journal*, 33(3), pp. 8-16.

## Appendix B. Document Review Templates

**Description of selected projects**

| No | Project description | | | |
|---|---|---|---|---|
| **1** | **General Information** | | | |
| 1.1 | Client | | | |
| 1.2 | Contractor | | | |
| 1.3 | Consultant | | | |
| 1.4 | Building Type | | | |
| 1.5 | Size of Building | | | |
| 1.6 | Purpose of the building | | | |
| 1.7 | Location | | | |
| 1.8 | Date of contract signing | | | |
| 1.9 | Contact amount | | | |
| 1.1 | Contract type | | | |
| 1.11 | Project delivery method | | | |
| 1.12 | Project duration | | | |
| **2** | **Contract Terms related with Project Cost** | | | |
| 2.1 | Contact terms related price escalation | Price Adjustment method | No adjustment | |
| | | | Fixed-price adjustment | |
| | | | Cost-based adjustment | |
| | | | Index-based adjustment | |
| | | | Market-based adjustment | |

| | | | | | |
|---|---|---|---|---|---|
| | | | If thy use the formula | Decision bout base price | |
| | | | | Index Assumption | |
| | | | | Weightage assumptions | |
| | | | | Data source for base price | |
| | | | Other | | |
| | | Condition must be met before the price escalation clause can be active | | | |
| | | Most triggered items for price adjustment | The whole item | | |
| | | | Specific item (list) | | |
| 2.2 | Other cost provisions availability | Change in legislation (change in government regulation or taxes) | | | |
| | | Currency fluctuation | | | |
| | | Unforeseen condition | | | |
| | | Foreseen events | | | |
| | | Amendment | | | |
| 3 | **Forecasting on the increment of price in the inputs** | | | | |
| 3.1 | How the contractor forecast the future risks related with price | Data Base Availability: | | | |
| | | Nature of existence of database: | | | |
| | | Pricing/forecasting techniques: | | | |
| | | List of items for forecasting: | | The whole item | |
| | | | | Specific item (list) | |

| | | | |
|---|---|---|---|
| 3.2 | Trend analysis | Benchmark for trend analysis: | |
| | | Type: | |
| | | Method/tools: | |
| | | Effectiveness to identify potential risks related with price increment | |
| Bulk Material purchase | | | |
| | Material type: | Whole materials: | |
| | | Items: | |
| Buyer-supplier | Contract availability: | | |

**Assessing the extent of price escalation**

| No | Item of work | | Quantity per month | Contract Unit price | Contract Amount | Current unit price | Curent Amount | Rise in % |
|---|---|---|---|---|---|---|---|---|
| **Sub-Structure/ Super-structure** | | | | | | | | |
| 1 | Lean | | | | | | | |
| 2 | Concrete | | | | | | | |
| 3 | Formwork | | | | | | | |
| 4 | Rebar | | | | | | | |