

STRATEGIC MITIGATION OF COST OVERRUNS IN ROAD CONSTRUCTION: AN INTEGRATED  
AHP-DEMATEL FRAMEWORK FOR ARSI ZONE, ETHIOPIA



GIRMA GELETA

A THESIS SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING, COLLEGE OF CIVIL  
ENGINEERING AND ARCHITECTURE OF ADAMA SCIENCE AND TECHNOLOGY  
UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF  
MASTER OF SCIENCE IN CONSTRUCTION ENGINEERING AND MANAGEMENT

OFFICE OF GRADUATE STUDIES  
ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY  
COLLEGE OF CIVIL ENGINEERING AND ARCHITECTURE  
DEPARTMENT OF CIVIL ENGINEERING

FEBRUARY 2026

ADAMA, ETHIOPIA

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Strategic Mitigation of Cost Overruns in Road Construction: An Integrated AHP-  
DEMATEL Framework for Arsi Zone, Ethiopia



Girma Geleta

Advisor: Meseret Getnet (PhD)

A Thesis Submitted to the Department of Civil Engineering, College of Civil  
Engineering and Architecture of Adama Science and Technology University in  
Partial Fulfillment of the Requirements for the Degree of Master of Science in  
Construction Engineering and Management

Office of Graduate Studies  
Adama Science and Technology University  
College of Civil Engineering and Architecture  
Department of Civil Engineering

February 2026

Adama, Ethiopia

## DECLARATION

I, Girma Geleta, declare that this thesis entitled “**Strategic Mitigation of Cost Overruns in Road Construction: An Integrated AHP-DEMATEL Framework for Arsi Zone, Ethiopia**” is my own work and has not been submitted to any university for similar purpose. The references used in this thesis are duly recognized by proper citations.

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Name of student

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Date

## RECOMMENDATION OF ADVISORS/ SUPERVISORS

I, **Meseret Getnet (PhD)**, the major advisor of this thesis, hereby certify that I have closely supervised the student, **Girma Geleta**, during the preparation of this thesis entitled “**Strategic Mitigation of Cost Overruns in Road Construction: An Integrated AHP-DEMATEL Framework for Arsi Zone, Ethiopia.**”

I confirm that the candidate has successfully defended the thesis and has incorporated the comments and suggestions offered by the Board of Examiners during the final defense. Therefore, I recommend the acceptance of this thesis by the department in partial fulfillment of the requirements for the Degree of Master of Science in Construction Engineering and Management.

Meseret Getnet (PhD)

Major Advisor/Supervisor

Signature

Date

## APPROVAL BOARD OF EXAMINERS

We, the undersigned, members of the Board of Examiners, have read and evaluated the thesis entitled “**Strategic Mitigation of Cost Overruns in Road Construction: An Integrated AHP-DEMATEL Framework for Arsi Zone, Ethiopia**” prepared by **Girma Geleta**. We have examined the candidate during the open defense and assessed their understanding of the thesis.

This is, therefore, to certify that the thesis is accepted, and we recommend the granting of the Degree of Master of Science in Construction Engineering and Management. Finally, approval and acceptance of the thesis is contingent upon the submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

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## **ABSTRACT**

*Cost overruns are a chronic and pervasive challenge in the global construction industry, posing a significant threat to the successful delivery of critical infrastructure, particularly in developing nations like Ethiopia. Existing research often identifies numerous contributing factors but frequently fails to analyze their complex interrelationships, limiting the development of effective, context-specific mitigation strategies. This thesis aims to address this gap by developing and validating a data-driven strategic framework for mitigating cost overruns in road construction projects within the Arsi Zone. The study employs an integrated Analytic Hierarchy Process (AHP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach. Data was collected through structured surveys with a purposively selected panel of 12 experienced industry experts representing clients, contractors, and consultants. The analysis was conducted using MS Excel for data organization and Python programming for the core AHP and DEMATEL computations. The AHP results identified Ineffective Right-of-Way Management as the single most critical factor, with a global importance weight of 29.28%, highlighting its status as a systemic bottleneck. The DEMATEL analysis further uncovered the underlying causal architecture, distinguishing foundational drivers, such as Political Instability and Interference and Weak Capacity of Local Firms, from their highly visible but largely symptomatic effects, like Financial Difficulties of Contractor. The novelty of this study lies in the integrated analysis, which reveals a critical strategic paradox: foundational drivers perceived as having low importance by stakeholders are, in fact, the most influential root causes. This disconnect explains the industry's tendency toward reactive firefighting of symptoms rather than proactively addressing root causes. The final validated framework translates these findings into actionable recommendations for key beneficiaries, including the Ethiopian Roads Authority, contractors, and supervising consultants, providing a clear roadmap to shift from a reactive to a proactive, cause-driven management paradigm. The primary conclusion is that effective cost overrun mitigation requires prioritizing interventions that target these foundational drivers to achieve sustainable and long-term improvements in project cost performance.*

*Keywords: AHP-DEMATEL, Causal Analysis, Cost Overruns, Road Construction, Strategic Mitigation*

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## LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation/Acronym	Full Description
AHP	Analytic Hierarchy Process
ANP	Analytic Network Process
BIM	Building Information Modeling
CI	Consistency Index
COQ	Cost of Quality
CR	Consistency Ratio
CSFs	Critical Success Factors
DEMATEL	Decision-Making Trial and Evaluation Laboratory
DGC	Department Graduate Council
DLP	Defects Liability Period
ERA	Ethiopian Roads Authority (or Administration)
EVM	Earned Value Method
GDP	Gross Domestic Product
ISM	Interpretive Structural Modeling
IoT	Internet of Things

KPI	Key Performance Indicator
M&E	Monitoring and Evaluation
MCDM	Multi-Criteria Decision-Making
MICMAC	Cross-Impact Matrix Multiplication Applied to Classification
OPGS	Office of Postgraduate Studies
PMIS	Project Management Information Systems
RBV	Resource-Based View
RI	Random Index
RMC	Ready-Mix Concrete
RoW	Right-of-Way
SDGs	Sustainable Development Goals
SEM	Structural Equation Modeling
SGC	School Graduate Committee
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
VIKOR	VlseKriterijumska Optimizacija I Kompromisno Resenje

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

The construction industry is widely recognized as a foundational pillar of the global economy, playing an essential role in ensuring economic stability, fostering growth, and enabling the development of essential physical infrastructure worldwide (Abdelalim et al., 2025; Gabriel et al., 2024; Sivilevicius et al., 2024). This sector's expansive reach is evidenced by a global output valued at \$9.7 trillion in 2022, with projections indicating a rise to \$13.9 trillion by 2037 (Abdelalim et al., 2025). Beyond its significant economic size, the construction industry is crucial for job creation, attracting significant investments, and supporting long-term national development, making substantial contributions to a nation's Gross Domestic Product (GDP) and serving as a cornerstone for social, economic, and environmental sustainability (Abdelalim et al., 2025; Gabriel et al., 2024; Mokoena et al., n.d.; Sivilevicius et al., 2024).

Despite its pivotal role and continuous advancements in technology and management practices, the construction industry is persistently plagued by the problem of cost overruns (Abdelalim et al., 2024; Afana et al., 2024; Ammar et al., 2022; Durdyev, 2021; Mokoena, 2022; Shah et al., 2023). This phenomenon, where actual project expenditures exceed initial budgetary estimates, is a common and significant challenge worldwide, with average cost overruns reported to be about 28% over the past 70 years, and individual project overruns ranging from 12% to 70% of the contract value (Afana et al., 2024). Such financial deviations frequently lead to substantial financial difficulty, compromise overall project success, foster stakeholder disagreements, and can even result in project abandonment due to their negative financial implications (Abdelalim et al., 2024; Afana et al., 2024; Gabriel et al., 2024; Shah et al., 2023). This challenge is particularly acute in developing countries, where cost overruns are a major issue and can sometimes exceed 100% of the anticipated project cost, making it crucial to understand their root causes for effective mitigation (Afana et al., 2024; Ammar et al., 2022; Durdyev, 2021).

Road construction projects, in particular, are integral to a country's national competitiveness and socio-economic advancement, typically necessitating considerable economic investments (Ammar et al., 2022; Andric et al., 2024; Ben, 2019; Lee & Kim, 2021; Lee, 2024; Sivilevicius et al., 2024).

However, these projects are highly susceptible to a multitude of risks that frequently culminate in significant cost overruns and schedule delays (Lee & Kim, 2021; Lee, 2024; Sivilevicius et al., 2024). Empirical studies from various regions consistently highlight these financial discrepancies; for instance, road projects have demonstrated average cost deviations of 14.6% in Palestine, 16.3% in Australia, 18.6% in Dutch transport infrastructure projects (Herrera et al., 2020), and 3.3% in South Asian infrastructure projects (Andric et al., 2024). Frequently identified factors contributing to cost overruns in road infrastructure projects include failures in design, price variation of materials, inadequate project planning, project scope changes, and design changes (Herrera et al., 2020). Additionally, poor communication, project cost and schedule constraints, and inadequate monitoring and evaluation are recognized as significant barriers to project success, particularly in developing economies (Al-Otaibi et al., 2025; Xegwana et al., 2024).

In Ethiopia, the construction industry is recognized as a critical catalyst for the nation's political, economic, social, and technological development, with a substantial portion, approximately 50%, of the federal capital budget allocated to physical infrastructure (Mengistu & Mahesh, 2020). Despite its profound importance, the Ethiopian construction sector, particularly its road projects, has been consistently plagued by severe performance issues, marked by a high prevalence of both cost overruns and delays (Belachew et al., 2017; Kassa, 2020; Kidane, 2021; Mengistu & Mahesh, 2020; Tadewos & Patel, 2018). Academic research indicates that as many as 80% of construction projects in Ethiopia experience cost overruns, and over 80% are subjected to delays and budget overruns (Belachew et al., 2017; Kassa, 2020). The average deviation in planned costs for projects in Ethiopia has been reported to range between 21-40% (Ayalew et al., 2016). Historical data specifically for road projects in Ethiopia underscores a troubling trend: virtually none have been completed within their planned timelines or estimated budgets, frequently becoming "victims" of these persistent challenges (Kassa, 2020; Kidane, 2021; Tadewos & Patel, 2018). Identified factors contributing to these challenges in Ethiopian road construction include inflation of material costs, scope changes, incomplete initial studies, poor specifications, inadequate project performance monitoring (Kassa, 2020), rising building material costs (Bedada, 2023; Borku & Yeniale, 2022), ineffective planning and site management (Darsa & Negash, 2023), late land acquisition, delay or non-payment of completed works, cash-flow problems (Darsa & Negash, 2023), and difficulty in budget availability (Kidane, 2021). Furthermore, issues such as inadequate review of drawings and contract documents, and variation orders, have also been highlighted (Belachew et al., 2017).

While extensive research has identified numerous factors contributing to cost overruns in construction projects globally and within Ethiopia, there remains a notable gap in comprehensive, integrated, and context-specific strategic analysis (Abdelalim et al., 2024; Afana et al., 2024; Durdyev, 2021; Herrera et al., 2020; Mejía et al., 2020). Many existing studies enumerate factors but often lack a unified framework for classifying them, analyzing their intricate causal interrelationships, or prioritizing them based on both importance and influence to develop actionable mitigation strategies, especially tailored for specific regions (Afana et al., 2024; Durdyev, 2021; Herrera et al., 2020). This absence of an integrated approach hinders the ability to transcend mere identification of problems, impeding a deeper understanding of the underlying dynamics of cost overruns and the formulation of truly effective, targeted interventions (Abdelalim et al., 2024).

Furthermore, much of the existing literature often focuses narrowly on particular aspects without comprehensively considering broader contexts such as diverse stakeholder perspectives or specific project lifecycle phases, and typically relies on traditional statistical methods without exploring more advanced techniques capable of modeling complex, non-linear relationships and interrelationships (Afana et al., 2024; Andric et al., 2024; Durdyev, 2021; Rivera et al., 2020; Sinesilassie et al., 2018). Given that the specific factors and their levels of importance vary significantly across different project environments and types (Afana et al., 2024; Herrera et al., 2020; Mejía et al., 2020; Winanda et al., 2024), the necessity for context-specific analysis, particularly for road construction projects in regions like the Arsi Zone of Ethiopia, where project performance is particularly challenging, is paramount. Therefore, a systematic and integrated approach is critically needed to identify, prioritize, and meticulously analyze the causal interrelationships among these hindering factors, thereby developing a practical and impactful strategic framework for effective mitigation and enhancing the cost performance of road construction projects in the specified region.

## **1.2 Statement of the Problem**

In Ethiopia, the construction industry plays a crucial role in the nation's political, economic, social, and technological development, with approximately 50% of the federal capital budget directed towards physical infrastructure (Ahady et al., 2017; Ayalew et al., 2016; Mengistu & Mahesh, 2020). Despite its importance, the Ethiopian construction sector, particularly its road projects, has

consistently faced severe performance issues, with a high prevalence of cost overruns and delays (Ahady et al., 2017; Ayalew et al., 2016; Belachew et al., 2017; Kassa, 2020; Kidane, 2021; Mengistu & Mahesh, 2020; Tadewos & Patel, 2018). Academic studies indicate that as many as 80% of construction projects in Ethiopia experience cost overruns, and over 80% are subjected to delays and budget overruns (Ahady et al., 2017; Belachew et al., 2017; Kassa, 2020). The average deviation in planned costs for projects in Ethiopia has been reported to range between 21-40% (Ayalew et al., 2016).

Historical data specifically for road projects in Ethiopia highlight that virtually none have been completed within their planned timelines or estimated budgets, making them "victims" of these persistent issues (Kidane, 2021; Tadewos & Patel, 2018; Kassa, 2020). Key factors contributing to these challenges in Ethiopian road construction include inflation of material costs, scope changes, incomplete initial studies, poor specifications, inadequate project performance monitoring (Kassa, 2020), rising building material costs (Bedada, 2023; Borku & Yeniale, 2022), and ineffective planning and site management (Darsa & Negash, 2023). These challenges are multifaceted, encompassing issues related to government roles, resource availability, industry characteristics, and the sector's developmental vision (Mengistu & Mahesh, 2020).

Furthermore, much of the existing literature often focuses narrowly on particular aspects without comprehensively considering broader contexts such as diverse stakeholder perspectives or specific project lifecycle phases, and typically relies on traditional statistical methods without exploring more advanced techniques capable of modeling complex, non-linear relationships and interrelationships (Afana et al., 2024; Andric et al., 2024; Durdyev, 2021; Rivera et al., 2020; Sinesilassie et al., 2018). Given that the specific factors and their levels of importance vary significantly across different project environments and types (Afana et al., 2024; Herrera et al., 2020; Mejía et al., 2020; Winanda et al., 2024), the necessity for context-specific analysis is paramount. The Arsi Zone was specifically selected for this study because it serves as a vital agricultural and economic corridor for the region, yet it faces unique logistical and administrative hurdles. Road projects in this zone, such as the Iteya-Roble road, have frequently suffered from budget escalations due to distinct regional reasons like difficult terrain and right-of-way disputes. Therefore, a systematic and integrated approach is critically needed to identify, prioritize, and carefully analyze the causal interrelationships among these hindering factors, thereby developing

a practical and impactful strategic framework for effective mitigation and enhancing the cost performance of road construction projects in the specified region.

Therefore, there is a critical need to systematically identify, prioritize, and analyze the causal interrelationships among these hindering factors to develop a practical and impactful strategic framework for effective mitigation, thereby improving the cost performance of road construction projects in the region.

### **1.3 Research Questions**

This study seeks to answer the following primary research questions:

- How do industry stakeholders prioritize these hindering factors in terms of their relative importance and impact on the project budget?
- What is the underlying cause-and-effect relationships among these factors, and which serve as foundational drivers versus dependent symptoms?
- How can the factors be classified into a strategic matrix by synthesizing their perceived importance with their causal influence?
- What constitutes an actionable and expert-validated strategic framework for effectively mitigating cost overruns in the Arsi Zone?

### **1.4 Objective of the Study**

#### **1.4.1 General Objective**

The primary objective of this study is to develop and validate a strategic framework for mitigating cost overruns in road construction projects in the Arsi Zone by identifying critical hindering factors, analyzing their relative importance and causal interrelationships, and synthesizing these insights into an actionable mitigation strategy.

#### **1.4.2 Specific Objectives**

The specific objectives designed to answer the research questions are:

- To quantify the relative importance of these factors as perceived by industry stakeholders to establish a priority ranking.

- To model the interrelationships among the factors to distinguish between causal drivers (root causes) and dependent effects (symptoms).
- To integrate the importance rankings and causal influence results into a strategic prioritization matrix to guide decision-making.
- To develop and validate a strategic framework for mitigating cost performance hindering factors based on the integrated analysis.

## **1.5 Significance of the Study**

The significance of this research is threefold, encompassing theoretical, practical, and contextual contributions to the field of construction engineering and management. Theoretically, this study advances the application of integrated Multi-Criteria Decision-Making (MCDM) methodologies by demonstrating the synergistic power of the AHP-DEMATEL approach in dissecting a complex, real-world problem. By moving beyond a simple hierarchical ranking of factors to reveal their underlying causal architecture, the research provides a more nuanced and structurally accurate model for analyzing systemic issues in project management, thereby addressing a noted limitation in studies that rely on single analytical methods.

Practically, the primary contribution of this thesis is the development of an expert-validated, actionable strategic framework. This framework translates complex analytical data into a clear roadmap for stakeholders, enabling them to shift from a reactive, symptom-focused management style to a proactive, cause-driven strategy. By distinguishing between high-impact root causes, visible symptoms, and foundational weaknesses, the framework provides a pragmatic tool for policymakers, project managers, and contractors to allocate limited resources more effectively, prioritize interventions, and ultimately improve the cost performance of critical infrastructure projects.

Contextually, this research addresses a significant and persistent challenge within a vital sector of the Ethiopian economy. By providing an in-depth, empirical analysis specific to the Arsi Zone, the study generates contextually relevant insights that are more actionable for local stakeholders than generalized national or international findings, offering a tangible path toward mitigating the severe cost overruns that impede regional development.

These multifaceted challenges underscore the urgent need for effective interventions within the Ethiopian road construction sector. Therefore, the findings of this study hold significant value for various beneficiaries. For government policymakers and the Ethiopian Roads Authority, the study offers data-driven insights to improve regulatory frameworks and contract management. For contractors and consultants, it provides a roadmap for better risk management and resource allocation. Furthermore, this research contributes to the academic community by filling the gap in context-specific literature, ultimately supporting the broader society through the delivery of more cost-efficient infrastructure that drives economic benefits.

## **1.6 Scope of the Study**

This study is carefully bounded to ensure depth and focus. The geographical scope of the research is exclusively delimited to road construction projects located within the Arsi Zone of the Oromia Region, Ethiopia. This case study approach allows for a detailed investigation of the specific administrative, economic, and operational challenges pertinent to this region. The thematic scope is centered on identifying, prioritizing, and analyzing the interrelationships among factors that hinder cost performance. While issues of time delay, quality, and safety are acknowledged as interconnected, the primary focus of this analysis remains on the variables directly impacting cost overruns.

Methodologically, the scope is defined by the application of an integrated AHP-DEMATEL model. The research, therefore, relies on the structured elicitation of expert judgments from a purposive sample of key industry stakeholders, including clients, contractors, and consultants, involved in the region's road construction sector, rather than on the analysis of quantitative financial data from specific project records. The factors analyzed are confined to those identified through a comprehensive literature review and validated by a panel of senior industry experts, ensuring their relevance to the study's context.

## **1.7 Limitations of the Study**

While this research was conducted with academic rigor, it is important to acknowledge its inherent limitations. A primary limitation relates to the geographical specificity of the case study. The findings and the resulting strategic framework are empirically grounded in the context of the Arsi Zone, Ethiopia. Consequently, the direct generalizability of these specific priorities and causal

relationships to other regions within Ethiopia or to other developing countries may be limited without further comparative research and validation. Secondly, a methodological limitation inheres in the nature of the AHP-DEMATEL approach, which is fundamentally based on the subjective judgments of a select group of experts.

Although measures were taken to ensure the expertise and diverse representation of the participants, the findings reflect their collective perceptions, and a different panel of experts could potentially yield variant results. Furthermore, the model provides a static snapshot of the causal relationships between factors at a specific point in time and does not capture their dynamic behavior or feedback loops over the entire project lifecycle. The study identifies and structures causal links but does not quantify the magnitude of their financial impact, which would require a different methodological approach such as econometric or simulation modeling. Finally, while the study's use of multiple stakeholder groups helps triangulate perspectives, the potential for respondent bias, influenced by organizational roles and experiences, cannot be entirely eliminated.

## **1.8 Structure of the Paper**

This thesis is organized into five distinct chapters to logically present the research from its conception to its conclusions. Chapter One serves as the introduction, establishing the context and background of cost performance issues in road construction, particularly in Ethiopia. It articulates the statement of the problem, defines the research questions and objectives, and outlines the significance, scope, and limitations of the study.

Chapter Two presents a comprehensive literature review, building the theoretical and empirical foundation for the research. This chapter critically examines existing knowledge on cost overrun factors, the specific challenges in the Ethiopian construction sector, and the theoretical underpinnings of Multi-Criteria Decision-Making methods, culminating in the identification of the specific research gaps this thesis aims to fill. Chapter Three details the research methodology, providing a systematic account of the integrated AHP-DEMATEL approach employed. It describes the research design, the process of data collection through expert surveys, the step-by-step procedures for data analysis, and the methods used for validating the final strategic framework.

Chapter Four presents the results and discussion of the analysis. It details the findings from the AHP and DEMATEL models, synthesizes them into the strategic prioritization matrix, and

interprets these results in the context of existing literature and the study's specific setting. This chapter culminates in the development and expert validation of the final strategic mitigation framework. Finally, Chapter Five provides the conclusions and recommendations, summarizing the key findings, translating them into actionable recommendations for various stakeholders, and suggesting promising directions for future research.

## CHAPTER TWO

### LITERATURE REVIEW

#### **2.1 Introduction**

To develop a strategic framework for mitigating the persistent challenge of cost overruns in road construction projects, a rigorous examination of the existing scholarly literature is a prerequisite. This chapter provides a comprehensive synthesis and critical analysis of the body of knowledge relevant to cost performance in construction. The primary purpose is to explore key concepts, identify established findings, and evaluate theoretical frameworks to contextualize the research problem. By critically synthesizing prior research, this chapter identifies gaps and unresolved questions, thereby constructing a robust scholarly foundation that substantiates the research questions outlined in chapter one and justifies the selection of the integrated analytical methodology for the specific context of Arsi Zone, Ethiopia.

The literature review is structured to logically navigate from a broad understanding of the construction context to the specific analytical tools required for this study. It commences by establishing the global and local importance of road infrastructure development. Subsequently, the chapter delves into the concept of cost performance, defining key metrics and examining the pervasive challenges that lead to cost overruns. A central focus is placed on detailing specific hindering factors, synthesizing findings from both international and Ethiopian contexts. To address the analytical challenge posed by these factors, the review explores Multi-Criteria Decision-Making (MCDM) approaches, specifically the synergistic potential of integrating prioritization and causal modeling methods. Finally, the chapter culminates in a review of existing theoretical frameworks and best practices, providing a basis for developing a practical strategic mitigation framework.

#### **2.2 Road Construction Projects and their significance**

The construction industry plays a pivotal role in stimulating global economic growth and is a direct indicator of a nation's economic health (Gabriel et al., 2024; Mokoena, 2022; Sultan & Kajewski, 2003). This sector is instrumental in enhancing the competitiveness of various industries and forms a pillar for achieving social, economic, and environmental sustainability within communities worldwide (Gabriel et al., 2024; Mokoena, 2022; Sivilevicius et al., 2024).

## **2.2.1 Global and Local Importance of Road Infrastructure Development**

Road infrastructure is fundamental for a country's economic and social development (Herrera et al., 2020) and serves as a key driver for sustainable development due to its long-term impact on economic growth, societies, and the environment (Andric et al., 2024). These vital networks facilitate critical services such as the transport of people and goods, telecommunication, energy, and waste management, all of which are essential for a functioning society (Andric et al., 2024). Indeed, infrastructure contributes, directly or indirectly, to achieving a significant portion of the targets set by the Sustainable Development Goals (SDGs) (Andric et al., 2024). Developing robust road infrastructure is crucial for national competitiveness and generates substantial socio-economic ripple effects across a country (Lee & Kim, 2021; Lee, 2024). In developing economies, the construction industry, including road projects, accounts for a considerable share of the economy, contributing approximately 10% to the global Gross Domestic Product (GDP) and over 50% of employment opportunities (Mokoena, 2022). High-quality roads are vital for enabling secure and timely trade of goods and services (Mejía et al., 2020) and improve access to essential social aspects like health, education, and employment in both rural and urban areas (Mejía et al., 2020). Furthermore, road transport's ability to offer door-to-door services can transform subsistence farming into dynamic commercial systems, thereby unlocking the economic potential of rural regions (Ben, 2019).

In Ethiopia, the construction sector stands as a major contributor to the country's political, economic, social, and technological advancement (Ahady et al., 2017; Ayalew et al., 2016). Approximately half of the federal capital budget is channeled towards the development of physical infrastructure, with extensive construction activities underway across infrastructure and residential sectors nationwide (Ahady et al., 2017). Despite the significant capital investment required, road projects are crucial for job creation and generate widespread economic benefits that ripple through other business activities (Tadewos & Patel, 2018). However, similar to many developing nations, Ethiopia consistently grapples with challenges in road projects, even as its road network expands (Kidane, 2021; Tadewos & Patel, 2018). The Ethiopian construction industry faces a unique set of challenges that impede its overall development (Mengistu & Mahesh, 2020).

## **2.2.2 Overview of Road Construction Project Life Cycle and Key Stakeholders**

A construction project is fundamentally defined as a temporary endeavor with a distinct beginning and end, designed to produce a unique outcome, service, or result (Kidane, 2021; Rivera et al., 2020). Throughout its execution, effective management is essential to navigate various issues, particularly concerning cost (Winanda et al., 2024). The conclusion of a project is typically marked by the achievement of its objectives or its termination if those objectives become unattainable or are no longer necessary (Mokoena, 2022). Effective project management frameworks, characterized by clear lines of authority, are critical for successful project execution (Mokoena, 2022).

The lifecycle of a construction project, especially in road infrastructure, encompasses several critical stages. These generally include the Planning and Definition Stage, the Design Stage, and the Procurement and Construction Stage (Rivera et al., 2020). The initial Planning and Definition phase involves establishing primary project requirements and setting preliminary budgetary constraints, which then serve as the foundation for the subsequent Design stage (Rivera et al., 2020). Cost overruns, a persistent challenge, can affect projects across their entire lifecycle, from initiation through execution, operation, and maintenance phases (Afana et al., 2024). Literature often highlights the "Construction Phase" and "Pre-Construction Phase" as particularly impactful on cost management (Afana et al., 2024). Moreover, the planning and implementation stages are identified as having a significant influence on cost escalation within a project (Winanda et al., 2024).

Key stakeholders are integral to construction projects, including clients, designers, contractors, subcontractors, specialists, construction managers, and consultants, who are typically involved from the project's inception to its completion (Sinesilassie et al., 2018). Each stakeholder group may hold a unique perspective on project success (Sinesilassie et al., 2018). Studies frequently identify contractors, consultants (including project managers, designers, and engineers), and clients as the most commonly mentioned stakeholder groups, alongside governmental authorities, suppliers, decision-makers, planners, and bankers (Afana et al., 2024). Effective coordination among these parties is crucial, as poor communication can emerge as a significant barrier to project efficiency (Al-Otaibi et al., 2025). Insights into managing and preventing cost overruns are invaluable for project managers, construction professionals, and all other stakeholders (Shah et al.,

2023). The capabilities of the owner and the competence of project managers are emphasized as vital for project success (Lee & Kim, 2021). In the context of road projects, implementers often include both government entities and contractors (Rivera et al., 2020), with local administrations and utility providers also playing a key role, particularly in right-of-way management (Kidane, 2021).

## **2.3 Cost Performance in Construction Projects**

The successful execution of construction projects hinges significantly on their cost performance, a critical metric that gauges the alignment between planned budgets and actual expenditures (Gabriel et al., 2024; Mokoena, 2022). Cost performance is often viewed as a key determinant of project success, alongside time and quality, forming what is widely recognized as the "iron triangle" of project management (Ayalew et al., 2016; Sinesilassie et al., 2018; Mokoena, 2022). However, achieving optimal cost performance remains a persistent challenge globally, as evidenced by a substantial body of research (Abdelalim et al., 2024; Afana et al., 2024; Abdel-Monem et al., 2022).

### **2.3.1 Definition and Measurement of Cost Performance in Projects**

The term "cost overrun", also known as "cost escalation" or a "budget overrun," fundamentally refers to a situation where a project's actual expenses surpass its initial budget or estimated costs (Abdelalim et al., 2024; Afana et al., 2024). This can be defined as an increase in project costs that stakeholders did not anticipate, or more precisely, the amount by which actual costs exceed estimates using consistent baseline measures (Abdelalim et al., 2024). It can also represent the difference between the final actual cost and the contract amount initially agreed upon (Abdelalim et al., 2024). Studies consistently reveal the significant scale of this issue, with up to 90% of construction projects reportedly suffering cost overruns, ranging from 5% to 200% of the original estimated cost (Abdel-Monem et al., 2022). Similarly, 85% of construction projects globally have been found to exceed their budgets, with overruns frequently ranging from 12% to 70% of the contract value (Abdelalim et al., 2024; Afana et al., 2024).

Measuring cost performance effectively is crucial for understanding project economic viability and providing feedback for future endeavors (Gabriel et al., 2024; Lee & Kim, 2021; Lee, 2024). One widely utilized method for this is the Cost Performance Index (CPI), derived from the Earned

Value Method (EVM) (Winanda et al., 2024). The CPI evaluates cost efficiency by comparing the value of physically completed work against the costs incurred within the same period (Winanda et al., 2024). A CPI value less than one indicates a cost overrun, meaning expenses are higher than budgeted; a value of one signifies that the project is on budget; and a value greater than one denotes a cost underrun or savings (Winanda et al., 2024). Despite the widespread recognition of cost overruns, existing research highlights a lack of consistent and unified classification frameworks for the contributing factors, making comprehensive analysis and the development of effective mitigation strategies challenging (Afana et al., 2024). For instance, one review identified 4,424 distinct cost overrun factors categorized across 628 different systems, underscoring this classification inconsistency (Afana et al., 2024). Various analytical tools, including neural networks, Delphi techniques, and fuzzy logic systems, have been employed to improve cost prediction and management accuracy (Afana et al., 2024).

### **2.3.2 Issues and Challenges Leading to Cost Overruns in Construction**

Cost overruns are a pervasive problem across the global construction industry, with few projects being completed within their initial estimated costs (Abdel-Monem et al., 2022; Ammar et al., 2022). The root causes of these overruns are multifaceted, impacting projects throughout their entire lifecycle, from the initial planning and definition stages through design, procurement, construction, operation, and maintenance (Afana et al., 2024; Winanda et al., 2024). Key phases such as "Construction Phase" and "Pre-Construction Phase" are particularly noted for their significant influence on cost management (Afana et al., 2024).

A multitude of factors are commonly identified as contributors to cost overruns in the construction industry. A primary and consistently highlighted issue is inaccurate cost estimation, which often originates from inadequate initial assessments and results in the underestimation of costs before the tendering process (Abdelalim et al., 2024; Afana et al., 2024; Ammar et al., 2022; Durdyev, 2021; Mokoena, 2022). Closely related to this are deficiencies in planning and scheduling; insufficient or poor planning is recognized as a major contributor that significantly influences cost escalation throughout the project lifecycle (Abdelalim et al., 2024; Durdyev, 2021; Herrera et al., 2020; Mokoena, 2022; Winanda et al., 2024).

Furthermore, issues related to project design and scope are highly influential. Failures in design, inefficiencies, and frequent modifications are significant drivers of increased costs (Abdelalim et

al., 2024; Ammar et al., 2022; Durdyev, 2021; Herrera et al., 2020; Mokoena, 2022). Similarly, alterations to or a poor definition of the project scope frequently lead to budget exceedances, which in turn necessitate adjustments to other critical project elements such as time and quality (Abdelalim et al., 2024; Ammar et al., 2022; Durdyev, 2021; Herrera et al., 2020; Mokoena, 2022).

External and logistical factors also play a crucial role. Price fluctuations, particularly in construction materials, and general inflation are significant external pressures that impact project budgets, especially for projects of long duration (Ammar et al., 2022; Durdyev, 2021; Herrera et al., 2020; Mokoena, 2022; Winanda et al., 2024). Financial problems, including insufficient resources, poor financial management, and payment delays to contractors, can severely compromise cost performance (Durdyev, 2021; Mejía et al., 2020; Mokoena, 2022). Moreover, unforeseeable site conditions, such as unexpected ground or terrain issues, are a frequent source of additional costs, underscoring the necessity of thorough preliminary site investigations (Abdelalim et al., 2024; Durdyev, 2021; Mokoena, 2022).

Finally, managerial and human factors are integral to cost control. Ineffective communication among stakeholders and a lack of coordination between different parties on the project are significant barriers to efficiency that can precipitate cost overruns (Al-Otaibi et al., 2025; Durdyev, 2021; Winanda et al., 2024). Contractual issues, such as ambiguities, discrepancies, or mismanagement of terms, also contribute to cost escalation (Abdelalim et al., 2024; Durdyev, 2021; Mejía et al., 2020). Compounding these challenges are issues related to personnel, including a lack of experience among construction managers, shortages of skilled labor, and generally poor project management practices, all of which can lead to inefficiencies and rework that directly inflate costs (Abdelalim et al., 2024; Al-Otaibi et al., 2025; Gabriel et al., 2024; Mokoena, 2022; Rivera et al., 2020).

The involvement and perspectives of various key stakeholders are integral to understanding cost performance issues. Clients, designers, contractors, subcontractors, and consultants are typically involved from inception to completion, and each group may hold unique views on project success (Sinesilassie et al., 2018; Afana et al., 2024). The capabilities of the owner and the competence of project managers are consistently highlighted as vital for project success (Lee & Kim, 2021).

### **2.3.3 Cost Performance Trends and Challenges in Developing Countries**

Cost overruns are a global phenomenon, but they present particular difficulties and are often more severe in developing countries (Mokoena, 2022; Ayalew et al., 2016; Sinesilassie et al., 2018). These nations frequently contend with unique challenges, including political and economic instability, chronic resource shortages, institutional weaknesses, and a general inability to directly address systemic issues (Abdelalim et al., 2024; Mokoena, 2022). In some instances, cost overruns in developing countries can exceed 100% of the anticipated project cost (Ayalew et al., 2016; Sinesilassie et al., 2018). Research focusing on African and Asian regions indicates variations in prevalent cost overrun factors, with financial issues often associated with project owners or contractors, and external influences or planning issues also playing a significant role (Mejía et al., 2020). The development of robust road infrastructure is particularly critical in developing economies, as it holds the potential to transform subsistence farming into dynamic commercial systems, thereby unlocking the economic potential of rural areas (Ben, 2019).

In Ethiopia, the construction sector is acknowledged as a major contributor to the country's political, economic, social, and technological advancement, with a significant portion of the federal capital budget allocated to physical infrastructure development (Ahady et al., 2017; Ayalew et al., 2016). Despite this crucial role and extensive investments, Ethiopia, much like many developing nations, consistently faces substantial challenges in its road construction projects, often leading to poor performance (Kidane, 2021; Tadewos & Patel, 2018; Mengistu & Mahesh, 2020). Studies indicate that a high proportion of construction projects in Ethiopia, including road projects, experience cost overruns and delays, with some reports suggesting that over 80% of projects run over budget (Ahady et al., 2017; Belachew et al., 2017; Tadewos & Patel, 2018; Kassa, 2020). The average deviation from planned costs can range between 21% and 40% (Ayalew et al., 2016).

Ethiopian road construction projects commonly face a multitude of specific challenges. One of the most significant issues is the rising cost of building materials and general inflation, which substantially affects construction costs (Bedada, 2023; Borku & Yeniale, 2022). In addition to economic pressures, projects are often hampered by inadequate planning and design issues, such as delayed designs, unclear or insufficient details and specifications, and a lack of diligent work efforts (Kassa, 2020).

Resource shortages present another major hurdle, encompassing a lack of skilled and unskilled labor, as well as insufficient equipment and materials. These shortages are further exacerbated by the inefficient use of time and unproductive labor (Kassa, 2020). Financial difficulties also play a critical role, with delays in debt collection from clients and a heavy dependence on bank loans contributing to project failures (Bedada, 2023). Furthermore, poor communication has been identified as a substantial problem that negatively impacts the efficiency of these projects (Darsa & Negash, 2023).

Issues related to right-of-way management, including challenges with land acquisition, adversely affect project performance and cost-effectiveness (Kidane, 2021). Finally, the road construction industry's high susceptibility to political and economic cycles is a recurring factor that contributes to project failures (Bedada, 2023).

Furthermore, accessing well-organized and easily accessible historical data on cost overruns for road projects in Ethiopia has been noted as challenging, as such information is often not publicly disclosed (Kassa, 2020). This limited data transparency hinders comprehensive analysis and the development of empirically informed mitigation strategies. Therefore, addressing these multifarious, interconnected factors is crucial for developing a strategic framework to mitigate cost performance hindering factors in road construction projects in Ethiopia.

## **2.4 Factors Hindering Cost Performance in Road Projects**

Cost overruns are a persistent and significant challenge that widely impacts the success of construction projects globally, with studies indicating that up to 90% of projects experience cost overruns, ranging from 5% to 200% above the initial estimated cost (Abdel-Monem et al., 2022). This issue is particularly pronounced in developing economies, where inefficiencies in project execution, alongside financial limitations, hinder economic growth and sustainable development (Al-Otaibi et al., 2025). Despite decades of research into cost overrun causes, the problem remains prevalent, with some studies finding that as many as 85% of construction projects exceed their budgets (Abdelalim et al., 2024). The complexities of these projects, often involving substantial financial investments, make them highly susceptible to various risks, including political, economic, and social factors (Lee & Kim, 2021). Therefore, a thorough understanding of the multifaceted factors contributing to cost overruns is crucial for enhancing cost management practices and achieving project success.

Previous research has attempted to classify these hindering factors to provide a structured understanding, though a fully unified classification system remains elusive (Afana et al., 2024). Different categorization frameworks have emerged from various studies, highlighting the complexity and diverse perspectives on cost overruns. For instance, some studies group factors into broad categories such as design and contract-related, estimation-related, planning and schedule-related, project management-related, labor-related, financial-related, material and machinery-related, construction phase-related, communication-related, and external factors (Albtoush & Doh, 2019). Other comprehensive categorizations identify ten key areas: Execution, Resource, and Project Management Factors; Design Factors; Contractor Factors; Consultant Factors; Client Factors; Financial Management Factors; Bidding and Cost Estimation Factors; Contracts, Legal, and Regulatory Factors; External Risks, Technology, and Sustainability Factors; and DLP Operations and Maintenance Factors (Afana et al., 2024). Another approach categorized factors into 14 groups including contract, contractor, contractual relationships, design, equipment, external factors, financial, laws and regulations, materials, owner, personal, programming and control, project, and site (Herrera et al., 2020). This variety underscores the interconnected nature of these factors, which can influence project outcomes across various dimensions and stages (Abdelalim et al., 2024).

A detailed review of specific factors commonly identified in previous research reveals several critical areas contributing to cost overruns. Inaccurate cost estimation is frequently cited as a primary cause (Ammar et al., 2022), often stemming from poor tender documentation, a lack of practical knowledge among estimators, and insufficient time allocated for the estimation process (Durdyev, 2021). Closely related are design problems and inefficiencies, which include design modifications and failures. These are considered top causes (Durdyev, 2021), appearing as "failures in design" and "design changes" among the most important and frequent factors in road projects (Herrera et al., 2020). Such issues may be mitigated through advanced approaches like Building Information Modeling (BIM) and Lean construction (Herrera et al., 2020).

Poor planning and inadequate scheduling represent another significant cluster of factors. They are consistently recognized as top contributors to cost overruns (Durdyev, 2021; Abdelalim et al., 2024) and are identified among the five most influential factors in road construction projects (Herrera et al., 2020). Poor planning can directly lead to project delays and substandard cost performance (Durdyev, 2021). Price fluctuations of materials and general inflation are widely

acknowledged as major problems, particularly in developing countries, leading to significant cost overruns (Ahady et al., 2017; Ammar et al., 2022; Oluwajana et al., 2021; Oluwajana et al., 2022). The long duration of infrastructure projects exacerbates the impact of fluctuating material, equipment, and labor costs (Andric et al., 2024).

Project scope changes are also a frequently cited cause of cost overruns (Ammar et al., 2022; Durdyev, 2021), listed among the top five influential factors in road projects (Herrera et al., 2020.pdf, 275, 286). These changes, if not carefully managed, can lead to substantial increases in project costs (Sinesilassie et al., 2018). Poor site management and supervision, along with insufficient human resources or lack of skilled labor, contribute to project inefficiencies and increased costs (Ahady et al., 2017; Mokoena, 2022; Kassa, 2020; Gabriel et al., 2024).

Financial difficulties of various stakeholders, including owners and contractors, are a prominent cause (Durdyev, 2021). Studies indicate that owner financial issues are particularly prevalent in African countries as a source of delays (Mejía et al., 2020). Contractual issues and ambiguities, such as unrealistic contract durations and poor contract management, are consistently identified as significant hindering factors (Durdyev, 2021; Abdelalim et al., 2024; Herrera et al., 2020).

External factors, including political instability, adverse weather conditions, and legal issues, pose considerable challenges beyond the direct control of project teams (Ammar et al., 2022; Abdelalim et al., 2024). These factors often require legislative changes or are tied to volatile economic and political events, making their mitigation complex (Herrera et al., 2020). Finally, poor communication among stakeholders is a critical barrier to project success, leading to misunderstandings, misaligned expectations, and potential delays (Al-Otaibi et al., 2025).

In the Ethiopian context, road construction projects consistently face severe time and cost overruns, reflecting a general "Poor" to "Moderate" performance in the construction industry (Tadewos & Patel, 2018; Ayalew et al., 2016). Approximately 80% of projects in Ethiopia experience cost overruns (Belachew et al., 2017). Key challenges include issues related to government roles, resource availability, the inherent nature of the industry, and its vision for self-development (Mengistu & Mahesh, 2020).

Specific factors hindering cost performance in Ethiopian road projects resonate with the broader international findings but often with heightened severity. Inaccurate cost estimates due to low budgeting for quantities are significant, as evidenced by case studies (Ammar et al., 2022). Design

modifications and changes, including late design, unclear details, and inadequate specifications, are consistently top causes for delays and cost increases (Ammar et al., 2022; Kassa, 2020). Political interference and an unstable economic environment are major contributors, as they complicate financial obligations and overall project stability (Ammar et al., 2022; Mahamid, 2017; Xegwana et al., 2024).

The rising cost of building materials and general inflation are critical issues directly impacting the Ethiopian construction business, leading to increased project prices (Bedada, 2023; Borku & Yeniale, 2022). Ineffective right-of-way management is identified as a significant obstacle, undermining timely completion and cost-effectiveness of Ethiopian Roads Authority (ERA) projects (Kidane, 2021). This includes challenges such as late land acquisition (Darsa & Negash, 2023). Additionally, insufficient work efforts, characterized by a shortage of skilled labor, equipment, and materials, contribute to poor project progress (Kassa, 2020). The weak capacity of local contractors and consultants further compounds these resource-related challenges (Mengistu & Mahesh, 2020). Furthermore, client-related issues, such as delays in debt collection and payment delays, can create ripple effects of cash flow problems throughout the project chain (Bedada, 2023; Mahamid, 2017). The pervasive problem of poor documentation and information management within the Ethiopian Road Authority also hinders effective project oversight (Belachew et al., 2017). Table 2.1 presents the factors hindering cost performance in road construction projects.

Table 2. 1 Factors hindering cost performance in road construction projects

Variables/Factors	Sources/References
Cost Estimation and Bidding	
Inaccurate Cost Estimation	Ammar et al., 2022; Durdyev, 2021
Poor Tender Documentation	Durdyev, 2021
Lack of Practical Knowledge Among Estimators	Durdyev, 2021
Insufficient Time for Estimation	Durdyev, 2021
Low Budgeting for Quantities (Ethiopia)	Ammar et al., 2022

Design and Planning	
Inadequate Planning and Scheduling	Durdyev, 2021; Abdelalim et al., 2024; Herrera et al., 2020
Design Problems, Modifications, and Failures	Durdyev, 2021; Herrera et al., 2020; Ammar et al., 2022; Kassa, 2020
Late Design, Unclear/Inadequate Details & Specifications	Kassa, 2020; Ammar et al., 2022
Project Scope Changes	Ammar et al., 2022; Durdyev, 2021; Herrera et al., 2020; Sinesilassie et al., 2018
Financial and Economic Factors	
Price Fluctuations of Materials and Inflation	Ahady et al., 2017; Ammar et al., 2022; Oluwajana et al., 2021; Oluwajana et al., 2022; Andric et al., 2024; Bedada, 2023; Borku & Yeniale, 2022
Financial Difficulties (Owner and Contractor)	Durdyev, 2021; Mejía et al., 2020
Delays in Payments / Client Debt Collection	Bedada, 2023; Mahamid, 2017
Unstable Economic Environment	Ammar et al., 2022; Mahamid, 2017; Xegwana et al., 2024
Management and Resources	
Poor Site Management and Supervision	Ahady et al., 2017; Mokoena, 2022
Insufficient Human Resources / Shortage of Skilled Labor	Ahady et al., 2017; Mokoena, 2022; Kassa, 2020; Gabriel et al., 2024
Insufficient Work Efforts	Kassa, 2020
Poor Communication Among Stakeholders	Al-Otaibi et al., 2025

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Weak Capacity of Local Contractors and Consultants (Ethiopia)	Mengistu & Mahesh, 2020
Poor Documentation and Information Management (Ethiopia)	Belachew et al., 2017
<b>Contractual and Legal Issues</b>	
Contractual Issues and Ambiguities	Durdyev, 2021; Abdelalim et al., 2024; Herrera et al., 2020
Unrealistic Contract Duration	Durdyev, 2021; Abdelalim et al., 2024
Poor Contract Management	Abdelalim et al., 2024; Herrera et al., 2020
<b>External Factors</b>	
Political Instability and Interference	Ammar et al., 2022; Abdelalim et al., 2024; Mahamid, 2017; Xegwana et al., 2024
Adverse Weather Conditions	Ammar et al., 2022; Abdelalim et al., 2024
Ineffective Right-of-Way Management / Land Acquisition Issues	Kidane, 2021; Darsa & Negash, 2023
Legal Issues	Abdelalim et al., 2024; Herrera et al., 2020

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In conclusion, the hindering factors for cost performance in road construction projects are numerous and interconnected, often originating from initial planning and design phases through to external political and economic conditions. While many factors are globally consistent, their specific manifestation and impact vary by regional context, highlighting the need for context-specific analysis and tailored mitigation strategies.

## **2.5 MCDM Approaches in Construction**

### **2.5.1 Overview of MCDM Methods**

The construction industry is inherently defined by complex decision-making environments that involve navigating numerous, and often conflicting, criteria and objectives to achieve project success (Tam et al., 2006). In response to these challenges, Multi-Criteria Decision-Making (MCDM) has become a significant and indispensable branch of operational research, offering structured, systematic methodologies for the analysis and resolution of problems characterized by multiple variables (El-helaly et al., 2023). These techniques provide a logical framework for systematically evaluating a set of alternatives against various criteria, with the goal of identifying an optimal or the most acceptable compromise solution (Pouraghajan et al., 2021).

The field of MCDM is composed of a diverse array of methods, each possessing distinct characteristics and philosophical underpinnings. Prominent approaches frequently utilized in construction research include the Analytical Hierarchy Process (AHP), which structures problems hierarchically; the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), which ranks alternatives based on their distance from an ideal solution; and Vlsekriterijumska Optimizacija I Kompromisno Resenje (VIKOR), which provides a compromise solution by considering the maximum group utility and minimum individual regret (Anafarta & Kaya, 2021; Bhatt & Darshana, 2014). Another critical and distinct method is the Decision-Making Trial and Evaluation Laboratory (DEMATEL), which is specifically designed not just for ranking but for analyzing and visualizing the causal relationships and interdependencies among various factors within a complex system (Raut et al., 2011). The selection of an appropriate MCDM method is therefore a strategic decision in itself, contingent upon the specific nature of the problem, the type of available data (quantitative, qualitative, or mixed), and, crucially, whether there is a need to model the intricate interactions between the decision criteria (El-helaly et al., 2023).

### **2.5.2 Applications of MCDM Methods in Construction**

Reflecting the industry's need for robust and transparent decision-support tools, the application of MCDM methods is extensive and continues to grow within the construction sector. These techniques are frequently employed to address a wide spectrum of challenges, including but not limited to strategic risk management, performance evaluation, and the critical task of supplier and

subcontractor selection (Pouraghajan et al., 2021; Osei-Kyei et al., 2022). For instance, MCDM models have been successfully utilized to formalize the subcontractor selection process, a decision that involves evaluating potential partners based on multiple conflicting criteria such as initial cost, past quality performance, technical capability, financial stability, and delivery time (Bhatt & Darshana, 2014; Gao et al., 2023; Luo et al., 2023).

Similarly, these methods are applied to risk assessment to empower project managers to systematically identify, analyze, and prioritize project risks, thereby enabling the formulation of more effective and targeted mitigation strategies (Chatterjee et al., 2018; Wijayaningtyas et al., 2024). The inherent flexibility of MCDM approaches allows them to be adapted to a wide range of decision-making contexts. A key advantage is their capacity to provide a systematic framework for incorporating both objective quantitative data and subjective qualitative expert judgments into a single, cohesive evaluation process, which is a hallmark of construction-related decision problems (Pouraghajan et al., 2021; Anafarta & Kaya, 2021).

### **2.5.3 Analytical Hierarchy Process (AHP) Approach**

The Analytical Hierarchy Process (AHP) stands out as one of the most widely utilized and recognized MCDM techniques within construction management, valued for its ability to structure complex problems and prioritize alternatives in a logical manner (Zeibak-Shini et al., 2024; Prasetyo et al., 2019). Developed by Saaty, the AHP methodology uniquely decomposes a multifaceted decision problem into a hierarchical structure consisting of the ultimate goal, intermediate criteria, and final alternatives. This structure facilitates a process where decision-makers conduct a series of pairwise comparisons to establish the relative importance of each element at every level of the hierarchy (Wijayaningtyas et al., 2024; El-helaly et al., 2023). This structured approach is particularly valuable for its ability to translate subjective, and often qualitative, expert opinions into quantitative priority weights. Consequently, AHP is highly effective in applications such as strategic project selection, comprehensive risk assessment, and the optimal allocation of resources (Zeibak-Shini et al., 2024; Chatterjee et al., 2018).

Despite its widespread use, the traditional AHP method is built upon a significant limitation: the underlying assumption that the criteria at each level of the hierarchy are independent of one another (Rahman et al., 2021). This assumption of independence can be particularly problematic in real-world construction scenarios, where factors are frequently interconnected and exhibit complex,

dynamic interdependencies (Raut et al., 2011). For example, in managing road construction projects, factors such as 'material cost', 'labor productivity', and 'project schedule' are not independent; an increase in material costs may force the use of less skilled labor, which in turn reduces productivity and leads to schedule delays. By ignoring these crucial relationships, the AHP method can lead to a misrepresentation of the problem's true structure, potentially resulting in skewed and unreliable prioritization results.

#### **2.5.4 DEMATEL Approach**

The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method was specifically conceived to overcome the challenge of understanding complex systems by mapping the causal interrelationships among their constituent factors (Dehdasht et al., 2017). Unlike AHP, which is primarily focused on hierarchical prioritization, the principal strength of DEMATEL lies in its ability to identify, quantify, and visualize the intricate web of interdependencies between criteria, thereby structuring them into distinct cause-and-effect groups based on their net influence (Rahman et al., 2021; Raut et al., 2011). By analyzing the degree to which one factor influences or is influenced by all other factors in the system, DEMATEL provides profound strategic insights into the underlying structure of a problem (Dehdasht et al., 2017).

This capability is particularly valuable in construction project management, where understanding the root causes of systemic issues like cost overruns is critical for developing effective mitigation strategies. The method allows decision-makers to quantitatively distinguish between causal factors (those with a high degree of influence on other factors) and effect factors (those that are highly influenced by others). This distinction enables management to focus resources on addressing the root drivers of a problem rather than merely treating its symptoms, leading to more targeted and impactful interventions (Kamranfar et al., 2022).

#### **2.5.5 Integrated AHP-DEMATEL Approach**

Recognizing the distinct yet complementary strengths of AHP and DEMATEL, researchers have increasingly championed an integrated approach that synergistically combines both methods to create a more powerful and realistic decision-making framework (Etraj & Jayaprakash, 2017; Rahman et al., 2021). This hybrid methodology directly addresses the primary limitation of the standalone AHP, its assumption of criteria independence, by first employing the DEMATEL

technique to establish and quantify the causal interrelationships among the decision factors (Raut et al., 2011).

The causal map and influence matrix generated by DEMATEL provide a more realistic and logically structured network of the problem, which subsequently serves as the foundational framework for the AHP analysis (Dehdasht et al., 2017). By using the total influence values from DEMATEL to inform the pairwise comparisons or structure the hierarchy in AHP, the integrated model ensures that the calculated priority weights account for the interdependencies. This integrated approach has been successfully applied in construction research to analyze complex problems, such as identifying the root barriers to green construction and assessing interdependent risks in large-scale projects (Kamranfar et al., 2022; Dehdasht et al., 2017). By combining DEMATEL's capacity for in-depth structural analysis with AHP's robust prioritization capabilities, the integrated method offers a more comprehensive and strategically insightful tool, perfectly suited for dissecting the multifaceted factors hindering cost performance in construction projects.

## **2.6 Frameworks for Mitigating Cost Performance Issues**

### **2.6.1 Overview of Existing Theoretical Frameworks**

A comprehensive understanding of project performance and risk management in construction requires the application of established theoretical frameworks that can structure the analysis of complex, multifaceted problems. A predominant concept in management literature that has been increasingly, though often implicitly, adopted by construction researchers is the contingency-based approach (Deng & Smyth, 2013). This theory posits that organizational performance is not achieved through a single "best way" of managing, but is rather a consequence of the "fit" between an organization's internal characteristics (such as structure and strategy) and its external environment (Deng & Smyth, 2013). In construction, this implies that the optimal strategies for managing cost performance are contingent upon the unique variables of each project, such as its complexity, novelty, and the specific stakeholders involved (Puddicombe, 2013). A strategic framework for mitigating cost-hindering factors must, therefore, be adaptable and sensitive to the specific context of the project rather than applying a universal template.

Further enriching this perspective, the Principal-Agent Theory provides a crucial lens for analyzing the contractual and relational dynamics that are central to construction projects (Ceric,

2011). This theory focuses on the relationship between a principal (e.g., the project owner) and an agent (e.g., the contractor), particularly in situations characterized by asymmetric information and potentially conflicting interests. Poor communication and misaligned objectives, which are frequently cited as sources of cost overruns, can be effectively explained by this framework (Ceric, 2011). It highlights how agents may prioritize their own interests, leading to issues like moral hazard or adverse selection, which manifest as project delays and budget escalations. Consequently, a robust framework for enhancing cost performance must include mechanisms, such as well-defined contracts and transparent communication protocols, to align stakeholder interests and mitigate the risks arising from information asymmetries (Ceric, 2011).

Complementing these ideas, Stakeholder Theory offers a broader framework that emphasizes the importance of identifying, understanding, and proactively managing the expectations of all parties with an interest in the project (Collinge, 2011; Wembe, 2019). Effective stakeholder management is now considered a fundamental concept for successful project completion, as unresolved issues with stakeholders, ranging from community opposition and regulatory hurdles to disputes with suppliers, are direct contributors to project delays and increased costs (Austen et al., 2008; Collinge, 2011). A strategic framework for cost performance is therefore incomplete without incorporating robust stakeholder management principles that ensure their competing claims are effectively assessed and managed throughout the project lifecycle (Wembe, 2019; Collinge, 2011).

From a more process-oriented perspective, the principles of Lean Construction provide a practical framework for enhancing cost performance by focusing on the systematic elimination of waste and the maximization of value (Wu et al., 2019; Dehdasht et al., 2020). Lean management identifies waste not only as material waste but also as any redundant process, delay, or inefficient use of resources that adds cost without adding value to the project (Wu et al., 2019). By applying lean tools and philosophies, construction projects can achieve significant improvements in efficiency and cost control, making it an essential component of any modern cost mitigation framework (Dehdasht et al., 2020). Table 2.2 presents the theoretical frameworks for mitigating and analyzing cost performance in road construction projects.

Table 2. 2 Theoretical frameworks for mitigating and analyzing cost performance

Theoretical Framework	Short Description	Sources/references
Contingency-Based Approach	Asserts that optimal project management strategies are contingent upon the project's specific internal and external environment, requiring a "fit" for best performance.	Deng & Smyth, 2013; Puddicombe, 2013
Principal-Agent Theory	Examines the relationship between a principal (owner) and an agent (contractor) to mitigate risks arising from conflicting interests and information asymmetry.	Ceric, 2011
Stakeholder Theory	Advocates for the active management of all parties with an interest in the project to prevent conflicts that lead to delays and cost increases.	Austen et al., 2008; Collinge, 2011; Wembe, 2019
Lean Construction	Aims to enhance cost performance by systematically maximizing value and eliminating all forms of waste (e.g., delays, rework, inefficient processes) throughout the project lifecycle.	Wu et al., 2019; Dehdasht et al., 2020
Cost of Quality (COQ) Framework	Proposes that investing in prevention and appraisal activities reduces more significant failure costs, thereby lowering the total project cost.	Sawan et al., 2018
Resource-Based View (RBV)	Suggests that a firm's cost performance is determined by its unique internal resources and capabilities, such as expertise and effective management systems.	Gitonga et al., 2022

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Performance Measurement Frameworks	Advocates for a holistic view of performance by integrating multifaceted indicators beyond just financial metrics to achieve effective cost management.	Deng & Smyth, 2013; Gitonga et al., 2022
Risk Management Frameworks	Provides a systematic process for proactively identifying, analyzing, and mitigating project risks, which are a primary cause of cost overruns.	Osei-Kyei et al., 2022; Dehdasht et al., 2017; Chatterjee et al., 2018; Zeibak-Shini et al., 2024

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## 2.6.2 Strategies for Enhancing Cost Performance in Road Projects

Building upon these theoretical foundations, the literature identifies several best practices and strategic areas that are critical for enhancing cost performance in road construction projects. A primary and foundational area of focus is the implementation of robust and integrated project cost management processes, which form the bedrock of financial control throughout the project lifecycle (Gitonga et al., 2022). These processes must be holistically applied, encompassing four key activities: diligent resource acquisition, accurate and data-informed cost estimation, realistic cost budgeting, and continuous, proactive cost control (Gitonga et al., 2022). A key strategy within this domain is the application of the Cost of Quality (COQ) model, which demonstrates that proactively investing in prevention and appraisal activities, such as detailed planning, quality inspections, and supplier audits, can significantly reduce more expensive failure costs associated with rework, material waste, and defects (Sawan et al., 2018). This proactive stance on quality, which requires steadfast management commitment, marks a fundamental shift from reactive problem-solving and is considered an essential best practice for modern construction management.

Another critical strategy is the integration of proactive risk and stakeholder management. The literature consistently demonstrates that a systematic and continuous approach to risk management is essential for identifying and mitigating the uncertainties that frequently lead to cost overruns (Osei-Kyei et al., 2022; Chatterjee et al., 2018). Best practices in this area extend beyond simple risk identification; they involve the comprehensive assessment of risks, the formulation of clear response strategies, and the negotiation of an equitable allocation of risk among the project parties

(Osei-Kyei et al., 2022). This must be intrinsically coupled with continuous and effective stakeholder engagement, as unresolved stakeholder issues, ranging from community opposition to regulatory disputes, are a direct cause of project delays, scope changes, and subsequent cost escalation (Austen et al., 2008; Puddicombe, 2013). Treating stakeholder management as a core risk mitigation function, rather than a peripheral activity, is a hallmark of high-performing projects.

Furthermore, strategic procurement and data-driven supply chain management are increasingly recognized as pivotal for achieving cost efficiency. Given that material procurement can constitute 40-45% of a project's total cost, optimizing this process offers significant potential for savings (Sawan et al., 2018; Alanazi et al., 2022). Modern best practices involve moving beyond traditional, static procurement methods and leveraging technology, such as the Internet of Things (IoT), to feed optimization models with accurate and dynamically updated supplier data (Alanazi et al., 2022). Using real-time information for material logistics, supplier selection, and inventory management helps to avoid decisions based on outdated or inaccurate data, which is a common source of inefficiency, excess cost, and project delays (Alanazi et al., 2022).

The adoption of Lean Construction principles offers a powerful philosophical and practical framework for enhancing cost performance. The core objective of lean management is to maximize value while systematically identifying and eliminating waste, defined not only as material scrap but also as any activity that consumes resources without adding value, such as delays, unnecessary transportation, and rework (Wu et al., 2019; Dehdasht et al., 2020). Tools such as the Last Planner System, Value Stream Mapping, and Just-in-Time delivery have been shown to improve workflow reliability, reduce schedule variability, and minimize the inefficiencies that are a primary driver of cost overruns in road construction (Wu et al., 2019).

A fundamental and overarching best practice is the establishment of effective communication and information management systems. Breakdowns in communication between project parties are a root cause of many other cost-hindering factors, including design errors, rework, and stakeholder conflicts, which are often exacerbated by the information asymmetry described in Principal-Agent Theory (Ceric, 2011). Best practices involve creating clear communication protocols, fostering a collaborative environment, and utilizing knowledge-based systems and technologies like Building Information Modeling (BIM) to ensure that accurate and timely information is accessible to all

project participants, thereby reducing misunderstandings and facilitating better-informed decisions (Osei-Kyei et al., 2022).

Finally, the initial structuring of the project, particularly the careful selection of appropriate contractual frameworks and project delivery systems, represents a foundational strategy for managing cost performance from the outset. The choice of contract type and bidding conditions significantly influences project outcomes, as it sets the formal rules of engagement, defines responsibilities, and allocates risk among the various parties (Lee, 2024; Ceric, 2011). A best practice is to select a delivery method and contractual model that aligns with the specific characteristics, complexity, and risk profile of the project, ensuring that the incentives of all stakeholders are aligned toward the common goal of delivering the project within budget and to the required quality standards.

Table 2. 3 Best practices and strategies for enhancing cost performance

Best Practice/Strategy	Brief Description	Sources/References
Integrated Project Cost Management	Implements comprehensive financial control across all project stages, from estimation to continuous monitoring.	Gitonga et al., 2022
Proactive Quality Management (Cost of Quality)	Strategically invests in prevention and appraisal activities to reduce costly failures like rework and waste, thereby lowering total project costs.	Sawan et al., 2018
Systematic Risk Management	Proactively identifies, assesses, and mitigates project uncertainties through clear response strategies and equitable risk allocation.	Osei-Kyei et al., 2022; Chatterjee et al., 2018; Zeibak-Shini et al., 2024
Effective Stakeholder Engagement	Continuously manages stakeholder expectations to preemptively resolve conflicts and external pressures that drive up costs.	Austen et al., 2008; Puddicombe, 2013; Collinge, 2011

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Data-Driven Supply Chain Management	Leverages technology and real-time data to optimize material procurement and logistics, thereby enhancing efficiency and reducing supply chain costs.	Sawan et al., 2018; Alanazi et al., 2022
Adoption of Lean Construction Principles	Maximizes value by systematically eliminating all forms of waste, such as delays and rework, to improve workflow and cost efficiency.	Wu et al., 2019; Dehdasht et al., 2020
Clear Communication & Information Systems	Establishes robust communication protocols and utilizes information technologies to ensure accurate and timely information flow, preventing costly errors.	Ceric, 2011; Osei-Kyei et al., 2022
Appropriate Contract & Delivery Model Selection	Strategically selects contractual and project delivery models that align stakeholder incentives and appropriately allocate risk based on project characteristics.	Lee, 2024; Ceric, 2011.pdf; Puddicombe, 2013

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## 2.7 Synthesis of Literature and Identification of Research Gaps

The comprehensive literature review has systematically established the theoretical and empirical foundations necessary for this study. It confirms that cost overruns are a critical and pervasive issue in the global construction industry, with the problem being particularly acute in the road construction sector of developing nations like Ethiopia. The review demonstrates that these cost performance issues do not stem from a single origin but rather from a complex and interconnected web of hindering factors that span technical, managerial, economic, and external domains. To analyze such multifaceted problems, the scholarly literature strongly advocates for the use of Multi-Criteria Decision-Making (MCDM) methods. Among these, the Analytical Hierarchy Process (AHP) has been identified as a robust and widely used tool for prioritizing factors based on their perceived importance. Concurrently, the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method is recognized for its unique capability to uncover and visualize

the causal interdependencies among a system's variables, thereby addressing the critical limitation of criteria independence often assumed in standalone AHP applications. A salient insight from the review is the growing recognition that integrated methodologies, particularly the AHP-DEMATEL approach, offer a more powerful and strategically insightful analysis than single-method approaches by linking the importance of factors to their causal influence.

Despite these valuable contributions, a critical analysis of the existing body of research reveals several significant gaps that this study aims to address. First, while general studies on cost overrun factors in the Ethiopian construction context exist, there is a notable scarcity of research that provides a focused, in-depth, and empirical analysis specifically within the Arsi Zone. Since regional economic conditions, local administrative practices, resource availability, and logistical challenges can vary significantly, a context-specific investigation is necessary to provide relevant and actionable insights for stakeholders operating in this particular geographical area. General findings may not adequately capture the unique dynamics and priorities of road construction projects within this zone.

Second, a methodological gap exists in the application of an integrated AHP-DEMATEL approach to the specific problem of cost performance hindering factors in Ethiopian road construction. While both AHP and DEMATEL have been applied individually or in other contexts within construction management, their synergistic application to identify, prioritize, and structure the causal relationships among cost overrun factors in this specific regional context remains an unexplored area. This integrated approach is essential for moving beyond a simple ranking of factors to a deeper understanding of the system's underlying dynamics.

Third, and most critically, a significant gap exists in translating analytical results into a practical, strategic framework for mitigation. The majority of existing studies conclude with a ranked list of hindering factors, providing valuable but limited guidance on how to strategically address them. There is a lack of research that integrates the priority weights derived from AHP with the causal influence scores from DEMATEL to develop a strategic prioritization matrix. Such a matrix would enable the classification of factors into distinct categories, such as "critical drivers," "key tangles," and "dependent effects", thereby providing a clear roadmap for decision-makers on where to focus their limited resources to achieve the most impactful and efficient mitigation of cost overruns.

The present study is designed to directly address these identified gaps and contribute new and practical knowledge to the field of construction management. By focusing on road construction projects within the Arsi Zone, this research will provide a much-needed, context-specific empirical analysis. Methodologically, it will apply the integrated AHP-DEMATEL approach to not only determine the relative importance of cost-hindering factors but also to unravel their complex web of cause-and-effect relationships. The primary contribution of this thesis will be the development of a strategic prioritization matrix and a subsequent strategic framework derived from the integrated model's outputs. This framework will move beyond a simple ranked list of problems to offer a nuanced, actionable guide that helps project managers and policymakers distinguish between the root causes and the resulting symptoms of poor cost performance. Ultimately, this study aims to bridge the gap between theoretical analysis and practical application by developing an impactful strategic framework for effectively mitigating cost performance hindering factors in the road construction projects of Arsi Zone, Ethiopia.

Table 2. 4 Synthesis of literature, identification of gaps, and contributions of the current study

Key Insights Derived from the Literature Review	Identified Research Gaps	How the Current Study Aims to Address These Gaps
Cost overruns are a significant and well-documented global issue in construction, particularly severe in the road projects of developing nations like Ethiopia. The hindering factors are numerous, interconnected, and span technical, managerial, economic, and external domains.	There is a scarcity of in-depth, empirical research focused specifically on the cost performance hindering factors within the unique regional context of Arsi Zone, Ethiopia, where local administrative practices, resource availability, and economic conditions create a distinct set of challenges.	By conducting a case study focused explicitly on the Arsi Zone, this research will provide a refined and contextually relevant analysis, offering actionable insights for local stakeholders that general national-level studies cannot provide.
Multi-Criteria Decision-Making (MCDM) methods are established as effective tools	A significant gap exists in the synergistic application of an integrated AHP-DEMATEL	This study will employ an integrated AHP-DEMATEL methodology to not only rank the

<p>for analyzing complex construction problems. AHP is widely used for prioritizing factors based on importance, while DEMATEL is uniquely capable of analyzing causal interdependencies.</p>	<p>approach to the specific problem of cost performance hindering factors in Ethiopian road construction. Standalone methods fail to capture the critical interplay between a factor's importance and its causal influence on the entire system.</p>	<p>hindering factors but also to map their causal interrelationships, thereby providing a more holistic and structurally accurate understanding of the problem's underlying dynamics.</p>
<p>The bulk of existing research successfully identifies and often ranks the factors contributing to poor cost performance, providing valuable diagnostic insights into the problem.</p>	<p>The literature largely stops at identifying problems, with a critical lack of research dedicated to translating analytical results into a practical and strategic framework for mitigation. There is no established methodology for integrating AHP weights with DEMATEL causal influence scores to create a strategic prioritization matrix for decision-making.</p>	<p>The primary contribution of this research is the development of a novel strategic prioritization matrix (using AHP-DEMATEL quadrant analysis) and a practical, impactful strategic framework. This will empower decision-makers to move beyond a simple list of problems to a strategic understanding of which factors are root causes (drivers) versus symptoms (effects), enabling more efficient and effective resource allocation for mitigation.</p>

## 2.8 Conceptual Farmwork of the Study

The conceptual framework underpinning this study operates on a systematic input-process-output model designed to deconstruct the complex dynamics of cost overruns in the Arsi Zone road construction sector. The framework initiates with the identification of sixteen critical hindering factors, distilled from a rigorous literature review and expert validation, which serve as the primary inputs. These factors are categorized into four distinct domains: Planning and Design, Financial and Economic, Management and Resource, and Contractual and External factors. The core analytical engine of this framework is the synergistic integration of the Analytic Hierarchy Process (AHP) and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) methods. While the AHP component is utilized to quantify the relative importance and priority weight of each factor based on stakeholder perception, the DEMATEL method is concurrently applied to map the causal interdependencies, effectively distinguishing between foundational drivers (cause group) and dependent outcomes (effect group).

The synthesis of these quantitative outputs forms the basis for the study's strategic contribution: the Strategic Prioritization Matrix. By plotting the importance weights derived from AHP against the causal influence scores calculated via DEMATEL, the framework classifies the hindering factors into four strategic quadrants: Critical Drivers, Key Tangles, Driving Factors, and Independent Factors. This classification facilitates a shift from a reactive, symptom-based management approach to a proactive, cause-driven strategy. Consequently, the framework culminates in the development of a Validated Strategic Mitigation Framework, which translates these analytical insights into targeted, stakeholder-specific interventions aimed at addressing root causes, thereby ensuring sustainable improvements in the cost performance of road infrastructure projects in the region.

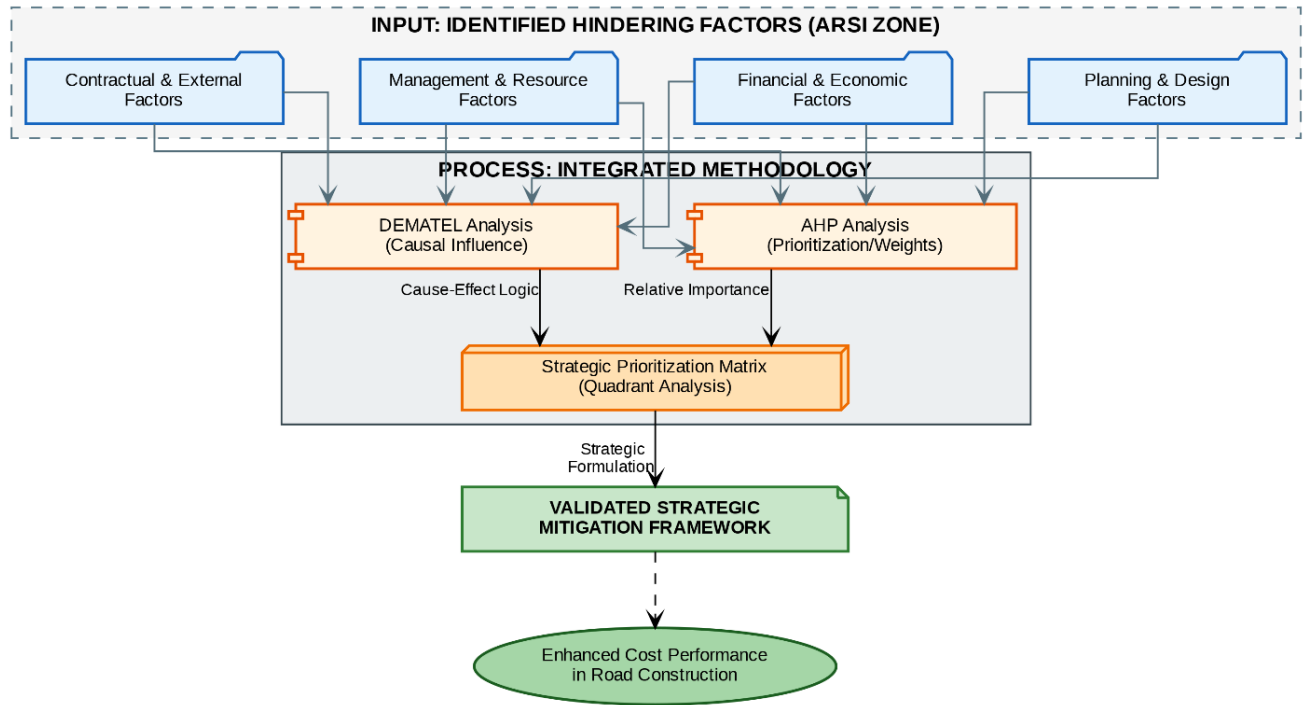


Figure 2.1: Conceptual Framework

## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

#### **3.1 Introduction**

This chapter provides a detailed and systematic account of the research methodology employed to achieve the study's objectives. It begins by outlining the overall research design and approach, followed by a description of the study area. The chapter then elaborates on the multi-stage process of data collection and analysis, which forms the core of this research. Specifically, it details the procedures for identifying and validating the study variables, the population and sampling strategies, the design of the data collection instruments, and the step-by-step application of the integrated Analytic Hierarchy Process (AHP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) methods. Finally, the chapter addresses the measures taken to ensure the validity and reliability of the research and discusses the ethical considerations that guided the study.

#### **3.2 Research Design and Approach**

Grounded in a pragmatist research philosophy, this study employed a multi-stage, sequential explanatory mixed-methods design embedded within a single-case study framework. This approach prioritizes the practical application of knowledge to address the problem of cost overruns in road construction. The integration of quantitative and qualitative methods allows for both statistical analysis and contextual understanding to produce an actionable solution.

The study utilized a single-case study approach focused on the Arsi Zone in Ethiopia. In accordance with the principles articulated by Yin (2018), this approach facilitates an in-depth investigation into the factors hindering cost performance within their specific context. The research process was executed in two distinct phases: an initial quantitative phase using AHP and DEMATEL to structure and analyze the problem, followed by a qualitative phase involving expert interviews to validate the findings and the proposed framework. The comprehensive research design and procedural flow are illustrated in Figure 3.1.

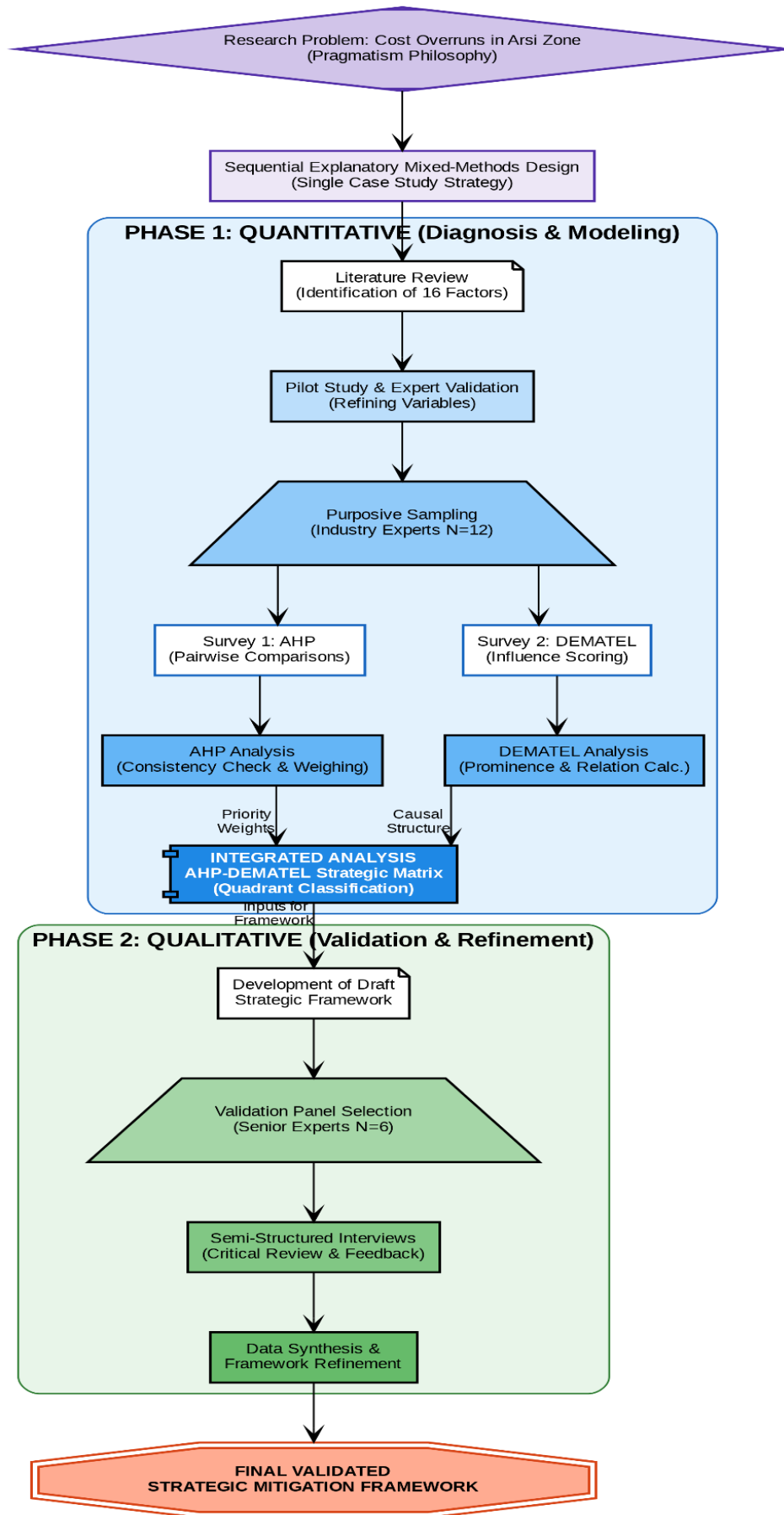


Figure 3. 1: Methodology Flowchart

### **3.3 Study Area**

The empirical investigation for this research was geographically delimited to road construction projects situated within the Arsi Zone of the Oromia Regional State, Ethiopia, as depicted in Figure 3.1. The selection of this specific zone was not arbitrary but was a strategic and purposive decision grounded in several methodologically significant criteria that establish its suitability as a case study. Firstly, the Arsi Zone represents a nexus of substantial and ongoing road infrastructure development, ensuring the presence of relevant and contemporary project data essential for the study.

Furthermore, the zone serves as an archetypal setting, as projects within its boundaries are widely recognized to confront the full spectrum of logistical, administrative, and socio-economic challenges that are characteristic of the broader Ethiopian construction sector. This makes the Arsi Zone an apt microcosm for a deep and explanatory analysis of cost overrun phenomena, allowing for findings that, while context-specific, possess a high degree of analytical generalizability to other regions facing similar conditions. The imperative for this research is amplified by the zone's vital role as a major agricultural and economic corridor, where the efficiency and reliability of road networks are directly linked to regional productivity and sustainable development. Consequently, the negative impacts of cost overruns are particularly acute in this area. This deliberate geographical focus facilitates a granular, context-sensitive analysis that captures the nuanced operational realities faced by project stakeholders, thereby enhancing the practical utility and validity of the research findings.

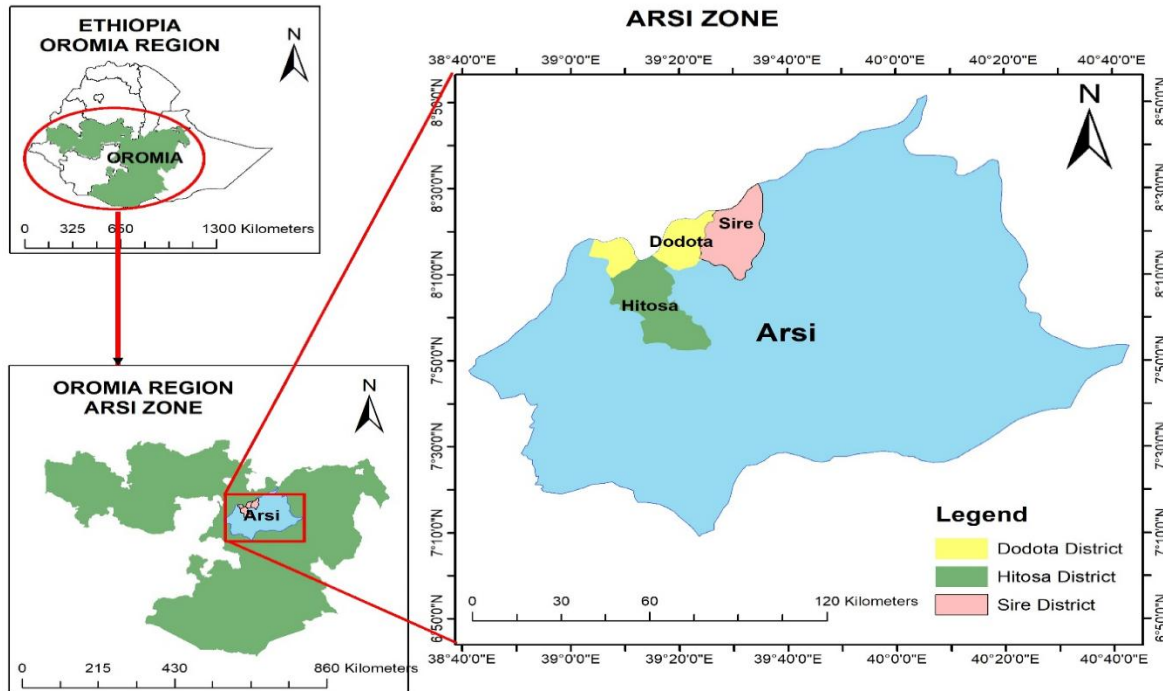


Figure 3. 2: Geographical Context of the Study Area (Adapted from Belete et al., 2022).

### 3.4 Identification and Validation of Study Variables

The analytical rigor of this study is contingent upon a meticulously identified and validated set of core variables. In the context of this research model, the dependent variable is the Cost Performance of road construction projects (specifically the occurrence of cost overruns). The independent variables are the 16 identified hindering factors (e.g., Ineffective Right-of-Way Management, Inflation, Poor Design) whose influence and importance are being measured against the dependent variable.

To ensure these variables were both theoretically sound and contextually relevant, a rigorous two-stage methodology was employed. The initial phase involved a systematic synthesis of extensive international and national scholarly literature. Subsequently, this preliminary list was subjected to expert validation by a panel of seven senior industry experts to ensure applicability to the specific conditions of the Arsi Zone. This process culminated in the final list of 16 critical factors presented in Table 3.1.

Table 3. 1 Refined and validated critical cost performance hindering factors for road construction

Critical Factor	Brief Description
Inaccurate Cost Estimation	Underestimation of project costs during the bidding and planning stages due to poor data, lack of expertise, or insufficient time.
Poor/Inadequate Design	Issues stemming from design errors, frequent modifications, unclear specifications, and late design delivery that lead to rework and delays.
Inadequate Planning and Scheduling	Deficiencies in project planning and the development of unrealistic or poorly structured schedules that fail to coordinate project activities effectively.
Project Scope Changes (Changes in Orders)	Alterations to the original project scope initiated by the client or other stakeholders during the construction phase, leading to additional costs.
Fluctuation in Material Prices and Inflation	Unpredictable increases in the cost of construction materials and general economic inflation that erode the project budget.
Financial Difficulties of the Contractor	Contractor's inability to manage cash flow effectively, often leading to delays in procuring materials and paying labor.
Delayed Payments from the Client	The client's failure to make timely payments to the contractor, creating cash flow problems that cascade through the project.
Shortage of Skilled Labor and Equipment	A lack of available and competent human resources and necessary construction machinery, leading to reduced productivity and delays.
Poor Site Management and Supervision	Ineffective on-site management and a lack of adequate supervision, resulting in low productivity, rework, and safety issues.
Ineffective Right-of-Way Management	Delays and disputes related to land acquisition, compensation, and securing the legal right-of-way for the project path.
Political Instability and Interference	Disruptions caused by political instability, government interference, or changes in regulations that impact project continuity and financing.

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Poor Contract Management	Issues arising from ambiguous contract clauses, unrealistic durations, and the ineffective administration of contractual obligations.
Ineffective Communication Among Stakeholders	Breakdowns in communication between the client, consultant, contractor, and other key parties, leading to misunderstandings, rework, and delays.
Adverse Weather Conditions	Unforeseeable and severe weather events that disrupt construction activities and cause project delays.
Weak Capacity of Local Contractors/Consultants	Insufficient technical, managerial, or financial capacity of local firms to execute projects according to the required standards.
Poor Documentation and Information Management	Inefficient systems for managing project documents and information, leading to delays, misinterpretations, and a lack of proper oversight.

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### 3.5 Population and Sampling Strategy

The target population for this study was defined as experienced professionals with direct involvement in road construction projects within the Arsi Zone. A non-probability, purposive sampling strategy was employed, as supported by Saunders et al. (2019), to prioritize the depth of expertise over statistical representativeness.

To ensure validity, a dual-panel sampling structure was used. The primary quantitative data was solicited from an AHP-DEMATEL Survey Panel (N=12) comprising project managers, engineers, and consultants with a minimum of five years of experience. A separate Validation Panel (N=6) of senior experts was engaged to review the final strategic framework. Regarding the sample size, while 12 to 18 experts may appear small compared to traditional statistical surveys, it is considered sufficient and standard for MCDM methodologies like AHP and DEMATEL. These methods rely on the consistency and transitivity of expert judgments rather than the statistical power derived from large populations; a small group of knowledgeable experts is preferred to a large group of unformed respondents (Saaty, 2008).

## **3.6 Data Collection Instruments and Procedure**

To ensure methodological rigor, the data collection for this study was executed systematically in two distinct but complementary phases, utilizing three primary research instruments. The first phase focused on quantitative modeling, employing structured questionnaires for the AHP and the DEMATEL to establish a data-driven understanding of the problem's structure. The second phase was qualitative in nature, using a semi-structured interview guide to validate, refine, and enrich the quantitative findings with deep contextual insights. This multi-instrument, sequential approach was designed to ensure a comprehensive and robust data collection process, leading to a credible and validated strategic solution.

### **3.6.1 AHP and DEMATEL Surveys (Phase 1)**

The initial phase of data collection was dedicated to gathering the primary quantitative data from the purposively selected AHP-DEMATEL survey panel (N=12). This was achieved through the administration of two distinct, structured questionnaires, the first of which was the AHP Questionnaire. This instrument was meticulously designed to systematically elicit expert judgments on the relative importance and priority weights of the cost-hindering factors. The questionnaire guided the experts through a structured process of pairwise comparisons, which was conducted hierarchically. Participants were first asked to compare the four main factor categories against each other to establish high-level strategic priorities. Subsequently, they performed a more granular set of comparisons, evaluating the relative importance of the individual factors within each of those categories.

To ensure consistency and quantifiability of these subjective judgments, the instrument utilized Saaty's classic 9-point fundamental scale of absolute numbers, as detailed in Table 3.2. For each pair of factors presented, experts were prompted to answer the fundamental question: "Which of these two factors has a greater impact on hindering cost performance, and by how much?" Their response was captured using the numerical scale, allowing for the precise measurement of their preference intensity. For example, if an expert deemed 'Factor A' to be strongly more important than 'Factor B', they would assign a value of '5' in favor of 'Factor A'. This rigorous process was essential for systematically translating the experts' subjective, experience-based knowledge into quantifiable priority vectors, which formed the foundation of the hierarchical analysis.

Table 3. 2 The Saaty 9-Point Scale for Pairwise Comparison

Intensity of Importance	Definition	Explanation of Judgment
1	Equal Importance	Both factors contribute equally to the objective. There is no discernible difference in their impact.
3	Moderate Importance	Experience and judgment slightly favor one factor over another. The preference is noticeable but not dramatic.
5	Strong Importance	Experience and judgment strongly favor one factor over another. The dominance of one factor is evident.
7	Very Strong Importance	One factor is favored very strongly over another; its dominance is demonstrated in practice and is not easily disputed.
9	Extreme Importance	The evidence favoring one factor over another is of the highest possible order of affirmation. The preference is unequivocal.
2, 4, 6, 8	Intermediate Values	Used when compromise or a finer degree of judgment is needed between two adjacent scale values.

*Source: Saaty (2008)*

Following the completion of the AHP survey, the same panel of twelve experts was administered the second quantitative instrument, the DEMATEL Questionnaire. The fundamental purpose of this instrument was to transcend the hierarchical prioritization established by the AHP and to map the intricate network of causal interrelationships that exist among the 16 validated factors. While the AHP answered *what* factors were most important, the DEMATEL method was selected to answer *why* and *how* these factors interact, thereby providing a structural model of the problem.

The questionnaire was structured as a 16x16 matrix, where each row represented an 'influencing factor' (a potential cause) and each column represented an 'influenced factor' (a potential effect). Experts were required to systematically evaluate each possible relationship within the matrix,

assessing the degree of direct influence that the row factor exerted on the column factor. This evaluation was guided by a 5-point ordinal scale, as detailed in Table 3.3, which provided a standardized measure of causal strength, ranging from no influence to very high influence.

Table 3. 3 DEMATEL 5-Point Direct-Influence Scale

Numerical Value	Level of Influence	Definition
0	No Influence	The row factor has no direct effect on the column factor.
1	Low Influence	The row factor has a small or indirect effect on the column factor.
2	Medium Influence	The row factor has a moderate and noticeable effect on the column factor.
3	High Influence	The row factor has a significant and strong effect on the column factor.
4	Very High Influence	The row factor has an extremely strong and direct effect on the column factor.

To ensure a consistent frame of reference for all participants, they were instructed to consider the core question for each judgment: "To what extent does the factor in the ROW directly influence the factor in the COLUMN?" This precise instruction focused their assessment on direct, first-order effects, which is the necessary input for the DEMATEL algorithm to later compute the total (direct and indirect) influence. The data gathered through this instrument was crucial for the subsequent analytical phase, as it provided the empirical basis for identifying the foundational drivers (net causes) that initiate systemic problems, and distinguishing them from the dependent effects (symptoms) that are often more visible but less fundamental. As with the AHP instrument, the DEMATEL questionnaire was distributed with a comprehensive set of instructions to ensure clarity of the task, consistency in interpretation, and the overall reliability of the collected judgments.

### **3.6.2 Framework Validation Interview (Phase 2)**

The second phase of data collection was qualitative and explanatory, designed specifically to validate, refine, and enrich the analytical outputs from the quantitative phase. The primary instrument for this stage was a Semi-Structured Interview Guide, which was meticulously developed to facilitate in-depth discussions with the senior validation panel (N=6). The semi-structured format was deliberately chosen to ensure a consistent line of inquiry across all interviews by addressing core thematic areas, while simultaneously affording the flexibility to pose probing, follow-up questions tailored to each expert's unique insights and experience. The guide contained a series of open-ended questions focused on critically assessing the proposed strategic framework's structural logic, contextual relevance, practical applicability, and overall completeness. This instrument served as the critical bridge between the data-driven model and its real-world utility.

The procedure involved conducting individual, one-on-one interviews with each of the six senior experts on the validation panel. This individual format was selected to elicit candid and uninfluenced feedback, mitigating the potential for groupthink that can occur in a focus group setting. At the outset of each interview, the expert was presented with a visual diagram of the proposed strategic framework derived from the AHP-DEMATEL analysis. This visual aid served as a concrete stimulus for discussion, allowing the experts to react to the structure, terminology, and strategic recommendations in a tangible way. With participants' consent, each interview was audio-recorded and subsequently transcribed verbatim to ensure the complete and accurate capture of their nuanced feedback. This systematically documented qualitative data formed the empirical basis for the final refinement and validation of the strategic mitigation framework.

## **3.7 Data Analysis Procedure**

Following the data collection procedures detailed in the preceding section, this section systematically outlines the sequential and integrated methodology used to analyze the collected data. The analytical process was strategically designed to transform the raw quantitative and qualitative expert judgments into a coherent, validated, and actionable strategic framework, directly addressing the core research objectives. The procedure commences with the separate analysis of the quantitative survey data, first employing the AHP to establish a clear hierarchy of

importance among the cost-hindering factors. This is followed by the application of the DEMATEL method to model the intricate causal relationships between these variables. The core of the analysis lies in the synthesis of these two quantitative outputs into an integrated strategic prioritization matrix. Finally, the qualitative data from the senior expert interviews is subjected to thematic analysis, the results of which are used to refine, interpret, and validate the quantitatively derived framework, ensuring its practical relevance and strategic utility.

### **3.7.1 Analytic Hierarchy Process (AHP) Analysis**

The primary quantitative analysis began with the application of the Analytic Hierarchy Process (AHP), a robust multi-criteria decision-making method developed by Saaty (2008). The principal goal of this analysis was to systematically quantify and prioritize the cost performance hindering factors by translating the subjective, qualitative judgments of industry experts into a ranked hierarchy of importance. The entire analytical procedure was facilitated by MS Excel for initial data organization and a custom Python script executed in a Google Colab environment for the core computations, ensuring both accuracy and repeatability. The process was executed through four distinct, sequential steps.

The initial step in the AHP methodology involved Structuring the Hierarchy. The complex problem of cost overruns was decomposed into a more manageable, hierarchical model. This study established a two-level hierarchy: the ultimate goal (identifying the most critical cost performance hindering factors) was placed at the apex, followed by the four main factor categories (Level 1), and finally, the 16 specific, validated factors nested within their respective categories (Level 2). This structure provided a logical framework for the subsequent evaluation.

The second step was the Pairwise Comparison and Matrix Aggregation. Following the hierarchy's establishment, the 12 experts on the survey panel performed pairwise comparisons at each level. For each pair of elements (e.g., 'Factor A' vs. 'Factor B'), experts used the 9-point Saaty scale to indicate which factor was more important and by how much. This process generated a set of 12 individual reciprocal square matrices ( $A$ ) for each level of the hierarchy, where if the judgment of element  $i$  over  $j$  is  $a_{ij}$  then the judgment of  $j$  over  $i$  is the reciprocal,  $a_{ji} = 1/a_{ij}$ . To synthesize the judgments from the 12 individual experts into a single, representative group matrix ( $A_{agg}$ ), the geometric mean was employed for each corresponding element in the matrices. The geometric

mean is preferred as it maintains the crucial reciprocal property of the aggregated matrix. The calculation for each element in the aggregated matrix is given by the formula:

$$a_{ij}^{(agg)} = \left( \prod_{l=1}^k a_{ij,l} \right)^{\frac{1}{k}}$$

Where:

- $a_{ij}^{(agg)}$  represents the final, aggregated judgment for the element in the i-th row and j-th column of the group's pairwise comparison matrix. .
- $\prod_{l=1}^k$  is the product operator, signifying the multiplication of the sequence of individual expert judgments from the first expert (l=1) to the last expert (l=k).
- $a_{ij,l}$  is the specific numerical judgment provided by the l-th expert (where l ranges from 1 to k) for the pairwise comparison of the factor in row i against the factor in column j.
- k is the total number of experts who participated in the AHP survey panel, which for this study is 12.

The third step was the Priority Vector Calculation. From the aggregated pairwise comparison matrix, a priority vector ( $w$ ) representing the relative weights of the factors was derived. This was achieved by first normalizing the matrix by dividing each element by the sum of its column, and then calculating the average of the elements in each row of the normalized matrix. This procedure provides a robust approximation of the principal eigenvector of the matrix, with each element in the resulting vector representing the priority weight of the corresponding factor.

The final and most critical step was the Consistency Check. To ensure the reliability and logical integrity of the expert judgments, the consistency of the aggregated matrix was calculated. A high degree of consistency indicates that the expert judgments were not random or contradictory. This was achieved by calculating the Consistency Ratio (CR) through a three-part process. First, the principal eigenvalue ( $\lambda_{max}$ ) was calculated. Second, this was used to find the Consistency Index (CI) using the formula:

$$CI = (\lambda_{max} - n) / (n - 1)$$

where  $n$  is the number of factors being compared (the size of the matrix). The CI measures the deviation from perfect consistency. To contextualize this value, it was compared against the

appropriate Random Index (RI), which is the average CI of a large number of randomly generated reciprocal matrices of the same size. The RI values used in this study are presented in Table 3.4.

Table 3. 4 Random Index (RI) Values

Matrix Size ( <i>n</i> )	1	2	3	4	5	6	7	8	9	10
RI Value	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

*Source: Saaty (2008)*

Finally, the Consistency Ratio (CR) was calculated by dividing the CI by the corresponding RI value:

$$CR = CI / RI$$

A CR value of less than 0.10 is widely considered acceptable, indicating that the expert judgments are sufficiently consistent to be considered reliable. This complete procedure was applied to the aggregated matrix for the main factor groups and for the matrices of the specific factors within each group, thereby generating a validated set of priority weights for the entire decision hierarchy.

### 3.7.2 Decision-Making Trial & Evaluation Laboratory (DEMATEL) Analysis

Following the prioritization of factors via the AHP, the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method was employed to elucidate the complex web of causal interrelationships among the 16 validated hindering factors. While AHP is effective at determining the perceived importance of variables, the primary objective of DEMATEL is to construct a structural model that distinguishes between foundational root causes (drivers) and their resulting symptoms (effects). This causal mapping provides a deeper, systemic understanding crucial for developing targeted and effective mitigation strategies. The analytical procedure, originally developed by Gabus and Fontela (1973), was executed using a custom Python script within a Google Colab environment, with MS Excel used for initial data collation. The methodology involved five systematic steps.

The first step was to Construct the Average Direct-Influence Matrix (*Z*). The judgments collected from the 12-member expert survey panel, based on the 5-point influence scale, were used to form 12 individual  $n \times n$  matrices (where  $n=16$ ). In each individual matrix, the element  $z_{ij}^{(l)}$  represented

a single expert's assessment of the direct influence of factor  $i$  on factor  $j$ . To create a single matrix representing the group consensus, these individual matrices were aggregated by calculating the arithmetic mean for each corresponding element. The resulting average direct-influence matrix  $Z$  is defined by:

$$Z = (z_{ij})_{n \times n}$$

where  $z_{ij} = \frac{1}{k} \sum_{l=1}^k z_{ij}^{(l)}$ , here,  $k$  is the number of experts (12), and  $z_{ij}^{(l)}$  is the score given by the  $l$ -th expert.

The second step involved Normalizing the Average Direct-Influence Matrix. This mathematical procedure is essential to ensure the properties required for the subsequent matrix calculations, specifically guaranteeing the convergence of the matrix power series. The matrix  $Z$  was normalized to produce the matrix  $X$  using the following formulas:

$$X = s \times Z$$

where the scaling factor,  $s$ , is calculated as:

$$s = \frac{1}{\max_{1 \leq k \leq n} (\sum_{j=1}^n z_{kj})}$$

This normalization process ensures that all elements in matrix  $X$  fall between 0 and 1, creating a stable basis for calculating the total influence.

The third and pivotal step was the Calculation of the Total-Relation Matrix ( $T$ ). This matrix represents the sum of all direct and indirect influences between factors. It is derived from the normalized matrix  $X$  using the following fundamental DEMATEL formula:

$$T = X(I - X)^{-1}$$

In this equation,  $I$  is the identity matrix of size  $n \times n$ . The term  $(I - X)^{-1}$  represents the inverse of the matrix, which mathematically corresponds to the sum of an infinite power series:  $I + X + X^2 + X^3 + \dots$ . This series elegantly captures the cascading, indirect effects within the system, where  $X$  represents direct influence,  $X^2$  represents influence through one intermediary factor (a two-step path),  $X^3$  through two intermediaries, and so on. The resulting matrix  $T = [t_{ij}]$  contains elements that quantify the total influence (both direct and indirect) that factor  $i$  exerts on factor  $j$ .

The fourth step was to Determine the Causal Parameters. To interpret the complex data within the total-relation matrix T, two vectors, D (Dispatchers) and R (Receivers), were calculated by summing the rows and columns, respectively:

$$D_i = \sum_{j=1}^n t_{ij} \text{ (for } i = 1, 2, \dots, n)$$

$$D_j = \sum_{i=1}^n t_{ij} \text{ (for } j = 1, 2, \dots, n)$$

The vector D represents the total influence that factor i exerts on all other factors, while the vector R represents the total influence that factor j receives from all other factors. These vectors were then used to calculate two key parameters for each factor:

- Prominence (Di+Ri): This value indicates the total degree of a factor's interaction within the system. A high prominence score signifies that a factor is a central hub, with strong connections to many other factors.
- Relation (Di–Ri): This value determines the net causal position of a factor. A positive (Di–Ri) value signifies that the factor is a net *cause* or *driver*, exerting more influence than it receives. Conversely, a negative (Di–Ri) value indicates that the factor is a net *effect* or *symptom*, being more influenced by other factors than it influences them.

Finally, the results were synthesized by Developing the Causal Influence Diagram. This diagram is a two-dimensional Cartesian plane designed for strategic interpretation. The Prominence (D+R) values were plotted on the horizontal axis (x-axis), representing each factor's overall degree of interaction, while the Relation (D–R) values were plotted on the vertical axis (y-axis), indicating its net causal influence. This visualization provides a clear structural map of the problem, identifying the foundational drivers and their ultimate effects.

### 3.7.3 Integrated AHP-DEMATEL Strategic Matrix

The culminating stage of the quantitative analysis involves the systematic synthesis of the AHP priority weights and the DEMATEL causal influence scores into a unified diagnostic model. This integration is designed to overcome the inherent limitations of using either method in isolation, providing a multi-dimensional perspective that accounts for both the perceived importance of

hindering factors and their structural interdependencies. The synthesis is operationalized through the development of a two-dimensional strategic prioritization matrix, where each of the 16 validated factors is mapped onto a Cartesian coordinate system. In this model, the vertical axis (Y-axis) represents the global importance weights derived from the AHP analysis, capturing the stakeholders' collective perception of each factor's impact. Concurrently, the horizontal axis (X-axis) represents the net causal influence (D-R) calculated via the DEMATEL method, which serves to distinguish between the foundational drivers of cost overruns and their symptomatic effects.

To ensure an objective and data-driven classification within the matrix, the factors are categorized into four distinct strategic quadrants using established statistical thresholds. The demarcation between causes and effects is established on the horizontal axis at a relation score of zero ( $D-R = 0$ ), a boundary inherent to the DEMATEL methodology that separates net dispatchers of influence from net receivers. For the vertical axis, the threshold between high and low importance is defined by the arithmetic mean of all 16 AHP global weights. This procedural approach facilitates the classification of hindering factors into:

1. Quadrant I (Critical Drivers): Factors exhibiting high importance and high causality;
2. Quadrant II (Key Tangles): High-importance factors that are largely symptomatic;
3. Quadrant III (Operational Symptoms): Lower-importance, dependent effects; and
4. Quadrant IV (Foundational Drivers): Latent factors that, despite lower perceived importance, exert a significant systemic push on the entire project environment.

This integrated classification serves as the structural foundation for the study's strategic mitigation framework, enabling a shift from reactive firefighting to a proactive, cause-driven management paradigm.

### **3.7.4 Development of the Strategic Framework for Mitigating Cost Overrun**

The culminating phase of the analytical procedure is the development of a practical and impactful strategic framework designed to mitigate the factors hindering cost performance. This process is not a direct output of a single statistical test but rather a multi-stage synthesis that methodically translates the quantitative analytical results into an actionable strategic tool. The development is grounded in the outputs of the integrated AHP and DEMATEL analysis, which provides the empirical foundation for the framework's structure and logic.

The initial step involves formulating a proposed strategic framework directly from the classifications derived from the strategic prioritization matrix. The distinct characteristics of the four quadrants, Critical Drivers, Key Tangles, Independent Factors, and Driving Factors, are used to define unique strategic imperatives and corresponding management actions for the factors within each category. This ensures that the initial framework is logically and directly tied to the data-driven diagnosis of the problem's structure, which considers both the perceived importance and the causal influence of each factor.

Following its initial formulation, this proposed framework is subjected to a rigorous qualitative validation and refinement process. This is achieved through a series of semi-structured interviews with a purposively selected panel of senior industry experts, a group distinct from the one that provided the initial survey data. The objective of this qualitative phase is to critically assess the proposed framework against several criteria, including its logical coherence, clarity, contextual relevance to the Ethiopian construction sector, and, most importantly, its practical applicability and completeness. The in-depth feedback and experiential insights gathered from these senior practitioners are systematically analyzed and incorporated to enhance the framework. This crucial step serves to refine terminology, increase the specificity and actionability of the recommended strategies, and ensure the final output is not merely an academic model but a robust, credible, and practical management tool for stakeholders.

### **3.8 Validity and Reliability**

To ensure the trustworthiness and academic rigor of this study's findings, a multi-faceted approach was employed to systematically address the validity and reliability of the data and analytical procedures. The foundation of the research was secured through meticulous attention to content validity, which confirms that the factors being measured are appropriate and relevant to the research question. This was achieved via a deliberate two-stage process. First, an exhaustive initial list of cost-performance-hindering factors was compiled from a comprehensive and systematic review of international and national scholarly literature, establishing a broad, theoretically-grounded inventory. Second, this preliminary list was subjected to a rigorous validation process, acting as a crucial contextual filter. A purposive panel of senior industry experts with extensive, direct experience in the Arsi Zone scrutinized, refined, and contextualized each factor, confirming its practical relevance. This critical step ensured that the final variables used for analysis were not

merely a generic academic list but a true and applicable representation of the significant challenges faced within the specific context of the study.

Construct validity, which refers to the degree to which the study measures the intended theoretical constructs, was systematically addressed through the adoption of well-established and empirically validated research methodologies. The use of the AHP and the DEMATEL method provided a structured and logically sound framework for measuring the abstract constructs of 'perceived importance' and 'causal influence'. The reliability of the quantitative data was statistically confirmed through the consistency check inherent in the AHP methodology. The aggregated expert judgments yielded a Consistency Ratio (CR) significantly below the maximum acceptable threshold of 0.10, indicating an exceptionally high degree of logical coherence and internal consistency in the pairwise comparisons. This confirms that the expert judgments were not random or contradictory, thus ensuring the reliability of the quantitative inputs. In the qualitative phase, the credibility of the final strategic framework was enhanced by employing a separate, more senior panel of experts for the validation process. This deliberate separation of the data-generation panel (composed of operational experts) from the validation panel (composed of strategic leaders) served to prevent confirmation bias and added a critical layer of objective scrutiny to the research outcomes.

Furthermore, the overall robustness of the findings was fortified through the principle of stakeholder triangulation. By intentionally sourcing judgments from a balanced representation of the primary stakeholder groups, clients, contractors, and consultants, the study captured a holistic and multi-dimensional perspective of the problem. Each group provides a unique and essential viewpoint: the client perspective on project financing and objectives, the contractor perspective on execution and resource management, and the consultant perspective on design and contractual oversight. This approach mitigated the potential for single-stakeholder bias, which could over-emphasize certain factors, and ensured that the resulting analysis reflects a more comprehensive, balanced, and objective understanding of the complex dynamics at play. Collectively, these integrated measures of content and construct validity, quantitative and qualitative reliability, and stakeholder triangulation provide a strong and defensible foundation for the credibility of the data analysis and the conclusions drawn therefrom.

### **3.9 Ethical Considerations**

The research was conducted in strict adherence to ethical principles. All participants were provided with a clear explanation of the study's purpose and procedures. Informed consent was obtained before their participation. They were assured of confidentiality and anonymity, with all data being aggregated and anonymized for analysis and reporting. Finally, their participation was entirely voluntary, and they were informed of their right to withdraw at any stage.

## **CHAPTER FOUR**

### **RESULTS AND DISCUSSIONS**

#### **4.1 Introduction**

Building upon the research methodology established in the preceding chapter, this study utilized a sequential mixed-methods design integrating AHP and DEMATEL approaches to analyze the critical factors hindering cost performance in Arsi Zone road projects. This chapter presents the empirical findings derived from that analysis, beginning with the demographic profiles of the participating experts to affirm data validity. The discussion subsequently details the hierarchical prioritization of factors via AHP, the modeling of causal interrelationships through DEMATEL, and the synthesis of these results into a Strategic Prioritization Matrix. The chapter concludes by presenting the development and expert validation of the final strategic mitigation framework.

#### **4.2 Profile of Industry Experts**

This section outlines the demographic and professional profiles of the experts who participated in the data collection and validation phases. Ensuring the credibility of the research findings relies heavily on the qualifications and contextual knowledge of these participants.

##### **4.2.1 Profile of Survey Experts**

The primary data for the AHP-DEMATEL analysis was collected from a panel of 12 industry practitioners. As illustrated in Figures 4.1 to 4.4, the respondents possess a robust combination of academic qualifications and practical experience. The majority of the panel holds a Bachelor's degree or higher and has served in the sector for over 11 years, primarily in direct operational roles such as Project Managers and Site Engineers. The strong representation of contractors, balanced by consultants and client representatives, ensures that the judgments provided are grounded in the daily operational realities of road construction in the Arsi Zone.

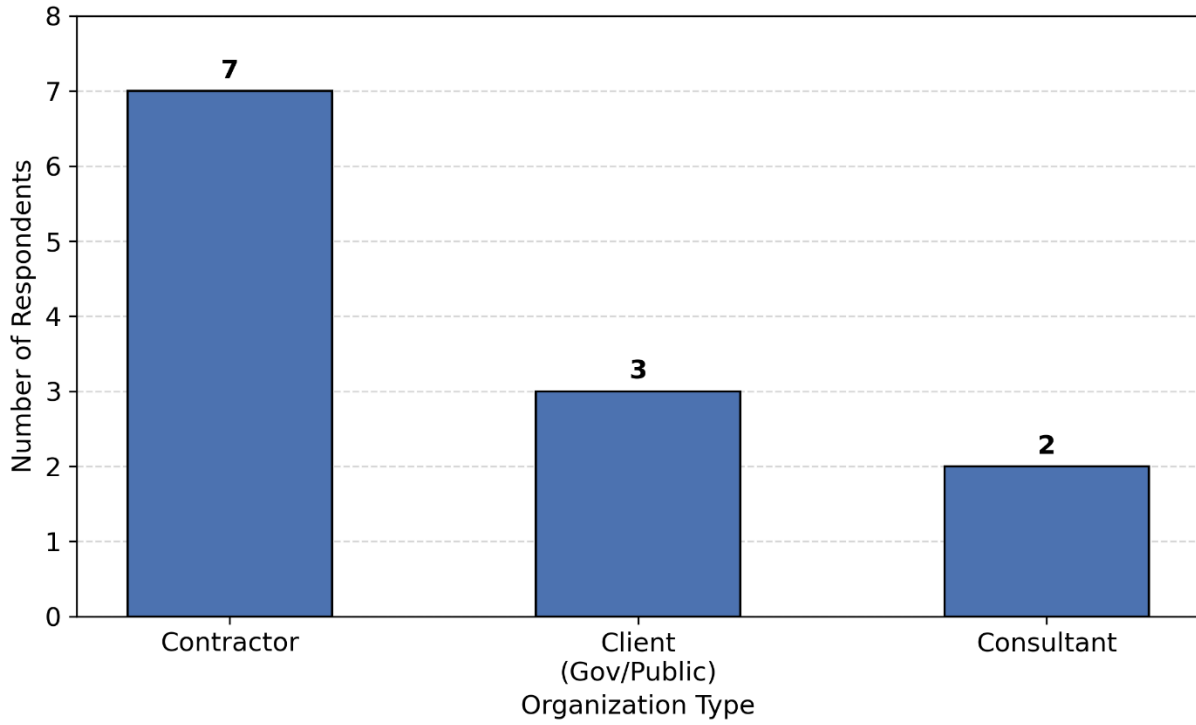


Figure 4. 1 Distribution of Respondents by Organization Type

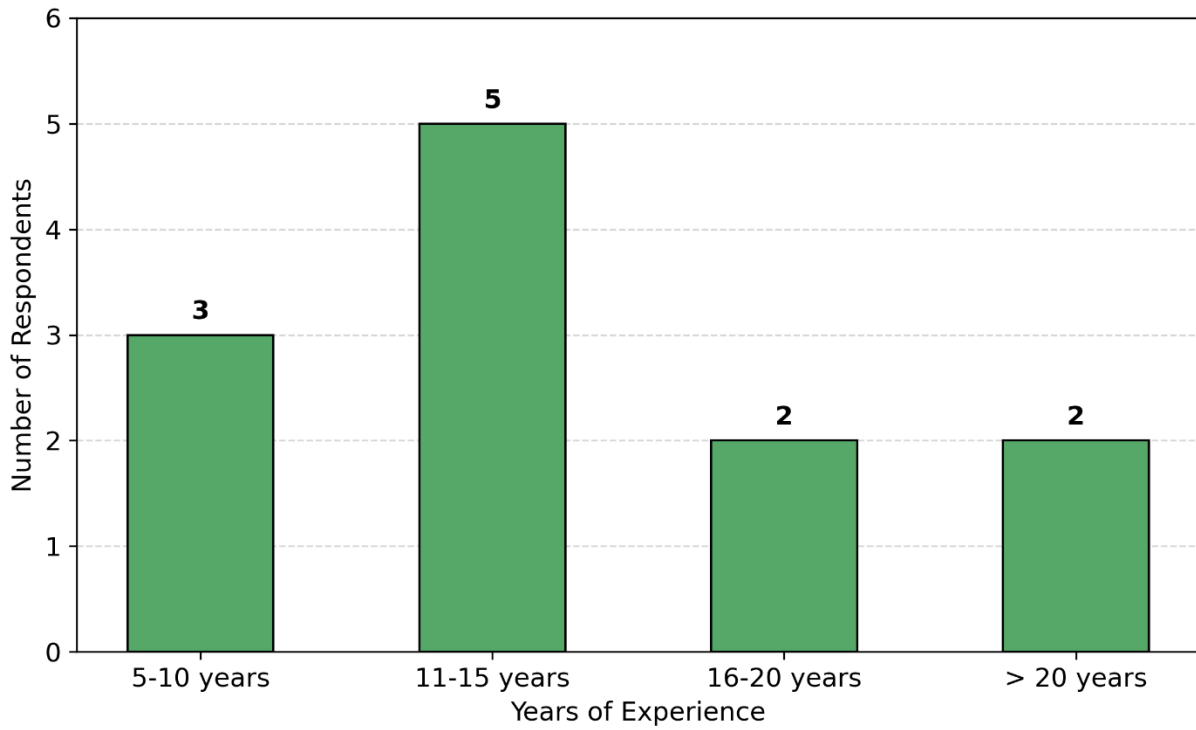


Figure 4. 2 Distribution of Respondents by Years of Experience

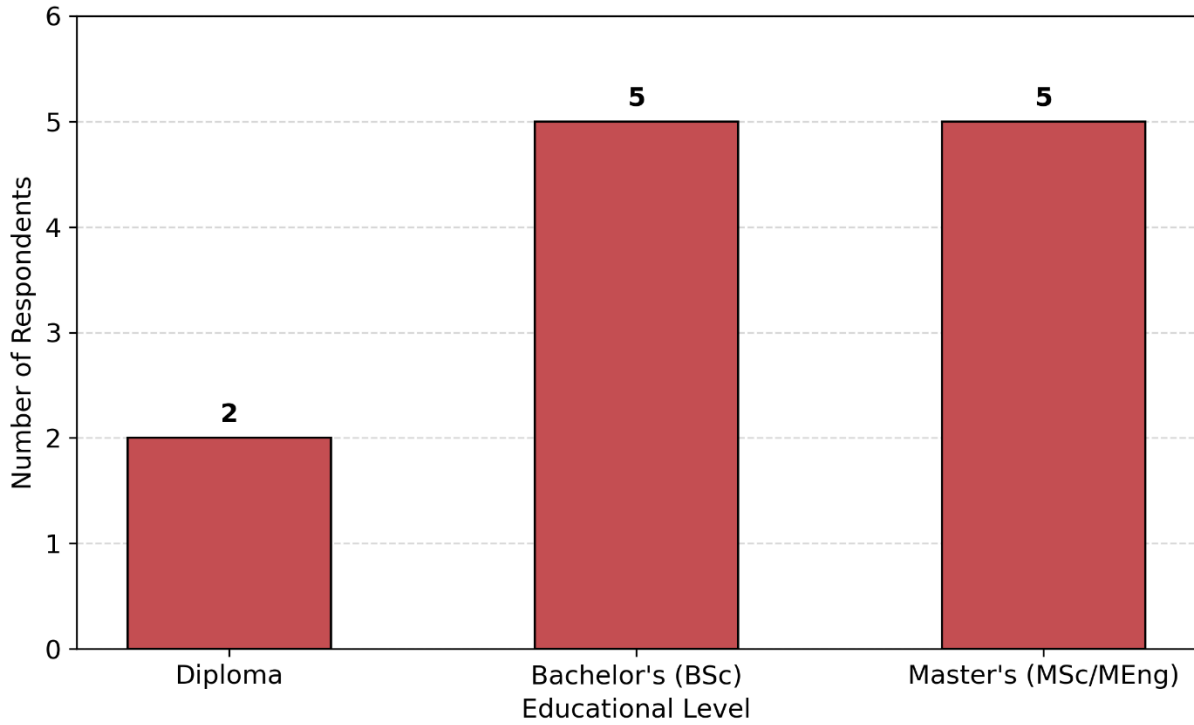


Figure 4. 3 Distribution by Highest Educational Level

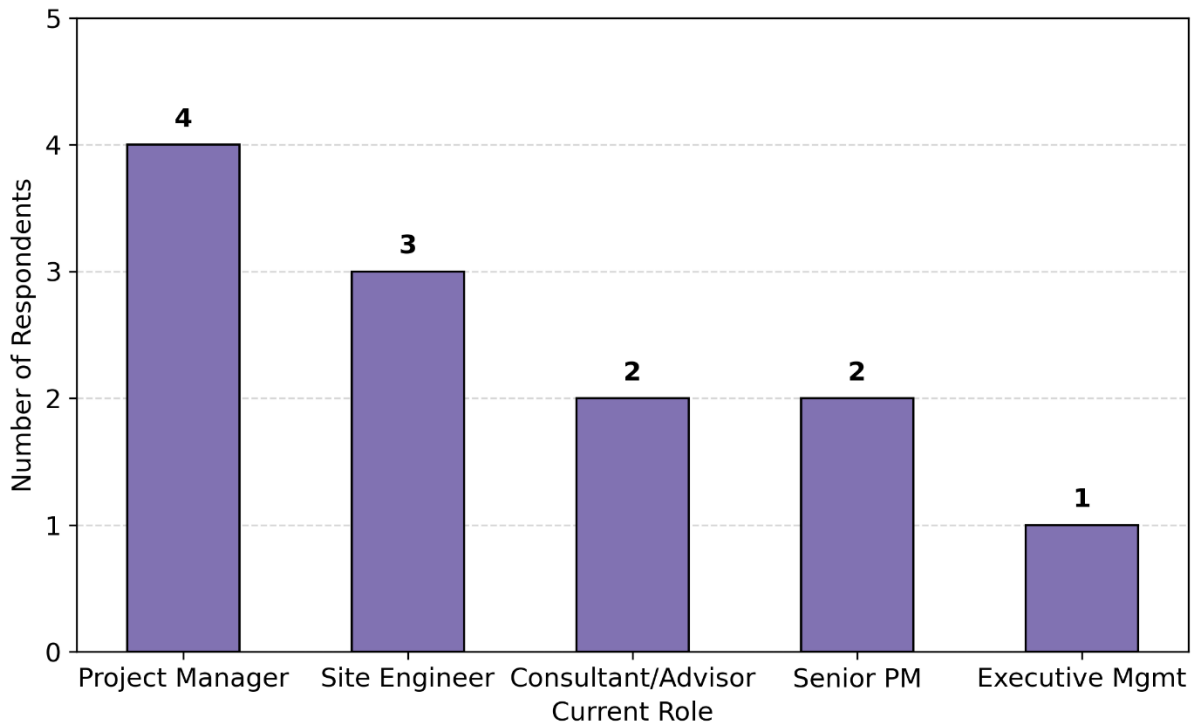


Figure 4. 4 Distribution of Respondents by Current Role

### 4.2.2 Profiles of Validation Panel

To validate the final strategic framework, a separate panel of six senior experts was consulted. The profiles presented in Figures 4.5 to 4.8 confirm the strategic depth of this group. Unlike the survey panel, this group is characterized by exceptional seniority, with all members possessing over 16 years of experience and holding executive or senior advisory positions. This high-level composition provides the necessary strategic oversight to ensure the proposed mitigation framework is not only theoretically sound but also institutionally feasible and actionable for decision-makers.

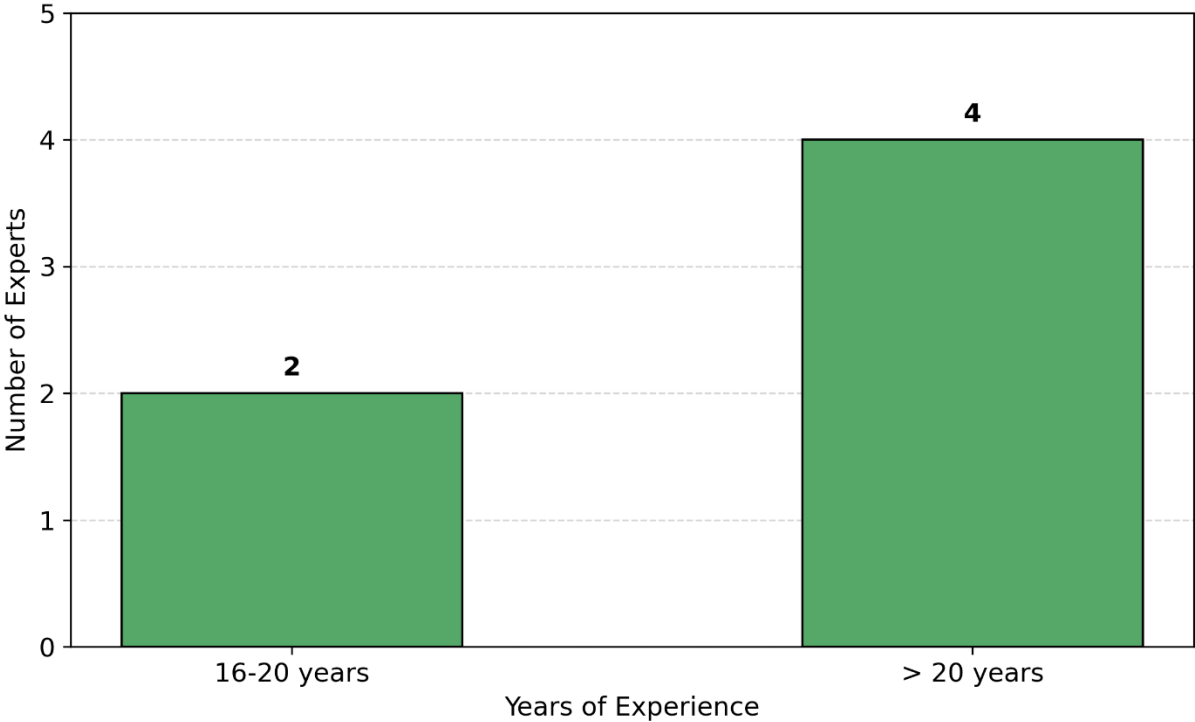


Figure 4. 5 Profile by Years of Experience (N=6)

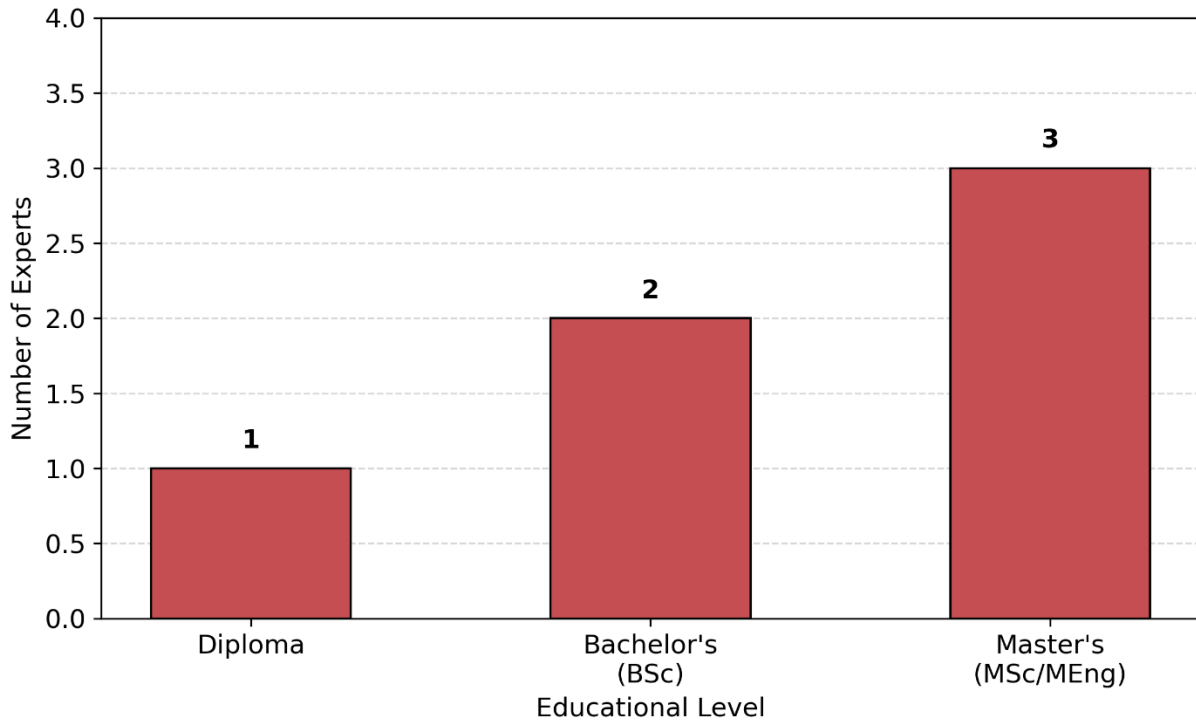


Figure 4. 6 Profile by Highest Educational Level (N=6)

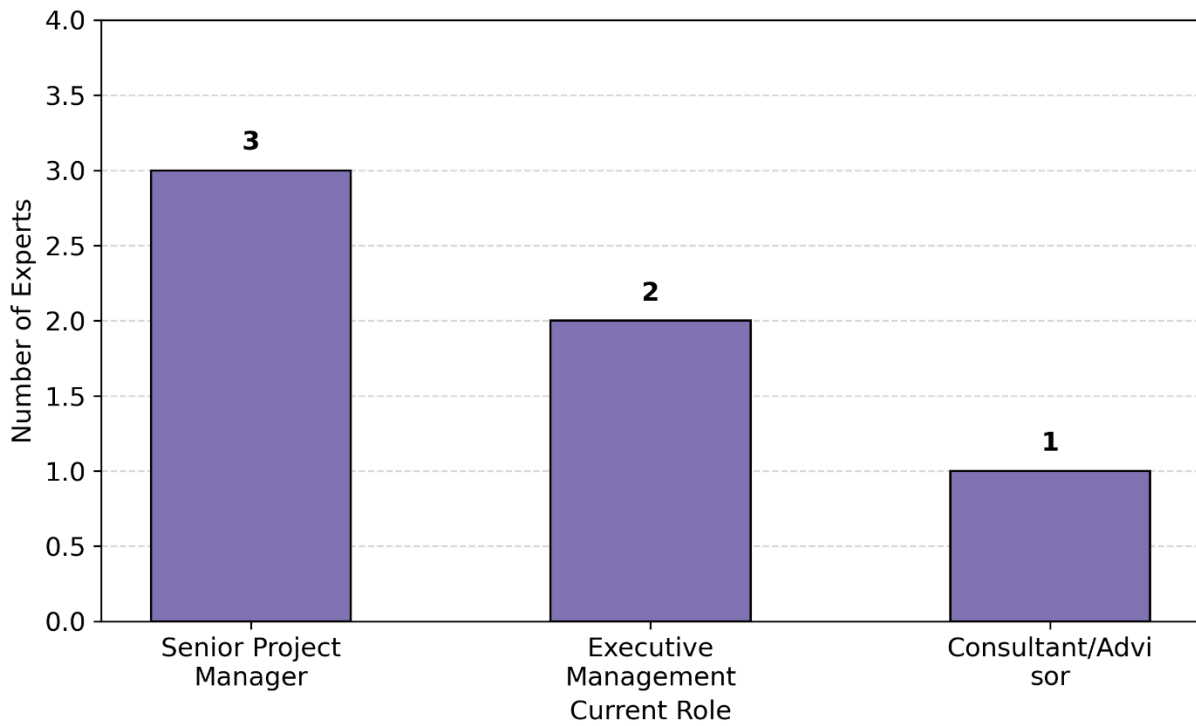


Figure 4. 7 Profile by Current Role (N=6)

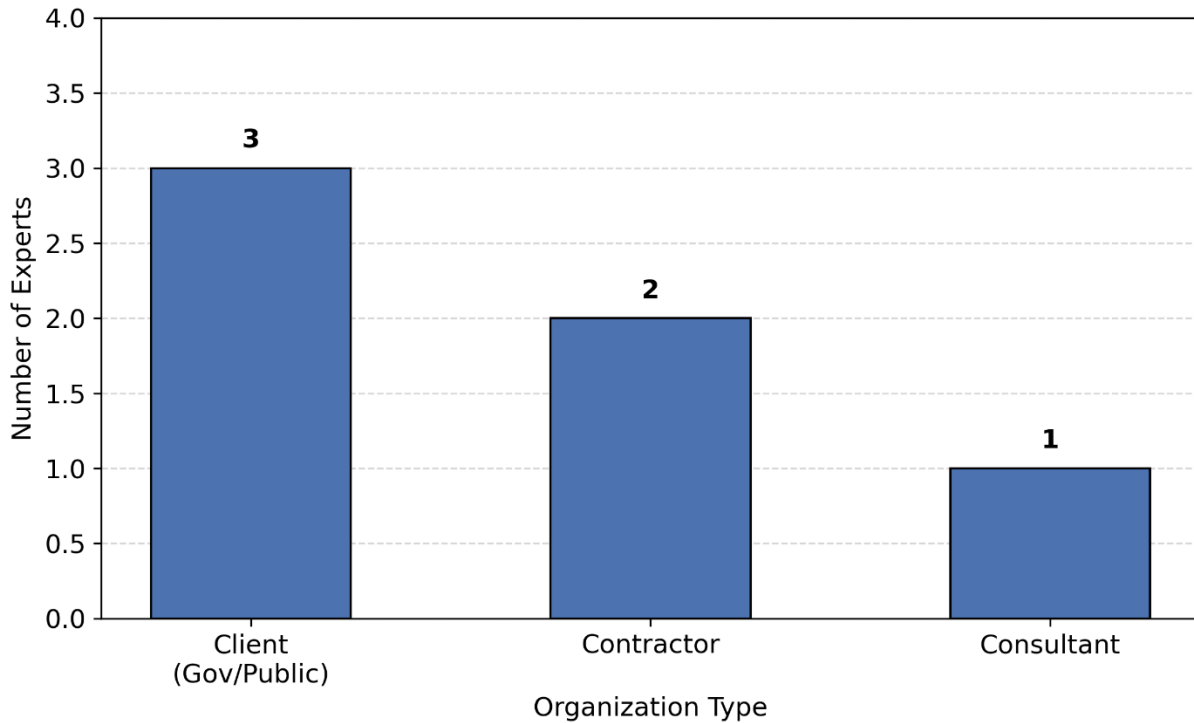


Figure 4. 8 Profile of Validation Experts by Organization (N=6)

### 4.3 AHP Results for Prioritization of Hindering Factors

This section presents the findings from the Analytic Hierarchy Process (AHP), a core component of the study designed to address the research question concerning the relative importance and priority ranking of cost performance hindering factors. The AHP methodology provides a structured approach for quantifying the subjective judgments of experts, thereby translating their experiential knowledge into a hierarchical ranking. The analysis was systematically conducted in two distinct stages: first, a high-level prioritization of the four main categories of hindering factors to understand the broader domains of concern, and second, a granular-level analysis to determine a comprehensive overall ranking of the 16 specific factors. This dual-stage approach allows for both a strategic overview and a detailed, actionable priority list.

Before presenting the results, it is imperative to establish the statistical validity of the expert judgments. The reliability of AHP outcomes is contingent upon the consistency of the pairwise comparisons made by the participants. The analysis yielded an aggregate consistency ratio (CR) of 0.0006. This value is substantially below the widely accepted maximum threshold of 0.10, indicating an exceptionally high degree of consistency and logical coherence in the expert

responses. Such a low CR provides strong confidence in the reliability of the derived weights and substantiates the credibility of the subsequent prioritization results.

The initial stage of the analysis focused on ranking the four main factor groups based on their perceived collective impact on cost performance. The prioritization of these categories, visually presented in Figure 4.9, reveals a clear hierarchy of concern among the industry experts. Financial and Economic Factors emerged as the most critical group, commanding the highest overall weight of 35.05%. This was closely followed by Contractual and External Factors, with a significant weight of 31.49%. Together, these two categories account for over two-thirds of the perceived importance, suggesting that stakeholders view macro-level, external, and institutional pressures as the primary drivers of poor cost performance. In comparison, Planning and Design Factors (20.85%) and Management and Resource Factors (12.61%) were perceived as having a comparatively lower, yet still significant, impact. This overarching result provides a crucial insight: the experts perceive the challenges originating from outside the direct control of the project team (e.g., inflation, political issues, contractual frameworks) as being more influential than the internal, operational factors (e.g., site supervision, resource allocation).

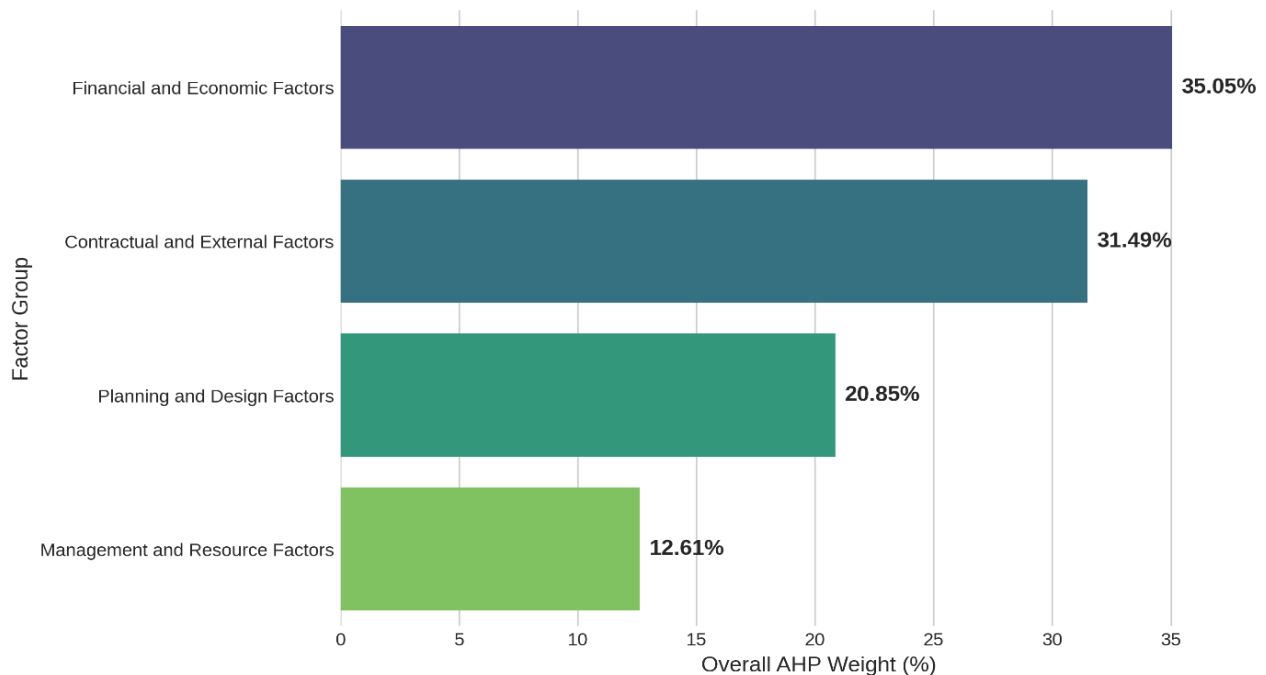


Figure 4.9 AHP Results: Prioritization of Main Factor Groups

To develop a more detailed and actionable understanding, the global weights of the 16 specific factors were calculated to create a comprehensive priority list. The results of this granular analysis, presented in Figure 4.10, are striking and offer profound implications. The factor 'Ineffective Right-of-Way Management' was unequivocally identified as the most critical factor, with a global weight of 29.28%. This factor stands in a category of its own; its weight is more than double that of the next-ranked factor, highlighting its dominant role in hindering cost performance from the experts' perspective. This overwhelming consensus points to a severe and systemic bottleneck in the pre-construction and construction phases, likely related to land acquisition, compensation disputes, and administrative delays, which has a cascading and debilitating effect on project costs.

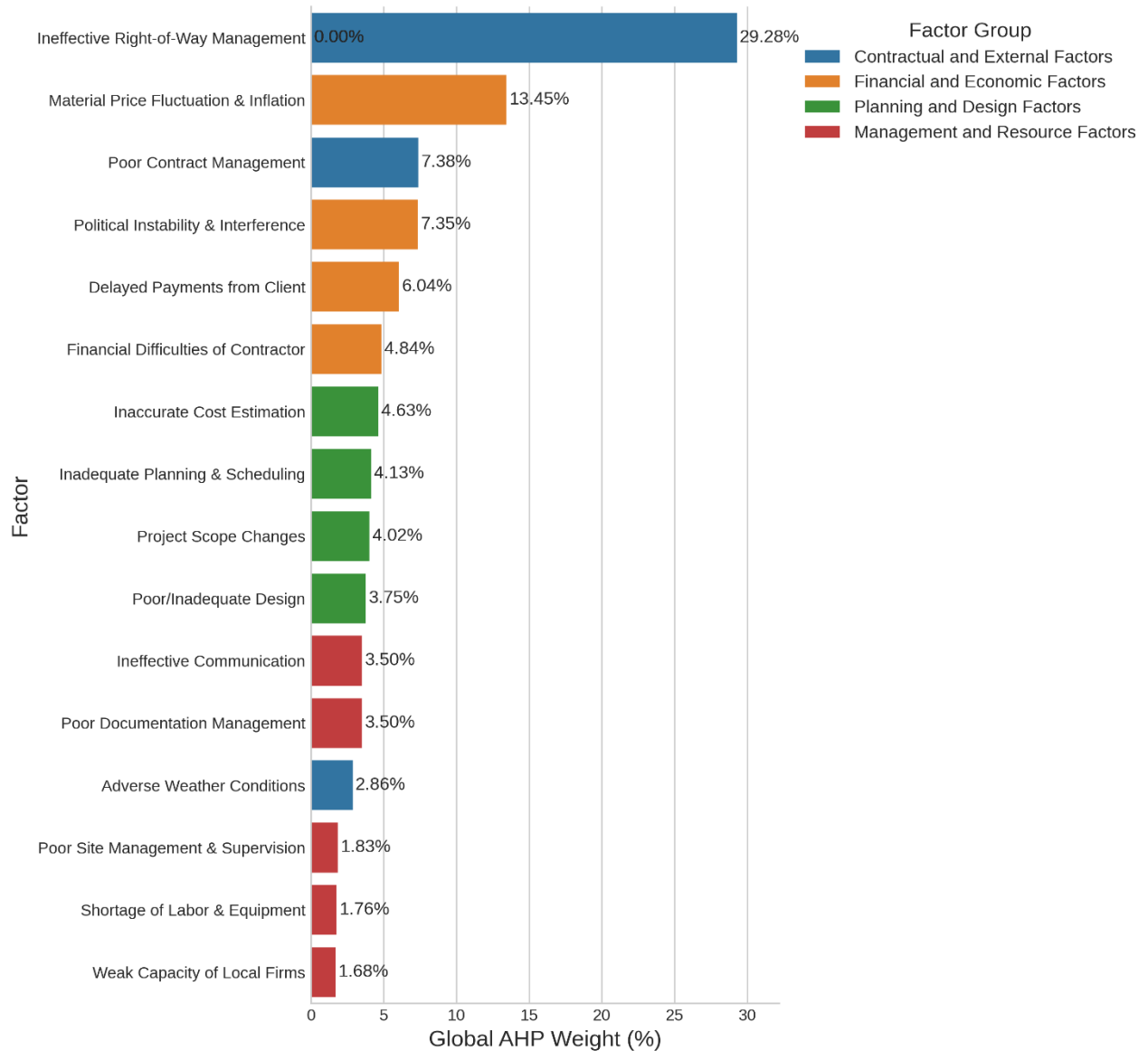


Figure 4. 10 AHP Results: Overall Ranking of Specific Factors

The second-ranked factor, 'Material Price Fluctuation & Inflation' (13.45%), reinforces the finding from the group-level analysis that economic volatility is a paramount concern. The significant gap between the first and second factors suggests that while inflation is a major problem, the administrative and institutional failures associated with right-of-way are perceived as a far more acute and impactful challenge within the Arsi Zone context. It is also noteworthy to consider the factors ranked at the bottom of the hierarchy. Foundational issues such as 'Weak Capacity of Local Firms' (1.68%) and 'Shortage of Labor & Equipment' (1.76%) received the lowest importance weights. The implication of this low ranking is not necessarily that these are non-existent problems,

but rather that their perceived direct impact on cost is overshadowed by the more dominant external and financial pressures. From the AHP perspective, stakeholders appear to be more focused on the immediate, high-impact symptoms (like land acquisition delays and price hikes) than on what might be considered underlying capacity issues.

A paramount finding from the AHP analysis is the overwhelming perceived importance of factors external to the immediate control of the project management team. The prioritization of 'Financial and Economic Factors' and 'Contractual and External Factors' as the two most critical categories, which collectively account for over two-thirds of the perceived importance, strongly indicates that stakeholders in Arsi Zone view macro-level pressures as the primary drivers of cost overruns. This perception aligns strongly with the broader body of research on construction challenges in developing nations, where studies have consistently underscored the profound impact of economic instability, institutional weaknesses, and volatile external environments on project outcomes (Mokoena, 2022; Ayalew et al., 2016). The present study empirically validates this perspective within the specific context of Arsi Zone, suggesting that stakeholders are most concerned with the institutional and economic frameworks within which projects must be delivered, often seeing these as more significant threats than internal, operational inefficiencies.

More specifically, the identification of 'Ineffective Right-of-Way Management' as the single most critical factor is a profound and contextually significant finding. Its calculated importance weight, which is more than double that of any other factor, elevates this issue beyond a simple line item on a list of problems to the status of a systemic and acute bottleneck within the Ethiopian road construction sector. This overwhelming consensus from industry experts strongly corroborates the findings of Kidane (2021) and Darsa & Negash (2023), who identified right-of-way and land acquisition challenges as major impediments to the timely and cost-effective delivery of road projects. However, the unique contribution of this research lies in its quantification of this factor's dominance, empirically establishing it as the most critical operational barrier to achieving cost performance in the region from the stakeholders' perspective. The AHP results thus paint a clear picture: while numerous factors contribute to cost overruns, the institutional failures associated with securing project land are perceived as the most damaging and immediate threat. This prioritization, based on perceived impact, identifies the most pressing symptoms but does not inherently diagnose their root causes, a limitation that the subsequent causal analysis will address.

This distinction between perceived importance and underlying causality is a critical theme that will be explored further in the subsequent DEMATEL analysis.

#### **4.4 DEMATEL Results for Causal Relationships Among Factors**

Whereas the Analytic Hierarchy Process (AHP) analysis served to identify what stakeholders perceive as the most important hindering factors, the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method was employed to elucidate why these factors are problematic by mapping the intricate web of cause-and-effect relationships that govern the system. The primary contribution of the DEMATEL analysis is its ability to move beyond a simple hierarchical ranking and model the underlying structure of the problem, revealing which factors are systemic drivers that initiate problems and which are dependent effects that manifest as symptoms. This causal understanding is fundamental for developing strategic interventions that target root causes rather than merely reacting to their outcomes.

The DEMATEL methodology calculates two key metrics for each factor based on expert assessments of their inter-influence. The first, Prominence (D+R), measures the total degree of a factor's interaction within the system, representing the sum of its influence on other factors (D) and the influence of other factors upon it (R). A high Prominence score indicates that a factor is a central and highly interactive component of the system. The second, and more strategically critical metric, is the Relation (D-R), which determines the net causal position of a factor. A positive (D-R) value signifies that the factor is a net cause or driver, exerting more influence than it receives. Conversely, a negative (D-R) value indicates that the factor is a net effect or symptom, being more influenced by other factors than it influences them.

The results of this analysis are visually synthesized in the causal influence diagram presented in Figure 4.11. In this diagram, factors positioned in the upper half of the plot are net causes (drivers), while those in the lower half are net effects (symptoms). The analysis reveals a powerful and strategically significant insight into the dynamics of cost overruns in the Arsi Zone. It identifies a distinct set of foundational drivers that trigger a cascade of subsequent problems. Specifically, factors such as 'Political Instability & Interference' (B4), 'Weak Capacity of Local Firms' (C3), and 'Poor/Inadequate Design' (A2) emerge as the strongest causal drivers in the system. The implication of this finding is that these factors function as the primary "sources of ignition" for cost-related issues. For instance, an unstable political environment can disrupt supply chains and

delay permits, while a poor design necessitates rework and scope changes, which in turn lead to cost and schedule overruns. These drivers are the fundamental levers for systemic change; addressing them proactively would prevent a multitude of downstream problems from ever occurring.

Conversely, the DEMATEL analysis identifies another group of factors that are primarily effects, heavily influenced by the aforementioned drivers. Factors such as 'Financial Difficulties of Contractor' (B2), 'Shortage of Labor & Equipment' (C1), and 'Poor Contract Management' (D1) are positioned as significant net effects. This is a crucial finding, as these are often the most visible and immediate problems that consume the attention of project managers. However, the analysis demonstrates that they are largely symptoms of deeper issues. For example, a contractor's financial difficulties (B2) are not an isolated event but are often the direct result of causal drivers like payment delays, politically induced work stoppages (B4), or unexpected costs arising from a poor design (A2).

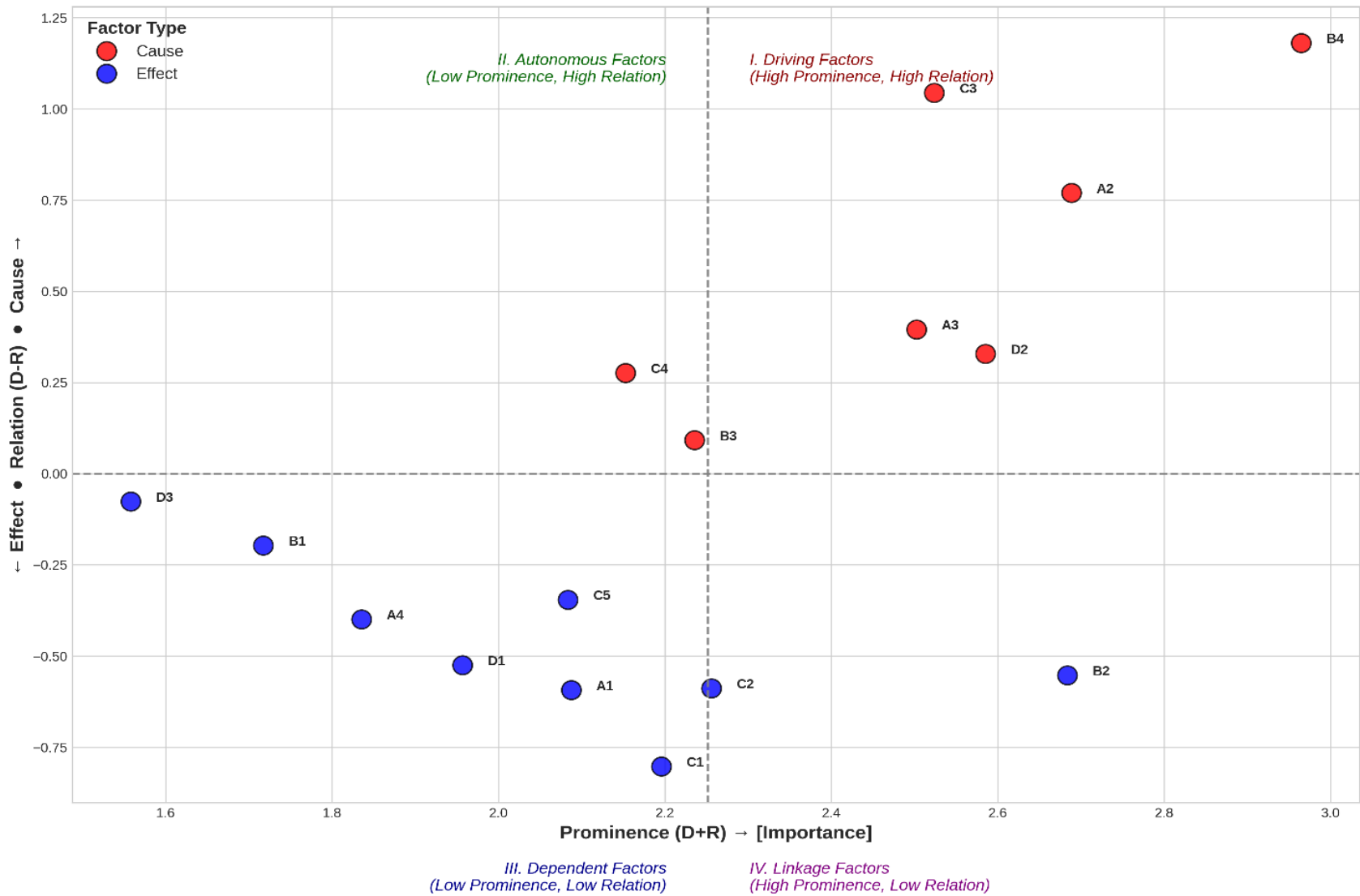


Figure 4. 11 DEMATEL Causal Influence Diagram for Cost Hindering Factors

Whereas the AHP analysis served to identify what stakeholders perceive as the most important hindering factors, the DEMATEL method was employed to elucidate the underlying causal structure, thereby explaining why these issues are so pervasive. By moving beyond a simple hierarchy of importance, this phase of the analysis modeled the intricate web of cause-and-effect relationships governing the system, providing a crucial structural diagnosis. The DEMATEL results revealed a clear and strategically significant distinction between a small set of foundational root causes that initiate problems and a larger group of dependent effects that manifest as the more visible, often-managed symptoms. This causal understanding is fundamental for shifting from a reactive management posture to a proactive one.

The analysis identified a distinct set of foundational drivers that function as powerful net causes within the system, exerting far more influence than they receive. Factors such as 'Political Instability & Interference' and 'Weak Capacity of Local Firms' emerged as having the highest positive Relation (D-R) scores, positioning them as primary causal drivers. These factors can be interpreted as the "sources of ignition" for cost-related problems; they do not exist in isolation but rather initiate a cascade of subsequent issues. For example, an unstable political environment can directly lead to delays in payments, disruptions in the supply chain, and unforeseen work stoppages, while weak local capacity fundamentally contributes to poor planning, design flaws, and inefficient site management, all of which ultimately manifest as cost and time overruns. These drivers represent the fundamental levers for systemic change, as addressing them proactively has the potential to prevent a multitude of downstream problems from ever occurring.

Conversely, the DEMATEL analysis identified another cluster of factors that are primarily net effects, or symptoms, which are heavily influenced by the aforementioned drivers. Factors such as 'Financial Difficulties of Contractor' and 'Poor Contract Management' were positioned as significant dependent variables, receiving substantial influence from other factors in the system. This is a crucial finding, as these are often the most visible and immediate problems that consume the attention and resources of project managers. However, the analysis demonstrates that they are largely symptoms of deeper, causal issues. A contractor's financial difficulties, for instance, are rarely an isolated event but are often the direct consequence of causal drivers like payment delays, politically induced work stoppages, or unexpected costs arising from a poor design. The strategic implication is profound: while these "fires" must be managed, any intervention focused solely on these symptomatic factors will be reactive and ultimately insufficient for preventing future

recurrence. Without addressing the root causes, stakeholders will remain trapped in a cycle of reactive problem-solving. This clear distinction between causal drivers and dependent effects provides the essential structural understanding needed for the development of a truly strategic mitigation framework.

This clear distinction between causal drivers and dependent effects provides the essential structural understanding needed for the development of a truly strategic mitigation framework, which will be explored in the next section by integrating these causal insights with the importance weights derived from the AHP.

#### **4.5 The AHP-DEMATEL Strategic Prioritization Matrix**

This section presents the core analytical contribution of the study, achieving the fourth research objective by integrating the distinct findings from the AHP and DEMATEL analyses. While the AHP identified factors based on their perceived importance and the DEMATEL analysis revealed their causal influence, the true strategic insight emerges from their synthesis. By plotting the AHP importance weights (Global Weight) on the y-axis against the DEMATEL causal influence scores (Relation, D-R) on the x-axis, a Strategic Prioritization Matrix is constructed. This matrix, shown in Figure 4.12, classifies the 16 hindering factors into four distinct strategic quadrants, transforming a complex dataset into a powerful visual tool for strategic decision-making.

The matrix provides a nuanced understanding that is impossible to achieve with either method in isolation. It allows for the differentiation of problems that are important *and* causal (Critical Drivers) from those that are important but are merely symptoms (Key Tangles), and crucially, those that are causal but may be overlooked due to low perceived importance (Driving Factors). To provide a more granular view beyond the visual plot, Table 4.1 presents the precise numerical data for each factor, organized by its strategic quadrant.

Table 4. 1 Classification of Factors in the AHP-DEMATEL Strategic Prioritization Matrix

Quadrant	Quadrant Description	Factor Name	Global Weight (Importance)	Relation (D-R) (Causality)	Group
I. Critical Drivers	<i>High Importance, High Causal Influence</i>	Ineffective Right-of-Way Management	0.2928	+0.3282	Contractual and External
		Political Instability & Interference	0.0735	+1.1804	Financial and Economic
II. Key Tangles	<i>High Importance, Low Causal Influence</i>	Material Price Fluctuation & Inflation	0.1345	-0.1973	Financial and Economic
		Poor Contract Management	0.0738	-0.5254	Contractual and External
III. Independent Factors	<i>Low Importance, Low Causal Influence</i>	Financial Difficulties of Contractor	0.0484	-0.5532	Financial and Economic
		Inaccurate Cost Estimation	0.0463	-0.5937	Planning and Design
		Project Scope Changes	0.0402	-0.3997	Planning and Design
		Poor Documentation Management	0.0350	-0.3462	Management and Resource
		Adverse Weather Conditions	0.0286	-0.0766	Contractual and External

		Poor Site Management & Supervision	0.0183	-0.5889	Management and Resource
		Shortage of Labor & Equipment	0.0176	-0.8031	Management and Resource
IV. Driving Factors	<i>Low Importance, High Causal Influence</i>	Delayed Payments from Client	0.0604	+0.0916	Financial and Economic
		Inadequate Planning & Scheduling	0.0413	+0.3949	Planning and Design
		Poor/Inadequate Design	0.0375	+0.7696	Planning and design
		Ineffective Communication	0.0350	+0.2757	Management and Resource
		Weak Capacity of Local Firms	0.0168	+1.0438	Management and Resource

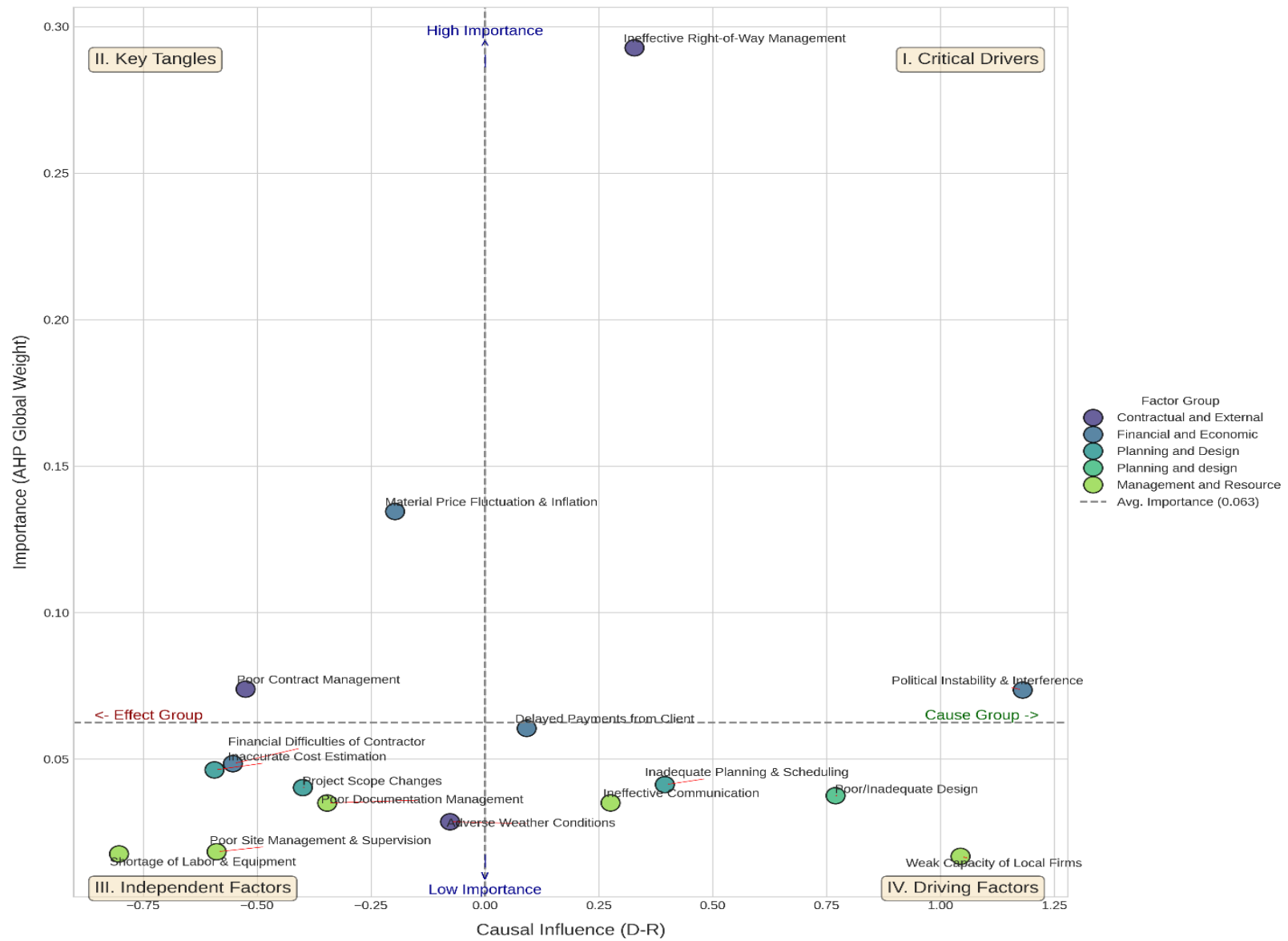


Figure 4. 12 AHP-DEMATEL Strategic Prioritization Matrix

The classification presented in Table 4.1 and Figure 4.12 provides a clear roadmap for strategic intervention. The factors in Quadrant I represent the most urgent priorities, as they are both highly important and strong root causes. In contrast, factors in Quadrant II, while highly visible and important, are largely effects; mitigating them without addressing the drivers in Quadrants I and IV will lead to recurring problems. Quadrant III contains secondary symptoms that are best managed through standard project controls, while Quadrant IV contains the hidden, foundational drivers that, despite their low perceived importance, exert a significant causal push on the entire system. This integrated analysis forms the empirical foundation for developing the strategic framework discussed in the next section.

The true strategic depth of the findings, and the core analytical contribution of this research, is revealed through the synthesis of the AHP and DEMATEL results into the integrated strategic prioritization matrix. This integration uncovers a critical paradox with profound implications for strategic intervention: a significant disconnect exists between the factors stakeholders perceive as most important and those that function as the most powerful underlying drivers of cost overruns. This paradox highlights the inherent limitation of relying solely on one dimension of analysis and underscores the unique value of the integrated methodological approach employed in this study. By reconciling perceived importance with causal influence, a more nuanced and strategically actionable understanding of the problem's architecture emerges.

The central paradox is clearly articulated by the classification of factors within the strategic quadrants. While the AHP analysis ranked factors such as 'Weak Capacity of Local Firms' as having very low perceived importance, the DEMATEL analysis identified this same factor as one of the most powerful foundational drivers in the entire system, exerting a significant net causal influence. This apparent contradiction offers a critical insight into stakeholder psychology and the typical focus of project management. It suggests that stakeholders and project managers tend to prioritize immediate, high-visibility problems, the symptoms, such as material price hikes or payment delays, because their direct impact on the budget is tangible and immediate. In doing so, they often underestimate the strategic importance of the underlying, systemic weaknesses that create the conditions for these symptoms to arise. This finding challenges the conventional wisdom that may arise from purely importance-based rankings, demonstrating that what is perceived as most critical is not always what is most causal.

This finding has significant implications, as it questions the reliability of strategic planning based solely on perceived importance. A strategy developed only from the AHP results would neglect a powerful root cause like 'Weak Capacity of Local Firms', thereby ensuring the perpetual recurrence of more visible and disruptive problems. This empirically validates the arguments of researchers like Mengistu & Mahesh (2020), who have highlighted the cascading negative effects of weak local contractor capacity in the Ethiopian context. The integrated framework provides concrete, data-driven evidence for why these seemingly "low importance" factors are, in fact, strategically critical. By failing to address these 'Foundational Drivers', however low their perceived immediate importance, stakeholders remain in a reactive posture, perpetually treating symptoms rather than curing the underlying disease. The integrated matrix, therefore, does not just present data; it offers a diagnostic tool that redirects strategic focus from the visible effects to the less obvious but far more influential root causes.

## **4.6 Development & Validation of Strategic Mitigation Framework**

This section addresses the fifth and final research objective: to develop a practical and impactful strategic framework for mitigating cost performance hindering factors. The analytical results from the AHP-DEMATEL matrix provide a data-driven diagnosis of the problem; however, translating this diagnosis into an effective, actionable strategy requires a further synthesis with industry best practices, relevant management theories, and the contextual wisdom of experienced professionals. This section details the two-stage process undertaken: first, the development of an initial proposed framework based on the analytical findings, and second, the rigorous validation and refinement of this framework through semi-structured interviews with a panel of senior industry experts.

### **4.6.1 The Proposed Framework and Expert Validation Process**

The analytical findings derived from the integrated AHP-DEMATEL model provided a data-driven diagnosis of the systemic issues hindering cost performance in Arsi Zone's road construction projects. However, translating this complex diagnosis into an effective and actionable strategic tool required a subsequent phase of synthesis and validation grounded in practical industry wisdom. Consequently, this research undertook a critical two-stage process to develop the final strategic mitigation framework. The first stage involved the formulation of an initial proposed framework, as depicted in Figure 4.13, which was designed to directly translate the logic of the

four analytical quadrants into distinct strategic imperatives. This initial model served as the foundational hypothesis for strategic intervention. The second, and more crucial, stage involved subjecting this proposed framework to a rigorous validation process through semi-structured interviews with a panel of six senior industry experts, whose profiles were detailed in Section 4.2.2. The primary objective of this validation process was to meticulously assess the proposed framework's clarity, contextual relevance, practical applicability, and overall completeness, thereby leveraging the collective professional experience of the panel to refine and fortify the final output.

The initial reception of the proposed framework by the expert panel was overwhelmingly positive, with strong endorsement for the core causal logic underpinning the model. The AHP-DEMATEL matrix was recognized as a powerful visualization of a complex reality. One senior official from the Ethiopian Roads Administration (ERA) affirmed this sentiment, stating, "This visualizes the systemic problem we face. We spend too many resources fighting fires in Quadrant II, while the real source of the fire is in Quadrant I." This commentary validated the fundamental premise of the research, that a distinction between high-impact symptoms and their underlying root causes is essential for effective management. This consensus on the paramount importance of the 'Critical Drivers' in Quadrant I confirmed that the analytical model resonated deeply with the lived experiences of senior decision-makers.

However, this general endorsement was accompanied by a series of profound and constructive critiques that were instrumental in elevating the framework from an analytical diagram to a robust strategic tool. A primary point of contention was the terminology derived directly from the analytical axes, which the panel argued was strategically misleading. The label 'Low Importance' for the foundational drivers in Quadrant IV was particularly contested. A project manager with extensive experience argued, "Factors like poor planning and weak local capacity are not low importance; they are foundational. They cause countless downstream problems." This insight revealed a critical interpretation: the AHP's 'importance' weighting captured immediate, visible project impact, whereas the experts' strategic perspective prioritized underlying, long-term systemic influence. Similarly, the term 'Independent Factors' for Quadrant III was deemed inaccurate, as the panel unanimously noted that these factors are clearly dependent effects of other systemic failures.

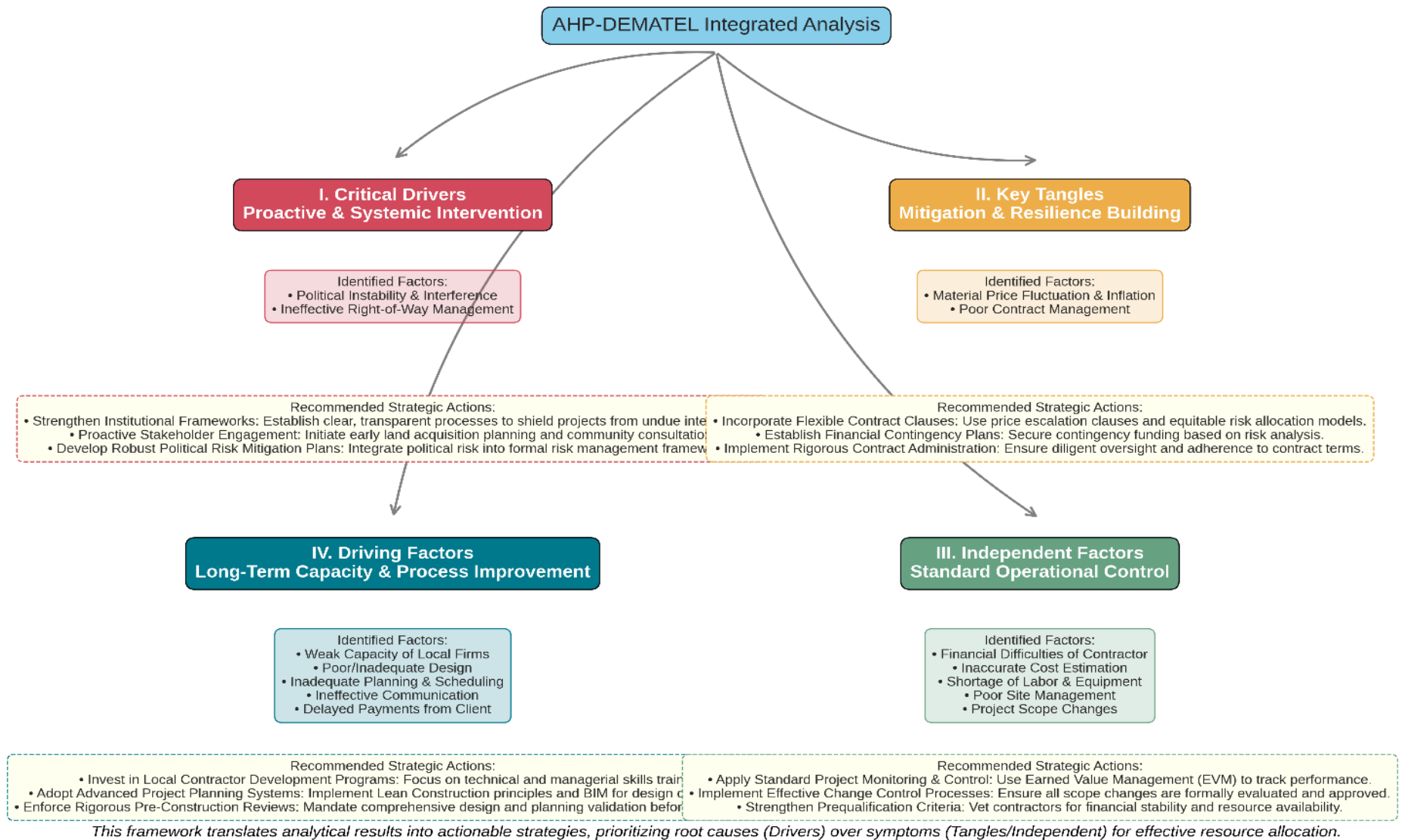


Figure 4. 13 Proposed Strategic Framework for Mitigating Cost Overrun in Road Construction

Furthermore, the expert panel emphasized a critical need for greater actionability and specificity in the proposed strategic actions. While the general strategies were considered relevant, they were perceived as too abstract for direct implementation. The experts called for a transformation of broad statements into concrete, tangible recommendations that could be operationalized at the project and institutional levels. This feedback highlighted a crucial gap between high-level strategic goals and the tactical steps required to achieve them. Complementing this call for actionability was a strong emphasis on accountability and ownership. The panel unanimously agreed that without clearly assigned responsibility, the framework would remain an academic exercise. A key suggestion was to link each strategic imperative to the primary stakeholder group, be it government bodies, consultants, or contractors, best positioned to lead its implementation, thereby embedding a mechanism for accountability directly into the framework's design. This collective feedback provided the essential practical wisdom necessary to refine the initial model, leading to the development of the final validated framework presented in the subsequent section.

#### **4.6.2 The Final Validated Strategic Mitigation Framework**

Following the comprehensive and insightful feedback from the expert panel, the initial proposed framework underwent a significant process of modification and refinement. This iterative process was essential for transforming the data-driven analytical model into a truly practical and strategically resonant management tool. The culmination of this synthesis between empirical analysis and experiential wisdom is the final, validated strategic mitigation framework, presented in Figure 4.14. This definitive framework preserves the core analytical foundation of the integrated AHP-DEMATEL analysis, which identifies and classifies hindering factors into four distinct quadrants based on their importance and causality. However, it has been substantively enriched with the practical nuances and strategic foresight of seasoned industry professionals, resulting in a more robust and actionable roadmap for stakeholders in the Ethiopian road construction sector.

The most pivotal enhancement in the final framework is its direct response to the experts' call for greater actionability and accountability. Moving beyond a simple diagnostic classification, the framework now translates the analytical findings from each quadrant into a set of consolidated and targeted recommendations assigned to the specific stakeholder groups best positioned to lead their implementation. As illustrated in Figure 4.14, the framework delineates clear strategic responsibilities for the Ethiopian Roads Authority (ERA), Consultants, and Contractors. For

instance, addressing the 'Critical Drivers' (Quadrant I), such as ineffective land acquisition, is now explicitly framed as a primary responsibility of the ERA, which is tasked with mandating robust contracts and streamlining the acquisition process. Similarly, mitigating the 'Key Tangles' (Quadrant II) and 'Driving Factors' (Quadrant IV) is translated into specific actions for consultants, such as conducting detailed pre-bid site investigations and enforcing better planning standards. Contractors are assigned responsibility for managing 'Independent Factors' (Quadrant III) through improved risk planning, project controls, and internal communication. This clear assignment of ownership transforms the framework from a descriptive model into a prescriptive tool for coordinated action.

Furthermore, the final validated framework embeds a mechanism for continuous improvement and measures of success, ensuring its long-term strategic utility. A dedicated Monitoring & Evaluation (M&E) component, informed by performance audits and stakeholder feedback, creates a feedback loop designed to refine and improve the strategic framework over time. The implementation of the stakeholder-specific recommendations is directly linked to a set of desired outcomes, including enhanced cost performance, timely project delivery, and increased stakeholder satisfaction. Critically, the framework establishes that progress toward these outcomes will be measured by tangible Key Performance Indicators (KPIs), such as reduced budget overruns, decreased project delays, and lower dispute resolution times. In its final form, this framework represents the ultimate contribution of this research. It successfully translates complex analytical findings into a clear, logical, and practical roadmap that empowers stakeholders to shift from a perpetually reactive, symptom-focused management style to a proactive, cause-driven, and accountable strategy for mitigating cost overruns.

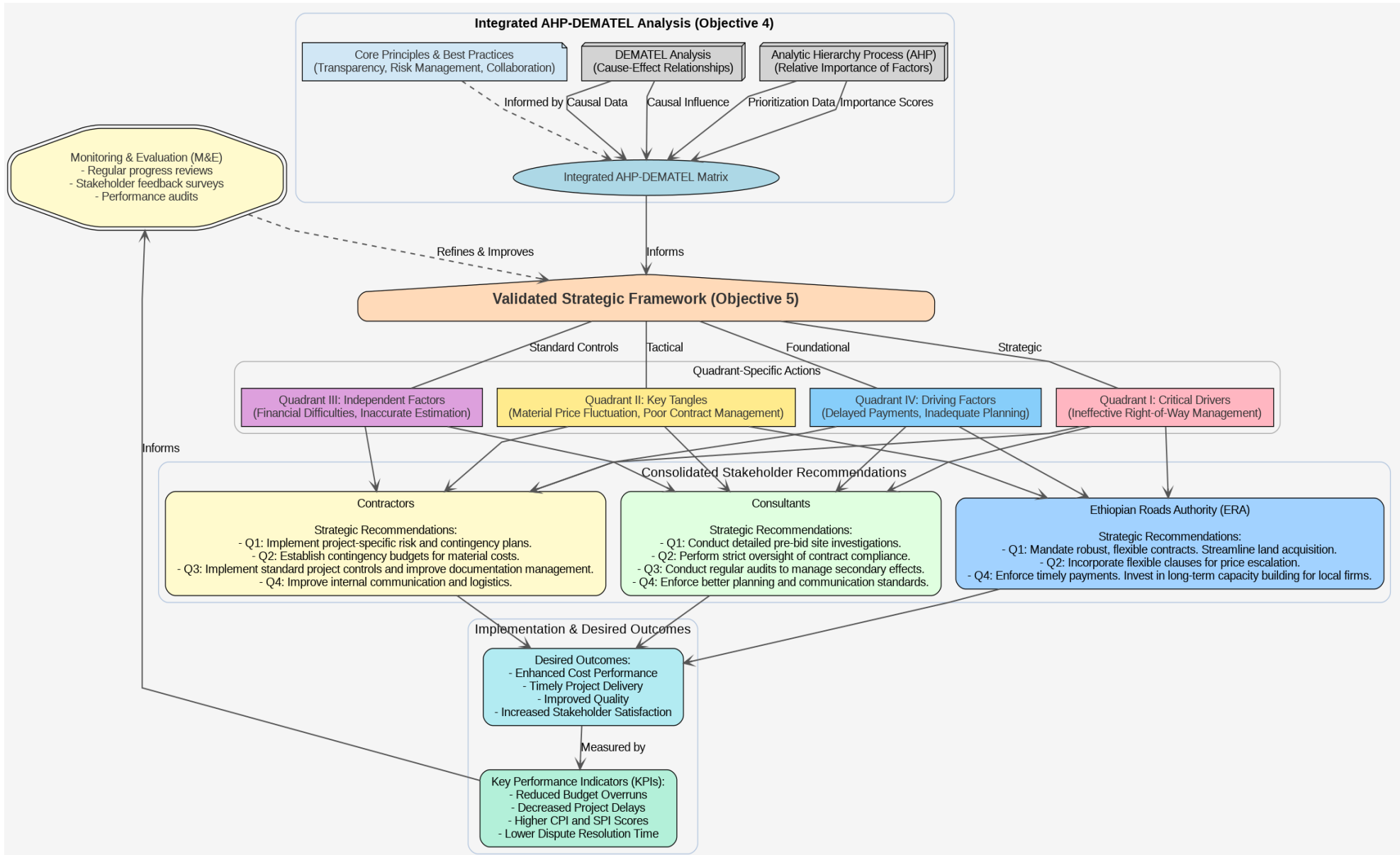


Figure 4. 14 Final Validated Strategic Framework for Mitigating Cost Overrun in Road Construction

### **4.6.3 Theoretical and Practical Implications of the Integrated Framework**

The culmination of this analytical journey is to address the fundamental "so what?" question, translating the complex findings into meaningful contributions for both academic theory and industry practice. The development and validation of the integrated strategic framework moves beyond a mere diagnosis of problems to offer a structured, evidence-based roadmap for intervention. This section, therefore, discusses the theoretical contributions of the study to the field of construction management research, as well as the practical implications for stakeholders involved in road construction projects in Arsi Zone and beyond.

From a theoretical standpoint, the findings of this research offer a robust validation of the synergistic power of integrated MCDM methodologies. The study empirically demonstrates that a standalone importance-ranking method like the Analytic Hierarchy Process (AHP), while useful for gauging stakeholder perceptions, is insufficient for comprehensive strategic planning. Its inherent assumption of criteria independence creates a risk of developing a superficial understanding of complex problems, a limitation previously noted in the literature (Raut et al., 2011). By integrating the DEMATEL method, this research overcomes that limitation. The integrated approach successfully maps the causal interdependencies that govern the system, providing a more holistic and structurally accurate model of the problem. This confirms the assertions of researchers who advocate for such hybrid approaches to capture the true complexity of real-world management challenges (Rahman et al., 2021). The study thus contributes a clear, context-specific example of how such an integrated methodology can yield deeper and more strategically relevant insights than either method could achieve in isolation.

On a practical level, the most significant implication of this research is the development of a validated strategic framework that provides a data-driven argument for a fundamental shift in management focus. The framework empowers stakeholders to move beyond a state of perpetual reactive firefighting, which involves expending resources on managing the highly visible symptoms found in the 'Key Tangles' and 'Operational Symptoms' quadrants, to a proactive, systemic approach. This new paradigm prioritizes interventions based on a nuanced understanding of causality. It calls for immediate, high-level attention on the urgent root causes ('Critical Drivers') while simultaneously advocating for long-term, systemic investments in the often-overlooked but highly influential 'Foundational Drivers'. Ultimately, the framework serves as an actionable guide

for policymakers and project leaders to allocate their limited financial and human resources more effectively, targeting interventions where they will have the most sustainable and far-reaching impact on mitigating the chronic issue of cost overruns.

## **4.7 Chapter Summary**

This chapter successfully achieved its objective of identifying, prioritizing, and structuring the causal relationships among key factors hindering cost performance in Arsi Zone's road construction projects. The initial phase of the analysis, employing the AHP, established a clear hierarchy of perceived importance, pinpointing 'Ineffective Right-of-Way Management' as the single most dominant factor influencing cost outcomes. However, the core analytical contribution emerged from the integrated AHP-DEMATEL analysis, which provided crucial strategic depth by distinguishing between high-impact root causes ('Critical Drivers' and 'Foundational Drivers') and their highly visible but symptomatic effects ('Key Tangles'). This causal understanding formed the empirical foundation for the development of a strategic mitigation framework, which was subsequently refined and validated through rigorous expert consultation to ensure its practical applicability. Ultimately, this chapter culminates in the presentation of a final, validated framework that provides a robust and actionable roadmap, designed to shift stakeholders from a reactive, problem-focused approach to a more strategic, cause-driven strategy for mitigating cost overruns.

## CHAPTER FIVE

### CONCLUSIONS AND RECOMMENDATIONS

This final chapter synthesizes the outcomes of the research, presenting the principal conclusions drawn from the analysis of cost performance hindering factors in Arsi Zone's road construction projects. It translates these conclusions into a set of targeted, actionable recommendations for key industry stakeholders. Finally, the chapter acknowledges the inherent limitations of the study and outlines promising avenues for future research that can build upon the foundations established herein.

#### 5.1 Conclusions

This study set out to develop a strategic framework for mitigating cost overruns in road construction projects within Arsi Zone, Ethiopia, by employing an integrated AHP-DEMATEL approach. Based on the rigorous analysis presented in the preceding chapter, the following core conclusions have been reached, directly addressing the research questions:

- The study successfully identified and prioritized 16 critical cost performance hindering factors. The Analytic Hierarchy Process (AHP) analysis conclusively demonstrated that stakeholders perceive external and institutional issues as the most significant threats to cost performance. Specifically, 'Ineffective Right-of-Way Management' was identified as the single most critical factor by a substantial margin, underscoring its dominant role in derailing project budgets from the outset.
- The Decision-Making Trial and Evaluation Laboratory (DEMATEL) analysis successfully moved beyond prioritization to map the intricate web of cause-and-effect relationships. A fundamental conclusion is the clear distinction between causal drivers and dependent effects. Factors such as 'Political Instability & Interference' and 'Weak Capacity of Local Firms' were identified as powerful root causes that exert significant influence across the system, while highly visible issues like 'Material Price Fluctuation & Inflation' and 'Financial Difficulties of Contractor' were revealed to be largely symptomatic effects.
- The primary analytical conclusion, derived from the integrated AHP-DEMATEL matrix, is the identification of a significant strategic paradox. Certain foundational drivers, such as 'Weak Capacity of Local Firms' and 'Poor/Inadequate Design,' though possessing immense

causal power, were perceived as having relatively low immediate importance by stakeholders. This disconnect explains why management efforts are often directed at fighting the "fires" of visible symptoms rather than addressing the underlying systemic weaknesses that ignite them.

- The study successfully translated these complex analytical insights into a practical, actionable, and expert-validated strategic mitigation framework. It is concluded that an effective strategy for mitigating cost overruns cannot be a one-size-fits-all approach. Instead, it must be a multi-pronged strategy that differentiates between: (a) immediate, high-level interventions for 'Critical Drivers'; (b) resilience-building measures for 'Key Tangles'; (c) long-term, systemic investments in 'Foundational Drivers'; and (d) standard operational controls for 'Operational Symptoms'. This framework represents the principal contribution of the research, offering a data-driven roadmap to shift the industry from a reactive to a proactive management paradigm.

## 5.2 Recommendations

Derived directly from the conclusions and the final validated strategic framework (Figure 4.14), the following recommendations are proposed to enhance cost performance in road construction projects. These recommendations are targeted at the specific stakeholders best positioned to effect change.

- a) For Government Policymakers and the Ethiopian Roads Administration (ERA)
  - Given its status as the most critical driver of cost overruns, RoW management must be elevated from a procedural task to a strategic priority. It is strongly recommended that dedicated, multi-agency RoW task forces be established with the executive authority to resolve land acquisition, compensation, and legal disputes *before* the commencement of construction contracts.
  - To counter the high causal influence of 'Political Instability & Interference,' it is recommended that institutional firewalls be strengthened to shield project-level decision-making from undue political influence. This can be achieved by mandating transparent project governance protocols and empowering independent technical oversight bodies.

- To address the 'Foundational Driver' of weak local capacity, a long-term, strategic investment is required. It is recommended that the government, in partnership with industry associations, launch a national program focused on building the technical, financial, and project management skills of local firms, linking advancement to higher-grade projects with demonstrated capacity improvements.
- b) For Project Owners (ERA) and Supervising Consultants
- To build resilience against the 'Key Tangles' of price and currency fluctuations, it is recommended that the use of flexible contract clauses, including price escalation for key materials and provisions for foreign currency fluctuation, be mandated. Furthermore, contingency funds should be based on quantitative risk analysis rather than arbitrary percentages.
  - To address the foundational issues of poor design and planning, it is recommended that a mandatory, independent review gate be established for all major projects. This review must certify the completeness of design, constructability, and budget adequacy before the project proceeds to tender.
- c) For Contractors and Industry Associations
- To improve long-term capacity and mitigate operational inefficiencies, it is recommended that the industry accelerate the adoption of modern tools. This includes the phased-in requirement for Building Information Modeling (BIM) for design integration and the use of Project Management Information Systems (PMIS) for real-time progress and cost tracking.
  - To manage the 'Operational Symptoms' effectively, it is recommended that contractors and consultants collaborate to strengthen pre-qualification criteria, ensuring firms have the verified financial and resource capacity to perform. Additionally, formal Change Control Boards should be implemented on all projects to ensure that scope changes are rigorously evaluated for their cost and time impacts before approval.

### **5.3 Further Research Works**

While this study provides a robust and context-specific framework, it also opens several avenues for future scholarly inquiry. The following areas are recommended for further research to build upon and expand the findings of this thesis:

- This research was conducted as a case study focused on Arsi Zone. Future research should test the applicability and validity of the strategic framework in other geographical and administrative zones within Ethiopia and in other developing countries. A comparative study could reveal significant regional variations and lead to a more universally applicable, yet context-sensitive, model.
- This study identified and structured the causal relationships between factors. The next logical step would be to quantify the magnitude of these relationships. Future research could employ structural equation modeling (SEM) or system dynamics simulation to model the financial impact of these causal chains, answering questions such as, "What is the average cost increase resulting from a one-month delay in RoW resolution?"
- The developed framework provides a prescriptive roadmap for improvement. A valuable long-term research project would be a longitudinal study that tracks the implementation of these recommendations over several years. Such research could empirically measure the framework's effectiveness in reducing the frequency and magnitude of cost overruns, providing ultimate validation of its practical utility.
- This study successfully utilized an integrated AHP-DEMATEL approach. Future work could explore more advanced Multi-Criteria Decision-Making (MCDM) techniques, such as the Analytic Network Process (ANP) to better model feedback loops, or incorporate fuzzy logic (e.g., Fuzzy DEMATEL) to more effectively handle the inherent ambiguity and uncertainty in expert judgments.

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## APPENDICES

### Appendix A. AHP Questionnaire

#### Prioritizing Cost Performance Hindering Factors in Road Construction Projects in Arsi Zone

##### Introduction and Purpose of the Study

Dear Participant,

Thank you for agreeing to participate in this critical research study, titled: "**A Strategic Analysis of Cost Performance Hindering Factors in Road Construction Projects Using an Integrated AHP-DEMATEL Approach: A Case Study of Arsi Zone, Ethiopia.**" This study aims to develop a strategic framework to mitigate cost overruns in road construction projects within the Arsi Zone.

Your expertise and hands-on experience are invaluable to this research. This questionnaire employs the **Analytical Hierarchy Process (AHP)** to determine the relative importance (weight) of various factors that hinder project cost performance. The data collected will be analyzed using Python-based tools to ensure robust and objective results, forming the basis for the subsequent DEMATEL analysis and framework development.

##### Confidentiality and Consent

All responses will be kept strictly confidential and will be aggregated for analysis. Your personal information will not be disclosed in the thesis or any related publications. Your participation is entirely voluntary.

By proceeding with this questionnaire, you provide your consent to participate in this study.

## **Part 1: Respondent's Profile**

*Please provide some information about your professional background. This will help contextualize the study's findings.*

### **1. Highest Educational Level Achieved**

- Diploma
- Bachelor's Degree (BSc)
- Master's Degree (MSc/MEng)
- PhD
- Other: \_\_\_\_\_

### **2. Type of Organization You Primarily Represent**

- Client (Governmental Body/Public Agency)
- Consultant (Designer, Supervising Engineer)
- Contractor
- Other: \_\_\_\_\_

### **3. Your Current Role/Position in the Organization**

- Senior Project Manager
- Project Manager
- Site Engineer
- Consultant/Advisor
- Executive Management
- Other: \_\_\_\_\_

### **4. Years of Experience in Road Construction Projects**

- 5-10 years
- 11-15 years
- 16-20 years
- More than 20 years

## Part 2: Instructions for Pairwise Comparison

In the following sections, you will be asked to compare two factors (or groups of factors) at a time to determine their relative importance in contributing to **cost overruns** in road construction projects in the Arsi Zone.

Please use the 9-point Saaty scale provided below. For each pair, ask yourself: "**Which of these two factors has a greater impact on hindering cost performance, and by how much?**"

### The 9-Point Saaty Scale

Intensity of Importance	Definition	Explanation
1	Equal Importance	Both factors contribute equally to the objective.
3	Moderate Importance	Experience and judgment slightly favor one factor over another.
5	Strong Importance	Experience and judgment strongly favor one factor over another.
7	Very Strong Importance	One factor is favored very strongly over another; its dominance is demonstrated in practice.
9	Extreme Importance	The evidence favoring one factor over another is of the highest possible order of affirmation.
2, 4, 6, 8	Intermediate Values	Used when compromise is needed between two judgments.

### How to Fill the Tables

- For each pair of factors, circle the number that best represents your judgment.
- If you believe Factor A is **moderately more important** than Factor B, circle **3** on the side of Factor A.
- If you believe they are **equally important**, circle **1**.
- You only need to fill out the comparisons on **one side** of the "1". The other side is the reciprocal and will be calculated automatically.

### Part 3: Pairwise Comparison of Factor Groups

**Objective:** To determine the relative importance of the main *categories* of cost performance hindering factors.

<b>Group A: Planning and Design Factors</b>	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	<b>Group B: Financial and Economic Factors</b>
Group A: Planning and Design Factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Group C: Management and Resource Factors
Group A: Planning and Design Factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Group D: Contractual and External Factors
Group B: Financial and Economic Factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Group C: Management and Resource Factors
Group B: Financial and Economic Factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Group D: Contractual and External Factors
Group C: Management and Resource Factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Group D: Contractual and External Factors

### Part 4: Pairwise Comparison of Factors within Each Group

<b>A1: Inaccurate Cost Estimation</b>	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	<b>A2: Poor/Inadequate Design</b>
A1: Inaccurate Cost Estimation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	A3: Inadequate Planning & Scheduling
A1: Inaccurate Cost Estimation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	A4: Project Scope Changes
A2: Poor/Inadequate Design	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	A3: Inadequate Planning & Scheduling
A2: Poor/Inadequate Design	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	A4: Project Scope Changes
A3: Inadequate Planning & Scheduling	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	A4: Project Scope Changes
<b>B1: Material Price Fluctuation &amp; Inflation</b>	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	<b>B2: Financial Difficulties of Contractor</b>

B1: Material Price Fluctuation & Inflation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	B3: Delayed Payments from Client
B1: Material Price Fluctuation & Inflation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	B4: Political Instability & Interference
B2: Financial Difficulties of Contractor	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	B3: Delayed Payments from Client
B2: Financial Difficulties of Contractor	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	B4: Political Instability & Interference
B3: Delayed Payments from Client	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	B4: Political Instability & Interference
<b>C1: Shortage of Labor &amp; Equipment</b>	<b>9</b>	<b>8</b>	<b>7</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>C2: Poor Site Management &amp; Supervision</b>
C1: Shortage of Labor & Equipment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C3: Weak Capacity of Local Firms
C1: Shortage of Labor & Equipment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C4: Ineffective Communication
C1: Shortage of Labor & Equipment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C5: Poor Documentation Management
C2: Poor Site Management & Supervision	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C3: Weak Capacity of Local Firms
C2: Poor Site Management & Supervision	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C4: Ineffective Communication
C2: Poor Site Management & Supervision	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C5: Poor Documentation Management
C3: Weak Capacity of Local Firms	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C4: Ineffective Communication
C3: Weak Capacity of Local Firms	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C5: Poor Documentation Management
C4: Ineffective Communication	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	C5: Poor Documentation Management
<b>D1: Poor Contract Management</b>	<b>9</b>	<b>8</b>	<b>7</b>	<b>6</b>	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>D2: Ineffective Right-of-Way Management</b>
D1: Poor Contract Management	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	D3: Adverse Weather Conditions
D2: Ineffective Right-of-Way Management	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	D3: Adverse Weather Conditions

## Appendix B. DEMATEL Questionnaire

### Analyzing Causal Relationships Among Cost Performance Hindering Factors in Road Construction Projects

#### Introduction and Purpose of the Study

Dear Participant,

Thank you again for your invaluable contribution to this research study: "**A Strategic Analysis of Cost Performance Hindering Factors in Road Construction Projects Using an Integrated AHP-DEMATEL Approach: A Case Study of Arsi Zone, Ethiopia.**"

This second questionnaire utilizes the **Decision-Making Trial and Evaluation Laboratory (DEMATEL)** method. Unlike the previous AHP survey which focused on determining the *importance* of each factor, the purpose of this questionnaire is to understand the **cause-and-effect relationships** among these critical factors. Your expert judgment will help us identify which factors are the root causes (drivers) and which are the resulting effects (symptoms) of poor cost performance in the Arsi Zone.

#### Confidentiality and Consent

As before, all responses will be kept strictly confidential and will be aggregated for analysis. Your personal information will not be disclosed. Your participation is voluntary.

By proceeding with this questionnaire, you reaffirm your consent to participate in this study.

#### Part 1: Respondent's Profile

*(This section is included to ensure complete data for each instrument. If you have already provided this, you may skip it, but completing it again is appreciated.)*

##### 1. Highest Educational Level Achieved

- Diploma
- Bachelor's Degree (BSc)
- Master's Degree (MSc/MEng)
- PhD
- Other: \_\_\_\_\_

2. **Type of Organization You Primarily Represent**

- Client (Governmental Body/Public Agency)
- Consultant (Designer, Supervising Engineer)
- Contractor
- Other: \_\_\_\_\_

3. **Your Current Role/Position in the Organization**

- Senior Project Manager
- Project Manager
- Site Engineer
- Consultant/Advisor
- Executive Management
- Other: \_\_\_\_\_

4. **Years of Experience in Road Construction Projects**

- 5-10 years
- 11-15 years
- 16-20 years
- More than 20 years

**Part 2: Instructions for the DEMATEL Matrix**

In the following table, you are asked to evaluate the **direct influence** that each factor has on every other factor. For each cell in the matrix, please ask yourself the question:

**"To what extent does the factor in the ROW *directly influence* the factor in the COLUMN?"**

Please use the 5-point influence scale provided below to assign a numerical value to each relationship.

## The 5-Point DEMATEL Influence Scale

Numerical Value	Level of Influence	Definition
0	No Influence	The row factor has no direct effect on the column factor.
1	Low Influence	The row factor has a small or indirect effect on the column factor.
2	Medium Influence	The row factor has a moderate and noticeable effect on the column factor.
3	High Influence	The row factor has a significant and strong effect on the column factor.
4	Very High Influence	The row factor has an extremely strong and direct effect on the column factor.

### How to Fill the Table

- In the large matrix in Part 3, write a number from **0 to 4** in each white cell.
- The **rows** represent the **influencing factor (the cause)**.
- The **columns** represent the **influenced factor (the effect)**.
- The greyed-out diagonal cells should be left blank, as a factor does not influence itself.

### Part 3: DEMATEL Influence Matrix

Please refer to the list below for the full description of each factor code used in the matrix.

#### List of Critical Factors and Their Codes

- **A1:** Inaccurate Cost Estimation
- **A2:** Poor/Inadequate Design
- **A3:** Inadequate Planning & Scheduling
- **A4:** Project Scope Changes
- **B1:** Fluctuation in Material Prices & Inflation
- **B2:** Financial Difficulties of Contractor
- **B3:** Delayed Payments from Client
- **B4:** Political Instability & Interference
- **C1:** Shortage of Labor & Equipment
- **C2:** Poor Site Management & Supervision

- **C3:** Weak Capacity of Local Firms
- **C4:** Ineffective Communication
- **C5:** Poor Documentation Management
- **D1:** Poor Contract Management
- **D2:** Ineffective Right-of-Way Management
- **D3:** Adverse Weather Conditions

**Please fill in the matrix below with values from 0 to 4.**

Influencing Factor (Cause) ↓	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	C5	D1	D2	D3
A1																
A2																
A3																
A4																
B1																
B2																
B3																
B4																
C1																
C2																
C3																
C4																
C5																
D1																
D2																
D3																

**Thank you for your invaluable time and expert contribution to this research.**

# **Appendix C. Expert Interview Guide**

## **Validation of the Strategic Mitigation Framework**

### **A Strategic Analysis of Cost Performance Hindering Factors in Road Construction Projects**

#### **Case Study: Arsi Zone, Ethiopia**

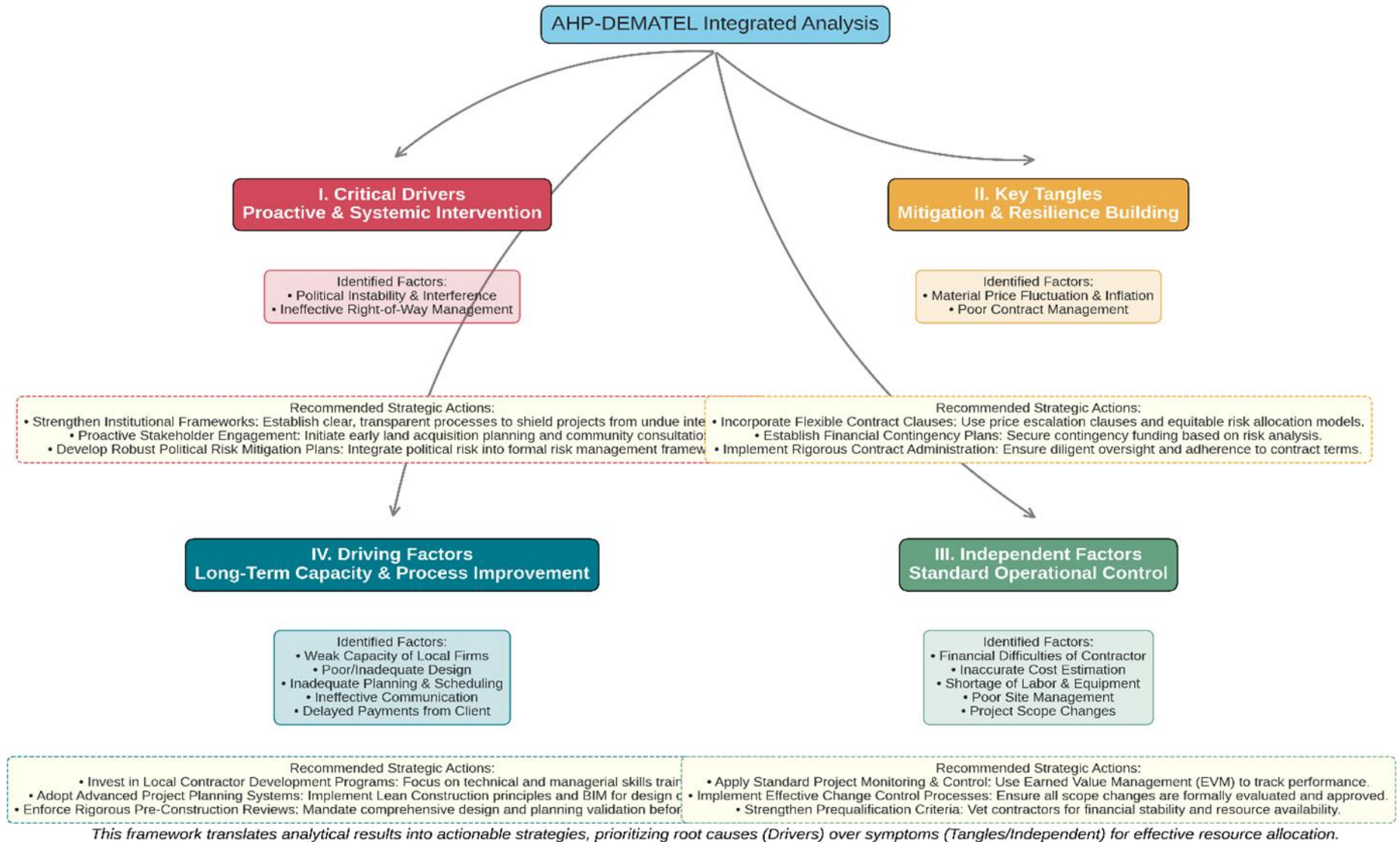
##### **Part 1: Introduction and Purpose of the Interview**

Good [morning/afternoon], thank you for taking the time to participate in this interview. My name is Girma Geleta, and I am a Master's student in Construction Engineering and Management at Adama Science and Technology University.

The primary purpose of this interview is to validate and refine a strategic framework developed as part of my thesis research. This framework aims to provide a practical guide for mitigating cost-hindering factors in road construction projects specifically within the Arsi Zone. Your extensive experience and insights are invaluable for ensuring the framework is both accurate and actionable.

The interview will last approximately 45-60 minutes. All your responses will be kept confidential and will be used solely for academic purposes. With your permission, I would like to record the audio of this session to ensure I capture your insights accurately.

## Part 2: General Perception of the Framework



1. Based on your initial review, what is your overall impression of this framework?
2. Is the structure, which classifies factors into four strategic quadrants (Critical Drivers, Key Tangles, Driving Factors, Independent Factors), clear and logical to you?
3. From your experience, does this framework appear to capture the key dynamics of cost overruns in the region?

### **Part 3: Detailed Validation of Strategic Quadrants**

#### ***3.1 Validation of Quadrant I. Critical Drivers (Proactive & Systemic Intervention)***

- The framework places the following factors in this quadrant:
  - Political Instability & Interference
  - Ineffective Right-of-Way Management
- 4. Do you agree with this grouping? Are there any factors you believe are missing from this category, or any that should be moved to another quadrant?
- The proposed strategic actions are:
  - Strengthen Institutional Frameworks
  - Proactive Stakeholder Engagement
  - Develop Robust Political Risk Mitigation Plans
- 5. How relevant and practical are these strategies for addressing the identified factors in the context of Arsi Zone?
- 6. What are the potential barriers to implementing these strategies effectively?
- 7. Can you suggest any alternative or more specific strategies for this group of factors?

#### ***3.2 Validation of Quadrant II. Key Tangles (Mitigation & Resilience Building)***

- The framework places the following factors in this quadrant:
  - Material Price Fluctuation & Inflation
  - Poor Contract Management
- 8. Do you agree with this grouping? Are there any factors you believe are missing from this category, or any that should be moved to another quadrant?

- The proposed strategic actions are:
    - Incorporate Flexible Contract Clauses (e.g., price escalation)
    - Establish Financial Contingency Plans
    - Implement Rigorous Contract Administration
9. How relevant and practical are these strategies for addressing the identified factors in the context of Arsi Zone?
10. What are the potential barriers to implementing these strategies effectively?
11. Can you suggest any alternative or more specific strategies for this group of factors?

### ***3.3 Validation of Quadrant IV. Driving Factors (Long-Term Capacity & Process Improvement)***

- The framework places the following factors in this quadrant:
    - Weak Capacity of Local Firms
    - Poor/Inadequate Design
    - Inadequate Planning & Scheduling
    - Ineffective Communication
12. Do you agree with this grouping? Are there any factors you believe are missing from this category, or any that should be moved to another quadrant?
- The proposed strategic actions are:
    - Invest in Local Contractor Development
    - Adopt Advanced Project Planning Systems (Lean/BIM)
    - Enforce Rigorous Pre-Construction Reviews
13. How relevant and practical are these strategies for addressing the identified factors in the context of Arsi Zone?
14. What are the potential barriers to implementing these strategies effectively?
15. Can you suggest any alternative or more specific strategies for this group of factors?

### ***3.4 Validation of Quadrant III. Independent Factors (Standard Operational Control)***

- The framework places the following factors in this quadrant:

- Financial Difficulties of Contractor
- Inaccurate Cost Estimation
- Shortage of Labor & Equipment
- Project Scope Changes

16. Do you agree with this grouping? Are there any factors you believe are missing from this category, or any that should be moved to another quadrant?

- The proposed strategic actions are:
  - Apply Standard Project Monitoring (EVM)
  - Implement Effective Change Control
  - Strengthen Prequalification Criteria

17. How relevant and practical are these strategies for addressing the identified factors in the context of Arsi Zone?

18. What are the potential barriers to implementing these strategies effectively?

19. Can you suggest any alternative or more specific strategies for this group of factors?

#### **Part 4: Framework Cohesion and Practical Implementation**

20. The framework is built on the idea that addressing the 'Drivers' (Quadrants I and IV) will naturally mitigate the 'Effects' or symptoms (Quadrants II and III). Does this causal logic align with your professional experience?

21. Who do you believe would be the primary user of this framework (e.g., project managers, policymakers at ERA, consultants, contractors)?

22. What would be the single biggest challenge to implementing this framework in a real-world project environment in Ethiopia?

23. Do you have any final recommendations on how this framework could be improved to make it more useful for the Ethiopian construction industry?

## **Part 5: Conclusion**

That concludes my questions. Thank you once again for your invaluable time and expert contribution. Your feedback is crucial for the successful completion of this research and will help in developing a tool that can genuinely benefit our local construction industry.

Do you have any final comments or questions for me?