



ADDIS ABABA UNIVERSITY

COLLEGE OF TECHNOLOGY AND BUILT ENVIRONMENT

DEPARTMENT OF INFRASTRUCTURE AND TECHNOLOGY MANAGEMENT

**CAUSES AND MITIGATION STRATEGIES FOR CONSTRUCTION DELAYS IN  
SMALL- AND MEDIUM-SCALE DAMS: THE CASE OF PHASE 1 OF THE FINNA  
OROMIA INITIATIVE**

BY

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*A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of*

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**Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale  
Dams: The Case of Phase 1 of the Finna Oromia Initiative**

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**DECLARATION**

I hereby declare that this thesis entitled “*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*” is my original work and has not been submitted to any other institution for any academic award. All sources of information used have been duly acknowledged.

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**ADVISOR’S RECOMMENDATION**

I hereby certify that I have read the revised version of the thesis entitled “***Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative***” prepared under my guidance by Gelana Kisi Baso submitted in partial fulfillment of the requirements for the degree of Master of Science in Construction Management. Therefore, I recommend the submission of a revised version of the thesis to the department following the applicable procedures.

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## **ABSTRACT**

*The Finna Oromia Initiative is an ambitious regional development program launched by the Oromia National Regional Government to enhance water storage capacity through the construction of small- and medium-scale multipurpose dams in four phases. However, projects in Phase 1 of the Initiative have experienced significant delays, undermining their intended benefits. This study investigates the causes of these delays. Employing a sequential explanatory mixed-methods research design, the research collected quantitative data using structured surveys from key project stakeholders across 24 dam projects and an in-depth qualitative case study of the Finna Oromia Keta Dibe Dam. The findings of the survey revealed that unrealistic initial time and cost estimations, the contractor's inadequate experience and limited capacity, and price escalations/lack of timely adjustments are the most critical factors causing delays in the studied projects. Other significant contributors are: design modifications, contractor's lack of commitment, political instability/security issues, shortage and late mobilization of resources, unfavorable weather conditions, and delays in land acquisition/Right-of-Way issues. The qualitative case study of the Finna Keta Dibe Dam further underscored how foundation-related design modifications and unforeseen site conditions led to extended time overruns. The study concludes that construction delays in Phase 1 projects of the Finna Oromia Initiative are multifactorial, resulting from the interaction of technical, financial, managerial, logistical, and external factors. Based on the findings, the study developed practical and stakeholder-specific recommendations on mitigation strategies for the identified causes of delay.*

**Key Words:** *Construction delays, Finna Oromia Initiative, causes of delay, delay factors, sequential explanatory mixed-methods research design, mitigation strategies, Ethiopia*

## **Table of Contents**

<b>DECLARATION .....</b>	<b>ii</b>
<b>ADVISOR’S RECOMMENDATION.....</b>	<b>iii</b>
<b>ACKNOWLEDGEMENTS .....</b>	<b>iv</b>
<b>ABSTRACT .....</b>	<b>v</b>
<b>LIST OF FIGURES.....</b>	<b>ix</b>
<b>LIST OF TABLES .....</b>	<b>ix</b>
<b>LIST OF APPENDICES .....</b>	<b>ix</b>
<b>ACRONYMS.....</b>	<b>x</b>
<b>1. INTRODUCTION.....</b>	<b>1</b>
1.1. Background to the Study .....	1
1.1.1. Ethiopia’s Water Resources Potential and Development Challenges.....	1
1.1.2. The Importance of Dams in Solving Contemporary Problems .....	2
1.2. Statement of the Problem .....	3
1.2.1. Construction Delays and Their Impacts .....	3
1.2.2. Prevalence of Construction Delays in Dam Projects.....	4
1.3. Research Aims and Objectives .....	5
1.3.1. General Objective (Aim of the Research) .....	5
1.3.2. Specific Objectives .....	5
1.4. Research Questions .....	6
1.5. Significance of the Study.....	6
1.6. Scopes of the Study .....	7
1.6.1. Thematic Scope .....	7
1.6.2. Spatial Scope .....	8
1.6.3. Temporal Scope .....	8
1.7. Limitations of the Study .....	8
1.8. Organization of the Thesis.....	9
<b>2. LITERATURE REVIEW.....</b>	<b>12</b>
2.1. Overview of the Construction Industry .....	12
2.2. Introduction to Construction Delay .....	14
2.3. Types of Construction Delay .....	15

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams:  
The Case of Phase 1 of the Finna Oromia Initiative*

2.4.	Prevalence of Delays in Dam Construction.....	17
2.5.	Common Factors Associated with Construction Delays in Dam Projects.....	18
2.6.	Previous Studies on Causes of Delays in Dam Construction Projects .....	25
2.6.1.	Global Studies .....	25
2.6.2.	Studies Specific to Ethiopia.....	27
2.6.3.	Critical Evaluation of Prior Studies and Research Gaps .....	28
2.7.	Common Mitigation Strategies for Construction Delays .....	33
2.8.	Summary of the Literature Review (Theoretical Framework).....	37
2.9.	Conceptual Framework.....	41
<b>3.</b>	<b>RESEARCH METHODOLOGY .....</b>	<b>44</b>
3.1.	Introduction .....	44
3.2.	Research Philosophy (Paradigm) .....	45
3.3.	Research Type.....	46
3.4.	Research Approach.....	47
3.5.	Research Design .....	49
3.5.1.	The Multi-strategy Research Design .....	49
3.5.2.	The Sequential Explanatory Research Design.....	51
3.6.	Methods of Data Collection.....	52
3.6.1.	Quantitative Data Collection Through Survey .....	52
3.6.2.	Qualitative Data Collection: Case Study .....	58
3.7.	Methods of Data Analysis .....	63
3.7.1.	Quantitative Data Analysis .....	63
3.7.2.	Qualitative Data Analysis .....	65
3.7.3.	Methods of Data Integration and Interpretation .....	66
3.8.	Methods of Ensuring Research Rigor.....	66
3.8.1.	Reliability and Dependability.....	67
3.8.2.	Validity .....	68
3.9.	Ethical Considerations.....	71
<b>4.</b>	<b>RESULTS AND DISCUSSION .....</b>	<b>73</b>
4.1.	Quantitative Analysis Results.....	73
4.1.1.	Response Rate and Demographic Characteristics .....	73

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams:  
The Case of Phase 1 of the Finna Oromia Initiative*

4.1.2. Reliability Analysis Results.....	75
4.1.3. Identification of Causes of Delay .....	77
4.1.4. Statistical Test Results .....	87
4.2. Qualitative Data Analysis Results: Case Study Results .....	90
4.2.1. Processes and Methods.....	90
4.2.2. Description of the Project.....	90
4.2.3. Interview Thematic Analysis Results .....	93
4.2.4. Document Review Results .....	100
4.2.5. Triangulated Discussion of the Case Study Findings.....	105
4.3. Integration of the Survey and Case Study Findings .....	107
4.3.1. Areas of Convergence .....	108
4.3.2. Complementarity of Findings.....	109
4.3.3. Divergences in Findings .....	109
4.3.4. Synthesis and Summary .....	110
4.4. Discussion of Overall Findings in Relation to Literature.....	111
4.4.1. Overview of Key Findings .....	111
4.4.2. Comparison with Global Studies.....	111
4.4.3. Comparison with Ethiopian Context Studies .....	113
4.5. Proposed Mitigation Strategies.....	113
<b>5. CONCLUSION AND RECOMMENDATIONS.....</b>	<b>117</b>
5.1. Conclusion.....	117
5.2. Recommendations .....	118
5.2.1. For the Client.....	119
5.2.2. For Contractors.....	120
5.2.3. For the Consultant .....	121
5.2.4. For Regional and Local Authorities .....	121
5.2.5. Multi-Stakeholder Recommendations .....	122
5.3. Areas for Future Research .....	122
<b>REFERENCES .....</b>	<b>124</b>
<b>Appendices .....</b>	<b>140</b>

## **LIST OF FIGURES**

Figure 1. Diagrammatic Representation of the Research Process Followed.....	11
Figure 2. Conceptual Framework for Investigating Causes of Delay in Dam Projects.....	43
Figure 3. Location Map of Finna Oromia Keta Dibe Dam Project .....	59
Figure 4. Response Rate of the Survey Questionnaire .....	74
Figure 5. Comparison of Top 10 Delay Factors Across Stakeholder Groups.....	84
Figure 6. Kruskal-Wallis Test Results for Delay Factors .....	87

## **LIST OF TABLES**

Table 1: Summary of Reviewed Studies on Causes of Construction Delay.....	28
Table 2: List of Delay Factors in Construction Compiled from the Existing Literature .....	38
Table 3: Profiles of the Surveyed Projects.....	53
Table 4: Distribution of Participants for the Survey Part .....	55
Table 5: Measurement Scale for the Survey Instrument (Questionnaire) .....	56
Table 6: Distribution of Respondents by Project Phase Involvement .....	74
Table 7: Organization's Previous Involvement in Dam Construction .....	75
Table 8: Stakeholder Group Level Reliability of Measure.....	76
Table 9: Perceptions of Contractors Group on Top 10 Causes of Delay .....	78
Table 10: Perceptions of Consultant Group on Top 10 Causes of Delay .....	79
Table 11: Perceptions of Client Group on Top 10 Causes of Delay .....	80
Table 12: Top 10 Delay Factors Based on Overall Ranking .....	83
Table 13: Agreement Between Stakeholders on Delay Factor Rankings .....	89
Table 14: Project Information for Finna Oromia Keta Dibe Dam.....	92
Table 15: Contractual Information related to the Finna Oromia Keta Dibe Dam Project.....	102
Table 16: Proposed Mitigation Strategies for the Critical Causes of Delay.....	114

## **LIST OF APPENDICES**

Appendix A: Prevalence of Delays in Phase 1 of the Finna Oromia Initiative .....	140
Appendix B. Survey Questionnaire Used in the Quantitative Data Collection.....	141
Appendix C. A Semi-structured Interview Guide Used for the Case Study.....	146
Appendix D. Perceptions of Contractors on Causes of Delay.....	149
Appendix E. Perception of Consultant on Causes of Delay .....	150
Appendix F. Perception of Client on Causes of Delay .....	151
Appendix G. Overall Ranking of Causes of Delay .....	152
Appendix H. Sample Notification Letter from Consultant to Contractor .....	154
Appendix I. Progress Report of Projects in Phase 1 of the Finna Oromia Initiative.....	155
Appendix J: Manuscript .....	156

## **ACRONYMS**

- AHP – Analytic Hierarchy Process
- AIA – The American Institute of Architects
- BCM – Billion Cubic Meters
- CoST – Construction Sector Transparency Initiative
- EIA – Environmental Impact Assessment
- ECO – Engineering Corporation of Oromia
- EoT – Extension of Time
- ETB - Ethiopian Birr
- FAO – Food and Agriculture Organization
- FIDIC – International Federation of Consulting Engineers
- GERD – Grand Ethiopian Renaissance Dam
- IAI – International Arbitration Institute
- ICARDA – International Center for Agricultural Research in the Dry Areas
- ICOLD – International Commission on Large Dams
- IFAD – International Fund for Agricultural Development
- IHA – International Hydropower Association
- JICA – Japan International Cooperation Agency
- MoWIE – Ministry of Water, Irrigation and Energy
- OBoANR – Oromia Bureau of Agriculture and Natural Resources
- OIDA – Oromia Irrigation Development Authority
- OIPDB – Oromia Irrigation and Pastoralist Development Bureau
- SDG – Sustainable Development Goals
- UNEP – United Nations Environment Programme
- UNDP – United Nations Development Programme
- WCD – World Commission on Dams
- WEF – World Economic Forum

## **1. INTRODUCTION**

This chapter provides the general background of the study by discussing Ethiopia's abundant yet underutilized water resources and the pivotal role of dams in addressing various development challenges. It introduces the Finna Oromia Dam Initiative as a strategic intervention to these challenges in line with Ethiopia's *Ten-Year Development Plan (2021 – 2030)*. Moreover, it highlights the research problem within the context of persistent construction delays in dam projects. The chapter further elaborates on the research objectives and questions, its importance, scope, and limitations. This framework lays a foundation for investigating the causes of delay in Phase 1 of the Finna Oromia Initiative.

### **1.1. Background to the Study**

#### ***1.1.1. Ethiopia's Water Resources Potential and Development Challenges***

Ethiopia is widely described as the 'water tower of Africa' because of its significant share of Africa's water resources, located at its high altitudes (Swain, 1997). Reports show that the country generates an estimated 122 billion cubic meters (BCM) of surface runoff annually from 12 major river basins (Awulachew, 2007; World Bank, 2006). This potential amounts to a *per capita* water availability of 1,016 cubic meters, considering the current estimated population of 120 million. As a result, the country is positioned above the international standard regular *water-stress* threshold of 1,000 cubic meters per year (FAO, 2012). In addition to the surface water mentioned, Ethiopia also has an estimated groundwater potential ranging from 25 to 40 BCM (MoWIE, 2021).

Despite this abundance, the country's water resource development remains limited, and as a result, only a fraction of this resource is believed to have been harnessed. As of 2021, only 34 BCM of surface water storage had been developed in all basins, and additional dams with a capacity of 89 BCM, including the Grand Renaissance Dam (GERD), were under construction (MoWIE, 2021).

Ethiopia's *per capita* water storage capacity has improved from 43 cubic meters (m<sup>3</sup>) in 2006 to 100 m<sup>3</sup> in 2018 and 309 m<sup>3</sup> in 2021 (ICARDA, 2018; MoWIE, 2021; UNDP, 2006). Nevertheless, this figure is still far lower when compared to other nations, such as South Africa (974 m<sup>3</sup>), China (2,200 m<sup>3</sup>), and the United States (over 5,000 m<sup>3</sup>) in 2018 (ICARDA, 2018; Mwendera & Atyosi,

2018). The country's inadequate hydraulic infrastructure and poor water resource management still limit effective use of this resource (World Bank, 2006). Ethiopia's infrastructure score, according to the Global Competitiveness Index, was 43.4 in 2019, lower than the average of 45.0 for Sub-Saharan Africa (World Economic Forum, 2019).

As a result, the country, despite being described as the 'water tower of Africa' for its generous surface and groundwater potential, is labeled as 'hostage to its hydrology' (Grey & Sadoff, 2007). This is to stress the country's vulnerability to recurrent droughts and food insecurity because of its dependence on rain-fed systems (Grey & Sadoff, 2007; World Bank, 2006; Yimere & Assefa, 2022). These challenges underscore the need for substantial investment in water storage and infrastructure development to ensure water security and foster sustainable economic growth.

### ***1.1.2. The Importance of Dams in Solving Contemporary Problems***

Dams are essential for reducing water scarcity by regulating the natural river flow regime with water demand in arid and semi-arid areas (Bhatia *et al.*, 2008; Verma *et al.*, 2022). Such investments in infrastructure, as the World Bank (2006) claims, can 'de-link' the Ethiopian economic performance from rainfall variability and promote long-term growth and resilience.

Ethiopia envisions becoming an 'African Beacon of Prosperity' by 2030, through its prevailing *Ten-Year Strategic Development Plan* (MoWIE, 2021). To achieve this, the country has set 17 sustainable development goals aligned with the United Nation's 2030 *Agenda for Sustainable Development*. One of these goals was to build a resilient infrastructure, including water resource development programs to facilitate sustainable access to water.

Following this strategic plan, the Oromia National Regional Government has launched the Finna Oromia Dam Initiative, an ambitious program for the improvement of water storage capacity through the construction of multiple small- and medium-scale multipurpose dams in four phases (Ethiopian Press Agency [EPA], 2022; Oromia Irrigation & Pastoralist Development Bureau, 2023).

The initiative targets especially drought-prone areas, where a lack of water poses a threat to life and economic stability. The dams are designed to collect rain and river water, supporting activities such as irrigation, flood event regulation, fishing, navigation, and water supply for various uses. Investing in these projects is critical for sustainable development and minimizing the adverse

impact of climate change on water-dependent sectors in the country, particularly within Oromia (Oromia Irrigation Development Authority [OIDA] & Japan International Cooperation Agency [JICA], 2014).

## **1.2. Statement of the Problem**

### ***1.2.1. Construction Delays and Their Impacts***

Despite ongoing development and enhancement of water infrastructure to meet the increasing demand, its construction often encounters several challenges (Ahmed *et al.*, 2003; Venkatesh & Venkatesan, 2017). One of the most significant challenges relates to the completion time of the construction projects. There has been universal criticism of the failure of the construction industry to deliver projects on time (Odeyinka & Oladapo, 1997), implying that construction projects frequently experience time overruns (delays).

Delays in construction projects have far-reaching consequences for various stakeholders and can be seen from multiple perspectives. From the viewpoint of project owners, delays lead to higher financial costs, pressure on budgets, and delayed revenue streams, which are all detrimental to development goals (Plummer Braeckman & Guthrie, 2016). It may also increase interest accrued on funds borrowed to finance construction activities (Clough *et al.*, 2015; World Commission on Dams, 2000).

For contractors, delays would mean extended project durations, which might lead to higher overhead costs, potential penalties, and reputational risks (Plummer Braeckman & Guthrie, 2016). They may also increase material costs (due to inflation) and labor expenses (Rathod *et al.*, 2020). Furthermore, delays signify a loss of opportunity and revenue, since the contractor can face challenges in becoming involved in other projects without completing active projects (Alsuliman, 2019). According to Clough *et al.* (2015), delays have other cost consequences for the contractor, such as standby costs of non-productive workers, supervisors, and equipment.

In public projects, the public may also be affected by delays in facility utilization. In this respect, delays mean additional periods of not being served with water for different purposes, which may cause public dissatisfaction and potential social unrest (Julca-Varas *et al.*, 2025; Plummer Braeckman & Guthrie, 2016).

Overall, construction delays can lead to cost overruns, loss of revenue, disputes, arbitration, litigation, negative social impacts, pressure on project stakeholders, abandonment, and termination of contracts, among other things (Aibinu & Jagboro, 2002; Kraiem & Diekmann, 1987; Kuşakcı *et al.*, 2017; Sambasivan & Soon, 2007). They can transform productive ventures into losing undertakings (Werku & K.N., 2016). Delays of projects such as dams can even lead to delays in government strategic plans that may impair the planned economic development (Alamri *et al.*, 2017).

### **1.2.2. Prevalence of Construction Delays in Dam Projects**

Reports show a worrying frequency of delays occurring in construction projects worldwide. It has been found that the construction of dam projects takes even longer (Flyvbjerg, 2013). Research carried out on 245 large dam projects implemented in various countries indicated that 80% of the projects experienced an average schedule overrun of 44% (Ansar *et al.*, 2014).

Even though delays are common to the construction industry globally, they are more prevalent in developing countries (Rajakumar, 2016). Consequently, most construction projects undertaken in Ethiopia have been delayed beyond the initially planned completion date.

For instance, the construction of Megech Dam project showed a time overrun of over 100% (Alwoye, 2018). Dhidhessa dam is another delayed project. According to the report by the Construction Sector Transparency Initiative (2015), the project was scheduled to be completed in 18 months, but only 23.98% was completed even after 42 months. Similarly, a significant delay (105%) was observed in Tendaho dam and irrigation project, while the construction of Kuraz Irrigation project showed a time overrun of 292% (Alemayehu, 2021). The delay experienced by Gibe III Hydroelectric Power Project is yet another case worth mentioning, showing a time overrun of three and a half years (Kirubel, 2021). The study on mega sugar projects in the country shows a similar trend. For example, the irrigation and infrastructure works of Tana Beles and Kessem projects experienced a time overrun of 174.5% and 639.4%, respectively (Temesgen & Denamo, 2020).

Last but not least, the Grand Ethiopian Renaissance Dam (GERD) is among the hydraulic infrastructure projects that have experienced a significant delay. Its construction started in March

2011 and was expected to be completed in July 2017. Nevertheless, it is still under construction as of March 2025, implying that the project has already been delayed by more than 8 years.

In line with the general trend of delays in project delivery nationwide, a recent report by the Engineering Corporation of Oromia (ECO) shows that the dam projects being implemented in Oromia National Regional State under the 'Finna Oromia Initiative' are also delayed. Appendix A presents the status of the projects in Phase 1 of this initiative as of October 2022, showing an average delay of 51%.

The delayed implementation of these projects poses great challenges in realizing the objectives of Ethiopia's *Ten-Year Strategic Development Plan (2020-2030)*, which targets water security and economic growth as well as better livelihoods through infrastructure development (MoWIE, 2021). This, in particular, will affect farmers who rely on stored water for irrigation and communities that need access to drinking water.

Given these implications, a thorough understanding of the causes is, thus, a vital step in implementing necessary preventative measures and minimizing their detrimental consequences, thereby ensuring the timely completion of such projects (Chang, 2002; Durdyev & Hosseini, 2019; Mengistu & Mahesh, 2020; Werku & K.N., 2016).

Several studies have addressed the causes of dam construction delays in Ethiopia. These studies focused on large-scale dams (Alwoye, 2018; Alemayehu, 2021; Kirubel, 2021). Small- and medium-scale dams have not, as far as the researcher knows, been thoroughly investigated, leaving a notable gap in the literature regarding causes of delays in such projects, including the Finna Oromia Initiative.

### **1.3. Research Aims and Objectives**

#### ***1.3.1. General Objective (Aim of the Research)***

This study aims to identify the causes of construction delays in Phase 1 of the Finna Oromia Dam Initiative and propose mitigation strategies to address these delays.

#### ***1.3.2. Specific Objectives***

The specific objectives of the research are:

- To identify the main causes of delay across multiple phase 1 projects.
- To explore why and how the causes manifest in a specific project.
- To propose practical and literature-informed mitigation strategies that address the identified causes of delay.

#### **1.4. Research Questions**

This study seeks to address the following research questions:

1. What are the main causes of construction delay in Phase 1 projects of the Finna Oromia Dam Initiative?
2. How and why do the causes manifest in a specific project?
3. What mitigation strategies can be proposed to address the identified causes of delay?

#### **1.5. Significance of the Study**

This research provides important insights to multiple stakeholders in the Finna Oromia Dam Initiative as presented in the following sub-sections.

##### **For Clients (Government Agencies and Investors)**

Construction delays in dam projects lead to significant negative impacts for clients, including financial burdens (Ahmed *et al.*, 2003; Ogunlana *et al.*, 1996) and severe impacts on the intended project benefits (Gebrehiwet & Luo, 2017; Petersen-Perlman *et al.*, 2017; World Bank, 2020). The findings and recommendations of this study will inform clients (including the Oromia Irrigation and Pastoralist Development Bureau) to make important precautions to control the causes at the early planning stage, thus avoiding their interference during construction and ultimately increasing the overall success rate of future dam projects. Such a practice aligns with the principles of effective project management, which emphasize learning from past experiences to improve future outcomes (Al-Khalil & Al-Ghafly, 1999; Chan & Chan, 2004).

##### **For Practitioners (Contractors and Consultants)**

The findings of this study are also significant for practitioners such as contractors and consultants. They can guide the consultants on what to consider during the early planning and design stage, and provide them with some practices to improve communication and collaboration among

stakeholders to facilitate construction processes at the supervision stage (Assaf & Al-Hejji, 2006; Sambasivan & Soon, 2007). Contractors are also informed of common delay factors in the construction of such projects and equipped with the necessary knowledge and effective management practices that will help them control the factors (causes) in their future projects.

### **For Future Research and Academics**

From an academic point of view, the study will add some knowledge on the challenges of dam construction, especially in the setting of public enterprises having similar characteristics. As the existing literature focuses more on the large water infrastructure, this research can fill a critical gap in the case of small- and medium-scale dam projects (Gebremedhin *et al.*, 2016; Lasage *et al.*, 2015). It may also guide the formulation of best practices on how to minimize delays during the construction process. The findings will, therefore, have both theoretical and practical implications for the construction project management field.

### **For the Public/Consumers**

This study is of great importance from the social/public perspective. A delayed dam project means a prolonged absence of water for different purposes, as discussed in the preceding sections, negatively affecting the livelihoods of the local community (Evans Chazireni & Tanyaradzwa Chigonda, 2018).

The identification of causes of delays in this initiative, thus, can be used to develop mitigation strategies that will prevent or minimize the delays and, therefore, ensure timely delivery of the critical infrastructure (dams in this case). This, in turn, improves access to water for irrigation and other domestic use for local communities and boosts their social and economic development in drought-affected areas (FAO, 2012; Grey & Sadoff, 2007).

## **1.6. Scopes of the Study**

### **1.6.1. Thematic Scope**

Delays can be attributed to different factors that occur in both the preconstruction and construction phases. However, the major delays usually take place in the construction phase. This research is, therefore, limited to assessing the causes of delay that have a direct impact on the construction phase. Moreover, the causes that are related to the efficiency (those related to resource utilization

for construction) of the developments are focused. The study of causes that are related to the effectiveness (goal attainment) of these projects (post-construction) is beyond the scope of this research. The research also tries to explore mitigation strategies to address these delays (both for the projects in the current phase and next phases), ultimately improving project delivery.

### ***1.6.2. Spatial Scope***

The study is geographically limited to the Oromia region of Ethiopia. The study projects are spread across 3 clusters (Dire Dawa Cluster, Robe Cluster, and Yabelo Cluster) and five zones: Arsi, Bale, Borena, Guji, and Harerghe.

### ***1.6.3. Temporal Scope***

The study covers the period from the initiation of the study projects to their status until the completion of data collection (March 2025).

## **1.7. Limitations of the Study**

The findings of this study have to be seen in light of the following potential limitations:

First, the study was limited to projects that are owned by a single client (OIPDB) and consulted (design and supervision) by a single consulting firm (ECO). This may limit the generalizability of the findings. Different client-consultant dynamics, contractual arrangements, or institutional frameworks in other regions or projects might yield varying delay patterns.

Second, the participants were selected using purposive sampling to ensure that only professionals with better experience and knowledge in the area were included. Although this increases the quality of responses, it still introduces a generalizability limitation in that the views may not fully represent all members of the whole population.

Another important limitation relates to the reliance on self-reported data in the survey component of the study. While the survey was carefully designed to elicit informed responses from experienced professionals, the data are nonetheless based on subjective perceptions. Such self-reported information may be subject to recall bias, social desirability bias, or subjective interpretation of events. These factors could influence the accuracy of the survey data and may bias the ranking of the delay factors.

In the qualitative data collection phase, interviews were conducted smoothly and provided very useful insights. However, access to some essential documents, such as financial records, design change requests/approvals, progress evaluations, and other internal memos, was restricted. The document review would have been more comprehensive had these been fully accessible.

Despite all these challenges and limitations, the research process was rigorous, and the findings remain valid and meaningful in understanding the causes of construction delays in the context studied.

## **1.8. Organization of the Thesis**

This research is structured into five chapters, each designed to address the research objectives and answer the research questions systematically. The organization of the study is as follows:

### **Chapter 1: Introduction**

This chapter introduces the research problem, providing the background and context for the study. It outlines the challenges Ethiopia faces in harnessing its water resources and the critical role of multipurpose dams in addressing water, food, and energy security. The chapter also presents the statement of the problem, research objectives, and research questions. Additionally, it discusses the significance of the study, its scope, and the limitations of the research.

### **Chapter 2: Literature Review**

This chapter provides a comprehensive review of existing literature on construction delays, with a focus on dam projects. It explores the global and Ethiopian contexts, identifying common causes of delays in the construction of dam projects. It also presents common mitigation strategies for these factors. The chapter then identifies gaps in the literature, especially concerning delay factors in small- and medium-scale dam construction projects. Finally, the conceptual framework for the study is introduced, categorizing delay factors into relevant groups and establishing the relationships between independent and dependent variables.

### **Chapter 3: Methodology**

This chapter outlines the research methodology adopted for the study. It discusses the research methodologies used along with their justifications. The chapter contains sections such as research

philosophy, the type and approaches to the study, strategies used and their designs, research process, data collection and analysis methods, strategies to assure research quality (rigor), as well as ethical considerations that guide the study.

#### **Chapter 4: Data Analysis Results and Discussions**

This chapter presents the results of different data analyses (both quantitative and qualitative). It identifies the key causes of delays in the Finna Oromia Dam Initiative and ranks them based on their impact on project progress following the statistical analyses of survey responses from the perspectives of stakeholders. It also presents the findings of the qualitative case study. The results of both datasets are then integrated and discussed in the context of the existing literature, providing actionable insights for improving project delivery.

#### **Chapter 5: Conclusion and Recommendations**

The final chapter summarizes the key findings of the study, linking them to the research objectives and questions. It also provides literature-based and practical recommendations for mitigating construction delays in the Finna Oromia Initiative and similar projects. The chapter concludes with suggestions for further studies in this area.

Overall, this research follows the process flow shown by the following diagram (Figure 1).

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase I of the Finna Oromia Initiative*

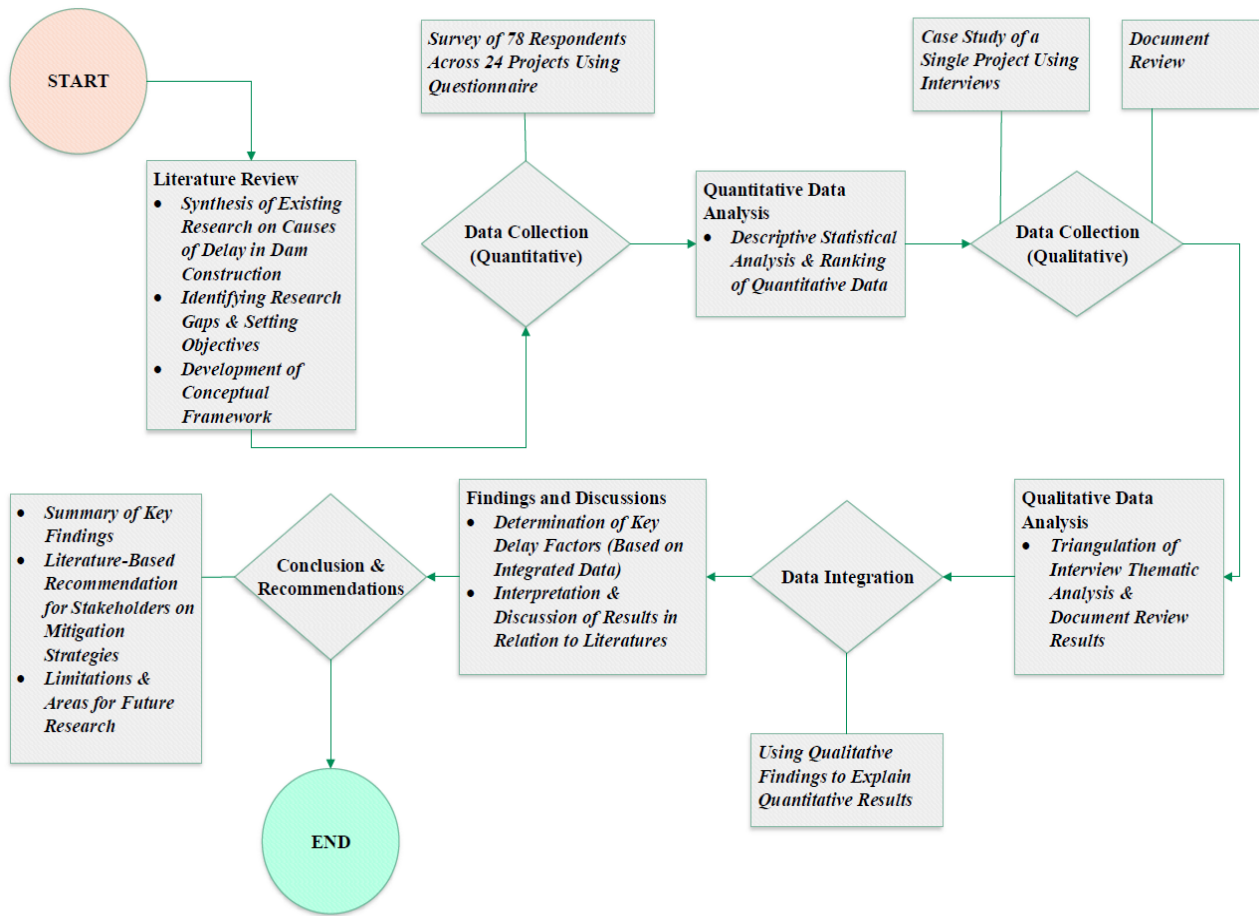


Figure 1. Diagrammatic Representation of the Research Process Followed

Source: Researcher (2024)

## **2. LITERATURE REVIEW**

This chapter provides a comprehensive review of the existing literature on construction delays, with a particular focus on dam projects. It begins by highlighting the role of the construction industry in socio-economic development. It then discusses different types of construction delays and their prevalence in dam projects. In addition, it presents common causes of these delays found in the existing literature. Moreover, it discusses previous studies on these causes in the global and Ethiopian contexts, focusing on dam projects. These studies are then critically evaluated in terms of context, project scale, and methodology. Following this, the knowledge gaps are identified, justifying the need for this study. Furthermore, some commonly cited delay mitigation strategies are presented. The chapter closes by providing the theoretical foundation for the study, which guides the development of the conceptual framework used for data collection.

### **2.1. Overview of the Construction Industry**

The construction industry is a sector of the economy that transforms various resources into constructed physical infrastructure necessary for socio-economic development (Ministry of Urban Development and Construction, 2012). These may include infrastructure such as buildings, transportation systems (airports, harbors, highways, subways, bridges, railroads, transit systems, pipelines and transmission and power lines), structures for fluid containment, control and distribution (such as water treatment and distribution, sewage collection and treatment distribution systems, sedimentation lagoons, dams, and irrigation and canal systems) and underground structures, such as tunnels and mines. These infrastructures are the basis for other sectors such as manufacturing, education, health, transportation, etc. Construction covers a vast range of activities from the planning and design of infrastructure to its construction, maintenance, and demolition.

Over the years, the construction industry has grown tremendously. In 2004, it was valued at \$1.7 trillion worldwide and provided between 5% and 7% of GDP in most countries (Wubishet, 2004; Kenny, 2009). The global market size of the industry significantly grew to about \$13.57 trillion by 2024 and is anticipated to reach \$25.47 trillion by 2034 (Research and Markets, 2024).

The industry is a key factor in economic growth and the enhancement of quality of life in both developed and developing countries. For example, in the United States, the contribution of the

sector to the country's Gross Domestic Product (GDP) is around 4.3%, while in the European Union, it is about 9% of GDP (Deloitte, 2024; Eurostat, 2023). These figures highlight the industry's economic importance and the number of jobs, investment, and innovation it can facilitate in developed countries.

The role of the construction sector is not limited to the developed nations. It is also very important in developing countries. For instance, the Kenyan Construction Industry accounted for 7% of the Gross Domestic Product (GDP) in 2015 (Competition Authority of Kenya, 2017). Ghana's share of the industry's contribution to GDP was 8.5% (Shah, 2016). It is the largest contributor to the GDP in Nigeria as well (G. J. Kikwasi & Escalante, 2020). Tanzania has also witnessed a significant rise in the sector's contribution to the GDP from 7.8% in 2010 to 13.6% in 2015 and 14.8% in 2019/2020 (Luvara & Mwemezi, 2017; Ministry of Finance and Planning, The United Republic of Tanzania, 2021).

Similarly, the construction industry has become the key driver of economic transformation in Ethiopia. The Ethiopia Construction Sector Report (2023) reveals that the share of the industry in the country's GDP has been increasing steadily, from 6% in 1981 to 22.7% in 2022. Over the last 10 years, the industry has had an impressive annual growth rate of 11.6%, making it one of the fastest-growing industries in the country (GlobalData, 2024). The industry is also acknowledged for its strategic importance in the *Ten-Year Development Plan (2021-2030)*, as it accounted for 37.9% of the GDP growth of the industrial sector in 2019/20 (FDRE Planning and Development Commission, 2021). This growth has been supported by massive public investments in infrastructure, such as roads, railways, dams, and industrial parks, as part of the government's long-term development vision.

Besides its contribution to GDPs, the construction industry is also one of the largest employers in the world. The sector employs a large portion of the workforce in developed countries and contributes to the economic stability and social well-being (Deloitte, 2024; Eurostat, 2023). The industry is even more important in job creation in developing countries, particularly for low-skilled and semi-skilled workers. For instance, in Ethiopia, the construction sector has provided many employment opportunities, especially in rural areas (FDRE Planning and Development Commission, 2021).

In general, the construction sector plays a significant role in both developed (OECD, 2008) and developing countries (Wubishet, 2004; World Bank, 2017), in many ways. The construction industry provides society with delivery mechanisms for many aspects of economic, social, political, and environmental needs, making its products essential to mankind's physical and social day-to-day activities (Solomon, 2015). It is considered to be the backbone of a country's economy and is the fundamental unit through which physical development is attained. It is, even, difficult to think of extensive investments like agriculture, manufacturing, fishery, etc., without construction facilities, even though their development and efficiency are relatively low compared to other industries (Abadir, 2011).

## **2.2. Introduction to Construction Delay**

A project schedule is one of the critical aspects of the construction management life cycle and a key driver for project success (Mbala *et al.*, 2019). Unfortunately, most construction projects, whether in developed or developing nations, are not completed within the predefined schedule. In other words, they are subject to delays (time overruns).

The definition of delay in a construction project is not universally agreed upon, but those found in the available literature share certain aspects. Some of the definitions are:

- The time overrun in the specified completion date or time overrun in the delivery of the construction project, on which all parties agreed (Assaf & Al-Hejji, 2006; Marzouk & El-Rasas, 2014).
- The amount of difference between the planned construction time for the project and the actual time to complete it (Alamri *et al.*, 2017; A. P. C. Chan, 2001; Faridi & El-Sayegh, 2006).
- A situation where a project's completion time is postponed due to causes that may be related to the client, consultant, contractor, or other unexpected conditions (Aibinu & Jagboro, 2002; Bramble & Callahan, 2011).
- A situation where an event occurs at a time later than expected, or is to be performed later than planned/anticipated, or completed later than intended; when prompt action is not taken, or occurs beyond the agreed date specified in the contract (Lo *et al.*, 2006; Sanni-Anibire *et al.*, 2022; Trauner, 2009).

### **2.3. Types of Construction Delay**

Construction delays can be categorized in various ways depending on different criteria. Based on their source and responsible party, delays can be classified as excusable and non-excusable (Ahmed *et al.*, 2003; Ghenbasha *et al.*, 2016; Kraiem & Diekmann, 1987; Trauner, 2009; Tumi *et al.*, 2009). Based on their impact on the construction progress, they can be critical or non-critical delays (Trauner, 2009). Depending on the duration of occurrence, delays can be either temporary or prolonged (Abd El-Razek *et al.*, 2008). They can further be classified as concurrent and non-concurrent delays based on occurrence (Ghenbasha *et al.*, 2016; Kraiem & Diekmann, 1987).

#### **Excusable (Non-avoidable) and Non-excusable (Avoidable) Delays**

Construction delays can be classified as either excusable (non-avoidable) or non-excusable (avoidable) based on the level of control that the parties had over the delay (Bramble & Callahan, 2011).

Excusable delays occur when the contractor is delayed by occurrences that are not attributable to either the contractor or the owner (Kraiem & Diekmann, 1987). According to Sweet (1977), cited in (Kraiem & Diekmann, 1987), the three general characteristics of excusable delays are 1) unforeseen events, which usually relate to future occurrences (conditions of which the contractor should have been aware are not considered to be foreseeable); 2) events beyond the contractor's control (in which work was impossible on the project); and 3) events without fault or negligence (those in which the contractor bears no blame). Examples of excusable delays are extreme weather conditions, natural disasters, unforeseen site conditions, and changes in government regulations (Trauner, 2009). In such cases, the contractor is usually entitled to a time extension and, in some cases, additional compensation as well (Aibinu, 2009; International Federation of Consulting Engineers [FIDIC], 1999; Jongo *et al.*, 2019).

Non-excusable delays are a result of the contractor's actions or negligence, such as poor project management, inadequate resource allocation, or failure to meet contractual obligations, among other things (Assaf & Al-Hejji, 2006). Contractors can be held responsible for these delays concerning cost and time consequences (Project Management Institute, 2021).

Usually, the contractor has no right to relief and must either recover the lost time by accelerating the work or compensating the owner (Bramble & Callahan, 2011). This compensation may come about through either liquidated damages or actual damages, provided there is no liquidated damages clause in the contract.

### **Critical and Non-critical Delays**

Delays can also be classified depending on the way they affect the project completion time (Al-Momani, 2000; Trauner, 2009). Activities can be either of critical or non-critical nature, depending on the project path progress, by which the project's completion date might be affected (Durdyev & Hosseini, 2019).

**Critical Delays:** Delays on the critical path will extend the overall project completion time (R. J. Sweis *et al.*, 2016), thus resulting in disruptions of the domino sequence. Critical delays can occur from, for example, late delivery of materials needed on site or late completion of important construction activities.

**Non-critical Delays:** These delays do not impair the ultimate project completion, but they might influence the intermediate project milestones and activities (Hatush & Skitmore, 1997). A non-critical delay can happen in activities that possess float or slack time, which enables the project to remain on schedule even with the delay (Al-Momani, 2000). They are delays that occur in non-essential tasks (activities) having flexible timelines.

### **Concurrent Delays**

Concurrent delays are delays that happen at the same time due to different reasons (Bordoli & Baldwin, 1998). This concurrency involves the occurrence of at least two independent delays at the same time (Bordoli & Baldwin, 1998; Durdyev & Hosseini, 2019; Pickavance, 2005; Trauner, 2009). For example, if the contractor was delayed because of design changes and at the same time the owner was delayed in obtaining permits, the delay could potentially be concurrent, meaning that each party could be responsible for the overall delay (AIA, 2017).

The concurrency argument is made from both the perspective of identifying the project's critical delays and the perspective of assigning responsibility for damages associated with delays to the critical path (Trauner, 2009). In general, if the delays are inextricably intertwined, neither the

Contractor can be held responsible for the delay (forced to accelerate, or be liable for liquidated damages) nor can he recover the delay damages from the Owner (Ahmed *et al.*, 2003). Concurrent delays can be excusable, non-excusable, compensable, or non-compensable, depending on the delay analysis results, and the delay analysis will determine which party is entitled to compensation or an extension of time (Adham, 2023). This is the most common type of delay in construction projects, and resolving disputes related to concurrent delays usually involves legal and contractual considerations as well as expert analysis of the project schedule and documentation.

### **Temporary and Prolonged Delays**

As mentioned above, construction delays can be temporary or prolonged based on duration and impact on the project (Bramble & Callahan, 2011). Temporary delays are short-term and minimal delays that have no significant impact on the project's overall schedule and are not difficult to overcome. These can be caused by minor interruptions, like temporary malfunctions of equipment or temporary labor shortages (Trauner, 2009). These delays will incur minor inconveniences, but sometimes can be averted without affecting the project completion date.

In contrast, the prolonged delays, which continue for a longer period, have a more serious effect on the duration of the project and necessitate more complicated remedial measures (Abd El-Razek *et al.*, 2008). They are often caused by catastrophic events, such as long-term equipment breakdown, long labor strikes, or major design changes (Bramble & Callahan, 2011). These delays can have significant cost overruns and usually lead to the need for renegotiating the project contracts.

In general, comprehending and grouping construction delays will allow not only project managers and stakeholders to better assess their root causes, assign responsibilities, but also help them create solutions aimed at reducing the negative outcome caused by these delays.

## **2.4. Prevalence of Delays in Dam Construction**

Reports show a worrying frequency of delays occurring in infrastructure projects worldwide. It has been found that the construction of dam projects takes an even longer time (Flyvbjerg, 2013). A study conducted on 245 dam projects implemented in different countries, for instance, revealed that 80% of the projects suffered a schedule overrun of 44% (Ansar *et al.*, 2014). For instance, 6

hydro power (multipurpose dam) projects implemented in Pakistan were completed with an average time overrun of 5 years (Batool & Abbas, 2017). Similarly, 35 irrigation and hydropower projects in Vietnam experienced an average time delay of 2.3 years (Hai & Son, 2021). Moreover, evidence from 11 projects in Pakistan indicates that small-scale dam projects experienced schedule overruns ranging from 10 to 43 months (Haviz, 2021). Other studies (Alamri *et al.*, 2017; Kamalan & Abedin Maghanaki, 2020) also showed similar trends.

Delays in the construction of dam projects are also common in Ethiopia. For example, the construction of Megech Dam project, which was scheduled to be completed in 5 years, was found to be 50% of the physical plan, showing a time overrun of 100% (Alwoye, 2018). Didessa Dam project is also among the delayed projects. According to the report by Construction Sector Transparency Initiative - Ethiopia (2015), the project was scheduled to be completed in 18 months, but only 23.98% was completed even after 42 months. Similarly, the construction of Tendaho and Kuraz irrigation projects was delayed by 105% and 292% time overruns, respectively (Alemayehu, 2021). The delay experienced by the Gibe III Hydroelectric Power project was another case worth mentioning. The construction of the project was launched in July 2006 and was planned to be completed in September 2013 (Kirubel, 2021). It was, however, completed in December 2016 and showed a delay of 3.5 years. Last but not least, the Grand Ethiopian Renaissance Dam (GERD) is also another hydroelectric project that experienced a huge delay. Its construction started in March 2011 and was expected to be completed in July 2017. However, as of March 2025, the project is still under construction, which means it has already suffered a delay of more than eight years.

Aligned with these national trends, the Finna Oromia Initiative has also faced widespread delays. According to the Engineering Corporation of Oromia (2022), projects under construction in Phase 1 of the initiative had an average delay of approximately 51%, as measured by the gap between planned and actual physical progress.

## **2.5. Common Factors Associated with Construction Delays in Dam Projects**

Delays in the construction of dam projects can be caused by a wide range of factors, which may vary in different contexts (Zidane & Andersen, 2018). These include the environment in which the project is undertaken, working culture, management methodology, site conditions (geological, geographical, and weather conditions), and economic situation, among other things.

This section examines common factors related to construction delays, particularly in dam projects, with more focus on study and planning, design, project management, economic and financial aspects, resources, logistics and supply chain, legal and regulatory, as well as social and political aspects.

### **Study and Planning Factors**

The initial stages of study and planning are very important in dam projects as they provide the basis for all subsequent activities. Some of the common causes of delays at this stage include poor feasibility studies, wrong site selection, and unrealistic project timelines and cost estimations (Assaf & Al-Hejji, 2006; Love *et al.*, 2002).

Unrealistic cost and time estimations at the planning stage may cause budget overruns and schedule slippages in the construction stage, particularly in complicated projects such as multipurpose dams (Flyvbjerg, 2008; Love *et al.*, 2002). Apart from this, poor definition of milestones and the absence of clearly defined project objectives can also result in inefficiencies and affect project timelines negatively (Project Management Institute, 2021). Moreover, a lack of sufficient geological surveys may result in unforeseen site conditions such as unstable foundations, which may delay construction significantly (Al-Momani, 2000).

### **Design Factors**

Engineering design has a significant influence on project time and cost. Many construction problems are caused by design defects and can be traced back to the design process (Bramble & Cipollini, 1995). Disruptions in construction activities and rework mostly arise from errors or omissions in design documents, frequent design changes, and lack of understanding of project requirements (Sambasivan & Soon, 2007).

Design-related factors cited in the available literature include design errors leading to modifications/changes, design discrepancies, unclear and inadequate details in design documents, delays in producing design documents, complexity of the project, misunderstanding of the owner's requirements by the design team, inadequate design-team experience, and lack of use of advanced engineering design software among other things (Assaf & Al-Hejji, 2006; D. W. M. Chan & Kumaraswamy, 1996; Hai & Son, 2021; Olawale & Sun, 2010; Sambasivan & Soon, 2007).

In addition, geotechnical uncertainties, such as unforeseen ground conditions and geological complexities, can significantly impact dam construction (Love *et al.*, 2002; Olawale & Sun, 2010). Moreover, unanticipated soil stability issues and rock formations, as well as underground water flow problems, result in delayed foundation works and, hence, force the need for supplementary remedial solutions (Olawale & Sun, 2010).

Overall, design factors have a significant impact on construction projects. These factors can cause re-estimation of time and cost, the requirement of extra labor, machinery, and materials. They can even lead to contractual disputes and project failure (Gizachew & Elsaye, 2020). Since dam projects are complex, the lack of proper coordination among designers, engineers, and contractors can result in inconsistent designs, which prolongs project delays (D. W. M. Chan & Kumaraswamy, 1996).

### **Project Management Factors**

The successful completion of dam projects depends on effective project management. Poor management practices in construction cause delays in the project. The most commonly mentioned delay factors in this group are poor planning and scheduling, lack of monitoring and control of projects, poor communication, quality control problems, failure to manage risk, inevitable changes that occur during implementation, and health and safety problems.

Ineffective planning and scheduling of projects may result in poor resource allocation and failure to meet deadlines in projects (Abd El-Razek *et al.*, 2008). In addition, other factors such as unrealistic schedules, failure to take into account resource constraints, and lack of risk identification in the early stage of planning also cause delays in the construction of dam projects (Odeh & Battaineh, 2002).

Similarly, lack of proper monitoring and progress tracking lessens the possibility of on-time detection and solution of potential problems, leading to delays (R. J. Sweis *et al.*, 2016). Insufficient surveillance systems or a lack of communication among the project teams may also block the way of progressive problem-solving, and problems will multiply over time, causing delays (Al-Momani, 2000).

Inadequate communication and coordination among all the stakeholders, such as clients, contractors, and consultants, can result in misinterpretations, rework, or even total project delays (Assaf & Al-Hejji, 2006).

Ineffective quality control measures may lead to defects and rework, hence affecting the project schedule (Love *et al.*, 2002). Lack of proper inspection of materials and construction processes may result in low-quality jobs that have to be rectified, causing delays in projects.

Poor risk management is also one of the most challenging factors. If there is no preventive risk management, such as identification, assessment, and mitigation of unwanted events, projects are left prone to unexpected incidents and delays (Project Management Institute, 2017). Failure to assess possible risks like extreme weather, labor grievances, or material shortages may lead to production being halted when the adverse events happen.

Sometimes, unexpected challenges may be encountered at the project site, despite all the planning (Olawale & Sun, 2010). These could include factors such as unforeseen geological formations and the adoption of new technologies for design and construction. Resolving such issues, thus, requires design changes, causing rework to the construction, ultimately affecting the schedule.

Delays can also be caused by health and safety issues. Construction accidents or incidents need investigation and implementation of safety improvements that can lead to work stoppages and delays (World Bank, 2017).

### **Economic and Financial Factors**

Economic and financial factors are among the major causes of delay in dam projects, particularly in developing countries. Construction activities can be disrupted by the budgetary constraints of the client and delayed payments (Assaf & Al-Hejji, 2006). These may hamper project progress and require further funding approvals. Underestimating the financial requirements of the project may also result in a construction delay (Odeh & Battaineh, 2002). According to Dessalegn (1999), project delays in Ethiopia occur mostly due to financial mismanagement and poor allocation of resources. This can be aggravated by unexpected costs, which can trigger other delays (Othman *et al.*, 2015). For instance, an increase in the price of fuel might increase the cost of material transportation, hence interfering with schedules (World Bank, 2017).

Late payments by the client for completed work can also lead to delays, as these result in an interruption of cash flow of the contractor (Ogunsemi & Jagboro, 2006). Cashflow problems may impede contractors from buying raw materials, paying workers, and maintaining equipment, thereby causing a delay (Abdul-Rahman *et al.*, 2009). Financial shortages emerge from both delayed funding and changes in material prices due to changes in the market or economy. This can disturb the supply chains and result in temporary work stoppages for contractors (Flyvbjerg *et al.*, 2003). For instance, an increase in the price of fuel will increase the cost of transporting material, hence affecting schedules (World Bank, 2017).

### **Resource-Related Factors**

Completion of construction projects depends greatly on availability and/or proper management of resources like labor, material, and machinery. Shortage of skilled manpower, delayed deliveries of material, and equipment breakdown are among the common resource-related causes of project delays (Sambasivan & Soon, 2007). Lack of skilled manpower can slow down construction activities, and late delivery of critical materials such as cement or steel may put a temporary halt to the work (Aibinu & Jagboro, 2002). Equipment breakdowns and poor maintenance practices can temporarily interrupt construction works (especially in machine-intensive projects), like dams (Love *et al.*, 2002). Low productivity of workers due to insufficient training, poor working environments, and low incentives can worsen the delays further (O D Oklobia & Prof Tsado, 2022).

### **Logistics and Supply Chain Factors**

Other major causes of delay in dam construction include logistical and supply chain problems. They are particularly common in remote areas and places that are difficult to access. Delay factors in this category are poor transportation networks, unreliable suppliers, and inadequate storage facilities, among others (G. Sweis *et al.*, 2008). These factors may interfere with the supply of resources (material and machinery) to the construction site (O D Oklobia & Prof Tsado, 2022) and affect the project schedule (Assaf & Al-Hejji, 2006).

Absence of basic infrastructure such as storage facilities, electricity, telecommunication services, and water shortages at the project site can cause delays as well. In addition, inappropriate storage and handling of materials on-site can cause damage, wastage, and delays in retrieving essential resources for construction activities. Improper arrangement of materials, lack of protection against

bad weather, and poor organization of the storage areas might lead to a situation where the materials are not used efficiently (Liu & Walker, 1998). All of these factors can cause project delays (Flyvbjerg *et al.*, 2003).

### **Institutional, Legal, and Regulatory Challenges**

The execution of dam projects often encounters delays because of institutional, legal, and regulatory issues. According to Dessalegn (1999), Ethiopia's policy for infrastructure development is fragmented because there are overlapping responsibilities among several different governmental bodies. In addition, poor coordination among project parties leads to poor decision-making, delays in regulatory processes, and mismanagement of project resources.

Some of the common legal and regulatory challenges cited in the existing literature are delays in obtaining permits, non-compliance with social and environmental regulations, as well as disputes over land acquisition (World Commission on Dams, 2000).

The initiation of projects can also be delayed due to land acquisition processes and approval of environmental impact assessments, which can take a long time (Branche, 2017). In addition, legal issues can arise due to contractual disputes among project stakeholders, and this may lead to litigation, which may even finally result in project termination (Aibinu, 2009).

### **Social, Cultural and Political Factors**

Political and social factors are also among the most important causes of delay in the construction of dam projects. Some of the common factors under this group are: political instability, government interference, public opposition, and resettlement delays.

An unstable political environment leads to many delays due to changes in political leadership, policy changes, and bureaucratic bottlenecks (World Bank, 2017). Repeated changes in government policies and structure or political elections can also derail the stability of projects, as new leaders may revisit project goals or make further decisions. Political disorder and ethnic conflicts can also stop construction activities and slow down the progress of work (Flyvbjerg *et al.*, 2003; World Commission on Dams, 2000). External geopolitical tensions also interfere with the smooth flow of essential construction materials such as cement and steel, and can also worsen project delays (Flyvbjerg *et al.*, 2003)

Sometimes, the government can intervene in decision-making processes, especially in public infrastructure. This may interfere with the established procedures, which can cause delays. Favoritism (preference) for specific contractors, change in the scope of projects for political reasons, or interfering with technical issues can all cause inefficiency and delays (Scudder, 2005).

Public opposition to the project may also arise. Community concerns, especially those related to social or environmental effects of the dam project, tend to be transformed into protests and delay the project if they are not tackled properly (Scudder, 2005; World Commission on Dams, 2000). The local community might get concerned about the possibility of their displacement because of flooding, environmental degradation, or disruption of their livelihoods, especially in large dam projects (World Commission on Dams, 2000). Inadvertently not taking stakeholders into account and addressing their concerns can trigger protests, lawsuits, and delays in project permitting.

Community dynamics also play their role in delaying construction projects, especially in dam construction, as such projects may touch culturally sensitive issues. Indigenous society can complain about natural heritage sites, for example, and conflicts related to them can bring legal claims and cause project delays (World Commission on Dams, 2000).

Last but not least, the process of relocating people affected by the project can also delay the project's progress (Tumi *et al.*, 2009). This is because the resettlement may involve compensation, development of new infrastructure, and settlement of relocated communities, making it a complex process. The delays in the resettlement process itself can postpone construction activities, especially for those projects that involve the acquisition (Branche, 2017).

### **Natural and Environmental Factors**

Dam construction progress can be greatly affected by natural and environmental challenges. Events such as earthquakes, floods, or landslides have quite an impact on construction progress and often lead to delays in the whole process. Climate factors are also among the most important issues. Heavy rainfall, extreme temperatures, or other adverse weather conditions may slow down the progress of the construction and necessitate rescheduling of resources (Assaf & Al-Hejji, 2006; Branche, 2017).

There are also certain unexpected environmental challenges. Unexpected geological conditions and environmental problems that lead to design changes and further mitigation measures (World

Commission on Dams, 2000), can severely affect the construction of dam projects. Similarly, failure to comply with regulations and shallow environmental impact assessments (Dessalegn, 1999) can also cause delays in projects.

### **Technological Challenges**

Adopting specialized and advanced construction methods and technologies may sometimes introduce delays to projects, even though they are generally beneficial for improving the overall efficiency (Arditi & Gunaydin, 1997). This is because the new technology and method require additional training for workers. Malfunctioning of equipment and technical failures can also disrupt the process and activities, extending the project timelines (Love *et al.*, 2002).

### **Pandemics**

Pandemics can disrupt the supply chain and delay construction projects. For example, COVID-19 has caused logistical problems as well as labor and materials shortages that have greatly impacted construction projects around the world (O D Oklobia & Prof Tsado, 2022).

### **Health and Safety Concerns**

Health and safety issues that may occur at the project site can also lead to delays in construction. This may include accidents and injuries, which can halt construction projects, culminating in investigations, legal proceedings, and further attention from regulatory bodies (G. Sweis *et al.*, 2008).

## **2.6. Previous Studies on Causes of Delays in Dam Construction Projects**

Several studies have been carried out in different parts of the world, including in Ethiopia, to understand why dam construction projects often experience delays. These studies show a range of interconnected issues causing these delays.

### **2.6.1. Global Studies**

Delays in the construction of dams have been the focus of international research, and numerous studies have identified the factors leading to these delays. For instance, Alamri *et al.* (2017) studied the causes of delay in dam construction in Oman using a quantitative survey methodology. Their study identified severe weather conditions, change orders, uncertainty in ground conditions, poor

site management, executive bureaucracy in the client's organization, poor feasibility study, mistakes in soil investigation, natural effects during construction work, difficulty of defining project requirements, and slow decision-making process as the main delay factors.

Studies in Pakistan (Sohu *et al.*, 2017; Batool & Abbas, 2017; Azam *et al.*, 2022; Wang *et al.*, 2014; Haviz, 2021) frequently identify material supply issues, financial difficulties faced by contractors, inadequate site management, inexperienced contractors, design changes, and challenges related to land acquisition and resettlement as critical.

In addition, Kamalan & Abedin Maghanaki (2020) investigated the causes of delay in dam projects in Iran. Based on the Analytic Hierarchy Process (AHP), their findings revealed that inappropriate selection of contractors, delay in the design preparation, budget deficit, unqualified personnel, economic issues, improper tender proposals, and poor site management by the contractors were among the major causes of delays in the country.

Similarly, Rahmayanti *et al.* (2022) investigated delay factors influencing the construction of Tugu Dam in Indonesia using a survey methodology. This research used quantitative analysis techniques (factor analysis and multiple linear regression) and derived two dominant variables of delays: the situation factor (i.e., land acquisition, social and cultural factors), and the change factor (design changes, planning design errors, and soil investigation errors). From the findings of the research, land acquisition and design changes were identified as the key indicators under the situation factor and change factor, respectively.

In Vietnam, Hai & Son (2021) conducted a study to explore the primary causes of construction delays in reservoir projects, identifying 32 causes of delay. As per the findings of the study, the most influential factors in construction delays are technical factors (unreasonable construction schedule, inefficient use of equipment, unreasonable testing methods, low productivity level of labor, change in material cost, etc.) and external factors (slowness in decision-making process by owner, hydrological and flow factors, slowness in supplying materials from distributors, accident during construction due to lack of safety measures, geological factors and extreme weather conditions).

Furthermore, World Commission on Dams (2000) also cited factors such as financial challenges, incompetence of contractors, unrealistic timelines, dissatisfaction with the workforce, and legal obstacles as the reasons for delays in dams globally.

Last but not least, recent empirical research from Peru by Julca-Varas *et al.* (2025) provides new insights on the factors responsible for delays and cost overruns in the construction of water infrastructure projects. Their study on 318 project contracts revealed such critical parameters as delayed change order approval, adverse weather conditions, inadequate site information, and inaccurate cost estimates at the design stage, with the COVID-19 pandemic being an external shock with a perfect association ( $\phi = 1.000$ ) to delays in projects.

### **2.6.2. Studies Specific to Ethiopia**

A few studies have been conducted on construction delays in Ethiopian water infrastructure projects (particularly dams), even though most of them focused on large-scale projects.

For instance, Temesgen & Denamo (2020) used a mixed methods approach consisting of stakeholder interviews, questionnaires, and project document analysis to study factors influencing mega sugar construction projects in Ethiopia in terms of time and cost overruns. Based on this study, the delays in irrigation infrastructure parts of these projects resulted from improper planning and scheduling, unrealistic contract duration, and lack of coordination among stakeholders. Their results highlight the need to undertake rigorous feasibility assessments and collaboration between all the players involved, insights that may apply to any other construction project.

In a study of large-scale irrigation projects in Ethiopia, Alemayehu (2021) found poor planning and activity scheduling, poor project management, problems in material delivery on time, poor monitoring and evaluation system, poor site management, delay in payment, unfinished designs, error in estimating durations, contractor financial problems, poor decision-making and issues related to Right-of-Way to be the highest ranking causes of delay.

Alwoye (2018) also conducted a case study on the Megech Dam using a mixed-methods approach (questionnaire surveys and semi-structured interviews) to collect data from the purposively selected stakeholders. The findings revealed mistakes in the planning stages, lack of risk management plan, poor management of scope changes, inadequate financing, political unrest, poor

estimation, and the complex nature of irrigation projects as the main factors affecting the construction of the project.

Similarly, the investigation on the Arjo Dhidhessa Dam project revealed that design changes, limited capacity of local contractors, and unanticipated weather conditions were the major causes of project delays (CoST - Ethiopia, 2015). The report stressed that the long rainy season (which lasted for about 5 months) was not adequately taken into account in the initial planning, making the construction of earth dams difficult as the soils had high moisture content.

Furthermore, Kirubel (2021) explored delays in the Gibe III Hydroelectric Power Project and concluded that a shortage of finance, poor planning, inadequate quality procedures, design changes, and unexpected circumstances were the major causes of construction delays.

Last but not least, Biruk & Birhane (2017) investigated the delays in small-scale irrigation development in Ethiopia and pointed out that the main hindrance to the timely implementation of these projects was a lack of communication and coordination among stakeholders.

### **2.6.3. Critical Evaluation of Prior Studies and Research Gaps**

Even though several studies have investigated the causes of delays in dam construction globally and within Ethiopia, their findings vary depending on context, project scale, and methodology, underscoring the importance of comparative analysis and contextual understanding. Table 1 below summarizes the previously reviewed studies to facilitate the comparison.

*Table 1: Summary of Reviewed Studies on Causes of Construction Delay*

<b>Author(s)</b>	<b>Country/ Region</b>	<b>Project Type</b>	<b>Methodology</b>	<b>Findings (Key Causes of Delay)</b>
Sohu <i>et al.</i> (2017)	Pakistan	Dam Projects	Quantitative Survey	delay in supply of materials, natural disaster, financial difficulties faced by the contractor, disputes at sites, poor site management, inexperienced contractor

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*

<b>Author(s)</b>	<b>Country/Region</b>	<b>Project Type</b>	<b>Methodology</b>	<b>Findings (Key Causes of Delay)</b>
Alamri <i>et al.</i> (2017)	Oman	Dam Projects	Survey (data collection with semi-structured questionnaire, ranking using Pareto's law of 80/20)	weather conditions, change orders, uncertainty in ground conditions, poor site management, executive bureaucracy in the client organization, feasibility study not covering all aspects
(Frimpong <i>et al.</i> , 2003)	Ghana	Groundwater	Quantitative Survey (Structured questionnaire, ranking analysis)	monthly payment difficulties from agencies, poor contractor management, material procurement, poor technical performance, and escalation of material prices
Kamalan & Abedin Maghanaki (2020)	Iran	Dam Projects	Case Studies (Ranking by AHP)	deficit budget allocation, economic problems of the country, the weakness of the contractor's site management, unqualified personnel in construction management, delay in preparing, and lots of mistakes/ modifications in the detailed design by the consultant
Rahmayanti <i>et al.</i> (2022)	Indonesia	Dam Project	Quantitative Survey (questionnaire, factor analysis, and multiple linear regression)	the situation factor (land acquisition, social and cultural factors), and the change factor (design changes, planning design errors, and soil investigation errors)

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*

<b>Author(s)</b>	<b>Country/Region</b>	<b>Project Type</b>	<b>Methodology</b>	<b>Findings (Key Causes of Delay)</b>
Hai & Son (2021)	Vietnam	Reservoir Projects	Survey (questionnaire, factor analysis, regression analysis)	technical factors (unreasonable construction schedule, unorganized construction method), external factors (hydrological and flow conditions, slowness in decision-making process by owner), human factors (lack of professional human resources, changes in subcontractors).
Wang <i>et al.</i> (2014)	Pakistan	Dam Project	Case Study	financial constraints, supply market fluctuation, contract disputes, irrational managerial system, natural disasters, political instability
Batool & Abbas (2017)	Pakistan	Hydro-Power Projects	Mixed methods (interviews, document reviews)	lack of political will, delay in civil work, delays in release of funds by the government, bad law and order situation, project start without proper site investigation, delays in land acquisition
Azam <i>et al.</i> (2022)	Pakistan	Dam Project	Case Study (questionnaire and interviews)	disputed boundary, resettlement issues, compensation of land, threat to cultural heritage, and ecological impacts of the project
Haviz (2021)	Pakistan	Small Dam Projects	Mixed Methods (questionnaire, interviews)	delay in land acquisition, poor project planning, ineffective controlling and management, design error, unqualified staff, poor site management

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*

<b>Author(s)</b>	<b>Country/Region</b>	<b>Project Type</b>	<b>Methodology</b>	<b>Findings (Key Causes of Delay)</b>
Julca-Varas <i>et al.</i> (2025)	Peru	Water Infrastructure	Empirical Research (Contract Analysis)	COVID-19, delayed change order approval, adverse weather conditions, inadequate site information, and inaccurate cost estimates at the design stage
Temesgen & Denamo (2020)	Ethiopia	Mega Sugar Projects with Irrigation infrastructure components	Mixed methods (interviews, questionnaires, and document analysis)	improper planning and scheduling, unrealistic contract duration, and lack of coordination among stakeholders
Alemayehu (2021)	Ethiopia	Large-scale Irrigation Projects	Quantitative Survey (Questionnaire, Pareto's law of 80/20)	poor planning and activity scheduling, poor project management, problems in material delivery on time, poor monitoring and evaluation system, poor site management
Alwoye (2018)	Ethiopia	Large-scale Irrigation Project (Megech Dam)	Case Study (questionnaire surveys and semi-structured interviews)	mistakes in the planning stages, failure to have a risk management plan, poor management of scope changes, lack of proper financing and forex, political unrest, poor estimation, and the complex nature of irrigation projects, etc.
Kirubel (2021)	Ethiopia	Gibe III Hydroelectric Project	Census Survey (structured questionnaire and analyzed using multiple linear regression)	lack of finance, improper planning, inadequate quality procedure, design change, and unforeseen circumstances
CoST – Ethiopia (2015)	Ethiopia	Arjo Dhidhessa Dam Project	Review	design changes, limited capacity of local contractors, and unanticipated weather conditions

As presented in the table, many global studies predominantly rely on quantitative survey methods. These often involve extensive questionnaires to identify and rank delay factors, sometimes employing statistical techniques like factor analysis, regression analysis, or AHP (Kamalan & Abedin Maghanaki, 2020) to determine factor significance. This approach is effective for identifying common, broadly applicable delay factors across multiple projects or large populations, providing a wide snapshot of perceived issues. However, the depth of understanding gained from such methods can be limited, as they may not fully capture the complex, context-specific interactions or the underlying reasons behind reported delays.

Conversely, some studies, particularly case studies (eg., Alwoye, 2018; CoST – Ethiopia, 2015; Wang *et al.*, 2014) or those utilizing mixed methods (Alamri *et al.*, 2017; Batool & Abbas, 2017; Haviz, 2021; Temesgen & Denamo, 2020), offer richer, more nuanced insights. These approaches often integrate qualitative data collection, such as interviews or document reviews, which allow for a deeper exploration of specific project dynamics and the contextual factors influencing delays. This qualitative depth is crucial for understanding why certain factors are significant in a particular setting, moving beyond mere identification and ranking.

From a contextual standpoint, the majority of previous studies on dam construction delays, especially within Ethiopia, have concentrated on large-scale national projects. These projects, often benefiting from centralized planning and robust national support, tend to have delay factors reflecting their scale and national importance (e.g., major financing hurdles, complex multi-stakeholder coordination, or national policy impacts). This contrasts with the focus of this current study. There is, therefore, a notable gap in understanding the unique delay dynamics of small- and medium-scale multipurpose dams operating under regional, decentralized initiatives like the Finna Oromia Initiative. These projects, by their nature, rely heavily on regional administrative capacity, local contractors, and fragmented coordination. This distinct context suggests they are likely to encounter a different set of challenges, including more acute site-specific delays due to limited early technical investigation, more pronounced contractor capacity limitations, and micro-level logistical issues.

This comparative analysis underscores that delay mitigation strategies cannot be universally applied across all dam projects, nor can a single methodological approach fully capture the complexity of delays in all contexts. While quantitative surveys provide breadth, qualitative or

mixed methods offer the necessary depth to understand contextual nuances. For this study, given its focus on the specific, decentralized nature of the Finna Oromia Initiative, a mixed-methods approach incorporating both quantitative data to identify prevalent factors and qualitative aspects to delve into project-specific complexities and the ‘why’ behind delays would be particularly beneficial. This strategy will allow the research to comprehensively capture the distinct challenges of small- and medium-scale dams within this unique regional context, thus filling a critical gap in the existing literature. By providing more tailored insights, it adds a more generalizable understanding of patterns at a programmatic scale. The details will be presented in Chapter 3.

## **2.7. Common Mitigation Strategies for Construction Delays**

Prevention and mitigation of delay in construction need to involve both proactive and reactive solutions. Such solutions should be framed in a manner that eliminates or minimizes the necessity of extending project duration beyond the originally planned completion date (Shengea & Misra, 2020). Well-developed plans that address the underlying causes of delays will make mitigation effective. There are several core strategies to achieve this.

### **Effective planning and scheduling**

Every successful project is built on careful planning and scheduling. This entails making detailed project execution plans, with all the required activities, early determination of construction issues that may arise, and formulating measures to address emerging problems (risks) in good time.

The accuracy of initial plans and the robustness of scheduling tools enable better resource allocation and risk management, ensuring the successful completion of the project. To visualize project timelines, identify the critical path, and manage dependencies between tasks, managers can use tools such as the Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT) (Kerzner, 2017).

### **Design management**

Design management is extremely important in the construction sector. This includes minimizing or avoiding design changes. Well-defined and stable design specifications will prevent design changes and costly rework that lead to delays (Sohu *et al.*, 2017). Furthermore, detailed design documentation coupled with strict design review by experienced professionals can prevent some

of the delays associated with design. Thus, before the construction starts, thorough site and geological condition assessments should be conducted to avoid the discovery of unforeseen subsurface issues that could cause significant delays and cost overruns (Liu & Walker, 1998; Sohu *et al.*, 2017).

### **Proactive risk assessment and management**

Proactive risk assessment and management are essential for effective delay mitigation. This entails the systematic identification of potential risks that could affect the project, the evaluation of their likelihood and potential impact, and the development of corresponding response strategies to mitigate or avoid these risks (Project Management Institute, 2021). To address potential geotechnical challenges, it is necessary to develop and implement appropriate geotechnical solutions tailored to the specific site conditions (Liu & Walker, 1998). Environmental and weather factors also have a very significant effect on the construction project timelines. Chan & Kumaraswamy (1996) emphasize the necessity of conducting comprehensive environmental assessments, weather impact analyses, and robust mitigation strategies to deal with the delays caused by these factors. This also encompasses strategies such as contingency planning to guarantee project resilience and address any potential disruptions.

### **Effective resource management**

Another key area for mitigating construction delays is effective resource management, which involves ensuring the timely availability and proper allocation of all required resources. This includes the availability of labor, equipment, as well as materials, and managing their allocation to meet project requirements and schedules (Koushki *et al.*, 2005; Project Management Institute, 2021). Sohu *et al.* (2017) contends that skilled workers with the required expertise are needed to ensure efficient and quality construction. To mitigate delays caused by material shortage, effective supply chain management strategies should be devised, including developing relationships with backup suppliers and diversifying sources of critical materials. Sambasivan & Soon (2007) note that proactive supply chain risk management is necessary to deal with disruptions and to keep steady project progress.

According to Assaf & Al-Hejji (2006), one type of delay often comes from the contractor's financial issues, such as late payments, which can disrupt the workflows of a project. Prevention

of such delays requires proper funding approval and timely allocation of financial resources (Sohu *et al.*, 2017).

Furthermore, robust financial management strategies (such as developing realistic budgets, effective cost control measures, and monitoring costs closely to detect any potential overruns at an early stage) are also crucial (Assaf & Al-Hejji, 2006). Alternative financing mechanisms, such as public-private partnerships (PPP) and risk-sharing agreements, can offer additional financial flexibility and reduce financial risks (World Bank, 2017).

### **Improved communication and collaboration**

Effective communication and collaboration among all project stakeholders is essential for successful project delivery and delay mitigation. This includes establishing efficient communication channels, enhancing information sharing among project teams and stakeholders, and fostering a collaborative team environment. Effective stakeholder engagement and well-defined conflict resolution strategies are also important for addressing and resolving stakeholder-related issues that could lead to delays (Tumi *et al.*, 2009). Utilizing collaborative project management software and other digital tools can further enhance communication and efficiency by facilitating real-time information sharing, document management, and collaborative workflows (Deloitte, 2024).

### **Efficient project management, monitoring, and control**

Efficient project management, continuous monitoring of project progress, and robust control mechanisms are crucial for keeping projects on track. This includes developing a strong project management approach, regularly comparing actual progress against planned progress to identify potential deviations from the schedule, and implementing appropriate corrective actions promptly (Kerzner, 2017). Employing a highly skilled and experienced project manager with strong leadership and management skills is vital for smooth project execution and effective site supervision (Müller & Turner, 2007; Sohu *et al.*, 2017).

### **Effective change management**

Implementing a strong change management process is essential for effectively managing changes in project scope, design, or requirements and minimizing their impact on the project schedule (Project Management Institute, 2021). This involves establishing a formal process for managing changes, including documenting change requests, assessing their impact on the project, and implementing appropriate adjustments to the project plan and schedule (Hao *et al.*, 2008). Establishing such a formal process ensures that all stakeholders are aligned and that changes are handled efficiently, reducing the risk of delays and cost overruns (Crawford, 2005).

### **Efficient decision-making processes**

Establishing a clear and efficient decision-making process is essential for ensuring timely and well-informed decisions throughout the project lifecycle. This includes defining clear roles and responsibilities for decision-making, establishing clear communication channels for escalating issues and making decisions, and implementing processes for documenting and communicating decisions to all relevant stakeholders (Müller & Turner, 2007).

A structured decision-making process ensures that decisions are made based on reliable data, stakeholder input, and well-defined objectives, which helps in avoiding delays and achieving project goals (Kerzner, 2017).

### **Regulatory compliance**

Ensuring full compliance with all applicable regulations and obtaining all necessary permits and approvals in a timely manner is crucial for preventing delays related to regulatory issues. This involves engaging with regulatory agencies early in the project planning process, understanding all applicable regulations, and developing a comprehensive permitting strategy (Chitkara, 2014). Early engagement with regulators and clear communication about project needs are essential to minimize delays caused by regulatory approvals (Oberlender, 2000).

### **Effective supply chain management**

Effective supply chain management is important for mitigating delays caused by material shortages or delivery problems. This involves establishing strong relationships with reliable suppliers, implementing robust procurement processes, and carefully managing logistics and transportation to ensure the timely delivery of materials to the project site (Carter & Liane Easton, 2011). Strong

procurement strategies and well-managed logistics are essential in preventing supply chain disruptions that can lead to costly delays in construction projects (Walker, 2015).

### **Technology adoption**

Adopting innovative construction technologies, such as Building Information Modeling (BIM), remote sensing, and other digital tools, can significantly improve project coordination, enhance efficiency, and reduce the likelihood of delays. These methods have shown improved performance for the design and construction phases of an asset lifecycle (Desbalo & Woldeesenbet, 2024). They can facilitate better communication, collaboration, and information sharing among project teams, improve design accuracy, and enable more efficient construction processes (Azhar, 2011). BIM and digital tools also help streamline workflows, improve project visualization, and allow for better decision-making throughout the construction process (Sacks *et al.*, 2018).

### **Optimized contractual practices**

Improved contract practices are very important for preventing and reducing construction delays. It is crucial to have contracts that are clear about the roles, responsibilities, and duties of everyone involved in the project. These contracts should also clearly state any consequences if there are delays or changes. Having fair methods to resolve disputes is important to keep projects from stopping due to contract-related arguments (RICS, 2019). Additionally, selecting the right contractors is important. Sohu *et al.* (2017) recommend that contracts should be awarded based on merit, selecting contractors with proven experience and a strong track record of successful project delivery. Implementing rigorous contractor selection processes, including thorough prequalification assessments, can ensure the engagement of experienced, qualified, and reliable contractors with a proven track record of timely project completion (Akintoye, 2009).

## **2.8. Summary of the Literature Review (Theoretical Framework)**

This research has reviewed various factors contributing to construction delays, focusing on dam projects. This literature review serves as the theoretical foundation for understanding the issue being scrutinized, offering insights into the broader context of construction delays across different regions and settings. Several causes of delay (delay factors) in dam construction projects have been

identified. The summary of these factors (after merging related descriptions) is presented in the Table below.

*Table 2: List of Delay Factors in Construction Compiled from the Existing Literature*

<b>No.</b>	<b>Delay Factor</b>	<b>Author(s) Identifying the Factor</b>
1	Improper/Poor Planning & Scheduling	Alamri <i>et al.</i> (2017); Kamalan & Abedin Maghanaki (2020); Hai & Son (2021); Haviz (2021); Temesgen & Denamo (2020); Alemayehu (2021); Alwoye (2018); Kirubel (2021); Abd El-Razek <i>et al.</i> (2008); Odeh & Battaineh (2002)
2	Unrealistic Time Estimates/ Contract Duration	Sohu <i>et al.</i> (2017); Batool & Abbas (2017); Julca-Varas <i>et al.</i> (2025); Temesgen & Denamo (2020); Alwoye (2018); Assaf & Al-Hejji (2006); Love <i>et al.</i> (2002); Flyvbjerg (2008)
3	Poor Feasibility Study	Alamri <i>et al.</i> (2017); Batool & Abbas (2017); Assaf & Al-Hejji (2006); Love <i>et al.</i> (2002)
4	Design Changes/ Errors/ Defects/ Omissions	Sohu <i>et al.</i> (2017); Rahmayanti <i>et al.</i> (2022); Haviz (2021); CoST – Ethiopia (2015); Kirubel (2021); Bramble & Cipollini (1995); Sambasivan & Soon (2007); Assaf & Al-Hejji (2006); Chan & Kumaraswamy (1996); Olawale & Sun (2010); Gizachew & Elsaye (2020)
5	Inadequate Site/ Soil Investigation / Geotechnical Uncertainties	Alamri <i>et al.</i> (2017); Rahmayanti <i>et al.</i> (2022); Batool & Abbas (2017); Julca-Varas <i>et al.</i> (2025); Al-Momani (2000); Love <i>et al.</i> (2002); Olawale & Sun (2010)
6	Technical Factors (General)	Hai & Son (2021)
7	Contractor Financial Difficulties	Sohu <i>et al.</i> (2017); Alemayehu (2021); Kirubel (2021); Abdul-Rahman <i>et al.</i> (2009)
8	Inexperienced/Inappropriate Contractor Selection	Sohu <i>et al.</i> (2017); Kamalan & Abedin Maghanaki (2020); CoST – Ethiopia (2015)
9	Poor Site Management/Control	Alamri <i>et al.</i> (2017); Sohu <i>et al.</i> (2017); Kamalan & Abedin Maghanaki (2020); Alemayehu (2021); Haviz (2021); Wang <i>et al.</i> (2014)
10	Unqualified Personnel/Labor Shortage/Low Productivity	Sohu <i>et al.</i> (2017); Kamalan & Abedin Maghanaki (2020); Haviz (2021); Hai & Son (2021); Sambasivan & Soon (2007); Aibinu & Jagboro (2002); O D Oklobia & Prof Tsado (2022)

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase I of the Finna Oromia Initiative*

<b>No.</b>	<b>Delay Factor</b>	<b>Author(s) Identifying the Factor</b>
11	Equipment Availability/Inefficient Use/Breakdowns	Alamri <i>et al.</i> (2017); Hai & Son (2021); Love <i>et al.</i> (2002)
12	Defective Work/Construction Mistakes/Rework/Quality Control Problems	Alamri <i>et al.</i> (2017); Love <i>et al.</i> (2002)
13	Bureaucracy/Slow Decision-Making/Government Interference	Alamri <i>et al.</i> (2017); Hai & Son (2021); Scudder (2005); Dessalegn (1999)
14	Inadequate Project Financing/Budget Deficit/Economic Issues/Financial Mismanagement/Late Payments	Kamalan & Abedin Maghanaki (2020); Wang <i>et al.</i> (2014); Batool & Abbas (2017); Alwoye (2018); Kirubel (2021); WCD (2000); Assaf & Al-Hejji (2006); Odeh & Battaineh (2002); Dessalegn (1999); Othman <i>et al.</i> (2015); World Bank (2017); Ogunsemi & Jagboro (2006); Flyvbjerg <i>et al.</i> (2003)
15	Poor Project Management/Monitoring/Control	Alemayehu (2021); Alwoye (2018); Sweis <i>et al.</i> (2016)
16	Lack of Coordination/Communication	Temesgen & Denamo (2020); Biruk & Birhane (2017); Al-Momani (2000); Assaf & Al-Hejji (2006); Chan & Kumaraswamy (1996)
17	Inconsistent Contract Enforcement	Wang <i>et al.</i> (2014)
18	Contract Disputes/Claims/Litigation	Alamri <i>et al.</i> (2017); Sohu <i>et al.</i> (2017); Wang <i>et al.</i> (2014); Julca-Varas <i>et al.</i> (2025); Gizachew & Elsaye (2020); Aibinu (2009)
19	Natural Disasters/Adverse Weather Conditions	Alamri <i>et al.</i> (2017); Sohu <i>et al.</i> (2017); Wang <i>et al.</i> (2014); Julca-Varas <i>et al.</i> (2025); CoST – Ethiopia (2015); Hai & Son (2021); Assaf & Al-Hejji (2006); Branche (2017); Flyvbjerg <i>et al.</i> (2003)
20	Land Acquisition/Resettlement Issues/Displacement	Alamri <i>et al.</i> (2017); Rahmayanti <i>et al.</i> (2022); Azam <i>et al.</i> (2022); Batool & Abbas (2017); Haviz (2021); Scudder (2005); World Commission on Dams (2000); Dessalegn (1999); Branche (2017); Tumiet <i>et al.</i> (2009)
21	Political Instability/Unrest/Policy Changes	Wang <i>et al.</i> (2014); Batool & Abbas (2017); Alwoye (2018); World Bank (2017); Flyvbjerg <i>et al.</i> (2003); World Commission on Dams (2000)

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase I of the Finna Oromia Initiative*

<b>No.</b>	<b>Delay Factor</b>	<b>Author(s) Identifying the Factor</b>
22	Economic Issues/Market Fluctuation (General)	Kamalan & Abedin Maghanaki (2020); Wang <i>et al.</i> (2014)
23	Material Supply Delays/Shortages/Logistics & Supply Chain Problems	Sohu <i>et al.</i> (2017); Alemayehu (2021); Hai & Son (2021); Sambasivan & Soon (2007); Aibinu & Jagboro (2002); Sweis <i>et al.</i> (2008), O D Oklobia & Prof Tsado (2022); Assaf & Al-Hejji (2006); Liu & Walker (1998); Flyvbjerg <i>et al.</i> (2003)
24	Social Resistance/Public Opposition to the Project	Alamri <i>et al.</i> (2017); Rahmayanti <i>et al.</i> (2022); Azam <i>et al.</i> (2022); Wang <i>et al.</i> (2014); WCD (2000); Scudder (2005)
25	Geological/Ground Conditions (General)	Alamri <i>et al.</i> (2017); Hai & Son (2021)
26	Permit/Approval Delays/Regulatory Processes	Alamri <i>et al.</i> (2017); World Commission on Dams (2000); Dessalegn (1999); Branche (2017)
27	Unforeseen Circumstances/Force Majeure	Kirubel (2021); Batool & Abbas (2017); Olawale & Sun (2010)
28	Covid-19 Pandemic	Julca-Varas <i>et al.</i> (2025); O D Oklobia & Prof Tsado (2022)
29	Threat to Cultural Heritage/Ecological Impacts	Azam <i>et al.</i> (2022); World Commission on Dams (2000)
30	Environmental Issues (General)	Scudder (2005); World Commission on Dams (2000); Dessalegn (1999)
31	Policy Uncertainty	WCD (2000)
32	Wrong Site Selection	Assaf & Al-Hejji (2006); Love <i>et al.</i> (2002)
33	Poor Definition of Milestones/Unclear Project Objectives	Project Management Institute (2021)
34	Complexity of the Project	Chan & Kumaraswamy (1996)
35	Misunderstanding of Owner's Requirements by Design Team	Sambasivan & Soon (2007)
36	Inadequate Design-Team Experience	Chan & Kumaraswamy (1996)
37	Lack of Use of Advanced Engineering Design Software	Sambasivan & Soon (2007)
38	Lack of Risk Management (Identification, Assessment, Mitigation)	Project Management Institute (2017); Odeh & Battaineh (2002)

<b>No.</b>	<b>Delay Factor</b>	<b>Author(s) Identifying the Factor</b>
39	Inevitable Changes During Implementation	Olawale & Sun (2010)
40	Health and Safety Problems/Accidents/Injuries	World Bank (2017); G. Sweis <i>et al.</i> (2008)
41	Unexpected Costs	Othman <i>et al.</i> (2015)
42	Unreliable Suppliers	Sweis <i>et al.</i> (2008)
43	Inadequate Storage Facilities/Improper Material Handling	Sweis <i>et al.</i> (2008); Liu & Walker (1998); Flyvbjerg <i>et al.</i> (2003)
44	Absence of Basic Infrastructure at Site (electricity, telecommunication, water)	(Implied from Logistics section)
45	Fragmented Policy/Overlapping Responsibilities	Dessaiegn (1999)
46	Non-compliance with Social and Environmental Regulations	World Commission on Dams (2000)
47	Inconsistent Designs (Lack of coordination among designers, engineers, contractors)	Chan & Kumaraswamy (1996)
48	Delays in Producing Design Documents	Assaf & Al-Hejji (2006); Chan & Kumaraswamy (1996); Olawale & Sun (2010); Sambasivan & Soon (2007)
49	Adoption of New Technologies (requiring training/malfunctioning)	Arditi & Gunaydin (1997); Love <i>et al.</i> (2002)

## 2.9. Conceptual Framework

The conceptual framework serves as a guide, drawing from the theoretical framework while focusing on the most relevant aspects of the issue that directly pertain to the research problem (Kumar, 2012). This step is crucial in transforming broad theoretical knowledge into a focused framework that supports the analysis of specific issues.

The conceptual framework for studying the causes of delay in this research builds upon the theoretical foundation established in the literature review, tailoring it to the unique context of the Finna Oromia Initiative. A key step in designing this framework is categorizing delay factors into relevant groups.

Different categorizations of construction delay factors have been proposed by authors. Because construction projects are unique, there is no agreement on how to classify them. These variations may occur due to project type, the region, the construction industry, the size of the firm, experience, cultural differences, technical expertise, etc. (Trauner, 2009; Annamalaisami & Kuppuswamy, 2022; Tariq & Shujaa Safdar Gardezi, 2023).

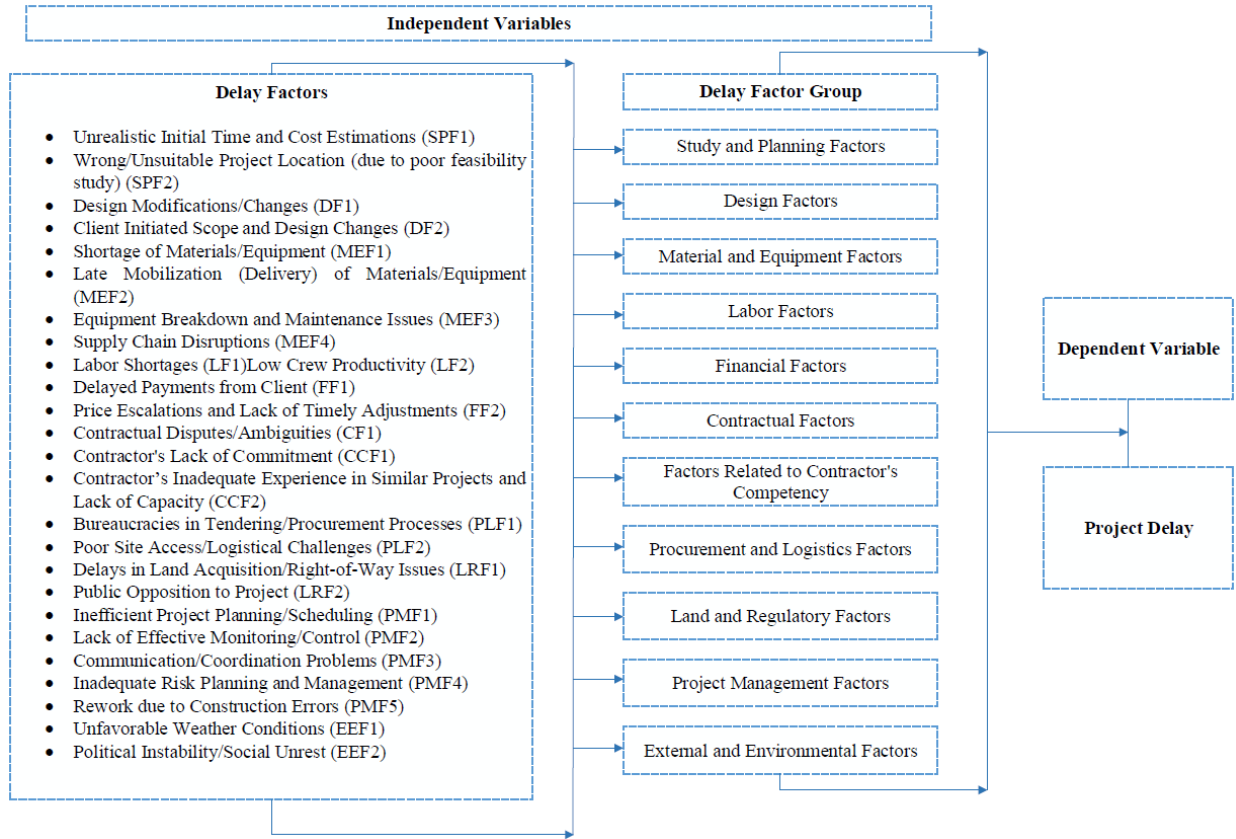
The conceptual framework of this research follows the researcher's original classification of delay factors based on thematic synthesis of the literature review, with some modifications to tailor them to the specific context of the Finna Oromia Initiative. From the several factors collected from the literature, a comprehensive list of representative delay factors was compiled by consulting with a small group of experts who have been involved in these projects. This led to the formation of 11 delay groups and the identification of 26 individual delay factors. Each question was selected based on contextual relevance to Ethiopian dam projects by merging related themes (ideas) and verification from ECO reports and expert consultations.

**Independent Variables:** The framework includes a wide range of potential factors categorized into study and planning factors, design factors, material and equipment factors, labor factors, financial factors, contractual factors, factors related to contractor's competence, procurement and logistics factors, land and regulatory factors, project management factors and external and environmental factors groups which serve as independent variables of the study.

**Dependent Variable:** The project delay (measured as schedule deviations from the planned project timeline as defined in the literature above), serves as the dependent variable.

**Relationships:** The framework explores the relationships between the independent and dependent variables, aiming to determine which factors contribute most significantly to delays in the Finna Oromia Multipurpose Dam Projects.

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*



*Figure 2. Conceptual Framework for Investigating Causes of Delay in Dam Projects*

### **3. RESEARCH METHODOLOGY**

#### **3.1. Introduction**

Research is a systematic, controlled, empirical, and critical investigation of hypothetical propositions concerning the presumed relations among observed phenomena to ensure that findings are added to the body of knowledge (Tayie, 2005). According to Fellows & Liu (2015), it is a process of enquiry that relates ‘what’ is being investigated (issues, facts, and conclusions) to ‘how’ conclusions are arrived at (methodologies).

This endeavor involves critical investigation of the problem under study (understanding and formulating guidelines that govern the research procedure) and developing and/or testing theories for the enhancement of the existing situation, state, or process (Solomon, 2015).

Therefore, research methodology is a way to systematically solve the research problem using a set of procedures and methods (Kothari, 2004). It is a crucial component in the research process because it helps develop a transparent and reliable approach for answering the research questions at hand (Creswell, 2014). The chapter describes the specific methodologies used in this research and justifies each methodological decision.

The research philosophy is introduced at the beginning of the chapter to provide the foundation upon which the nature of knowledge and the role of the researcher will be established (Creswell & Creswell, 2023; Saunders *et al.*, 2023; Solomon, 2015). This is important because the philosophical position informs the entire research process, including the research approaches and methods.

Following this, the chapter discusses the research type, classifying the study based on its purpose and its relationship with the real world (Saunders *et al.*, 2023). It also explains the reasoning and methodological approaches used to help fully understand the problems under study, paving the way to solve them (Bryman, 2012).

The research design section provides a clear framework (procedural plan) adopted to deal with the research questions at hand (Robson & McCartan, 2016; Yin, 2018). As it encompasses all aspects, including what questions to study, what data are relevant, what data to collect, and how they are analyzed, the research design serves as a ‘blueprint’ for the research (Frankfort-Nachmias *et al.*, 2015; Yin, 2018).

Next, the chapter outlines the methods of data collection and analysis, detailing how data were retrieved from stakeholders and how they were analyzed (Miles & Huberman, 1994; Tavakoli, 2013).

Finally, the chapter discusses research rigor (validity and reliability) and ethical concerns to maintain the credibility and integrity of the research findings (Israel & Hay, 2006; Lincoln & Guba, 1985).

### **3.2. Research Philosophy (Paradigm)**

A paradigm (philosophy) is a broad belief system, world view, or framework that guides research (Willis, 2007). Choosing the right research philosophy is, thus, critical because it determines the important aspects of the research, including the nature of knowledge to be produced, the researcher's role in the study, and the methods employed for data collection and analysis (Solomon, 2015). This decision can be influenced by three basic considerations: the questions the research is seeking to answer, the type of research, as well as the researcher's stance about the nature of reality (ontology) and knowledge (epistemology) (Rashid *et al.*, 2019; Yong *et al.*, 2021).

In light of these considerations, this research is grounded in the pragmatist paradigm (Creswell & Plano Clark, 2007; Morgan, 2007; Teddlie & Tashakkori, 2009). Pragmatism is particularly suited to this study for four main reasons:

First, the problem-solving orientation of pragmatism aligns well with the research questions and objectives. Pragmatism goes for the practical solutions for a real-world problem instead of looking for theoretical discussions (Kaushik & Walsh, 2019). As Yvonne Feilzer (2010) highlights, a central tenet in pragmatic inquiry is the view that all research should emanate from a desire to produce useful and actionable knowledge and solve existing problems. In light of this, the study looks for practical solutions for the real delay factors prevalent in the Finna Oromia Initiative, which suggests its effectiveness in real-world applications (Teddlie & Tashakkori, 2009; Patton, 2002; Yvonne Feilzer, 2010). Adopting this philosophy, therefore, ensures both theoretical soundness (grounding the study in a recognized philosophical framework) and practical applicability (because the study can be translated into actionable solutions that address actual problems).

Second, the pragmatic paradigm accommodates different perspectives to deal with the issue under scrutiny. Pragmatists argue that research should consider diverse viewpoints and incorporate the lived experiences of stakeholders (Merriam & Merriam, 2009; Denzin & Lincoln, 2018). In line with this, the research included views of key stakeholders such as client, consultant, and contractor representatives to emphasize their understanding of delay factors in the projects they were involved in. As Kaushik & Walsh (2019) note, pragmatic inquiry values pluralism, participation, and inclusivity, ensuring that the research remains contextually grounded and stakeholder-relevant.

Third, given the unique challenges of the Finna Oromia Initiative (including its geography, resources, and stakeholder dynamics), a flexible, context-sensitive approach is essential. This calls for the use of pragmatic philosophy, which is suitable for addressing context-specific issues (Teddlie & Tashakkori, 2009).

Finally, pragmatism facilitates methodological pluralism and provides freedom to select methods that better address research questions (Morgan, 2014; Morse, 2015). It allows selecting from the full range of methods or tools to answer a research question within the research design. This aligns with the principle of ‘what works’ (Teddlie & Tashakkori, 2009) in a mixed-methods research. Consequently, in this research, the pragmatism’s flexibility enables the integration of both broad survey data (quantitative) and in-depth qualitative insights (Johnson & Onwuegbuzie, 2004), offering a more comprehensive understanding than any single method could provide (Morgan, 2014; Teddlie & Tashakkori, 2009).

Overall, this philosophical stance (pragmatism) is highly advocated in construction management research involving complex issues, as it ensures methodological heterogeneity, which further strengthens the overall justification (Solomon, 2015; Johnson & Onwuegbuzie, 2004; Wing *et al.*, 1998).

### **3.3. Research Type**

This research is classified as applied research (Fellows & Liu, 2015; Saunders *et al.*, 2023) as it intends to solve practical problems with the knowledge that already exists (Denscombe, 2017; Mouton & Marais, 1988; Punch, 1998). The results of this study are intended to provide insights and actionable recommendations that stakeholders (practitioners and policy formulators) can use

to mitigate delays in current and future dam projects in the Finna Oromia Dam Initiative and potentially in similar contexts.

The study incorporates a combination of descriptive and explanatory goals (Creswell & Creswell, 2023; Robson & McCartan, 2016) to address the full scope of the research objectives.

The initial quantitative phase of this study was descriptive, aiming to summarize stakeholder responses. The results were then used to describe the relative importance of these factors, thus determining their ranks across the surveyed projects (Bryman, 2012; Fink, 2017; Kumar, 2012). This element directly addressed the first research objective, serving as the foundation for identifying patterns of delay factors and prioritizing areas for further exploration.

The subsequent qualitative phase served an explanatory purpose, intending to understand how and why some delay factors manifested in practice, and examine the interplay between those delay factors in the context of the specific project. This phase was used to identify the underlying reasons for the observed phenomena by creating causal links between different factors (Bryman, 2012; Creswell, 2014; Yin, 2014). It helped to explain not only the presence of certain delay factors but also how project-specific conditions amplified their effects or introduced new challenges. The second objective of the study was, thus, addressed directly by this explanatory element.

Overall, the current study is a carefully integrated blend of the two types, each playing a distinct and necessary role. It is important to note that both types are not contradictory, but rather complementary. The descriptive goal described the problem (prevalence and severity of different delay factors), and the explanatory component explained how and why the delays occurred (by forming causal links). Together, these types allowed the study to achieve its objectives of diagnosing the causes of delay, interpreting them in a real-life setting, and providing evidence-based recommendations for future project phases.

### **3.4. Research Approach**

The research approach is informed by both the logical reasoning guiding the theoretical framework, the type of information sought, and specific methods used for data collection and analysis (Creswell & Poth, 2018).

In terms of theoretical reasoning, this study adopts a combination of deductive and inductive approaches. To identify relevant causes (factors) for the Finna Oromia initiative, previous studies were reviewed through deductive reasoning, a theory-testing process (Creswell, 2014; Hyde, 2000). This prior knowledge informed the development of the instrument used to collect quantitative data from the project stakeholders, allowing the empirical testing of established theoretical concepts.

In addition, context-specific observations were used to draw some general conclusions about a case study project inductively through a theory-building process (Creswell, 2014). This helped in getting a sense of stakeholder experiences and the contextual nature of the reasons for delays within a particular case. It was also intended to discover new or unanticipated causes of delay that may not have been captured or reported in the literature.

Based on the information sought (Taherdoost, 2022) and the specific methods employed for data collection and analysis (Al-Ababneh, 2020; Creswell, 2014), this study utilizes a mixed methods approach (combining quantitative and qualitative aspects). This choice was guided by the complex nature of the research problem, which could not be fully addressed using a single methodological tradition.

The quantitative component collected numerical data and used statistics to find the prevalence and significance of different delay factors (Creswell, 2014). This approach is aligned with deductive reasoning and offers objectivity, scalability, facilitates hypothesis testing, and allows for generalizability (Antonius, 2004; Denscombe, 2017). However, it can be limited in capturing context-specific nuances and providing in-depth explanations for observed patterns (Carr, 1994).

To complement these quantitative findings, a qualitative approach was also employed to collect and analyze non-numerical data (Creswell & Plano Clark, 2007). This allowed for a richer and more nuanced understanding of the underlying causes of delays identified quantitatively, and the exploration of additional site-specific factors (Denzin & Lincoln, 2018; Flick, 2014). However, it is sometimes criticized for limited generalizability and inability to establish the widespread nature of factors (Greene, 2007; Merriam & Tisdell, 2016; Creswell & Creswell, 2023).

The adoption of a mixed methods approach (Neuman, 2014) in this study is justified by the complementary nature of quantitative and qualitative aspects. This helped to overcome the

limitations of individual approaches and use their strengths through methodological triangulation to increase the validity, reliability, and depth of understanding of the study (Bryman, 2012; Creswell & Plano Clark, 2007; Denzin, 2010; Zou *et al.*, 2014).

Overall, the quantitative component provided structured and generalizable information, aligning with the deductive reasoning employed, while the qualitative component offered context-rich, detailed insights, aligning with the inductive reasoning (Greene, 2007; Creswell & Creswell, 2023).

Despite its advantages, there are some challenges associated with the mixed methods approach. It is complex in its instrument design and implementation. It is also a resource-intensive and time-consuming process compared with a single approach (Teddlie & Tashakkori, 2009). However, its benefits were focused on achieving the study objectives. The researcher based the inquiry on the assumption that collecting diverse types of data best provides a more complete understanding of a research problem than either quantitative or qualitative data alone. To address the challenges, strategies such as carefully designing and testing the research instruments, member-checking, and data triangulation were used during the research process.

### **3.5. Research Design**

Given the objectives of the study, a non-experimental research design was used in this research (Creswell & Creswell, 2023; Kumar, 2012). This design was used because the study started with the observed effect (project delays) and went backwards to identify contributing factors.

Considering the time horizon, the study employed a cross-sectional design (Bryman, 2012; Saunders *et al.*, 2023). This means that the data on the perceived impact of the delay factors across the projects in the study projects were collected at a single point in time. A cross-sectional design is appropriate for obtaining a snapshot of the current conditions and perceptions regarding the phenomenon under investigation at a specific moment (Bordens & Abbott, 2022; Kumar, 2012), without tracking changes over time.

#### **3.5.1. The Multi-strategy Research Design**

In terms of the strategy used for data collection and analysis, this research employs the multi-strategy research design (Robson & McCartan, 2016), involving a survey (primary strategy) and a case study (complementary strategy). The research strategy to be used is distinguished based on

three conditions (Yin, 2003): the type of research question posed, the extent of control the investigator has over actual behavioral events, and the degree of focus on contemporary as opposed to historical events. Accordingly, the ‘what’ question used to identify major delay causes and how different stakeholders perceived them calls for a survey strategy in the quantitative phase. In the qualitative case, the researcher had no control over the events (as the project activities were ongoing or completed), and the inquiry focused on contemporary implementation challenges (current, real-world issues), making the case study approach appropriate to answer the ‘how’ and ‘why’ questions.

#### *3.5.1.1. Survey Strategy (Quantitative Phase)*

To quantify the prevalence and significance of different delay factors, a structured survey was conducted. This enabled statistical analysis of patterns and relationships. Surveys are known to cover a wide range of variables and generate highly valid, objective, and accurate data (Neuman, 2014). They are well suited for collecting a large amount of data in a short period at relatively low cost, and allowing the collection of data from representative samples, which can be generalized to the population (Kelley, 2003; Neuman, 2014).

#### *3.5.1.2. Case Study Strategy (Qualitative Phase)*

To supplement the survey’s breadth, a qualitative case study strategy was used with the intention to investigate the issue in greater detail. This was useful in helping to explore the ‘why’ and ‘how’ behind the patterns observed in the survey and revealed new relationships within the data. Yin (2018) describes case studies as particularly useful for studying such complex phenomena in their real-life and generating rich, contextual insights. As a case study has an inductive nature (Merriam & Merriam, 2009), it also allowed for the discovery of unexpected delay factors not captured in the survey, resulting in the generation of new insights and a more complete understanding.

Case studies are often criticized for lacking testable generalizations. But, as the goal of case study research is not statistical generalization based on frequencies, the findings are generalized to theories or propositions (analytic generalization) as opposed to the universe of population (Yin, 2003; Solomon, 2015). In this regard, the insights gained from the selected project in this study are invaluable for other projects in similar settings, too.

### **3.5.1.3. Justification for the Multi-strategy Design Used**

The complexity of the research problem, i.e., delay factors in construction projects, calls for a multifaceted approach (Mertens, 2010). This suits the potential of the multi-strategy design to give the study the breadth and depth, thereby increasing the overall validity and richness of the findings (Morse, 2015).

In light of this, the survey strategy gave a broad, quantitative overview of delay factors from a large sample, revealing patterns, allowing for generalization (to the context studied) and statistical validity. The case study, on the other hand, offered in-depth, qualitative insights into specific instances of delay factors, enriching the quantitative data and uncovering unforeseen factors (Tayie, 2005; Merriam & Merriam, 2009). Integrating these two approaches helped offset the limitations of each. The survey's breadth was complemented by the case study's depth, and the case study's contextual richness helped give meaning to the survey's statistical findings. The triangulation of data sources and methods increased the validity and reliability of the research, making it more robust and comprehensive in its understanding of the delay factors within the Finna Oromia Initiative.

### **3.5.2. The Sequential Explanatory Research Design**

The multi-strategy designs can constitute sequential, concurrent, and transformative designs (Bryman, 2012; Robson & McCartan, 2016). Consequently, the sequential multi-strategy design (Creswell & Plano Clark, 2007) was used in this study. This design involved collecting and analyzing quantitative and qualitative data in distinct phases, allowing the results from one stage to inform the other (Ivankova *et al.*, 2006). This means that the second phase builds on the first phase, and the two phases are connected in the intermediate stage in the study (during instrument design) and interpretation of the findings.

Sequential designs can have different forms (Creswell, 2014; Robson & McCartan, 2016). In this research, the sequential explanatory mixed-methods design was utilized. With this, quantitative data were collected and analyzed first, and, building on these results, the qualitative data were used to explain them in more detail. It is considered explanatory because the initial quantitative data results are explained further with the qualitative data. It is considered sequential because the initial quantitative phase is followed by the qualitative phase.

This way, the study was able to address both the ‘what’ and the ‘why’ of the issue under scrutiny (Creswell & Creswell, 2023). Such a strategy enhances the understanding of the research topic (Ivankova *et al.*, 2006; Robson & McCartan, 2016), by allowing the researcher to proceed from broad insights about the issue being scrutinized to specific details, enabling informed decision-making.

Despite its benefits, the sequential explanatory design is also subject to some constraints. It is a time-consuming and resource-intensive process because it requires completion of two separate phases. The quantitative phase may also influence the direction of the qualitative phase and may overlook important factors (Bryman, 2012). However, the careful design of the instruments (questionnaire and interview guide) as well as the triangulation of the findings (within the qualitative phase) helped to minimize the effects of these constraints as much as possible.

Overall, the sequential explanatory design used in this study allowed the research to transition logically from ‘what’ the main delay factors were (through survey) to ‘why’ and ‘how’ they occurred (through case study), a structure that enhances both validity and explanatory power (Ivankova *et al.*, 2006).

### **3.6. Methods of Data Collection**

In this section, the methods used for data collection for the study are outlined. As a sequential mixed methods approach was adopted, data were collected in two phases.

#### ***3.6.1. Quantitative Data Collection Through Survey***

Quantitative data were collected on the prevalence and perceived impacts of various delay factors affecting dam projects within the initiative through a survey. As Tayie (2005) suggests, the survey went through target population (sample) selection, questionnaire design, mailing the questionnaire, monitoring responses, sending follow-up mailings, and tabulating and analyzing the data.

##### ***3.6.1.1. Research Area and Population***

The Finna Oromia Initiative involves the construction of 255 multipurpose dam projects across four phases, clustered geographically into five regions. The quantitative phase of this study focused on 24 small- and medium-scale dam projects implemented in Phase 1 of the Initiative. The selection of Phase 1 projects allowed for a focused investigation of projects that were in relatively similar

stages of implementation, providing a relevant context for assessing the perceived impact of delay factors. Even though 28 projects were planned in this phase, others, whose construction was terminated or those that started very recently, were excluded to avoid certain biases.

The surveyed projects are located across three of the five geographical clusters within the initiative: Arsi-Bale (Cluster 2), Harerghe (Cluster 3), and Guji-Borena (Cluster 4).

In this Initiative, the Oromia Irrigation and Pastoralist Development Bureau (OIPDB) acts as a Client for all the projects. The client is solely consulted by the Engineering Corporation of Oromia (ECO). However, multiple contractors were involved in the execution. Table 3 shows the details of the projects and the contractors responsible for execution.

*Table 3: Profiles of the Surveyed Projects*

<b>Cluster</b>	<b>Project Name</b>	<b>Zone</b>	<b>Woreda</b>	<b>Contractor</b>
<b>Cluster-2</b>	Finna Becho	West Arsi	Gedeb Asasa	Gutema Firisa Construction
	Finna Keta Dibe	East Bale	Sawena	Oromia Construction Corporation
	Finna Kalle	Bale	Delo Mena	Oromia Construction Corporation
	Finna Mekala	West Arsi	Adaba	Oromia Construction Corporation
	Finna Uru Gimbichu	Arsi	Sude	Anwar Seid Construction
	Finna Goider	East Bale	Ginnir	Mulugeta Benti WWC
	Finna Dhofa	East Bale	Sawena	Nayama Construction WWC-1
<b>Cluster-3</b>	Finna Ija lencha	West Harerghe	Burqa Dimtu	OBM Construction Company
	Finna Kufa Bobasa	East Harerghe	Fadis	OBM Construction S.C
	Finna Hayyu Kenteri	West Harerghe	G/ Bordode	OBM Construction Company

	Finna Goda Chale	West Harerghe	Gumbi Bordode	Alemayehu Tefera GWWC
	Finna Anuba	West Harerghe	Burqa Dimtu	MCG Construction PLC
<b>Cluster-4</b>	Finna Hiddi Romso	Borena	Dire	Girma Tafese WWC
	Finna Burkuke	Borena	Dembi Hara	Belete Megersa WWC
	Finna Worbate	Borena	Gomole	Walabu Construction SC
	Finna Liso	Borena	Dillo	Werkineh Guday
	Finna Fula Bura	Borena	Elwaya	Walabu Construction SC
	Finna Kersa Yai	Borena	Miyo	Tinsae Ashok GC
	Finna Bokossa	Borena	Dubluk	KidCon Engineering
	Finna Qoa Dhamota	Borena	Guchi	Yot Construction
	Finna Haya Guracha	Borena	Gomole	Walabu Construction SC
	Finna Jigessa	West Guji	Dugda Dawa	Tilahun Abebe Construction
	Finna Dibe Adama	Guji	Liben	Gashaw Benti WWC
	Finna Keta Arba Boru	Guji	Liben	Hebron Construction

*Source: Oromia Irrigation and Pastoralist Development Bureau (2023)*

### **3.6.1.2. Survey Respondents**

This study purposively selected three key roles from each project to participate in the survey. This consisted of Project Managers (PMs), Resident Engineers (REs), Site Engineers (SEs), and Cluster Coordinators (CCs). This group was selected for their active role in the projects, and for their ability to provide informed opinions on project delays and their causes (Palinkas *et al.*, 2015). Project managers and site engineers represent the Contractor; resident engineers represent the Consultant, while the cluster coordinators represent the Client organization.

A census approach was used within this purposively defined group, by which all individuals identified in these roles were invited to participate in the survey. This approach increases representativeness within the expert population and provides the study with diverse but focused views on the causes of delay (Saunders *et al.*, 2023). It also avoids sampling bias and enhances the comprehensiveness of the quantitative data. Consequently, for each project, 3 project-based participants (Project Manager, Resident Engineer, and Site Engineer) were targeted. In addition, 6 cluster coordinators who were assigned to supervise multiple projects were included. Overall, 78 participants were included in the survey with the following distribution:

*Table 4: Distribution of Participants for the Survey Part*

<b>Role</b>	<b>Count</b>	<b>Percentage</b>
Project Manager	24	30.77%
Resident Engineer	24	30.77%
Site Engineer	24	30.77%
Cluster Coordinator	6	7.69%
Total	78	100.00%

### **3.6.1.3. Survey Instrument Design**

The quantitative data were collected using a closed-ended questionnaire, a commonly used data collection instrument in survey research. A questionnaire can collect data from large samples and geographically dispersed populations cost-effectively and efficiently (Evans & Mathur, 2005). It also provides a standardized way to collect data and thus reduces the possibility of interviewer bias and increases the consistency of responses (Bryman, 2012). This allows a meaningful comparison of the responses of participants.

#### **A. Instrument Development and Framing Logic**

The questionnaire was developed based on the following sources:

- **Extensive Literature Review:** A thorough review of existing academic literature on construction delays in dam and infrastructure projects globally and in Ethiopia was conducted to compile factors relevant to the Finna Oromia Initiative.

- **Project Reports:** Additionally, internal documents from the Engineering Corporation of Oromia (ECO), which reported recurring causes of delay across sites, were also used.
- **Expert Input:** Furthermore, informal consultations with five experienced professionals (two project managers, one resident engineer, one site engineer, and one academic) were held to refine and validate the clarity and contextual relevance of questionnaire items.

## **B. Questionnaire Structure**

The questionnaire was divided into two main parts:

**Part 1 (Background Information):** The first section gathered general information about the participants, including their organization, role, experience, and their project involvement, to contextualize their responses (Fowler, 2014). This also ensured the relevance of their responses to the study's focus.

**Part 2 (Rating of Delay Factors):** The second section was designed to involve operational perceptions. This section measured the level of impact of each delay factor on the project delay. It contained a comprehensive list of 26 pre-identified delay factors. For each factor, respondents were asked to rate the level of its impact on the occurrence and extent of delays in their projects, using a 5-point Likert scale (Boone, Jr & Boone, 2012; DeVellis, 2017; Jamieson, 2004). The scale was chosen for its simplicity in capturing a reasonable range of perceptions (DeVellis, 2017).

This scaling approach allowed for the transformation of subjective perceptions into quantifiable data suitable for statistical analysis (Cohen *et al.*, 2007). It was anchored with clear verbal descriptors for each point as presented in Table 5 below, and the final version of the questionnaire is annexed as Appendix B.

*Table 5: Measurement Scale for the Survey Instrument (Questionnaire)*

<b>Value (Scale)</b>	<b>Interpretation</b>
1	No contribution at all
2	Very little contribution
3	Some contribution
4	Significant contribution
5	Very significant contribution

## **D. Distribution and Data Collection**

The questionnaire was developed in Microsoft Word and self-administered for broad accessibility and ease of filling. This method aimed to minimize interviewer bias, encouraging honest responses (Fowler, 2014). Each questionnaire was accompanied by a cover letter explaining the study's purpose, assuring confidentiality and anonymity, and providing clear instructions for completion and return. Participants were asked to complete and return the questionnaire at their convenience via Telegram, a platform widely used by project teams within the Finna Oromia Dam Initiative.

### *3.6.1.4. Challenges and Mitigation Strategies: Quantitative Data Collection*

As with most survey-based research, there were some limitations anticipated. Because the survey was self-administered, one of the main concerns was non-response bias, which potentially lowers the response rate (Groves, 2009). To maximize response rates, participants were pre-contacted and followed up. Follow-up reminders were sent at two-week intervals as Tayie (2005) recommends. Additional strategies included keeping the estimated completion time reasonable, promising access to the final research report (Denscombe, 2017), and emphasizing the confidentiality of responses throughout the process (De Vaus, 2014). The response rate was closely monitored, and a basic demographic comparison between respondents and the overall target population was conducted where possible to assess representativeness and identify potential biases, thereby strengthening the credibility of the study's findings.

Social desirability bias (the tendency for respondents to provide answers they believe are more socially acceptable rather than their honest opinions) is another potential challenge. This was addressed by creating the questionnaire with neutrally worded items designed to elicit honest and unbiased responses (Tourangeau, 2004). Likert scale items, which are inherently subjective, were accompanied by clearly defined descriptions for each scale point to reduce ambiguity and to ensure consistent interpretation among participants.

Additionally, there may be selection bias because participants were chosen according to their role (participation) in the projects. While this ensured that respondents had the required expertise, it could also limit the diversity of perspectives. In order to deal with this, each respondent group's specific roles and responsibilities were clearly defined so that their answers made sense within the context.

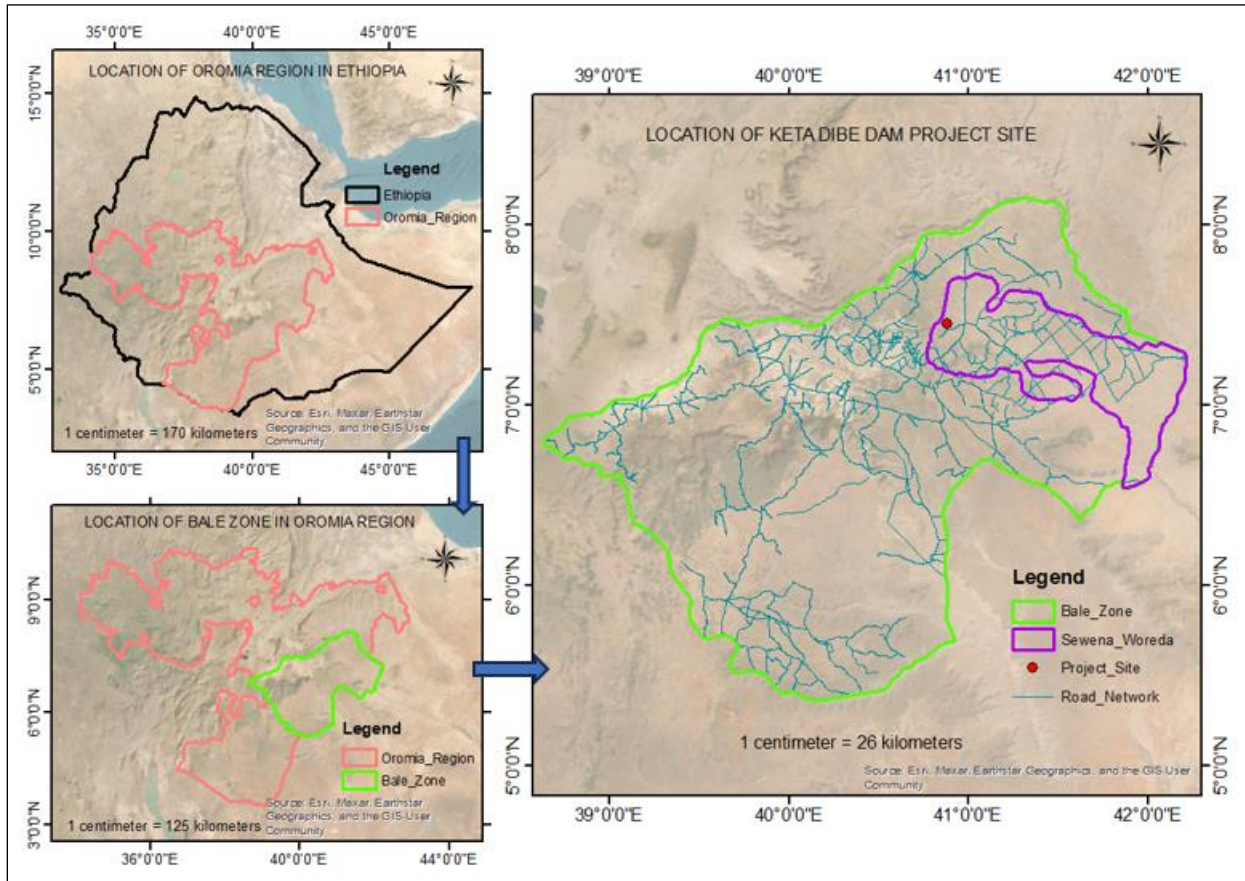
### **3.6.2. Qualitative Data Collection: Case Study**

In the second phase of data collection, a qualitative case study approach was employed. This was intended to provide an in-depth and contextual understanding of delay factors in a particular project.

#### **3.6.2.1. Case Selection**

The study followed qualitative inquiry principles in using purposive sampling to select a single information-rich case. According to Yin (2003), a single case can effectively explore a unique phenomenon or a critical event. Consequently, the Finna Oromia Keta Dibe Dam Project was selected as a critical or extreme case (Seawright & Gerring, 2007), because of its significant delay with many complexities compared to other projects in the initiative. Patton (2010) suggests that critical (deviant) cases are selected for study because they enable researchers to examine under what conditions problems escalate and become most visible, and thus, to gain a greater understanding of systemic challenges. This was especially relevant case for understanding delay dynamics that may not be present in more typical projects.

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*



*Figure 3. Location Map of Finna Oromia Keta Dibe Dam Project*

*Sources: Own Mapping (2024); Google Map (2023); Photo Taken by ECO (2024)*

### **3.6.2.2. Unit of Analysis**

This case study uses a holistic single-case design (Yin, 2003) with the entire project (Finna Keta Dibe Dam) as the unit of analysis. The approach was designed to capture the complex

interrelationships between the delay factors and uncover dynamics that were not visible in broader survey data. The holistic single case design facilitates analytical generalization (as opposed to statistical generalization), where the results of a detailed investigation of one case may provide conceptual insights for similar cases within the Finna Oromia Initiative and in similar contexts (Stake, 1995; Yin, 2018).

### ***3.6.2.3. Qualitative Data Collection Instruments***

Two key qualitative data collection instruments were utilized to investigate the causes of construction delay in the selected project: semi-structured interviews and document review. These instruments were combined to provide a triangulated, in-depth understanding of delay factors, which aligns with the recommendations of methodological triangulation to improve credibility and dependability in qualitative research (Denzin & Lincoln, 2018; Patton, 2002).

#### ***A. Semi-Structured Interviews***

Interviews were conducted with the representatives of each stakeholder of the Finna Keta Dibe Dam Project. Four participants were targeted: the project manager, cluster coordinator, resident engineer, and one participant from the design team. The participants were purposively selected with the anticipation that they would provide rich insights (relevant, experience-based, and reflective of on-the-ground realities) regarding the project.

Interviews are appropriate for gathering rich, contextually sensitive data (Bryman, 2012) and generating thematic insights (Braun & Clarke, 2006). They are effective in extracting deep reflections from professionals working in real-world construction settings (Solomon, 2015).

In this study, the interview process allowed the researcher to delve into the reasons behind the delay factors identified in the survey, while being open to uncovering other project-specific issues of the Finna Keta Dibe Dam.

#### ***A. Document Review***

In addition to interviews, a range of official project documents (contract agreement, feasibility study and detailed engineering report, geotechnical report, progress reports, price adjustments and contract amendments, meeting minutes, and extensions of time granted) were reviewed.

As Yin (2018) notes, document review is a powerful case study research tool, which provides objective, traceable evidence to complement the verbal accounts. It helps to identify issues (such as procedural or administrative delay factors) that interviewees may not focus on. In addition, documents can reveal patterns of communication, coordination, and decision making, which are critical to understanding complex implementation problems (Bowen, 2009). This integration of document review into the case study ensured methodological triangulation, which increased the validity of findings.

#### **3.6.2.4. Case Study Protocol**

In order to ensure methodological rigor and improve transparency, a case study protocol was developed (Yin, 2018). This protocol was informed by the principles of qualitative research design (Stake, 1995; Yin, 2018) and was tailored to capture contextualized stakeholder experiences, perceptions, and insights relevant to project-specific delays.

##### **A. How the Protocol Was Established**

The case study protocol was designed following a sequential explanatory research strategy, where qualitative inquiry builds on quantitative results. Specifically, it was informed by:

- The top ten delay factors identified through the survey of 24 dam projects
- Themes from literature on dam project delays
- Document reviews of the case study project.

The case protocol formed the basis for conducting semi-structured interviews, designed to confirm or deepen the understanding of the causes of delay. The interview guide was also flexible enough to allow for exploration of emergent themes that may not have been covered in the structured questionnaire (Kvale & Brinkmann, 2015; Merriam & Tisdell, 2016; Yin, 2018).

##### **B. Summary of the Case Study Protocol: Themes and Question Logic**

The case study protocol was structured into four key sections, each designed to gather specific information aligned with survey findings, existing literature, or anticipated contextual factors. The first section, general information, established respondent credibility and project familiarity by inquiring about roles, project involvement, and current status. The second section, survey-informed delay factors, delved deeper into the top ten delay factors identified in a prior survey, aiming to

understand their specific contribution to delays within the case study project. The third section, emergent/context-specific factors, allowed for the exploration of new or under-represented delay causes, such as administrative or coordination issues, ensuring that project-specific dynamics not captured in the initial survey could be uncovered. Finally, closing reflections provided an opportunity for open-ended feedback and consent for follow-up, encouraging unstructured contributions and identifying areas for further investigation.

#### ***3.6.2.5. Challenges and Mitigation Strategies: Qualitative Data Collection***

While the case study provides valuable insights, it has some limitations. As Tayie (2005) and Yin (2018) note, case studies are often criticized for being overly subjective, heavily reliant on the researcher's interpretation, and vulnerable to bias. To address this concern, the study incorporated a structured case study protocol, employed systematic coding procedures, and used data triangulation to ensure consistency, reduce bias, and increase the trustworthiness of findings (Lincoln & Guba, 1985; Patton, 2002).

The issue of limited generalizability is another widely acknowledged limitation. Results from a single project may not be generalized to other projects within the Finna Oromia Initiative or beyond. In line with Stake (1995) and Neuman (2014), case studies are not meant to provide statistical generalization but analytical generalization, where theoretical insights can help understand similar contexts. Although the case was unique for its complexity and delay history, it offered conceptual implications for similar public infrastructure projects not only in the initiative being studied but also for others in similar settings.

Social desirability bias (Crowne & Marlowe, 1960) is yet another potential issue in which participants may respond in a manner that they believe is more acceptable or favorable. Additionally, this method is subjective, and data interpretation might influence findings. To overcome this bias, the researcher ensured the interviewees were anonymous and confidential, built rapport with them, and used probing techniques to get more honest and reflective answers. Interview data were also cross-verified with project documents to identify discrepancies and to provide a check for the credibility of the data (Creswell & Miller, 2000; Denzin & Lincoln, 2018).

### **3.7. Methods of Data Analysis**

This section outlines the methods used to analyze the data collected for this study. As a mixed-methods approach was employed, quantitative and qualitative techniques were used to analyze the data.

#### **3.7.1. Quantitative Data Analysis**

Quantitative data collected through a structured survey were analyzed using statistical methods to identify the prevalence and severity of different delay factors, establishing general patterns. The data were screened first to ensure data integrity. This included checking the completeness, consistency, and accuracy of the data. Inconsistent data were checked for validity, and incomplete responses were filtered out (Field, 2013). The final dataset was analyzed using the Statistical Package for the Social Sciences (SPSS), a widely used software for statistical analysis (Pallant, 2020). The responses (perceptions) were then summarized employing descriptive statistics such as means and standard deviations (Field, 2013). The delay factors were finally ranked based on the mean scores as rated by the stakeholder groups.

##### **3.7.1.1. Statistical Validation**

In this study, several statistical tests were utilized to address different aspects of the research focus. Below, the roles of the reliability test, Kruskal-Wallis Test, and Spearman's Rank Correlation are detailed, highlighting their relevance and justification in the context of assessing delay factors in the study projects. These tests provide a rigorous foundation for analyzing the data, ensuring that conclusions drawn are statistically valid, reliable, and actionable.

##### **A. Reliability Test**

To check the reliability of the survey instrument, Cronbach's Alpha ( $\alpha$ ), the most widely used metric for measuring internal consistency, ensuring that the questionnaire items effectively capture the intended constructs (Nunnally, 1978; Tavakol & Dennick, 2011), was computed using IBM SPSS 27. Results were then interpreted based on established reliability benchmarks.

A Cronbach's Alpha value of 0.7 or higher is generally considered acceptable for ensuring reliability (Nunnally, 1978). However, due to the grouping structure of the delay factors in the questionnaire, the reliability test was not performed separately for all eleven delay factor groups,

as all groups contained only one to five items. It is recognized in literature that reliability coefficients such as Cronbach's alpha tend to produce unacceptably low values when the number of items is small (Gliem & Gliem, 2003; Tavakol & Dennick, 2011). Hence, calculating alpha values for these small sets would lead to misleading interpretations regarding the reliability of the data.

To address this, the reliability analysis was conducted across stakeholder groups (contractor, consultant, and client representatives) rather than by factor categories. This allowed the researcher to assess the internal consistency of all items as perceived by each group. This approach helps ensure internal consistency without distorting the interpretation of reliability results and is methodologically supported in applied construction and project management research (Bolarinwa, 2015; Creswell, 2014).

### ***B. The Kruskal-Wallis Test***

To assess differences in stakeholder perceptions of delay factors, an appropriate statistical approach for this study was selected. The decision on the choice between ANOVA and Kruskal-Wallis tests was based on the type of data collected. ANOVA assumes normally distributed data and homogeneity of variances among groups. But, Likert scale measurements (yielding ordinal-level responses), are often non-normally distributed. For such data, therefore, Kruskal-Wallis test is preferred over ANOVA, as it does not require normality assumptions (Jamieson, 2004; Ghasemi & Zahediasl, 2012). Previous studies on construction delays have also recommended the use of this test when data do not satisfy the ANOVA's assumptions (Sambasivan & Soon, 2007; Doloi *et al.*, 2012).

### ***C. Spearman's Rank Correlation: Agreement Between Stakeholder Rankings***

Spearman's rank correlation was used to measure the level of agreement between stakeholders in ranking delay factors. This non-parametric test is particularly suited for ordinal data like Likert-scale rankings and does not require the assumption of normality (Corder & Foreman, 2014; Dancey & Reidy, 2017). The analysis aimed to determine the extent to which stakeholder perceptions were aligned across the study projects. A correlation coefficient, rho ( $\rho$ ), with +1 indicating perfect

agreement, and -1 indicating complete disagreement, was calculated. The Spearman's rank correlation coefficients were evaluated at a 5% level of significance ( $p < 0.05$ ), following standard research practices (Field, 2024). Correlations with p-values less than 0.05 were considered statistically significant.

### **3.7.2. Qualitative Data Analysis**

Unlike quantitative methods, qualitative analysis does not follow a fixed approach, but relies on interpretive strategies such as pattern matching, explanation building, and time series analysis (Tayie, 2005). Thematic analysis was chosen as the main qualitative data analysis method for this study as it is suitable and effective in finding recurring patterns and themes. The choice of this method over other types of qualitative methods, such as grounded theory, was based on the fact that it allowed the researcher to concentrate on pre-existing theoretical frameworks and crucial research questions, without having to develop new theories.

After data collection, the audio recordings from the interviews were transcribed word-for-word to maintain the depth and essence of the participants' responses (Gibbs, 2007). The transcripts were then screened for completeness and clarity. Ambiguous responses were clarified by follow-up communications with the interviewees (Merriam & Merriam, 2009).

Then, coding was conducted to categorize data systematically and look for patterns and themes. The coding process involved familiarizing with the data, generating initial codes, looking for themes, reviewing, defining and naming the themes, followed by report writing (Braun & Clarke, 2006). This approach enabled the identification of the specific factors that may have contributed to the delay, in addition to other contextual factors that may not have been captured through a quantitative survey.

In addition to the interview data, documents associated with the selected case project were also reviewed. The document review entailed the systematic scrutiny of these documents to extract information related to decision-making, communication, and project implementation challenges (Yin, 2018). The information gathered from the document analysis was then incorporated with the results obtained from the interviews to get a better view of the delay factors.

Finally, it is important to acknowledge the limitations of qualitative data analysis and inform how they were addressed. One of the limitations of qualitative data analysis is the subjectivity involved in the process of coding and developing themes, which could influence the analysis of the data collected (Creswell, 2014). To overcome this, 2 different researchers were engaged in coding to increase reliability and reduce subjectivity. Further, member checking was used to ensure that the interview participants' responses were correctly articulated, hence enhancing the credibility of the results (Lincoln & Guba, 1985).

### **3.7.3. Methods of Data Integration and Interpretation**

Data were integrated mainly during the interpretation phase in accordance with the sequential explanatory design used. The quantitative component was prioritized, and the qualitative phase was used to explain and elaborate upon the statistical findings (Creswell & Plano Clark, 2007; Ivankova *et al.*, 2006). This was achieved by connecting and explaining (where the qualitative findings of the case study were used to interpret, contextualize, and provide deeper insight into the delay factors first identified through the survey). However, the qualitative phase also created space for previously unknown but contextually important delay factors to emerge.

Through interpretive linking, it allowed the identification of convergence (factors confirmed by both datasets), divergence (factors with varying importance or interpretation), and expansion (additional insights beyond the survey data), which is consistent with the logic of mixed methods integration (Fetters *et al.*, 2013; Greene *et al.*, 1989).

For the case study component, data triangulation was used for internal validity purposes by comparing interview responses with document reviews (Jick, 1979; Yin, 2018), but the overall mixed methods integration is not about triangulation in the traditional sense. Instead, it was an explanatory model, where the qualitative results explained and elaborated on the quantitative ones to reflect the sequential explanatory approach.

## **3.8. Methods of Ensuring Research Rigor**

Establishing research rigor is fundamental to ensuring the trustworthiness, meaningfulness, and applicability of study findings in real-world contexts. This study ensured rigor in both its quantitative and qualitative components.

### **3.8.1. Reliability and Dependability**

Reliability ensures a research instrument yields stable and consistent results across different conditions, times, or evaluators (Bolarinwa, 2015; Tavakol & Dennick, 2011). The reliability of the study was ensured using the following strategies:

**Internal Consistency:** For the closed-ended questionnaire, Cronbach's alpha was used to assess internal consistency, which examines how well items in a scale are correlated and measure the same underlying construct (Cronbach, 1951). Although individual delay factor groups had fewer than 10 items (making individual alpha interpretation challenging, as noted by Tavakol & Dennick (2011), reliability analysis was conducted at the stakeholder group level. This approach, supported in applied construction and project management research (Bolarinwa, 2015; Creswell, 2014), considered all items rated by a particular stakeholder group as a whole. The use of Cronbach's alpha was appropriate given the Likert-scale responses.

**Pilot Testing and Instrument Refinement:** A preliminary pilot survey was conducted to find issues related to item clarity, wording consistency, and potential misinterpretations. Based on feedback from this phase, ambiguous or redundant items were revised, thereby improving the reliability and validity of the instrument. This pre-testing aligns with scale development practices to enhance internal consistency by improving item quality (DeVellis, 2017).

**Standardization of Administration Procedures:** The study further improved reliability using standardized data collection procedures in which respondents were given the same version of the questionnaire, with clear and concise instructions. This minimized the risk of procedural variability that could compromise consistency. As these steps help minimize measurement error and promote the repeatability of the research process, they contribute to a larger idea of replicability, which is core to reliability.

**Dependability:** In qualitative research, reliability is termed dependability (Lincoln & Guba, 1985), focusing on the stability and traceability of the research process. This was ensured through:

- **Systematic Documentation (Audit Trail):** All key decisions, interview protocols, coding manuals, and analytic memos were thoroughly documented, allowing others to evaluate the methodological decisions and theme derivation.

- **Peer Review and Supervision:** The coding process and theme development were discussed with a senior academic supervisor and a qualitative methods expert, minimizing subjective interpretations and enhancing methodological soundness.

**Inter-coder Agreement and Thematic Coherence (Qualitative Component):** To minimize subjective interpretations (Braun & Clarke, 2006), a second coder independently reviewed and coded a portion of the transcripts. Discussions resolved discrepancies, increasing inter-coder reliability.

### **3.8.2. Validity**

Validity refers to the extent to which a research instrument accurately measures a concept it is designed to measure (Creswell, 2014; Polit & Beck, 2012). A valid instrument yields credible, meaningful, and relevant results to the phenomenon under study. This section details the types of validity relevant for this study.

**Face Validity (Quantitative Component):** Face validity, the degree to which an instrument appears to measure its intended construct (Haynes *et al.*, 1995), was established through informal examination by experts. Experienced engineers and researchers reviewed the initial questionnaire draft to ensure each question was relevant and appropriate for measuring specific delay factors in dam construction. This practical initial step ensured the questions were meaningful and applicable to respondents.

**Content Validity (Quantitative Component):** Content validity assesses whether instrument items comprehensively cover all dimensions of a construct (Polit & Beck, 2012). This was crucial for construction delays, which are multifactorial. A step-by-step process was employed:

- **Literature Foundation:** The questionnaire was formulated based on an extensive review of the literature on construction delays in dam and infrastructure projects.
- **Expert Panel Review:** Five experts (two construction engineers, two project managers, and an academic in civil engineering) reviewed items for clarity, coverage, and representativeness.
- **Revisions:** Items were revised, rewritten, or regrouped based on feedback to ensure comprehensive coverage of all delay factors, aligning with recommendations for employing domain experts (Haynes *et al.*, 1995; Sangoseni *et al.*, 2013).

**Construct Validity (Quantitative Component):** Construct validity concerns whether the instrument measures the theoretical constructs it intends to measure (Strauss & Smith, 2009). In this study, it was ensured through:

- **Theoretical Structuring:** The survey was structured within a conceptual framework, categorizing delays into functional (process-based) categories such as planning, design, financial, and management-related factors. Some groups also reflected stakeholder-linked responsibilities.
- **Pilot Testing:** A small-scale pilot survey with diverse stakeholder groups checked for consistency in item interpretation and logical alignment of items with their respective constructs.

**Internal Validity Considerations (Quantitative Component):** While primarily associated with experimental studies, internal validity, in terms of measurement accuracy and minimization of bias, was addressed (Polit & Beck, 2012). Measures taken included:

- **Pretesting:** The questionnaire was pretested on a small group to eliminate ambiguities and clarify item wording.
- **Standardized Procedures:** Data collection followed standardized procedures, ensuring all participants received the questionnaire in the same format, minimizing variation from procedural inconsistencies.
- **Careful Wording:** Leading and double-barreled questions were avoided, and clear instructions were provided, collectively enhancing internal validity by reducing systematic bias and ensuring responses reflected participants' true perceptions.

**External Validity and Generalizability (Quantitative Component):** External validity concerns the extent to which findings can be generalized to other populations, settings, and contexts (Bordens & Abbott, 2022; Edmonds & Kennedy, 2017). In this study, statistical generalizability to the broader population is limited due to purposive (non-probability) sampling. However, analytical generalization can be achieved (Merriam & Tisdell, 2016), meaning insights apply to similar dam development programs in comparable institutional, geographical, and project management settings, as participants were carefully selected to meet study objectives.

**Credibility (Qualitative Component):** Credibility, the believability and authenticity of qualitative findings (Lincoln & Guba, 1985), was enhanced through:

- **Member Checking:** Interview participants reviewed and confirmed interpretations, ensuring accuracy and reducing researcher bias (Birt *et al.*, 2016; Yin, 2018).
- **Triangulation:** Integration of multiple data sources (interviews and document reviews) provided a more stable and verifiable understanding of delay factors (Denzin, 2010).
- **Thick Description:** Detailed and context-sensitive descriptions of the case study and participant experiences were provided (Geertz, 1973; Shenton, 2004).

**Confirmability (Qualitative Component):** Confirmability ensures findings are determined by participants' records rather than researcher biases (Lincoln & Guba, 1985). This was enhanced through:

- **Use of Direct Quotations:** Verbatim statements from participants validated key findings, clearly linking data and interpretation.
- **Reflexivity:** The researcher noted personal reflections, emergent questions, and assumptions to track and counteract potential bias.
- **Verifiable Data Record:** Audio recordings combined with detailed interview notes strengthened the reliability of qualitative findings (Merriam & Tisdell, 2016).

**Transferability (Qualitative Component):** Transferability, conceptually parallel to external validity in quantitative studies, concerns the extent to which findings can be applied in similar contexts (Lincoln & Guba, 1985; Polit & Beck, 2012). This was supported by thick description, providing rich, context-sensitive details of the Finna Keta Dibe Dam case study (geographic setting, construction scope, stakeholder structure, delay types, institutional dynamics). This allows readers to evaluate the potential relevance of findings to other dam construction initiatives in Ethiopia or similar infrastructure projects in comparable socio-institutional environments. While readers bear responsibility for determining applicability, the researcher facilitated this by providing sufficient contextual information.

### **3.9. Ethical Considerations**

Ethical considerations are fundamental to ensuring the integrity, credibility, and social responsibility of any research process, particularly when human participants are involved (Kumar, 2012; Creswell, 2014). This research was conducted in accordance with the ethical principles outlined by Addis Ababa University (AAU) and other international ethical research standards.

#### **Ethical Approval**

Prior to data collection, approval was obtained from the Department of Construction Management of the College of Technology and Built Environment (the former Ethiopian Institute of Architecture, Building Construction and City Development [EiABC], Addis Ababa University, and the relevant stakeholder organizations that were involved in the construction of the projects under investigation.

#### **Informed Consent**

Before they participated in both the quantitative (survey) and qualitative (interview) phases, participants were provided with comprehensive information about the study's purpose, procedures, the voluntary nature of their involvement, their right to withdraw at any time without consequence, and the measures taken to ensure confidentiality and anonymity (Fowler, 2014). Informed consent was obtained from all participants before data collection, ensuring their full understanding and agreement. For the survey, completion and return of the questionnaire implied consent, while written consent was obtained before the commencement of interviews.

#### **Voluntary Participation and Right to Withdraw**

Participation in this study was entirely voluntary, and participants were explicitly informed of their right to refuse to participate or to withdraw from the study at any time without any negative consequences. This was reiterated in the information provided during the consent process. All participants gave informed consent, and data were not collected without their full understanding and agreement.

#### **Anonymity and Confidentiality**

Personal identifiers were excluded from all records of data to protect the confidentiality and anonymity of participants. The respondents' identities were covered by use of pseudonyms and unique codes (P1 to P78 for the survey part and I1 to I2 for the interview part) were assigned. In order to avoid any information that can be used to trace the identity of an individual or an organization, care was taken during data analysis and reporting. These measures are also in line with ethical practices recommended for social and applied research (Lincoln & Guba, 1985; Yin, 2018).

### **Minimizing Bias and Ensuring Fair Representation**

The researcher had made deliberate efforts to minimize bias and influence, especially when engaging with stakeholders who might have had competing roles or interests in the projects. Data collection was maintained in a respectful, non-directive manner, and all questions were worded neutrally and objectively. Member-checking was applied during interviews, wherein participants were allowed to review and clarify their responses after or during transcription. This step allowed for accurate representation of their perspectives and increased the trustworthiness of the qualitative data (Birt *et al.*, 2016).

### **Data Security and Management**

Data storage was managed securely, with recordings and transcripts stored in encrypted files accessible only to the researcher. The physical documents were kept in secure locations and subsequently destroyed after digitalization. This ensured compliance with ethical data handling standards.

### **Transparency and Accountability**

Finally, transparency and accountability were maintained in the course of the research. Data collection and analysis methods, ethical approvals, participant communications, and analytical procedures were all detailed, and data were kept in such a way that the study could be audited or replicated if necessary. These practices were key to upholding the integrity of the study on an ethical level and contributed to ensuring the credibility, reliability, and validity of the findings of the study.

## **4. RESULTS AND DISCUSSION**

This chapter presents a comprehensive analysis of the data collected from stakeholders involved in the construction of dam projects under the Finna Oromia Initiative. This analysis aims to identify the most important factors that caused construction delays in this Initiative based on the perceptions of key stakeholders (contractor, consultant, and client groups).

The quantitative survey results are presented first, followed by the qualitative case study findings. As the case study used two data collection instruments (interview and document review), the data collected through each will be analyzed separately first and then triangulated. Then this triangulated finding is combined with the survey data, facilitating a robust examination of the delay factors. This helps in providing actionable insights to improve the project delivery in the Finna Oromia Initiative and similar infrastructure projects.

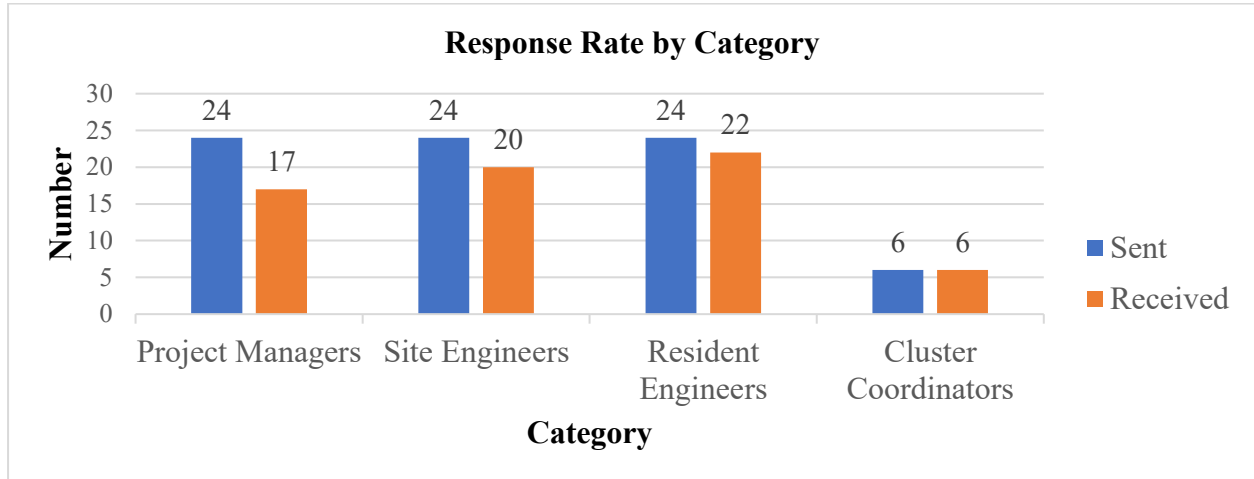
### **4.1. Quantitative Analysis Results**

#### ***4.1.1. Response Rate and Demographic Characteristics***

This section outlines the analysis of the survey response rate and demographic characteristics of the respondents. It is important to understand the background of the respondents for proper interpretation of the survey results. The demographic analysis includes respondent roles, experience in dam construction, involvement in the project phase, and background of their organization.

##### ***4.1.1.1. Response Rate***

In this study, the survey questionnaire was distributed to 78 targeted respondents, including project managers and site engineers from contractors, resident engineers from the Consultant, and cluster coordinators from the Client. Consequently, a response rate of 83.3% was achieved with a total of 65 completed responses. The breakdown of responses by stakeholder group is as follows:



*Figure 4. Response Rate of the Survey Questionnaire*

Although there is no hard rule for the acceptable response rate, the general rule is that ‘higher is better’, with 50-75% suggested to be acceptable for email, mail, and web surveys (Denscombe, 2017; Fink, 2017; Tayie, 2005). So, the response rate for this study is acceptable.

Cluster Coordinators (Client group) and Resident Engineers (Consultant group) achieved a high response rate of 100.0% and 91.7%, respectively, reflecting their strong engagement with the research. Project Managers had the lowest response rate (70.8%), which may be attributed to their busy schedules or unwillingness to participate in the study.

#### *4.1.1.2. Respondent’s Project Phase Involvement*

Participants were also asked to indicate their involvement in the dam projects’ design and construction phases. The result is as follows:

*Table 6: Distribution of Respondents by Project Phase Involvement*

<b>Project Phase</b>	<b>Contractor’s Side (n=37)</b>	<b>Client’s Side (n=6)</b>	<b>Consultant’s Side (n=22)</b>	<b>Total (n=65)</b>
Design Phase Only	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Construction Phase Only	37 (100.0%)	0 (0%)	14 (63.6%)	51 (78.5%)
Both Design & Construction	0 (0%)	6 (100.0%)	8 (36.4%)	14 (21.5%)

All respondents in contractor organizations (100.0%) were involved only in the construction phase, reflecting their primary role in project execution. All the respondents from the client side (100.0%) were involved in both design and construction phases, indicating their role throughout the project lifecycle. Those from the consultant side were split between the construction phase only (63.6%) and both phases (36.4%), highlighting that some of them had a dual role in design supervision and construction monitoring.

**4.1.1.3. Organization’s Previous Involvement in Dam Construction**

The organization’s previous involvement in similar projects is very important for the successful completion of the current project. The table below shows the distribution of organizations based on their previous involvement:

*Table 7: Organization’s Previous Involvement in Dam Construction*

Organization	Yes		No	
	Frequency	Percentage	Frequency	Percentage
Contractor	8	40%	12	60%
Consultant	1	100%	0	0%
Client	1	100%	0	0%

The data indicate a significant difference in organizational experience across stakeholder types. Only 40% of contractor organizations reported previous involvement in dam construction, reflecting a substantial gap in sector-specific expertise. Conversely, consultant and client organizations exhibited full prior exposure (100%) to dam projects, underscoring their institutional knowledge and long-term engagement in similar works.

This disparity highlights a critical issue in project implementation. Limited prior engagement by contractor organizations may contribute to capacity-related challenges, especially in technically demanding aspects such as foundation treatment, instrumentation installation, and managing design changes.

**4.1.2. Reliability Analysis Results**

To ensure the internal consistency and reliability of the questionnaire, Cronbach’s Alpha ( $\alpha$ ) was computed for the entire set of survey items and separately for each stakeholder group using IBM

SPSS 27. Because each delay factor group contained only one to five items in this study, computing alpha scores for individual groups would not provide meaningful reliability coefficients. As noted by Gliem & Gliem (2003) and supported by Tavakol & Dennick (2011), small item sets tend to yield low alpha values, potentially leading to misinterpretation. Therefore, following accepted methodological standards (Bolarinwa, 2015), the reliability analysis was conducted across the entire set of 26 delay items at the stakeholder group level. The results of this analysis are presented below:

*Table 8: Stakeholder Group Level Reliability of Measure*

<b>Stakeholder Group</b>	<b>Number of Items</b>	<b>Cronbach's Alpha</b>	<b>Interpretation</b>
Contractors	26	0.874	High reliability
Consultant	26	0.866	High reliability
Client	26	Not Applicable	Program-level perspective
<b>Overall</b>	<b>26</b>	<b>0.827</b>	<b>High reliability</b>

The Cronbach's Alpha values of 0.874 for the contractor and 0.866 for the consultant groups are relatively high, which indicates that their responses were consistent and the survey instrument was effective in measuring the intended construct. These values are within the range considered 'excellent' for research purposes (Field, 2013). As Cronbach's Alpha values above 0.80 generally indicate high reliability, the overall reliability score of 0.827 suggests that the survey instrument effectively captured consistent responses (George & Mallery, 2019).

Nevertheless, it is important to mention here that because of the small size of the data, Cronbach's Alpha was not computed for the Client group. The respondents in this group, six in number, rated a program-level assessment of all 24 dam projects rather than project-specific ratings. The reliability of their perspective was not based on repetitive item responses common to project-level data, and thus, Cronbach's Alpha was deemed inapplicable in this case. However, their insights are useful in understanding the client's holistic view of delay factors, but not as reliable as project-level data. According to Nunnally (1978), reliability coefficients should be interpreted in light of the specific context and purpose of the measurement. In this case, the responses of the client give a unique program-level view.

The high overall reliability indicates that, despite the small client sample and its unique role, the data collected is consistent and reliable for the contractor and consultant groups, and provides a valuable program-level perspective from the client.

#### **4.1.3. Identification of Causes of Delay**

This section presents the results of the analysis conducted to identify the causes of delay in Phase 1 of the Finna Oromia Dam Initiative, based on the perceptions of three key stakeholder groups: contractors, the consultant, and the client. To identify the most significant delay factors, mean-based rankings were performed. The factor with the highest average score was considered the most significant. While Likert scale data are ordinal, mean rankings are commonly used in construction delay studies for comparative purposes (Sambasivan & Soon, 2007; Gebrehiwet & Luo, 2017), provided interpretive caution is exercised.

The relative importance (ranking) of 26 predefined delay factors was determined by statistically analyzing the data collected through a structured questionnaire based on mean scores (Agresti, 2019). The mean scores were calculated using the following formula (by summing Likert-scale responses for each delay factor and dividing them by the number of respondents in each stakeholder group):

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

Where:

- $\sum_{i=1}^n x_i$  is the sum of all Likert scale responses for a particular delay factor.
- $n$  is the number of respondents in the respective stakeholder group.

This standard formula (Freedman *et al.*, 2007) provides a measure of central tendency for the data, enabling a comparison of the perceived impact of each delay factor across stakeholder groups. The factor with the highest mean score was ranked first, meaning it was perceived as the most important cause of delay. The second highest mean score is ranked second, and so on. The results are

presented in tables and charts, providing a clear visual representation of the stakeholders' perceptions.

#### **4.1.3.1. Perceptions of the Contractors Group**

The contractor group, comprising 37 respondents, provided valuable insights into the factors that led to project delays. The top 10 delay factors, as per the contractors' perceptions, are listed in the Table below. Appendix D lists the mean score and ranking of all delay factors.

*Table 9: Perceptions of Contractors Group on Top 10 Causes of Delay*

<b>Rank</b>	<b>Delay Factor</b>	<b>Mean Score</b>
1	Unrealistic Initial Time and Cost Estimations (SPF1)	4.73
2	Price Escalations and Lack of Timely Adjustments (FF2)	4.62
3	Design Modifications/Changes (DF1)	4.22
4	Political Instability/Security Issues (EEF2)	3.73
5	Shortage of Materials/Equipment (MEF1)	3.70
6	Contractor's Inadequate Experience and Limited Capacity (CCF2)	3.68
7	Contractor's Lack of Commitment (CCF1)	3.68
8	Late Mobilization (Delivery) of Materials/Equipment (MEF2)	3.35
9	Unfavorable Weather Conditions (EEF1)	3.30
10	Delayed Payments from Client (FF1)	3.14

The contractor group identified *unrealistic initial time and cost estimations (SPF1)* as the most significant delay factor, with a mean score of 4.73. *Price escalations and lack of timely adjustments (FF2)* also scored highly at 4.62, highlighting the impact of economic factors. *design modifications/changes (DF1)* was rated third, with a mean score of 4.22.

Four delay factors: *political instability/security issues (EEF2)*, *shortage of materials/equipment (MEF1)*, *contractor's lack of commitment (CCF1)*, and *contractor's inadequate experience and*

*limited capacity (CCF2)* also received mean scores above 3.5, suggesting these are also significant contributors to delays.

However, factors such as *wrong/unsuitable project location (SPF2)*, *poor site access/logistical challenges (PLF2)*, *contractual disputes/ambiguities (CF1)*, and *labor shortages (LF1)* were rated relatively low, indicating these issues are perceived as less critical by the contractors.

#### **4.1.3.2. Perceptions of the Consultant Group**

The consultant group, comprising 22 respondents, also provided insights into the factors contributing to project delays. The following table presents the top 10 delay factors based on their perceptions, determined by mean scores. The full rank is attached as an appendix.

*Table 10: Perceptions of Consultant Group on Top 10 Causes of Delay*

<b>Rank</b>	<b>Delay Factor</b>	<b>Mean Score</b>
1	Contractor’s Inadequate Experience and Limited Capacity (CCF2)	4.77
2	Price Escalations and Lack of Timely Adjustments (FF2)	4.36
3	Unrealistic Initial Time and Cost Estimations (SPF1)	4.09
4	Shortage of Materials/Equipment (MEF1)	4.05
5	Late Mobilization (Delivery) of Materials/Equipment (MEF2)	3.82
6	Contractor’s Lack of Commitment (CCF1)	3.73
7	Design Modifications/Changes (DF1)	3.55
8	Political Instability/Security Issues (EEF2).	3.41
9	Inadequate Risk Planning and Management (PMF4)	3.36
10	Inefficient Project Planning/Scheduling (PMF1)	3.23
10	Unfavorable Weather Conditions (EEF1)	3.23

The consultant group identified *contractor’s inadequate experience and limited capacity (CCF2)* as the most significant delay factor, with a mean score of 4.77. Next to that, *price escalations and lack of timely adjustments (FF2)* scored 4.36, highlighting the impact of market and economic

factors. Following this, *shortage of materials/equipment* (MEF1) scored 4.05, indicating significant resource-related challenges.

Other factors, such as *unrealistic initial time and cost estimations* (SPF1), *late mobilization (delivery) of materials/equipment* (MEF2), and *contractor’s lack of commitment* (CCF1) were also rated highly, with mean scores of 4.09, 3.82, and 3.73, respectively.

Factors such as *wrong/unsuitable project location* (SPF2), *poor site access/logistical challenges* (PLF2), *delayed payments from the client* (FF1), and *client-initiated scope and design changes* (DF2) were rated relatively low, suggesting these issues are perceived as less critical by the consultant group.

#### **4.1.3.3. Perceptions of the Client Group**

The Client group, overseeing all 24 projects, provided a program-level perspective on the factors contributing to project delays. The following table presents the top 10 delay factors based on their perceptions, determined by mean scores.

*Table 11: Perceptions of Client Group on Top 10 Causes of Delay*

<b>Rank</b>	<b>Delay Factor</b>	<b>Mean Score</b>
1	Contractor’s Inadequate Experience and Limited Capacity (CCF2)	4.83
2	Unrealistic Initial Time and Cost Estimations (SPF1)	4.67
3	Political Instability/Security Issues (EEF2)	4.50
4	Late Mobilization (Delivery) of Materials/Equipment (MEF2)	4.33
5	Contractor’s Lack of Commitment (CCF1)	4.33
6	Price Escalations and Lack of Timely Adjustments (FF2)	4.17
7	Design Modifications/Changes (DF1)	4.00
8	Delays in Land Acquisition/Right-of-Way Issues (LRF1)	4.00
9	Inefficient Project Planning/Scheduling (PMF1)	3.83
10	Inadequate Risk Planning and Management (PMF4)	3.67

<b>Rank</b>	<b>Delay Factor</b>	<b>Mean Score</b>
10	Supply Chain Disruptions (MEF4)	3.67
10	Lack of Effective Monitoring/Control (PMF2)	3.67

According to the Client group, *contractor's inadequate experience and limited capacity* (CCF2) was rated the highest, with a mean score of 4.83, indicating a strong emphasis on contractor competence. *unrealistic initial time and cost estimations* (SPF1) and *political instability/security issues* (EEF2) follow the rankings with mean scores of 4.67 and 4.50, respectively.

*Late mobilization (delivery) of materials/equipment* (MEF2) and *contractor's lack of commitment* (CCF1) are also among the highly rated factors with a mean score of 4.33 each. *Price escalations and lack of timely adjustments* (FF2) follows them with a mean score of 4.17.

It is noteworthy that *design modifications/changes* (DF1) scored 4.00 with a standard deviation of 0.000, indicating complete agreement among the client respondents on this factor. Conversely, *client-initiated scope and design changes* (DF2) scored the lowest at 1.00, also with a standard deviation of 0.000, suggesting that these respondents agree that the Client did not initiate the design modifications/changes.

Factors such as *wrong/unsuitable project location* (SPF2), *poor site access/logistical challenges* (PLF2), *contractual disputes/ambiguities* (CF1), and *public opposition to project* (LRF2) were rated relatively low, suggesting that these issues are perceived as less critical by the Client group.

#### ***4.1.3.4. Overall Ranking and Identification of the Most Significant Causes of Delay***

The study examined the causes of delay in the study projects from the perspectives of the stakeholders (Contractor, Consultant, and Client groups). One important aspect of the analysis was the development of the overall ranking of these factors that integrates the perspectives of all the stakeholder groups. Because each group had differing numbers of respondents and some responses were at the project level and some were at the program (Initiative) level, a robust methodology was used to provide an unbiased and meaningful overall ranking.

Based on the principle of equal importance of the perspectives of all the stakeholder groups in projects, an equal weighting scheme (1/3 for each stakeholder group) was employed. This approach provides a neutral and transparent starting point, acknowledging the importance of all stakeholder perspectives without making unjustified assumptions about their relative influence (Burnham & Anderson, 2002; Krueger *et al.*, 2007). This aligns with best practices for such data and ensures comparability across stakeholder groups (Hox, 2010; Snijders & Bosker, 2012).

The weighted average score for each delay factor was calculated using the following formula:

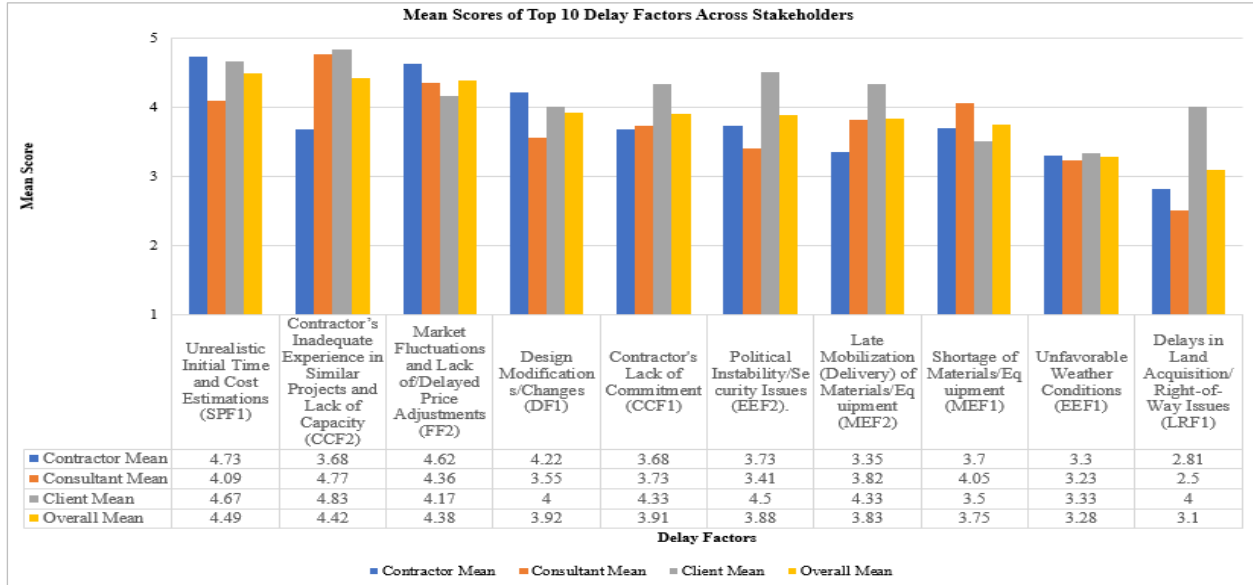
$$\text{Weighted Average} = \left(\frac{1}{3} * \text{Contractor's Mean}\right) + \left(\frac{1}{3} * \text{Consultant's Mean}\right) + \left(\frac{1}{3} * \text{Client's Mean}\right)$$

The delay factors were finally ranked from the highest to the lowest based on their calculated weighted average scores. Overall, this ranking presents an overview of the perceived importance of the different delay factors from the point of view of all the key stakeholders in a balanced and statistically sound way.

The table below presents the final ranking of all top 10 delay factors after applying equal-weighted averaging to integrate the perspectives of contractor, consultant, and client groups.

*Table 12: Top 10 Delay Factors Based on Overall Ranking*

<b>Delay Factor</b>	<b>Contractor</b>		<b>Consultant</b>		<b>Client</b>		<b>Overall</b>	
	Mean Score	Rank	Mean Score	Rank	Mean Score	Rank	Mean Score	Rank
Unrealistic Initial Time and Cost Estimations (SPF1)	4.73	1	4.09	3	4.67	2	4.49	1
Contractor's Inadequate Experience and Limited Capacity (CCF2)	3.68	7	4.77	1	4.83	1	4.42	2
Price Escalations and Lack of Timely Adjustments (FF2)	4.62	2	4.36	2	4.17	5	4.38	3
Design Modifications/Changes (DF1)	4.22	3	3.55	7	4.00	6	3.92	4
Contractor's Lack of Commitment (CCF1)	3.68	6	3.73	6	4.33	4	3.91	5
Political Instability/ Security Issues (EEF2)	3.73	4	3.41	8	4.50	3	3.88	6
Late Mobilization (Delivery) of Materials/Equipment (MEF2)	3.35	8	3.82	5	4.33	4	3.83	7
Shortage of Materials/ Equipment (MEF1)	3.7	5	4.05	4	3.50	9	3.75	8
Unfavorable Weather Conditions (EEF1)	3.3	9	3.23	10	3.33	10	3.28	9
Delays in Land Acquisition/Right-of-Way Issues (LRF1)	2.81	11	2.5	18	4.00	6	3.10	10



*Figure 5. Comparison of Top 10 Delay Factors Across Stakeholder Groups*

Although Table 12 shows considerable alignment among stakeholder groups on the most significant delay factors, some notable variations emerge in their rankings. These differences are both expected and informative, as they reflect the distinct roles, operational priorities, and accountability structures of contractors, consultants, and clients within dam project implementation.

For instance, Contractors rated *unrealistic initial time and cost estimations* (SPF1) as the top delay factor (mean = 4.73), whereas Consultants ranked *contractor’s inadequate experience and limited capacity* (CCF2) highest (mean = 4.77), and Clients did the same with an even higher mean score (4.83). This divergence reflects how contractors experience the burden of flawed initial planning, while the client and consultant focus more on the contractor’s capacity to deliver, which directly affects supervision and delivery targets.

On the other hand, Contractors ranked *delays in land acquisition/Right-of-Way issues* (LRF1) as least significant (11th), while Clients ranked it 6th. This gap likely reflects the division of responsibility, as land acquisition is often handled by the client side and may not be as visible to contractors unless it directly stalls site access.

These differences are not contradictions but reveal each party's perspective based on functional proximity to the problem. Recognizing and interpreting these differences is essential for developing multi-dimensional delay mitigation strategies that align stakeholder interests and address both technical and institutional bottlenecks in dam project delivery.

Based on the overall ranking, *initial time and cost estimation* (SPF1) was identified as the most important cause of delay in this Initiative, with a weighted mean score of 4.49, which reflected broad consensus among stakeholders on the importance of accurate project planning. This is clear evidence that the initial planning was rough. All projects in this phase were allocated a 300-calendar day in a similar way without taking into consideration the complexity and site-specific conditions of the projects. With a weighted average mean score of 4.42, *contractor's inadequate experience and capacity* (CCF2) was ranked second. This was especially a major concern from the client and consultant perspectives, underscoring the importance of the contractor's ability to execute projects effectively. This also reflects the reality in this phase. There were no criteria for selection and competition among contractors, as they were just awarded (invited).

*Price escalations and lack of timely adjustments* (FF2) ranked third (4.38), which highlights the impact of financial instability and cost unpredictability on project timelines. Another prominent delay factor was found to be *design modifications/changes* (DF1), which ranked fourth with a weighted average score of 3.92. This was followed by *contractor's lack of commitment* (CCF1), which scored 3.91.

External factors such as *political instability/security issues* (EEF2) with 3.88, and resource-related factors such as *late mobilization of materials/equipment* (MEF2) with 3.83, and *shortage of materials/equipment* (MEF1) with a score of 3.75, ranked from sixth to eighth.

Finally, *unfavorable weather conditions* (EEF1) scored 3.28 and *delays in land acquisition/Right-of-Way issues* (LRF1) with 3.10 ranked ninth and tenth, respectively, and were also partly responsible for delays in this Initiative.

Overall, the differences in responses from different perspectives (parties) indicate that stakeholder roles and/or their organizational affiliation influence the perception of construction delays.

Contractors often emphasize financial and resource-related issues, while consultants focus on design and planning, and clients highlight contractor performance and regulatory factors. These will be detailed in the Kruskal-Wallis Test Results section.

#### *4.1.3.5. Key Findings and Implications from the Survey*

- Cost-related issues, such as Unrealistic Cost and Time Estimations (SPF1) and Price Escalations (FF2), ranked among the top factors, reinforcing the need for better financial planning and risk mitigation strategies.
- Contractor-related factors are highly significant. Contractor's Inadequate Experience and Limited Capacity (CCF2) and Contractor's Lack of Commitment (CCF1) ranked among the top five, underscoring the need for stricter prequalification criteria and capacity-building initiatives to ensure capable contractors are engaged.
- Design modifications also significantly contributed to project delays. Design Modifications/Changes (DF1) ranked fourth, indicating the need for rigorous design management processes to minimize last-minute changes that extend project timelines.
- Similarly, Political Instability/Security Issues (EEF2) was identified as one of the most significant delay factors with the overall rank of sixth.
- Supply chain and resource availability are also major concerns. Late Mobilization (Delivery) of Materials/Equipment (MEF2) and Shortage of Materials/Equipment (MEF1) ranked seventh and eighth, respectively, highlighting the importance of improved logistics management, supplier coordination, and contingency planning to mitigate disruptions.
- Moreover, external and bureaucratic delays such as Unfavorable Weather Conditions (EEF1) and Delays in Land Acquisition/Right-of-Way Issues (LRF1) were also among the top ten delay factors, ranking ninth and tenth, respectively. These suggest that construction projects are susceptible to external risks, necessitating proactive planning, stakeholder engagement, and regulatory streamlining.

Overall, the weighted average ranking highlights financial constraints, contractor-related challenges, design factors, and supply chain disruptions as the primary causes of construction project delays. While external and bureaucratic delays are also significant, they rank lower than these issues. Therefore, addressing these key factors through better cost and time estimations, improving the contractor selection process, conducting adequate site investigation to enhance the

design process, and effective supply chain management could significantly improve project delivery and reduce the impacts of delay in construction projects.

#### 4.1.4. Statistical Test Results

##### 4.1.4.1. Kruskal-Wallis Test Results

The Kruskal-Wallis test was employed instead of ANOVA to compare differences in stakeholder perceptions of delay factors, as the data violated the normality assumptions. The ‘K Independent Samples’ procedure in SPSS was used to conduct the Kruskal-Wallis test for each of the 26 delay factors. Respondent Organization was used as a grouping variable, and the scores of individual delay factors were used as the test variables. The test was run with the “Kruskal-Wallis H” option selected, and the asymptotic significance (p-value) was recorded for each factor.

The Kruskal-Wallis H statistic, degrees of freedom (df = 2), and asymptotic significance (p-value) for each delay factor are presented in Figure 6 below. The results indicate that stakeholder perceptions varied significantly across several delay factors.

Test Statistics <sup>a,b</sup>													
	SPF1	SPF2	DF1	DF2	MEF1	MEF2	MEF3	MEF4	LF1	LF2	FF1	FF2	CF1
Kruskal-Wallis H	8.658	1.494	6.968	5.311	4.327	3.632	2.923	3.437	26.508	8.150	22.011	3.616	8.884
df	2	2	2	2	2	2	2	2	2	2	2	2	2
Asymp. Sig.	.013	.474	.031	.070	.115	.163	.232	.179	<.001	.017	<.001	.164	.012

a. Kruskal Wallis Test  
b. Grouping Variable: Respondent's Organization

CCF1	CCF2	PLF1	PLF2	LRF1	LRF2	PMF1	PMF2	PMF3	PMF4	PMF5	EEF1	EEF2
5.722	38.163	14.970	.320	4.169	.689	26.951	15.643	23.494	21.875	6.425	.070	5.476
2	2	2	2	2	2	2	2	2	2	2	2	2
.057	<.001	<.001	.852	.124	.709	<.001	<.001	<.001	<.001	.040	.965	.065

*Figure 6. Kruskal-Wallis Test Results for Delay Factors*

Based on the Kruskal-Wallis test results, statistically significant differences were observed for 13 delay factors ( $p < 0.05$ ): *unrealistic initial time and cost estimations (SPF1), design modifications/changes (DF1), labor shortages (LF1), low crew productivity (LF2), delayed payments from client (FF1), contractual disputes/ambiguities (CF1), contractor’s inadequate experience and limited capacity (CCF2), bureaucracies in tendering/procurement processes (PLF1), inefficient project planning/scheduling (PMF1), lack of effective monitoring/control*

(PMF2), *communication/coordination problems* (PMF3), *inadequate risk planning and management* (PMF4) and *rework due to construction errors/failures* (PMF5).

This suggests that the representatives of contractor, consultant, and client organizations held significantly different views regarding the impact of these delay factors.

For the remaining 13 delay factors, the Kruskal-Wallis test revealed no statistically significant differences ( $p \geq 0.05$ ). This suggests that the three stakeholder groups shared similar perceptions regarding the significance of these factors.

These findings align with previous research indicating that stakeholder roles and/or their organizational affiliation influence the perception of construction delays. Contractors often emphasize financial and resource-related issues, while consultants focus on design and planning, and clients highlight contractor performance and regulatory factors (Aibinu & Jagboro, 2002; Assaf & Al-Hejji, 2006; Doloi *et al.*, 2012; Odeh & Battaineh, 2002; G. Sweis *et al.*, 2008). The results underscore the importance of tailored interventions and communication strategies to address the specific concerns of each stakeholder group.

The use of p-values in this test was restricted to Kruskal-Wallis results to avoid overgeneralization. In case the Kruskal-Wallis test shows a significant difference, it was not identified which pairs of groups differ. However, this approach is consistent with the descriptive goal of the quantitative part in the study.

#### ***4.1.4.2. Spearman's Rank Correlation: Agreement Between Stakeholder Rankings***

Spearman's rank correlation was used to measure the level of agreement between stakeholders in ranking delay factors. This non-parametric test is particularly suited for ordinal data like Likert-scale rankings and does not require the assumption of normality (Corder & Foreman, 2014; Dancy & Reidy, 2017). The analysis aimed to determine the extent to which stakeholder perceptions were aligned across the study projects. A correlation coefficient, rho ( $\rho$ ), with +1 indicating perfect agreement, and -1 indicating complete disagreement, was calculated. The Spearman's rank correlation coefficients were evaluated at a 5% level of significance ( $p < 0.05$ ), following standard research practices (Field, 2024). Correlations with p-values less than 0.05 were considered statistically significant.

Based on the common thresholds (J. D. Evans, 1996), the results are interpreted as follows:

*Table 13: Agreement Between Stakeholders on Delay Factor Rankings*

Stakeholder Comparison	Spearman Coefficient ( $\rho$ )	p-Value	Interpretation
Contractor vs. Consultant	0.682	< 0.05	Strong agreement
Contractor vs. Client	0.745	< 0.05	Strong agreement
Consultant vs. Client	0.852	< 0.05	Very strong agreement

All correlations are statistically significant at the 5% level. The results show that there is a strong agreement between Contractor and Consultant groups ( $\rho = 0.682$ ,  $p < 0.05$ ) and between Contractor and Client groups ( $\rho = 0.745$ ,  $p < 0.05$ ). This suggests a high level of consensus between these groups in their ranking of delay factors, which indicates that they share many of the same views about the delay factors.

Furthermore, there is very strong agreement between the Consultant and the Client ( $\rho = 0.852$ ,  $p < 0.05$ ). This indicates a very high level of similarity in how these two groups perceive the importance of various delay factors.

This might indicate that the Client's perspective on delay factors aligns more closely with both the Consultants and Contractors compared to the alignment between the Consultants and Contractors themselves.

In summary, Spearman's rank correlation analysis reveals that the Client group has a strong agreement with both the Consultant and the Contractor groups in the ranking of delay factors. This might suggest that the Client's perspective is more aligned with the other two stakeholder groups. Consequently, it is important to consider the Client's perspective as a central point of reference when addressing project delays, while also acknowledging the unique insights of both Contractor and Consultant groups.

This implies a high level of shared understanding among the stakeholders regarding the major delay factors in the Finna Oromia Initiative. Interestingly, the Consultant and Client show the highest level of agreement, possibly reflecting closer collaboration in design supervision and overall project governance.

These findings support the reliability of the ranking outcomes and indicate that, despite different roles in the project lifecycle, stakeholders largely converge on their perceptions of delay causes. The implications of this convergence are meaningful for designing integrated mitigation strategies that reflect the consensus among key project actors.

## **4.2. Qualitative Data Analysis Results: Case Study Results**

### ***4.2.1. Processes and Methods***

To complement the findings of the survey, a case study on a purposively selected project (Finna Keta Dibe Dam Project) was conducted. Information on the causes of delay in this particular project was gathered using two instruments (semi-structured interview and document review). After that, thematic analyses were conducted separately first, and then the triangulated discussion of findings was presented.

### ***4.2.2. Description of the Project***

The Finna Oromia Keta Dibe Dam Project is a medium-scale irrigation development designed to address food insecurity and enhance agricultural productivity in the East Bale Zone of Oromia National Regional State, Ethiopia. It is one of the dam projects implemented under Phase 1 of the Finna Oromia Initiative.

The project is financed by the International Fund for Agricultural Development (IFAD) and implemented under a contract agreement between the Oromia Bureau of Agriculture and Natural Resources (OBoANR) and the Oromia Construction Corporation (OCC), with the Oromia Irrigation and Pastoralist Development Bureau (OIPDB) serving as the client. The Engineering Corporation of Oromia (ECO) is responsible for the detailed feasibility study, design, and construction supervision. The project cost was estimated at a total of 380,228,800.47 Birr.

The main components of the project include the construction of a zoned earth-fill dam, a spillway, and an irrigation system to serve approximately 1,492.82 hectares of command area, classifying it as a medium-scale dam according to Dessalegn (1999). The dam has a height of 23.7 meters and features a chimney filter and horizontal drains to control seepage. The spillway is a side-channel type with a chute and an energy dissipater, designed to safely convey a maximum discharge of

287.8 m<sup>3</sup>/s, corresponding to a 1000-year return period flood, as per the hydrological assessment conducted by ECO.

The irrigation infrastructure includes a network of main, secondary, and tertiary canals, with a total main canal length of 4 kilometers. The system is supported by drainage structures to manage excess water and prevent waterlogging. River diversion during construction was designed using upstream and downstream cofferdams, a dry season diversion conduit, and the natural river channel, as outlined in the project design documents and the contract agreement.

Hydrological analysis indicates that the annual catchment yield is sufficient to meet irrigation, domestic, livestock, and environmental flow demands (Engineering Corporation of Oromia, 2021). The reservoir has a total storage capacity of 11.4 million cubic meters at a full supply level (FSL) of 1376 meters above sea level. Reservoir operations are projected to achieve 86% reliability for irrigating 1,500 hectares of land, with OIPDB overseeing water management to ensure sustainability.

Geological and geotechnical investigations (Engineering Corporation of Oromia [ECO], 2024) revealed that the project area consists of Quaternary alluvial deposits, Quaternary calcrete (limestone), and Tertiary basaltic rocks. The foundation is characterized by unconsolidated soils and fractured bedrock, necessitating careful seepage control measures. Laboratory testing indicated medium to high plasticity and compressibility in the soils, and the bedrock was found to be pervious. As stipulated in the contract, OCC was required to perform additional geophysical surveys and core drilling during construction to verify and adapt foundation treatment strategies.

The initial dam design comprised an impervious clay core, shell zones, and drainage layers, and upstream and downstream slopes of 1:3 and 2.5:1, respectively. The upstream face was protected against erosion using riprap. Seepage calculations, made with the GeoStudio 2018 software, yielded seepage of 0.03443 m<sup>3</sup>/day per meter length of dam. The spillway design provided for complete dissipation of flow energy before returning to the river, and aeration ramps were not necessary.

Construction materials were locally available. The core clay was extracted from a borrow pit 1 kilometer to the southeast of the dam site, where a reserve of about 3 million cubic meters is estimated to be available. Sand was extracted from the Buduk and Dhekat Rivers, and basaltic rock

and limestone were used for riprap and masonry. Quality control supervision of materials, procurement, and transport was carried out by OCC, as per the contract agreement.

Key technical suggestions forwarded during the project feasibility study include stripping of organic topsoil to a depth of 5 meters, strengthening of the foundation using rock pieces, lining of the main canal for water loss prevention, and constant observation of groundwater levels to safeguard the dam’s integrity. The agreement requires OCC to implement these suggestions and provide periodic progress reports to OIPDB.

The contract agreement between OBoANR and OCC ensures that all aspects of the project, from design to construction and supervision, are carried out to the highest standards, with a focus on sustainability, safety, and efficiency. ECO is also responsible for training local communities in the operation and maintenance of the irrigation system, as stipulated in the contract agreement, to ensure the long-term success of the project.

*Table 14: Project Information for Finna Oromia Keta Dibe Dam*

<b>Project Description</b>	
<b>Project Name</b>	<b>Finna Keta Dibe Dam (Medium Scale Irrigation Project)</b>
<b>Location</b>	The project is located in the East Bale Zone of the Oromia National Regional State, specifically in the Sewena district and Keta Dibe Kebele.
<b>Accessibility</b>	The site is approximately 610 km southwest of Finfinnee (Addis Ababa), 70 km from the zonal capital Ginnir, and 15 km from the Woreda capital Micha. Access is via a 70 km all-weather gravel road, with an additional 1.5 km requiring a new access road.
<b>Dam Type</b>	Medium-scale irrigation project
<b>Project Stakeholders</b>	
<b>Client</b>	Oromia Irrigation and Pastoralist Development Bureau (OIPDB)
<b>Consultant (Design and Supervision)</b>	Engineering Corporation of Oromia (ECO)
<b>Contractor</b>	Oromia Construction Corporation (OCC)
<b>Cost and Time</b>	

<b>Estimated Cost of the Project</b>	380,228,800.47 Ethiopian Birr
<b>Estimated Project Duration</b>	300 Calendar Days
<b>Contract</b>	
<b>Project Delivery Method</b>	Design-Bid-Build (DBB)

#### ***4.2.3. Interview Thematic Analysis Results***

Part of the qualitative component of this study included in-depth interviews to explore the underlying causes of the delay in the Finna Oromia Keta Dibe Dam Project. Initially, four interview informants (project manager, resident engineer, cluster coordinator, and a member of a design team) were purposively targeted for their project knowledge. However, the project manager and design team withdrew from participation due to personal reasons. Therefore, the analysis was based on the responses from two key informants, a Resident Engineer from the Consultant side and a Cluster Coordinator who acts as the Client Counterpart Engineer.

The interviews were conducted based on the semi-structured interview guide prepared for this purpose (following the findings of the survey to align with the sequential explanatory design used). In order to capture every aspect of the responses, the interviews were recorded with the permission of the participants. Each interview took approximately one hour and was conducted both in person (round 1) and via online video call (round 2) at the participant’s preference and availability.

After data collection, the interviews were transcribed verbatim and later subjected to thematic analysis. To validate key findings, direct quotations were primarily used to ensure a clear linkage between the raw data and the interpretations. Below are seven key themes that emerged from the interviews.

#### ***Theme 1: Unrealistic (Inaccurate) Time and Cost Estimations***

Unrealistic time and cost estimation during the project's initiation was mentioned as one of the key causes of delay. Both the respondents (interviewees) highlighted that the time and budget allocated for the Finna Keta Dibe Dam Project were not based on a realistic assessment of the specific scope and complexity of the project, leading to inaccurate estimations.

The Resident Engineer stated:

*“The time estimation was rough and just allocated in the same way for all the Finna Oromia Dam Projects. One year was not enough given the scope of the project.”*

The Client's Counterpart Engineer also pointed out that the 300-day schedule did not take into account the activity-specific needs.

*“The estimations in terms of time and cost were not accurate. All Finna Oromia projects were allowed the same duration without considering each activity of the works.”*

### ***Theme 2: Design Modifications and Foundation Complexity (Core Delay Factor)***

Both the Resident Engineer and the Client's Counterpart Engineer independently identified design modifications as the most critical delay factor in the Finna Keta Dibe Dam Project.

*“There were many design modifications. For the only spillway, four modifications were made. The foundation was also complex beyond initial expectations.”* - Resident Engineer

Several issues were reported under this theme and are discussed in sub-themes as follows:

#### ***Theme 2.1: Challenges in Getting a Firm and Stable Foundation***

The informants reported that excavation revealed a deeper and more complex foundation profile than what had been anticipated in the design stage. The foundation conditions encountered during construction were significantly different from those anticipated.

*“Even though shallow investigations (geophysical studies) were conducted before starting excavation, it was very challenging to get a firm and stable foundation.”* - Resident Engineer

The Client's Counterpart Engineer also stated:

*“In the initial design, the firm foundation was assumed to be at a depth of 3 to 5m, but it was found at about 15m during construction.”*

To address these challenges, core drilling was carried out during construction as was recommended in the feasibility study. However, since these investigations were not completed early enough to influence initial design decisions, the construction had to be adapted mid-way, often reactively.

This, the Resident Engineer said, “*could not have happened if core drilling had been done as early as possible. The core drilling was later conducted by being subcontracted to another firm. So, it was difficult to start filling during this situation.*”

This revealed a mismatch between assumed and actual geotechnical conditions, requiring mid-course corrections that delayed implementation. The gaps forced design changes and halted progress.

### ***Theme 2.2: Change in Foundation Type***

The Client’s Counterpart Engineer described how original assumptions regarding foundation layering had to be revised:

*“The foundation was originally designed as heterogeneous, but during construction, it was changed to homogeneous type due to the absence of enough shell layer.”*

The Resident Engineer also supported this, saying:

*“Excavations revealed differing site conditions. Suitable shell materials were not available in the quantities assumed in the initial design. And, there was too much clay. So, the best option was found to be changing the foundation to homogeneous type.”*

This change required structural re-design and revised construction methodology, which introduced delays and required contractual adjustments. It also influenced material selection, treatment methods, and sequencing of works, in addition to delaying the project, as the informants underscored.

### ***Theme 2.3: Foundation Treatment Methodologies***

With the foundation material being both deep and weak, several treatment options were explored. For example, grouting was proposed to stabilize the foundation and reduce seepage, even though it was rejected due to budget limitations.

*“Grouting was recommended during construction. But the Client rejected it because of its high budget requirement. Therefore, it was suspended for some time to find other alternatives.”* - Resident Engineer

The informants mentioned that bentonite was introduced to modify the properties of the clay used for dam construction instead of grouting. This was intended to increase the plasticity index (PI) of the material, which improved its compaction, reduced permeability, and enhanced structural stability:

*“As foundation treatment, bentonite was also proposed to increase the PI of the clay, which enhanced the backfilling process to some extent.”* - Client’s Counterpart Engineer

These adjustments represent the consequences of limited site data. According to the informants, the foundation treatment methodology was the main source of debate in this regard.

#### ***Theme 2.4: Spillway Design Modifications***

The informants also mentioned that there were repeated spillway design revisions. In the final modification, for example, a multi-layer system comprising crushed stone, lean concrete, and RCC (roller-compacted concrete) was adopted to minimize the risk of infiltration-induced settlement:

*“Finally, it was recommended that a 120m spillway with 30m embedded in the dam body be constructed with a 50cm hard core layer (crushed stone), lean concrete, and then roller-compacted concrete (RCC) to prevent foundation settlement due to water infiltration.”* - Resident Engineer

These were not initially included in the design and were developed reactively, which prolonged construction timelines.

#### ***Theme 2.5: Instrumentation Design and Installation Issues***

The informants also cited the delay in dam instrumentation as a non-structural, but critical issue. Both pointed to dam instrumentation as an unresolved issue (even until the interview was conducted) and caused a significant delay to the project. According to them, the system was originally planned to be installed during foundation compaction. However, this method was later deemed impractical and changed to post-compaction drilling, necessitating specification revisions and cost reassessments.

*“Initially, the dam instrumentation was supposed to be done concurrently with the foundation compaction. But the contractor found it unsuitable and decided to do it by drilling after the foundation compaction was completed.”* – Client’s Counterpart Engineer

This change led to miscommunication and a prolonged pricing dispute between the Client and Contractor, as stated by the same informant:

*“This led to changes in the specification of the work. To accommodate this change, the client requested the contractor to quote the new price for this work. The client then checked the quoted price and sent it to the Oromia Construction Authority for final approval. After the approval process (which took longer than expected), the Contractor started the tendering process. But the price was too high at the time. Due to this, the Contractor refused to go ahead with the next process, resulting in additional delays.”*

Ultimately, the Contractor declined to proceed with the next steps due to pricing disputes, causing the instrumentation works to fall behind even as other project components neared completion. This created a complex project environment, where specification changes and financial delays converged to hinder timely execution.

### ***Theme 3: Contractor’s Commitment and Mobilization Issues***

Both informants acknowledged that the contractor is technically competent (experienced) and well-equipped in terms of machinery and manpower, but drew some criticism, particularly regarding late-stage demobilization of resources and occasional lack of commitment.

*“The contractor fully mobilized resources at the beginning, but after 90% progress, it demobilized machinery to prioritize new projects,”* noted the Resident Engineer.

The other respondent also supported this idea, stating: *“This contractor usually lacks commitment and prioritizes new projects once the ongoing one nears completion.”*

These actions disrupted the completion phase, causing tasks like backfilling and instrumentation works to be delayed and equipment to be reallocated according to both interviewees.

### ***Theme 4: Price Escalation and Payment Delays***

Though not ranked as a primary delay source in this particular project, both informants noted the impact of economic conditions.

*“Price escalation caused by the national economic instability also affected the project's progress. To minimize its effects price adjustment was carried out once at 15.62%, even though it was not requested by the Contractor, but applied across all projects of Phase 1 of the Finna Oromia Initiative.”* - Resident Engineer

The Client’s Counterpart Engineer further explained this, saying:

*“As the agreement is a fixed price, the price adjustment was done only for fuel, and there were no adjustments on other items. Therefore, market fluctuation and price escalation have impacted the project implementation to some extent.”*

Related to this, both respondents mentioned that payment procedures were sometimes informal, particularly at fiscal year-end, due to budget release schedules. Although these issues did not have a significant impact, they contributed to financial uncertainty and highlighted the rigidity of fixed-price contracts in an inflationary context.

#### ***Theme 5: Weather-Related Disruptions***

Both participants acknowledged that seasonal weather fluctuations, especially heavy rains during September and October, posed some challenges, given the dam’s reliance on clay materials, which are sensitive to moisture.

*“When it rains, the whole work would stop. The impact of weather conditions was, however, moderate as it was not continuous. The event usually occurs during September and October,”* explained the Resident Engineer. He further mentioned that the work would proceed after temporary treatments such as shaving and mixing the top layers, but delays were inevitable during heavy rainfall periods.

#### ***Theme 6: Project Rework Due to Flood Damage***

A significant incident of flood-induced rework also emerged in the Finna Keta Dibe Dam project. During one flood event, a portion of the dam was overtopped and damaged due to insufficient height in that section.

*“A strong flood occurred once, and the dam body collapsed in the lowest part (between stations 580 and 700). So, the option was to cut in the direction of the lowest elevation and fill again. This rework delayed the project for months,”* the Resident Engineer recalled.

According to the Client’s Counterpart Engineer, this flooding event even caused some public disappointment.

*“The contractor initially planned to bypass the flood safely, but a strong and unexpected flood broke through the body of the dam, collapsing its body, leading to the flooding of the downstream areas owned by local communities, causing some damage. However, there was some consultation with the public, and the problem was instantly solved by convincing the local community. But the contractor carried out a rework to reconstruct the collapsed dam body, which took about 3 months.”*

Though this was a one-time event, it added strain to resource and timeline commitments already under pressure from design-related delays.

### ***Theme 7: Administrative Complexity and Limited Accountability***

There was also a recurring theme related to the institutional environment in which the project operated. Because both client and contractor were public institutions, decision-making and accountability mechanisms were sometimes blurred. The Client-side informant pointed out:

*“It is usually difficult to take every necessary measure, as in the case of private contractors, because many stakeholders are involved in such decisions.”*

Regarding this, both interviewees stated that sometimes the contractor was unwilling to strictly follow the Client’s instructions.

*“However, as a client, the OIPDB strictly follows every procedure and tries to guide, enforce, and act contractually against the contractor in the same way as other private contractors. Currently, the client has filed a “liquidated damages” against the contractor, as it failed to complete the project even after multiple time extensions. As of March 2025, the project has taken about 560,000,000 ETB. But the originally estimated cost was ETB 380,000,000.”* - Client’s Counterpart Engineer

The contractor's public status limited the enforcement of penalties despite being under liquidated damages. This was reiterated by the same informant as:

*"The contractor is in a liquidated damages state, but because it is a government entity, strict contractual enforcement is difficult."*

This weakened institutional accountability and delayed critical approvals. In addition, challenges in finalizing dam instrumentation (due to delays in approval processes and cost negotiations) highlighted bureaucratic bottlenecks that extended the timeline despite nearing completion.

### ***Summary of the Interview Results***

The thematic analysis of the interviews reveals that although several issues contributed to the delay in this particular project, design modifications due to foundation complexities emerged as the most dominant and multifaceted cause. This was supported and confirmed by consistent narratives from the interviewees representing the consultant and the client, and underpinned by direct quotations that linked data to interpretation. Other contributory factors, such as unrealistic planning assumptions (estimations), price escalation, weather conditions, and issues related to resource demobilization, were also noted but were largely secondary in impact. These findings provide essential qualitative depth to the understanding of project delays in the Finna Oromia Keta Dibe Dam Project.

#### ***4.2.4. Document Review Results***

A detailed review of key project documents on the Finna Oromia Keta Dibe Dam Project was conducted to supplement the interview findings and enhance methodological rigor by triangulation. These include the Geotechnical Report, Detailed Engineering Report (including feasibility study and design), Construction Contract Agreement, formal notification letters, and minutes of meeting. The document review was intended to verify and enrich the thematic insights from the interview analysis.

##### ***1. Challenges in Obtaining a Firm and Stable Foundation***

Identifying a firm and stable foundation was one of the earliest and most consequential technical challenges revealed in the document review. The Detailed Engineering Report shows that, in early design, firm foundation was estimated to be at a depth of 3-5 meters based on test pits and valley

cross sections. It, however, explicitly recommended additional core drilling during construction to determine the actual bedrock levels.

The Geotechnical Report, which was compiled during construction, indicated that the dam foundation consisted of deep layers of weak, pervious materials, particularly Quaternary Alluvium 2 (Qal2), and firm foundation was not found until depths of 12-15 meters, requiring revised foundation strategies.

Because of these unforeseen subsurface conditions, core drilling investigations had to be undertaken as recommended in the feasibility study. Even though it provided essential data that fundamentally changed the foundation treatment approach, the delay in this core drilling limited its use in driving initial design decisions.

## ***2. Changes in Foundation Type***

As per the Detailed Engineering Report, the dam was originally planned as a zoned (heterogeneous) earth-fill structure with separate materials for the core and shell zones. However, the Geotechnical Report shows that the borrow area was dominated by clay-rich materials, and the amount of suitable shell materials was negligible. This necessitated a change to a homogeneous dam design, increasing reliance on single-material compaction and altering hydraulic performance assumptions.

This changed construction methodology, compaction procedures, and seepage control measures to a great extent. This shift was formally recognized in EoT #3 which included “dam type change” as one of the approved delay justifications.

## ***3. Challenges in Foundation Treatment Strategies***

As a result of this revised understanding of the subsurface conditions, the methods of foundation treatment were reconsidered. In zones where Quaternary Alluvium 2 (Qal2) materials had high permeability and poor stability, either grouting or redesign of the foundation was recommended as indicated in the Geotechnical Report.

Initially, grouting was identified as the preferred stabilization method, but it was ruled out for budgetary reasons, as explained in the interviews. As an alternative, bentonite slurry was used as a stabilizing additive to improve compaction and impermeability in clay backfills, especially during deep trenching. These changes were technically effective, but they were not anticipated in the

original design, and implementation required procurement, additional laboratory validation, and procedural approvals. This contributed to EoT #3, where 60 calendar days were explicitly attributed to “foundation treatment method,” and the time to adopt and implement these new treatment strategies.

**4. Time Claims and Contract Amendments**

Significant delays in implementation resulted in three officially approved Extensions of Time for the project. Overall, these resulted in a 249% time overrun as of March 2025. With this, the current completion status, as of March 2025, stands at 99%.

These time extensions were accompanied by two major contract amendments. The recurring references to “design modifications” in all EoTs and amendments demonstrate how delayed technical understanding translated into evolving scope, budget escalation, and delivery failure. Table below summarizes these details.

*Table 15: Contractual Information related to the Finna Oromia Keta Dibe Dam Project*

Project Name		Finna Oromia Keta Dibe Dam Project			
Project Signing Date		11th September 2021			
Project Commencement Date		19 <sup>th</sup> November 2021			
Contract Duration		300 calendar days			
Original Completion date		21 <sup>st</sup> September 2022			
Number of Extension of Time (EoT)s Granted		3 Times			
Revised Completion Date		11 <sup>th</sup> July 2024			
Project Time Overrun		249% until the end of March 2025			
Current Status of the Project		Ongoing: 99% as of March 2025			
Time Claim	Number of Days (Cal. Day)			Major Claim Heads	Remark
	Requested by Contractor	Recommended by Engineer	Approved by Employer		
EoT #1	329 days	329 days	330 days	1. Design modifications	From report
EoT #2	315 days	315 days	315 days	1. Design modifications and rework	From report

EoT #3	210 days	200days	200 days	<ol style="list-style-type: none"> <li>1. Permission to use spillway control blasting (40 days)</li> <li>2. Foundation treatment method (60 Days)</li> <li>3. Dam type Change (30 days)</li> <li>4. Outlet design modification (40Days)</li> <li>5. Fuel price escalation (10 days)</li> <li>6. Rain Case (20 days)</li> </ol>	From report
<b>Cost Claims and Amendments</b>					
<b>Claims (Amendments)</b>		<b>Date</b>	<b>Reason and how it was done</b>		<b>Remark</b>
Contract Amendment #1			<ol style="list-style-type: none"> <li>1. Design modification due to foundation complexity</li> <li>2. Electromechanical work changes</li> </ol>		523,891,780.23 birr
Contract Amendment #2			<ol style="list-style-type: none"> <li>1. Design Modification by addition and omission of tasks</li> </ol>		495,353,001.31 birr
Price Adjustment #1			<ol style="list-style-type: none"> <li>1. Fuel price escalation</li> </ol>		15.61% of the original contract

### **5. Delays in Dam Instrumentation Works**

Another area that led to significant procedural delay was dam instrumentation. The design originally envisioned that instrumentation would be done at the same time as compaction of the foundation. However, a formal notification letter by the Engineering Corporation of Oromia (Consultant) shows that it was not even started as of 9<sup>th</sup> August 2024. As per the letter, the following activities were among the outstanding items:

- Dam instrumentation

- Movable crane and 50 KVA Generator supply and fix
- Spillway backfill not completed
- Exit channel next to the impact basin, boulder riprap placement
- As-built drawing, operation, and maintenance manual

The letter urged the contractor to speed up the above outstanding items as the administrative processes had become a bottleneck in the closing phase of the project.

### **6. Flood Damage and Rework**

In both the meeting minutes and EoT #2 justification, there is a notable incident of structural damage due to flooding. A section of the dam body was overtopped and failed during one rainy season because of insufficient fill height. The affected portion of the dam had to be excavated and rebuilt, introducing significant rework to the construction timeline. The flood also caused property damage in the downstream area, leading to legal action. A certain minutes of meeting shows that the contractor was ordered by a local court to compensate affected farmers, and this not only delayed progress but also put strain on institutional relations with the community.

In summary, the document review validates the core findings of the interview-based thematic analysis by providing concrete and archival evidence for the following conclusions. The primary sources of delay in this project, therefore, stemmed from:

- Late discovery of deep, unstable foundation material,
- Design modifications including dam type change and treatment adaptation,
- Delays in critical components like instrumentation and spillway completion,
- Rework arising from environmental vulnerabilities,
- Time-consuming procedural approvals, and
- Budgetary and technical adjustments requiring formal contract amendments.

Each of these factors demonstrates how initial design assumptions, once invalidated during construction, led to iterative technical and contractual responses that collectively extended the project timeline and inflated costs. These findings provide a solid basis for subsequent triangulation with interview results and inform broader lessons for infrastructure project management in similar contexts.

#### **4.2.5. Triangulated Discussion of the Case Study Findings**

The triangulated analysis of the Finna Oromia Keta Dibe Dam Project, combining qualitative interview insights with technical and contractual evidence (from documents), consistently reveals delay factors stemming from a complex interplay of technical, administrative, and contextual variables.

Both interviews and project documents strongly converge on the problem of inaccurate assumptions about foundation conditions. The feasibility study estimated a firm foundation at 3-5 meters, yet construction investigations, particularly core drilling, exposed unstable conditions at depths of 12-15 meters. This discrepancy, acknowledged by interviewees (resident engineer and Client's counterpart engineer) and documented in the geotechnical report, caused delays by necessitating core drilling and reevaluation of foundation treatments.

Another point of convergence is the change in the dam's structural design from a zoned (heterogeneous) earth-fill to a homogeneous dam. Interviews revealed that anticipated shell materials were unavailable in the required quality and quantity, a fact corroborated by the Geotechnical Report and construction records indicating clay-dominated borrow areas. This led to the adoption of a homogeneous dam structure, formally listed as a justification for Extension of Time (EoT) #3. This revision not only changed construction methodology but also influenced compaction strategies and material placement, significantly extending the project timeline. This triangulated evidence suggests that material availability is a critical factor in early-stage design, especially for earth-fill dams relying on local sourcing.

Both interviews and documents strongly agree that unanticipated foundation treatment methods were required. While the Consultant proposed grouting, the Client rejected it due to cost. As an alternative, bentonite was used to improve clay plasticity and compaction quality for backfill. This decision, contextualized by interviews, was validated by the Geotechnical Report as a substitute stabilization method in deep trench zones. This shift reflects how budget constraints influenced technical decisions, necessitating real-time engineering adjustments. Although practical, the assessment and implementation of alternatives caused significant delays, cited under "foundation treatment method" in EoT #3, directly linking treatment delays to contract time adjustments.

A key insight from the document review is that design changes were formally identified as the dominant driver behind all three Extensions of Time (EoTs), collectively adding 249% to the original contract period. Interview narratives emphasized the iterative nature of design decisions based on site realities, while formal documentation consisted of amendment records and delay justifications. Both sources strongly converge on the fact that design-related issues were not limited to one element but encompassed various elements such as dam type, outlet design, spillway dimensions, and instrumentation methods. This triangulated evidence points to reactive project management practices (delayed discovery, late decision-making, and procedural backlog), which created cumulative impacts on time and budget.

Delays in dam instrumentation represent a case where administrative and technical challenges overlapped. The original design included instrumentation for foundation compaction, but this was abandoned mid-construction. Interviews described a prolonged dispute over revised specifications and pricing, and formal notifications from the Consultant confirmed that instrumentation was never implemented. This triangulated insight reveals that technical changes, slow procurement processes, and weak contractual responsiveness combined to create bottlenecks that undermined project closure. The Contractor's refusal to proceed due to pricing disputes, even after approved changes, indicates a lack of enforcement mechanisms when both parties are public sector entities.

Both interview and document data reveal a major flood event that overtopped a partially constructed dam section, causing structural damage and rework. Interviews cited a one-month delay, while documents formally validated the event, including a court decision finding the contractor liable for downstream farmland damages. This rework was a justification for EoT #2. This finding highlights the compounded effects of natural hazards, design execution timing, and quality assurance gaps, reinforcing the need for climate-resilient scheduling and contingency planning in dam construction projects.

It was evidenced by both sources that institutional limitations also played a role in causing project delay. Weak accountability was among the themes of interviews, while contract clauses and administrative documentation confirmed a slow, inflexible system for technical change and price revision approvals.

In summary, the triangulated findings strongly converge on design modifications as the most critical cause of delay in the Finna Oromia Keta Dibe Dam Project. Interviews and project documents provide evidence that almost all major disruptions, including foundation challenges, treatment methods, or structural components, ultimately necessitated a change in the original design, altering the project's scope, schedule, and cost structure. The most significant modification was the change in dam type from a zoned (heterogeneous) earth-fill structure to a homogeneous type due to the unavailability of suitable shell materials and an abundance of clay. This design shift had far-reaching implications, requiring a complete re-evaluation of compaction methods, seepage control strategies, and structural integrity considerations. It also prompted revisions to outlet structures, spillway layout, and instrumentation methodology, all formally recorded in contract amendments and Extensions of Time. Each modification, whether due to unforeseen foundation depth, foundation treatment methods (rejection of grouting and adoption of bentonite), or instrumentation redesign, represented a departure from original planning assumptions. These were not isolated adjustments but rather sequential and cumulative, with each new finding or constraint driving additional rounds of design adaptation. This is supported by documents, as all three EoTs explicitly list 'design modifications' as a key justification. Furthermore, the reactive nature of these design decisions, often made in response to delayed technical information or administrative processes, meant that investigation lagged behind implementation. This sequencing failure highlights the challenge of managing infrastructure projects where site-specific data are deficient at planning stages and institutional mechanisms for rapid response are weak. Consequently, the project deviated from its initial plan, instead responding to emerging technical, financial, and institutional constraints.

### **4.3. Integration of the Survey and Case Study Findings**

This section provides an integrated interpretation of the results of the quantitative and qualitative phases of the study. In line with the sequential explanatory mixed-methods design, the purpose of the qualitative case study was to provide a deeper understanding and contextual explanation of the statistically significant delay factors identified in the quantitative phase. This process supports what is known as interpretive triangulation, where different sources of evidence are used to enrich and explain the patterns emerging from the data rather than to validate one another directly. It identifies

consistent patterns, contextual elaborations, and areas of divergence between the two data sources, thereby improving the credibility and depth of the study's conclusions.

#### ***4.3.1. Areas of Convergence***

Several key findings from the qualitative case study of the Finna Keta Dibe Dam aligned with the most critical delay factors identified in the survey data. For instance:

The unrealistic initial time and cost estimations was one of the most consistent findings. While the survey participants ranked this factor highest, interviewees elaborated that feasibility studies were rushed, and all the projects in Phase 1 were allocated the same duration without considering their actual scope and complexity.

Similarly, design modification was highlighted in both phases. It was the fourth top-ranked cause of delay in the survey, and the case study confirmed that design-related revisions contributed the most to delay in the Finna Keta Dibe Dam project. The findings from the case study showed that design modifications were caused by challenges in getting a firm foundation, dam type change because of differing site conditions, foundation treatment methodologies, spillway design modifications, and instrumentation installation approaches.

The third area of convergence was about the fluctuations in the market, compounded by the delayed price adjustments. This factor ranked third in the survey, and the case study supported this, as delays in implementing price adjustments were stated as one of the reasons for time extensions. The case study also highlighted that even the delayed price adjustment was made only for fuel, as the agreement is a fixed price, stressing that this factor has also impacted the project implementation to some extent.

Another convergent issue was related to unfavorable weather conditions. The survey indicated that weather conditions were among the top 10 delay factors, ranking ninth. The case study also identified that this factor repeatedly interrupted construction activities, especially during September and October.

The convergence of the two datasets in these areas reinforces the survey findings and demonstrates their applicability in practice.

### **4.3.2. Complementarity of Findings**

While the quantitative survey identified and ranked delay factors across multiple projects, the case study added rich contextual narratives that explained how and why these delays occurred. The case study, thus, provided complementary insights (by adding depth, explanation, and narrative detail) that helped contextualize some of the survey findings. For example:

The case study highlighted additional significant contributing factors, such as the administrative and accountability issues, which were not explicitly listed in the survey questionnaire. Interviewees mentioned a lack of clear enforcement mechanisms in a project where the contractor and the client are both public entities. These findings offered deeper insight into institutional inefficiencies that extended beyond individual project teams.

The case study also provided another complementary insight into dam instrumentation delays. This was not mentioned in the survey as a contributing factor, but interviews and project documents showed that dam instrumentation installation was found to be among the most significant delay factors in the Finna Keta Dibe Dam project. Although it was originally planned to start at the same time as the compaction of foundations, it was not implemented even after other civil works were completed.

### **4.3.3. Divergences in Findings**

Although there are many areas of convergence, some differences were found between survey and case study findings. One notable divergence was related to the *political instability/ security issues*, which was ranked relatively highly (sixth) by respondents in the survey. This, however, was not mentioned in the case study and was not found in the project documentation either. This implies that, unlike other projects under the initiative, political or security concerns did not play a role in the case of the Finna Keta Dibe Dam project.

Another area of divergence is the *contractor's inadequate experience and limited capacity*. This factor was ranked second in the survey. On the contrary, the case study did not reveal any problems with the contractor's technical expertise or experience. The survey revealed that many inexperienced contractors were involved in other projects within the Finna Oromia Initiative. Fortunately, the contractor in the case study (OCC) was not among them. Interviewees even mentioned that the contractor was highly competent in project execution, citing its financial

capacity, experience in similar projects, manpower, and machinery. The document review (progress report compiled after a year of commencement) also shows that the machinery mobilization of OCC was 102.38%, by far better than other contractors.

Moreover, the survey identified the *rework due to construction errors/failures* as the sixteenth-ranked item, however, it was mentioned as a significant delay factor in the case study.

Lastly, delay in *land acquisition/Right-of-Way issues* was among the top ten delay factors identified by the survey, but it was not even mentioned in the case study.

These differences may reflect project-specific conditions or differing stakeholder perceptions across the broader program versus the individual project level.

#### **4.3.4. *Synthesis and Summary***

This study integrates quantitative and qualitative findings to give a complete and balanced understanding of the causes of construction delay in the Finna Oromia Dam Initiative, specifically in phase 1 projects. While the survey offered a broad perspective by ranking and identifying delay factors in 24 projects, the case study offered a micro-level perspective with project-specific explanations and insights from the Finna Keta Dibe Dam project.

Both methods consistently supported key areas of convergence, namely unrealistic time and cost estimations, design modifications, price escalations, and unfavorable weather conditions. The qualitative findings then further elaborated on the broader survey categories by illustrating how technical and administrative problems hampered project progress in practical terms.

Divergences, such as those pertaining to political instability, contractor capacity, rework, and Right-of-Way issues, underscore the need to contextualize findings rather than generalize them.

Overall, the integrated interpretation provides validity for the study's conclusions by confirming that the delays in phase 1 of the Finna Oromia Initiative are a product of a complex set of initial project planning, design, financial, and administrative issues. The conclusions and recommendations in Chapter 5 are based on these findings.

#### **4.4. Discussion of Overall Findings in Relation to Literature**

This section provides a detailed discussion of the findings of the study by combining the results from the quantitative survey of Phase 1 dam projects with the qualitative case study of the Finna Oromia Keta Dibe Dam Project. The results are discussed in relation to the body of knowledge reviewed in Chapter 2, specifically concerning factors that are directly aligned with the results of this research.

##### **4.4.1. Overview of Key Findings**

As per the findings of the survey, the three most critical factors causing construction delays were: *unrealistic initial time and cost estimations, contractor's inadequate experience and capacity, and price escalations and lack of timely adjustments. these were followed by design modifications, contractor's lack of commitment, and political instability/security issues.*

In the meantime, the triangulated analysis of the case study on the Finna Keta Dibe Dam revealed that Design Modifications (especially those resulting from unexpected geotechnical conditions and insufficient early investigations) were the principal causes of delay. Factors related to initial estimations (in terms of time and cost), price escalations, and technical decision-making delays were among supporting factors.

These findings suggest that delays in the Finna Oromia Phase 1 projects were largely caused by deficiencies in project planning (including feasibility study and design), contractor performance, financial risks, and adaptive project management issues.

##### **4.4.2. Comparison with Global Studies**

The findings of this study regarding *unrealistic initial time and cost estimations* is consistent with international research findings that emphasize the under-estimation of project risks and complexities at early planning stages. It echoes the work of Flyvbjerg (2008) who assert that optimism bias and strategic misrepresentation are common causes of underestimation of costs and schedules in large-scale infrastructure projects. As Ansar *et al.* (2014) also conclude, dam projects around the world have consistently experienced time and cost overruns because of initial scope understatements. Similar conclusions were drawn from the study of water infrastructure projects

in Peru (Julca-Varas *et al.*, 2025), where poor risk assessments during early stages and overly optimistic cost/time projections were identified as primary drivers of project delays.

The fact that Contractor's Inadequate Experience and Limited Capacity ranks as second in causing project delays is consistent with the findings of Haviz (2021), who found that, in the small dam projects in Pakistan, insufficient contractor experience in specialized infrastructure projects led to time and quality issues. The study also aligns with Alamri *et al.* (2017) who found that inadequate technical qualifications (i.e., particularly in complex construction environments) are key predictors of schedule slippage. This finding is further supported by other studies by Kikwasi (2013) from Tanzanian construction projects and those from water infrastructure projects in Peru (Julca-Varas *et al.*, 2025). These studies highlighted that contractor incompetence is one of the major causes of delay in developing countries.

The impact of price escalations and lack of timely adjustments, identified as a major delay factor in this study, is consistent with the conclusions of Frimpong *et al.* (2003) and Doloji *et al.* (2012), who highlighted that market fluctuations and uncontrolled inflation significantly disrupt project scheduling in developing economies.

The emphasis on design modifications as a critical cause of delay in the case study is supported by numerous studies. For example, unforeseen technical site conditions and subsequent design changes have been identified as recurrent causes of project construction delay globally (Scudder, 2005; World Commission on Dams, 2000). This also aligns well with Julca-Varas *et al.*'s (2025) finding that geotechnical conditions and inaccurate site information are among the most common primary delay factors identified, consistent with global observations that technical uncertainties significantly contribute to delays.

However, unlike global experiences, where public opposition and environmental activism are often mentioned (World Commission on Dams, 2000; Tilt, 2015; Wheeler *et al.*, 2016), the Finna Oromia projects did not exhibit much public opposition. These issues are prevalent globally, especially in large dam projects, and even in the Peruvian water and sanitation projects (Julca-Varas *et al.*, 2025) had experienced little social opposition. They played a limited role in Phase 1 of the Finna Oromia projects. This difference may reflect the smaller scale of these projects or effective community engagement, or highlight the context-specific nature of delay factors.

#### **4.4.3. Comparison with Ethiopian Context Studies**

The findings of this study are also aligned with previous research on the causes of project delays in Ethiopian construction.

The top-ranked factor of unrealistic initial estimations in this research closely parallels the findings of Temesgen & Denamo (2020), who cited unrealistic contract durations, improper planning and scheduling as well as poor feasibility studies in their study on mega sugar project delays in Ethiopia.

Similarly, the challenges related to the contractor's performance encountered in this study are similar to those reported by Werku & K.N. (2016) and Solomon *et al.* (2021), where they pointed out that the inadequate technical and managerial capacity of contractors (especially in the public infrastructure projects) contributed greatly to the delay.

The findings of the case study part of this research are consistent with those of Alemayehu (2021) in the case of Tendaho Dam and Alwoye (2018) in the case of Megech Dam, where incomplete early investigations and differing site conditions led to costly repeated design revisions.

Furthermore, the administrative challenges observed in the Finna Keta Dibe Dam Project, including delayed technical approvals, weak contractual responsiveness, and slow procurement decisions, are in line with the systemic inefficiencies documented by Abadir (2011) and Temesgen & Denamo (2020) in Ethiopian infrastructure projects.

In contrast, external factors such as community opposition, which are typically highlighted in large dam projects like the Grand Ethiopian Renaissance Dam [GERD] (Wheeler *et al.*, 2016), were not dominant delay factors in Phase 1 of the Finna Oromia projects, suggesting a context-specific nature of delay factors.

#### **4.5. Proposed Mitigation Strategies**

In line with the third specific objective, this study proposes practical mitigation strategies based on the findings of both the quantitative survey and the qualitative case study. The table below outlines each major delay factor identified, along with targeted mitigation strategies tailored to address the root causes. These strategies are informed by the existing literature for practical application.

*Table 16: Proposed Mitigation Strategies for the Critical Causes of Delay*

<b>Identified delay factor</b>	<b>Proposed mitigation strategy</b>	<b>Supporting Literature</b>
Unrealistic initial time and cost estimations	Develop detailed project scopes and profiles using project size, complexity, and resource requirements (in-depth feasibility study)	Flyvbjerg <i>et al.</i> (2008)
	Apply structured Work Breakdown Structure (WBS) and Activity-Based Costing (ABC) models that reflect productivity norms and resource realities	Project Management Institute (2021)
	Involve experienced estimators and technical reviewers to validate budget and schedule assumptions	Frimpong <i>et al.</i> (2003); Olawale & Sun (2010)
	Use past project performance data to adjust and improve planning accuracy	Plummer Braeckman & Guthrie (2016)
Contractor's inadequate experience and limited capacity	Use multi-criteria contractor evaluation frameworks emphasizing past experience, technical capability, and financial stability	Doloi (2009)
	Encourage joint ventures with more experienced firms to close capacity gaps	Haviz (2021)
	Facilitate continuous professional development through workshops and training	Temesgen & Denamo (2020)
	Conduct periodic performance monitoring to promote accountability	Suhas Nalamwar & Pruthviraj Waghmare (2024)
Price escalation and lack of timely adjustments	Include escalation clauses in contracts, tied to inflation and construction material indices	Aibinu & Jagboro (2002); Assaf & Al-Hejji (2006)
	Allocate contingency budgets for absorbing market disruptions	Doloi <i>et al.</i> (2012)
	Update project budgets regularly and include time-cost buffers in risk registers	Project Management Institute (2021)
Design changes/modifications	Conduct comprehensive early-stage investigations, including site and subsurface assessments	Liu & Walker (1998); World Commission on Dams (2000)

<b>Identified delay factor</b>	<b>Proposed mitigation strategy</b>	<b>Supporting Literature</b>
	Establish mandatory design review panels and validation processes prior to contract award	Frimpong <i>et al.</i> (2003)
	Implement change management systems with justification protocols, approval workflows, and deadlines	Kirubel (2021)
	Ensure availability of local construction materials to avoid mid-project design changes	Solomon <i>et al.</i> (2021)
Poor contractor commitment	Link payments to milestone achievements and enforce penalties for non-compliance	Doloi <i>et al.</i> (2012)
	Limit overcommitment by discouraging contractors from taking on multiple projects simultaneously	Frimpong <i>et al.</i> (2003); Project Management Institute (2021)
	Improve internal planning systems through regular progress reviews and corrective action tracking	Plummer Braeckman & Guthrie (2016)
Political instability/ security issues	Conduct project-specific political risk assessments during feasibility	Ansar <i>et al.</i> (2014)
	Form joint coordination teams with local security forces to monitor risks and respond to incidents	Wheeler <i>et al.</i> (2016)
	Develop site-specific contingency plans for project continuity in unstable regions	Plummer Braeckman & Guthrie (2016)
Late mobilization (delivery) of materials/equipment	develop detailed pre-construction mobilization schedules and strictly monitor milestones linked to progress	Assaf & Al-Hejji (2006); Chan & Kumaraswamy (1996)
	Include early procurement tasks in WBS and logistics plans	Walker (2015)
	Develop strong procurement strategies and well-managed logistics	Carter & Liane Easton (2011); Walker (2015)
Shortage of materials/ equipment	Strengthen procurement strategies and use local supplier networks where feasible	Carter & Liane Easton (2011); Werku & K.N. (2016)

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*

<b>Identified delay factor</b>	<b>Proposed mitigation strategy</b>	<b>Supporting Literature</b>
	Maintain buffer stocks for critical materials and adopt multi-sourcing to reduce risk	Doloi <i>et al.</i> (2012); Frimpong <i>et al.</i> (2003)
	Implemented multi-sourcing strategies as a risk management approach for supply disruptions	Frimpong <i>et al.</i> (2003)
Unfavorable weather conditions	Provide seasonal climate forecasting to aid contractor scheduling of weather-sensitive activities	Gebremedhin <i>et al.</i> (2016); World Bank (2017)
	Schedule critical works during drier seasons based on historical climate data	Sambasivan & Soon (2007)
	Integrate weather risk buffers into construction schedules and contractual timelines	
Delays in land acquisition/Right-of-Way issues	Begin land clearance and compensation processes before tendering	Branche (2017); Ghenbasha <i>et al.</i> (2016)
	Engage community leaders early to build trust and reduce resistance	Plummer Braeckman & Guthrie (2016)
	Establish grievance redress mechanisms in collaboration with local administration	Scudder (2005)
	Ensure RoW issues are resolved prior to site mobilization	Wang <i>et al.</i> (2014)
weak institutional responses to technical changes and emergent risks	Develop a learning repository of delay cases and mitigation strategies from Phase 1 to institutionalize knowledge and guide future interventions	(Frimpong <i>et al.</i> , 2003; Gebremedhin <i>et al.</i> , 2016)
	Train all parties (client, contractor, consultant) on adaptive project delivery under uncertainty	

## **5. CONCLUSION AND RECOMMENDATIONS**

This chapter presents the key findings of the study and links them to the initial research objectives and questions. It summarizes the main reasons behind project delays in Phase 1 of the Finna Oromia Initiative based on the quantitative survey and case study analyses. The chapter also provides practical, stakeholder-specific recommendations, which, if implemented, will ensure the timely delivery of projects in subsequent phases and other similar projects implemented in Ethiopia. It concludes by suggesting areas for further research informed by the limitations of the study.

### **5.1. Conclusion**

This study aimed to investigate the causes of construction delays in small- and medium-scale multipurpose storage dam projects under Phase 1 of the Finna Oromia Initiative. It also sought to explore project-specific delay factors and propose practical mitigation strategies. The research employed a sequential mixed-methods design where quantitative data were collected from a survey of 24 projects and qualitative data were collected using a detailed case study of the Finna Oromia Keta Dibe Dam project.

In response to research question 1, the quantitative survey used a closed-ended questionnaire to identify the main delay factors across all the study projects based on the perceptions of key stakeholders (contractor, consultant, and client groups). The integration of stakeholder perspectives allowed for a holistic understanding of the problem. Consequently, the top five factors identified are:

- 1) Unrealistic initial time and cost estimations
- 2) Contractor's inadequate experience and limited capacity
- 3) Price escalations compounded by lack of timely adjustments
- 4) Design modifications/changes
- 5) Contractor's lack of commitment.

Other highly ranked factors included political instability/security issues, late mobilization of resources, shortage of resources, unfavorable weather conditions, and delays in land acquisition/Right-of-Way Issues.

Regarding research question 2, the case study of Finna Keta Dibe Dam was used to deepen the survey findings and explore the mechanisms (why and how) of the main delay factors. As design modification was found to be the most significant delay factor in this case, in-depth investigation revealed that this was initiated by issues such as firm foundation depth which deviated from the initial assumptions, dam type change because of differing site conditions, arguments on foundation treatment methodologies, spillway design modifications, and instrumentation installation approaches. This qualitative part also identified how and why additional factors such as poor initial estimations, unfavorable weather conditions, reworks caused by construction failures due to flooding, and administrative bottlenecks (decision-making processes), as well as weaknesses in contractual responsiveness, impacted the progress of the Finna Keta Dibe Dam.

The findings from both datasets confirm that construction delays are not caused by isolated factors, but rather by the interaction of technical, managerial, financial, logistical, and external factors. This is in line with the findings from previous studies in infrastructure projects, both globally (World Commission on Dams, 2000; Frimpong *et al.*, 2003; Scudder, 2005; Flyvbjerg, 2008; Dolo *et al.*, 2012; G. Kikwasi, 2013; Ansar *et al.*, 2014; Wheeler *et al.*, 2016; Alamri *et al.*, 2017) and in Ethiopia (Werku & K.N., 2016; Alwoye, 2018; Temesgen & Denamo, 2020; Solomon *et al.*, 2021; Alemayehu, 2021; Abadir, 2011).

In response to these findings and to answer the third research question, the study developed a comprehensive set of mitigation strategies. These strategies are synthesized in Chapter 4 (Section 4.5) and operationalized in the recommendations presented in the following section.

## **5.2. Recommendations**

Building on section 4.5, this section provides stakeholder-specific and actionable recommendations that directly address the most critical delay factors identified through the survey and case study. The focus on the stakeholders takes into consideration the different roles they exercise, as in the case of this typical Initiative. The purpose of these recommendations is to enhance the planning, execution, and resilience of the ongoing and future dam projects under the Finna Oromia Initiative and other similar programs.

### **5.2.1. For the Client**

#### **Improve Planning Accuracy and Early Estimations**

To address the critical delay factor of unrealistic initial time and cost estimates, the Client should:

- ✓ Develop comprehensive project scopes and profiles to create accurate estimates that represent project dimensions (including project size and complexity) and resource requirements, rather than merely relying on assumptions.
- ✓ Ensure experienced estimators participate in the planning process to produce realistic budgets and timelines.
- ✓ Obtain the project duration and cost estimates through a detailed Work Breakdown Structure (WBS) and Activity-Based-Costing (ABC) models, which consider realistic productivity levels and resource availability, along with potential challenges.
- ✓ Have multidisciplinary experts review schedules and budgets against technical requirements independently before contract awards take place.
- ✓ Apply lessons learned from previous similar projects to refine the initial forecasts in future projects.

#### **Implement Price Adjustment and Contingency Frameworks**

Given that price escalations and a lack of timely adjustment were significant delay factors, the Client should:

- ✓ Adopt dynamic pricing mechanisms and conservative estimation practices (based on inflation and input price indices) to account for market uncertainties.
- ✓ Ensure project managers implement budgetary contingencies to help projects effectively absorb market disruptions.
- ✓ Regularly update the project budget, proactively identifying risks and allocating necessary time and cost buffers.

#### **Improve Contractor Selection Process and Strengthen Their Capacity**

Addressing the issue of contractor's inadequate experience and limited capacity, the Client should:

- ✓ Select contractors through a multi-criteria evaluation approach, focusing more on their previous work experiences, technical capability, and financial stability.

- ✓ Facilitate capacity-building and continuous training for contractors.
- ✓ Encourage joint ventures between contractors and experienced firms to enhance overall expertise.
- ✓ Regularly assess contractor performance to maintain high accountability standards.

### **Proactive Land Acquisition and Stakeholder Engagement**

To mitigate land acquisition delays (Right-of-Way issues), the Client should:

- ✓ Initiate compensation and land clearance processes before tendering.
- ✓ Establish grievance redress mechanisms in collaboration with local administrations.
- ✓ Ensure the land acquisition process is completed ahead of contractor mobilization to avoid potential delays and disputes.
- ✓ Strengthen engagement with affected communities and local authorities.

#### **5.2.2. For Contractors**

### **Improve Resource Mobilization and Supply Chain Management**

Given that late mobilization of materials/equipment and shortage of materials/equipment were the top delay factors, contractors should:

- ✓ Implement robust mobilization and supply chain management systems. This includes developing and strictly adhering to detailed pre-construction mobilization schedules with clear monitoring milestones.
- ✓ Develop strong procurement strategies and well-managed logistics to ensure the timely delivery of materials to the project site and prevent supply chain disruptions.
- ✓ For remote sites, establish reliable supplier networks to minimize transport requirements from distant locations and maintain buffer stocks of critical materials.
- ✓ Ensure the project WBS includes detailed logistics plans with early procurement schedules.
- ✓ Implement multi-sourcing strategies as a risk management approach for supply disruptions.
- ✓ Maintain minimum critical material stock levels and utilize flexible procurement frameworks.

### **Improve Work Planning and Commitment**

The project team should develop detailed work plans while improving performance levels and commitment through:

- ✓ Incorporating milestone-based payment incentives and contractual penalties to promote adherence to timelines and quality.
- ✓ Limiting the number of concurrent projects to ensure adequate attention and resources for each project.
- ✓ Actively participating in regular performance evaluations to foster accountability.

### **5.2.3. For the Consultant**

#### **Ensure Design Integrity and Change Control**

To avoid or minimize design modifications/changes, which were ranked highly as a delay factor, the Consultant should:

- ✓ Conduct comprehensive early-stage site investigations to provide realistic and feasible designs.
- ✓ Perform extensive geological assessments before construction to prevent unforeseen subsurface issues.
- ✓ Proactively identify potential risks during the preconstruction phase to anticipate changes and develop mitigation strategies.
- ✓ Execute preconstruction design reviews and field validations, especially in challenging terrain.
- ✓ Validate designs, schedules, and budgets by establishing independent technical review panels before contract award.
- ✓ Verify the availability of local materials to prevent mid-project design changes.
- ✓ Implement change management systems that require full justification for design changes.
- ✓ Establish formal protocols for design revision requests, including documentation, approval timelines, and communication flowcharts.

### **5.2.4. For Regional and Local Authorities**

#### **Facilitate Weather-Responsive Scheduling**

To mitigate weather-related issues (such as rainfall disruptions), authorities should:

- ✓ Provide seasonal climate forecasting to aid contractor scheduling of weather-sensitive activities.
- ✓ Schedule critical works during drier seasons based on historical climate data.
- ✓ Integrate weather risk buffers into construction schedules and contractual timelines.

### **Ensure Project Security and Public Safety**

- ✓ Establish joint coordination teams between security agencies and project teams for monitoring and rapid response.
- ✓ Integrate political and security risk assessments into feasibility studies, especially in historically unstable regions.
- ✓ Develop project contingency plans to manage security disruptions and protect assets and personnel.

#### **5.2.5. Multi-Stakeholder Recommendations**

### **Institutionalize Project Data and Knowledge Sharing**

To ensure lessons from Phase 1 projects are captured and inform future implementation:

- ✓ Systematically reuse and refine geotechnical, material, and design data from Phase 1 for future projects.

### **Develop Integrated Risk Management Protocols**

Addressing weak institutional responses to technical changes and emergent risks, all stakeholders should:

- ✓ Develop a learning repository of delay cases and mitigation strategies from Phase 1 to institutionalize knowledge and guide future interventions.
- ✓ Formalize risk registers and mitigation plans as a standard part of project startup.
- ✓ Train all parties (client, contractor, consultant) on adaptive project delivery under uncertainty.

### **5.3. Areas for Future Research**

To build upon the limitations of this study, the following areas are recommended for future research:

1. Comparative multi-project case studies should be conducted across different clusters, dam sizes, and stakeholders to understand how delay factors differ between different settings.
2. Longitudinal studies that track the implementation of mitigation strategies in subsequent phases of the Finna Oromia Initiative would be valuable in assessing whether the lessons learned from Phase 1 are applied effectively.
3. Quantitative risk assessment models, such as Monte Carlo simulation or decision tree analysis, can be developed to evaluate the probability and impact of specific delay drivers under uncertainty, thereby aiding predictive planning and contingency budgeting.
4. Future studies should incorporate quantitative modeling techniques to assess the proportional contribution of each delay factor to project time and cost overruns. This would enable prioritization of mitigation efforts based on measurable impact.
5. Post-construction Effectiveness Studies should assess whether the implemented dam projects fulfill their targeted benefits (irrigation, water supply, economic development, etc.).

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## Appendices

### Appendix A: Prevalence of Delays in Phase 1 of the Finna Oromia Initiative

Cluster	Project Name	Physical Plan (%)	Physical Progress (%)	Machinery Mobilization (%)	Extent of Delay (%)
<b>CLUSTER-2</b>	Finna Becho	84.79	33.83	9.5	60.10
	Finna Keta Dibe	94.31	35.88	102.38	61.96
	Finna Kalle	99.33	64.03	61.9	35.54
	Finna Mekala	97.85	68.4	102.38	30.10
	Finna Uru Gimbichu	99.32	31	19.04	68.79
	Finna Semira Kolba	100	22.84	35.71	77.16
	Finna Goider	43.39	14.12	38.09	67.46
	Finna Warga	59.33	10.1	9.52	82.98
	Finna Chiticha Kuntufa	71.78	11.07	2.38	84.58
	Finna Dhofa	62.8	19.45	59.5	69.03
<b>CLUSTER-3</b>	Finna Ija lencha	100	57.14	92.85	42.86
	Finna Kufa Bobasa	99.28	46.79	85.71	52.87
	Finna Hayyu Kenteri	99.37	42.35	73.8	57.38
	Finna Goda Chale	79.6	65.3	176.2	17.96
	Finna Anuba	99.37	49.32	119	50.37
	Finna Hiriye	47.095	9.91	14.28	78.96
	Finna Doroba	58.59	18.23	26.19	68.89
<b>CLUSTER-4</b>	Finna Hiddi Romso	99.35	53.74	52.38	45.91
	Finna Burkuke	98.22	73.72	66.66	24.94
	Finna Worbate	100	48.13	52.38	51.87
	Finna Liso	77.19	29.34	28.57	61.99
	Finna Fula Bura	96.63	54.38	97.19	43.72
	Finna Kersa Yai	98.03	50.33	40.47	48.66
	Finna Bokossa	98.28	80.04	59.52	18.56
	Finna Qoa Dhamota	99.22	43.63	59.52	56.03
	Finna Haya Guracha	93.15	48.52	92.8	47.91
	Finna Jigessa	90.71	22.45	78.57	75.25
	Finna Kundhi	47.99	17.34	83.33	63.87
	Finna Kukuba	51.87	11.94	45.23	76.98
	Fula Dukanoftu	25.27	23.36	30.95	7.56
	Finna Biressa	24.32	36.55	111.9	-50.29
	Finna Dibe Adama	6.66	3.97	21.4	40.39
Finna Keta Arba Boru	6.8	2.57	26.19	62.21	
<b>Average</b>		<b>76.06</b>	<b>36.36</b>	<b>59.86</b>	<b>50.99</b>

## **Appendix B. Survey Questionnaire Used in the Quantitative Data Collection**



### ***Survey Questionnaire on Causes of Construction Delay in the Finna Oromia Dam Initiative***

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Dear respondent, I am doing research titled ‘***A STUDY OF CAUSES OF CONSTRUCTION DELAY IN MULTIPURPOSE STORAGE DAMS IN FINNA OROMIA INITIATIVE***’ as part of completing my MSc study in Construction Management (COMA). The research was initiated by a report by the Engineering Corporation of Oromia (ECO) that almost all dam projects in ***Phase 1*** of the Finna Oromia Initiative have been experiencing **delays (requiring more time than previously estimated)**. To identify the factors behind these delays, I am distributing this survey questionnaire among professionals who have been directly involved in the implementation of the initiative to supplement the data to be collected through other methods (case studies).

The questionnaire contains closed-ended questions, mostly with pre-defined options. An open-ended text box is also provided at the end, allowing for capturing valuable insights beyond these options. Overall, the questionnaire consists of two parts: background information and the respondent’s opinion about the causes of delay. The feedback from the pilot study revealed that filling out the questionnaire takes about 30 minutes.

Hence, you are kindly requested to provide your genuine opinions on the subject being studied by filling out the questionnaire. After filling out the questionnaire, please save it as a Word document and return it ***within a week via Telegram using the contact address provided below***. Dear respondent, filling this questionnaire is not your obligation, but if you would like to co-operate with the research voluntarily, you are very welcome! I would like to assure you that the information gathered will be kept strictly confidential and used for academic purposes only. Moreover, I promise to share with you the final research paper for your reference and evaluation of the whole work. Please do not hesitate to contact me in case you have any question!

Thank you in advance for your time and genuine responses!

**Gelana Kissi**

**Phone Number: +251910609793**

**E-mail: [gelanakissi@gmail.com](mailto:gelanakissi@gmail.com)**

**PART ONE: BACKGROUND INFORMATION**

Dear respondent, please fill in the following background information about you and your company.

- *The boxes are editable, and you can tick by simply clicking in the box in front of your choice.*

**I. RESPONDENT INFORMATION**

**1. On which side of the parties are you employed?**

Contractor  Client  Consultant

**2. What is your role in the company?**

Project Manager  Resident Engineer  Site Engineer  Cluster Coordinator

**3. Your specific experience in dam construction projects (in years):**

0 - 5  6 - 11  12 - 15  16 - 20  Above 20

**4. Your Highest Degree in Civil Engineering or Construction Management**

BSc  MSc  PhD  Other (Specify): \_\_\_\_\_

**5. Your Project Involvement:**

Design Phase Only  Construction Phase Only  Both Design and Construction Phases

**II. ORGANIZATION INFORMATION**

**1. Organization Type:**

Construction Company  Engineering Consultancy Firm  Government Agency  Other

**2. Overall experience (in years) of your company in construction in general:**

0 - 5       6 - 11       11 - 15       16 - 20       Above 20

**3. Previous involvement of your organization in the construction of dam projects:**

Yes       No

**PART TWO: IDENTIFICATION OF CAUSES OF DELAY IN FINNA OROMIA DAM PROJECTS**

**Question 1:** Dear respondent, some of the following causes of project delay have been reported from different project sites of the Finna Oromia Initiative at different times and compiled by the Engineering Corporation of Oromia (ECO), while most of them were collected from the literature.

Please rate the listed possible causes of delay on your project based on their level of contribution to project delay using a 5-point Likert Scale below by clicking in the box corresponding to the scale of your choice (☒)!

**Notes: -**

- *The questionnaire is project-based and, hence, you should consider only the project you have been involved in (just one dam project)!*
- Please do not tick more than one box for one delay factor (cause of delay)!

**Example:** If ‘*Unrealistic Initial Time and Cost Estimations (SPF1)*’ had no contribution at all in delaying your project, you tick the box corresponding to 1, and if it had very significantly contributed to the project delay, you tick the box corresponding to 5.

(1) Has no contribution      (2) Has very little Contribution      (3) Has some contribution

(4) Has significant contribution      (5) Has very significant contribution

Delay Group	No.	Delay Factor	Level of Contribution					
			1	2	3	4	5	

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*

<b>Study and Planning Factors</b>	1	Unrealistic Initial Time and Cost Estimations (SPF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	2	Wrong/Unsuitable Project Location (due to poor feasibility study) (SPF2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Design Factors</b>	3	Design Modifications/Changes (DF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	4	Client Initiated Scope and Design Changes (DF2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Material and Equipment Factors</b>	5	Shortage of Materials/Equipment (MEF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	6	Late Mobilization (Delivery) of Materials/Equipment (MEF2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	7	Equipment Breakdown and Maintenance Issues (MEF3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	8	Supply Chain Disruptions (MEF4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Labor Factors</b>	9	Labor Shortages (LF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	10	Low Crew Productivity (LF2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Financial Factors</b>	11	Delayed Payments from Client (FF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	12	Price Escalations and Lack of Timely Adjustments (FF2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Contractual Factors</b>	13	Contractual Disputes/Ambiguities (CF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Factors Related to Contractor's Competency</b>	14	Contractor's Lack of Commitment (CCF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	15	Contractor's Inadequate Experience and Limited Capacity (CCF2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Procurement and Logistics Factors</b>	16	Bureaucracies in Tendering/Procurement Processes (PLF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*

	17	Poor Site Access/Logistical Challenges (PLF2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Land and Regulatory Factors</b>	18	Delays in Land Acquisition/Right-of-Way Issues (LRF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	19	Public Opposition to Project (LRF2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Project Management Factors</b>	20	Inefficient Project Planning/Scheduling (PMF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	21	Lack of Effective Monitoring/Control (PMF2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	22	Communication/Coordination Problems (PMF3)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	23	Inadequate Risk Planning and Management (PMF4)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	24	Rework due to Construction Errors/Failures (PMF5)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>External and Environmental Factors</b>	25	Unfavorable Weather Conditions (EEF1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	26	Political Instability/Social Unrest (EEF2)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## **Appendix C. A Semi-structured Interview Guide Used for the Case Study**



### ***An Interview Guide for Understanding the Causes of Construction Delay in the Finna Oromia Keta Dibe Dam Project***

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Thank you for taking the time to participate in this interview! The interview is part of a sequential explanatory research design, intended to gain in-depth insights into the causes of delays in the Finna Oromia Keta Dibe Dam Project, their impacts, and potential mitigation strategies. It integrates key delay factors identified in the survey across the 24 projects under Phase 1 of the Finna Oromia Dam Initiative, while focusing on the specific conditions of the Finna Keta Dibe Dam Project. Your responses are kept strictly confidential and used solely for research purposes.

#### **Section 1: General Information**

- Can you introduce your role in the Finna Oromia Keta Dibe Dam Project?
- How long have you been involved in the construction of Finna Keta Dibe Dam Project?
- What aspects of the project (design, execution, supervision, etc.) are under your direct responsibility?
- What is the current status of the project and how is it progressing in comparison to the original schedule?

#### **Section 2: Explanation of Survey-Identified Delay Factors**

The following topics are based on the top ten delay factors identified in the survey phase. These questions aim to explore why and how these factors contributed to delay in the selected case project.

##### **2.1. Unrealistic Initial Time and Cost Estimations**

- Do you think the original schedule or cost estimates were realistic in this project? If not, can you explain why they were not realistic?
- How did these early planning inaccuracies (if any) affect later stages of implementation?

##### **2.2. Contractor's Inadequate Experience and Capacity**

- How was the contractor to execute this project selected?

- How would you evaluate the contractor's performance (in terms of capacity and experience with similar projects)?
- If the contractor's capacity and previous experience is not adequate, why do you think these gaps emerged, and how did they impact project progress?

### **2.3. Market Fluctuations and Delayed Price Adjustments**

- Did market fluctuations or economic instability (e.g., inflation) affect the project? How?
- Were payments from the Client made on time? If no, how did this affect the contractor's ability to continue work?
- Were financial adjustments or cost revisions required during implementation? If yes, please explain how this issues impacted the project progress.

### **2.4. Design Modifications/Changes**

- Were there any major design changes during the project? If yes, why were they needed?
- How did these modifications affect the schedule, cost, or sequencing of work?

### **2.5. Contractor's Lack of Commitment**

- Did you observe any delays due to the contractor's lack of commitment or inefficiencies? How?
- How did this affect team coordination, planning, or response to problems?

### **2.6. Political Instability or Security Issues**

- Did security issues as well as political, regulatory, or policy changes impact project progress?
- How did they influence work continuity, and how were such events managed?

### **2.7. Late Mobilization of Materials/Equipment**

- Where there any delays (challenges) related to resource mobilization? If yes, why were these resources (materials or equipment) mobilized later than planned?
- What effect did this have on critical tasks, resource planning and overall project progress?

### **2.8. Shortage of Materials/Equipment**

- Did the project experience shortages in materials, equipment, or workforce? If yes, what caused these shortages and how did they affect the project?
- How did these shortages contribute to delays, and how were they managed?

### **2.9. Unfavorable Weather Conditions**

- How did weather conditions affect construction work at different stages (if any)?
- Was there any mitigation plan? If so, how effective was it?

### **2.10. Delays in Land Acquisition or Right-of-Way Issues**

- Were there any land acquisition issues or community resistance during project execution? If yes, why?
- How did these affect the project and how did you handle them?

### **SECTION 3: Exploration of Emergent or Context-Specific Delay Factors**

This section is designed to give space for issues not captured in the survey, and for participants to introduce project-specific or contextual factors that may have caused delays.

- Besides the issues we've discussed, were there any other significant factors that delayed this project?
- Did you encounter coordination problems among the client, contractor, consultant, or other actors?
- Were there institutional or administrative delays, such as slow decision-making or bureaucratic bottlenecks?
- Were there any local challenges (e.g., labor availability, community engagement, terrain/access) that impacted implementation?
- How did these additional factors combine or interact with the known ones?

### **SECTION 4: Closing Reflections**

- Is there anything important we haven't covered that you think should be included in this study?
- Do you have any final comments, suggestions, or reflections on the causes of delay or project delivery?
- Would you be open to a follow-up discussion if needed?
- Thank you for your time and responses!

**END OF THE INTERVIEW!**

**Appendix D. Perceptions of Contractors on Causes of Delay**

<b>Descriptive Statistics (Contractor Side)</b>			
<b>Delay Factor</b>	<b>N</b>	<b>Mean Score</b>	<b>Std. Deviation</b>
1. Unrealistic Initial Time and Cost Estimations (SPF1)	37	4.73	0.450
2. Wrong/Unsuitable Project Location (due to poor	37	1.81	1.101
3. Design Modifications/Changes (DF1)	37	4.22	1.228
4. Client Initiated Scope and Design Changes (DF2)	37	1.54	0.900
5. Shortage of Materials/Equipment (MEF1)	37	3.70	0.812
6. Late Mobilization (Delivery) of Materials/Equipment	37	3.35	1.338
7. Equipment Breakdown and Maintenance Issues (MEF3)	37	2.49	0.989
8. Supply Chain Disruptions (MEF4)	37	2.57	1.191
9. Labor Shortages (LF1)	37	1.62	0.861
10. Low Crew Productivity (LF2)	37	2.30	1.266
11. Delayed Payments from Client (FF1)	37	3.14	0.713
12. Price Escalations and Lack of Timely Adjustments (FF2)	37	4.62	0.492
13. Contractual Disputes/Ambiguities (CF1)	37	1.65	1.207
14. Contractor’s Lack of Commitment (CCF1)	37	3.68	0.530
15. Contractor’s Inadequate Experience and Limited Capacity	37	3.68	0.530
16. Bureaucracies in Tendering/Procurement Processes	37	1.97	1.013
17. Poor Site Access/Logistical Challenges (PLF2)	37	1.73	0.902
18. Delays in Land Acquisition/Right-of-Way Issues (LRF1)	37	2.81	1.697
19. Public Opposition to Project (LRF2)	37	2.24	1.011
20. Inefficient Project Planning/Scheduling (PMF1)	37	1.92	1.010
21. Lack of Effective Monitoring/Control (PMF2)	37	2.27	1.045
22. Communication/Coordination Problems (PMF3)	37	1.78	0.787
23. Inadequate Risk Planning and Management (PMF4)	37	2.16	0.727
24. Rework due to Construction Errors/Failures (PMF5)	37	2.14	0.673
25. Unfavorable Weather Conditions (EEF1)	37	3.30	0.878
26. Political Instability/Security Issues (EEF2).	37	3.73	1.018

**Appendix E. Perception of Consultant on Causes of Delay**

<b>Descriptive Statistics (Consultant Side)</b>			
<b>Delay Factor</b>	<b>N</b>	<b>Mean Score</b>	<b>Std. Deviation</b>
Unrealistic Initial Time and Cost Estimations (SPF1)	22	4.09	1.109
Wrong/Unsuitable Project Location (due to poor feasibility)	22	1.50	0.598
Design Modifications/Changes (DF1)	22	3.55	1.405
Client Initiated Scope and Design Changes (DF2)	22	1.86	1.037
Shortage of Materials/Equipment (MEF1)	22	4.05	0.575
Late Mobilization (Delivery) of Materials/Equipment (MEF2)	22	3.82	0.958
Equipment Breakdown and Maintenance Issues (MEF3)	22	2.36	1.002
Supply Chain Disruptions (MEF4)	22	2.59	1.593
Labor Shortages (LF1)	22	3.14	1.082
Low Crew Productivity (LF2)	22	2.86	1.207
Delayed Payments from Client (FF1)	22	1.86	1.037
Price Escalations and Lack of Timely Adjustments (FF2)	22	4.36	1.049
Contractual Disputes/Ambiguities (CF1)	22	2.18	0.853
Contractor's Lack of Commitment (CCF1)	22	3.73	1.279
Contractor's Inadequate Experience and Limited Capacity	22	4.77	0.429
Bureaucracies in Tendering/Procurement Processes (PLF1)	22	2.95	1.174
Poor Site Access/Logistical Challenges (PLF2)	22	1.82	0.958
Delays in Land Acquisition/Right-of-Way Issues (LRF1)	22	2.50	1.263
Public Opposition to Project (LRF2)	22	2.32	0.780
Inefficient Project Planning/Scheduling (PMF1)	22	3.23	0.685
Lack of Effective Monitoring/Control (PMF2)	22	3.18	0.795
Communication/Coordination Problems (PMF3)	22	3.00	0.926
Inadequate Risk Planning and Management (PMF4)	22	3.36	1.217
Rework due to Construction Errors/Failures (PMF5)	22	2.68	1.249
Unfavorable Weather Conditions (EEF1)	22	3.23	1.232
Political Instability/Security Issues (EEF2).	22	3.41	1.297

**Appendix F. Perception of Client on Causes of Delay**

<b>Descriptive Statistics (Client Side)</b>			
<b>Delay Factor</b>	<b>N</b>	<b>Mean Score</b>	<b>Std. Deviation</b>
1. Unrealistic Initial Time and Cost Estimations (SPF1)	6	4.67	0.516
2. Wrong/Unsuitable Project Location (due to poor feasibility)	6	1.33	0.516
3. Design Modifications/Changes (DF1)	6	4.00	0.000
4. Client Initiated Scope and Design Changes (DF2)	6	1.00	0.000
5. Shortage of Materials/Equipment (MEF1)	6	3.50	0.548
6. Late Mobilization (Delivery) of Materials/Equipment	6	4.33	0.516
7. Equipment Breakdown and Maintenance Issues (MEF3)	6	3.00	0.632
8. Supply Chain Disruptions (MEF4)	6	3.67	0.816
9. Labor Shortages (LF1)	6	3.00	0.632
10. Low Crew Productivity (LF2)	6	3.50	0.548
11. Delayed Payments from Client (FF1)	6	2.33	0.516
12. Price Escalations and Lack of Timely Adjustments (FF2)	6	4.17	0.408
13. Contractual Disputes/Ambiguities (CF1)	6	1.67	0.516
14. Contractor’s Lack of Commitment (CCF1)	6	4.33	0.516
15. Contractor’s Inadequate Experience and Limited Capacity	6	4.83	0.408
16. Bureaucracies in Tendering/Procurement Processes (PLF1)	6	3.17	0.408
17. Poor Site Access/Logistical Challenges (PLF2)	6	1.50	0.548
18. Delays in Land Acquisition/Right-of-Way Issues (LRF1)	6	4.00	0.632
19. Public Opposition to Project (LRF2)	6	2.00	0.632
20. Inefficient Project Planning/Scheduling (PMF1)	6	3.83	0.408
21. Lack of Effective Monitoring/Control (PMF2)	6	3.67	0.516
22. Communication/Coordination Problems (PMF3)	6	3.17	0.753
23. Inadequate Risk Planning and Management (PMF4)	6	3.67	0.516
24. Rework due to Construction Errors/Failures (PMF5)	6	3.00	0.632
25. Unfavorable Weather Conditions (EEF1)	6	3.33	0.816
26. Political Instability/Security Issues (EEF2).	6	4.50	0.548

**Appendix G. Overall Ranking of Causes of Delay**

Delay Factor	Mean Score				Rank
	<i>Client</i>	<i>Consultant</i>	<i>Contractor</i>	<i>Weighted</i>	
Unrealistic Initial Time and Cost Estimations (SPF1)	4.67	4.09	4.73	4.49	1
Contractor’s Inadequate Experience and Limited Capacity (CCF2)	4.83	4.77	3.68	4.42	2
Price Escalations and Lack of Timely Adjustments (FF2)	4.17	4.36	4.62	4.38	3
Design Modifications/Changes (DF1)	4.00	3.55	4.22	3.92	4
Contractor’s Lack of Commitment (CCF1)	4.33	3.73	3.68	3.91	5
Political Instability/Security Issues (EEF2).	4.50	3.41	3.73	3.88	6
Late Mobilization (Delivery) of Materials/Equipment (MEF2)	4.33	3.82	3.35	3.83	7
Shortage of Materials/Equipment (MEF1)	3.50	4.05	3.70	3.75	8
Unfavorable Weather Conditions (EEF1)	3.33	3.23	3.30	3.28	9
Delays in Land Acquisition/Right-of-Way Issues (LRF1)	4.00	2.50	2.81	3.10	10
Inadequate Risk Planning and Management (PMF4)	3.67	3.36	2.16	3.06	11
Lack of Effective Monitoring/Control (PMF2)	3.67	3.18	2.27	3.04	12
Inefficient Project Planning/Scheduling (PMF1)	3.83	3.23	1.92	2.99	13
Supply Chain Disruptions (MEF4)	3.67	2.59	2.57	2.94	14
Low Crew Productivity (LF2)	3.50	2.86	2.30	2.88	15

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*

Bureaucracies in Tendering/Procurement Processes (PLF1)	3.17	2.95	1.97	2.69	16
Communication/Coordination Problems (PMF3)	3.17	3.00	1.78	2.65	17
Equipment Breakdown and Maintenance Issues (MEF3)	3.00	2.36	2.49	2.61	18
Rework due to Construction Errors/Failures or Failures (PMF5)	3.00	2.68	2.14	2.60	16
Labor Shortages (LF1)	3.00	3.14	1.62	2.58	20
Delayed Payments from Client (FF1)	2.33	1.86	3.14	2.44	21
Public Opposition to Project (LRF2)	2.00	2.32	2.24	2.18	22
Contractual Disputes/Ambiguities (CF1)	1.67	2.18	1.65	1.83	23
Poor Site Access/Logistical Challenges (PLF2)	1.50	1.82	1.73	1.68	24
Wrong/Unsuitable Project Location (due to poor feasibility study) (SPF2)	1.33	1.50	1.81	1.55	25
Client Initiated Scope and Design Changes (DF2)	1.00	1.86	1.54	1.47	26

## Appendix H. Sample Notification Letter from Consultant to Contractor



**Korporeeshiinii Injiinariingii Oromiyaa**  
**የኦሮሚያ ኢንጅነሪንግ ኮርፖሬሽን**  
**Engineering Corporation of Oromia**

Document No.  
OF/ECO/GM/035

External Letter

Issue 1 No.1 Page No. Page 1 of 1

Lak.#ጥር/Ref. No. \_\_\_\_\_

Guyyaa /ቀን/Date-----

**Oromia Construction Corporation Keta Dibe Dam Project Office**

**Keta Dibe**

*Ref: - Finna Oromia Keta Dibe Dam Project*

Subject: - **Notification to Finalize the Remaining Activities**

Dear Sir/ Madam.

It is recalled that an agreement was made between your Company (Oromia Construction Corporation) and the client (Oromia Irrigation and Pastoralist Development Bureau) for the construction of **Finna Oromia Keta Dibe Dam Project** under Contract Administration and Construction Supervision of our Corporation (ECO) on **October, 2021**.

Reference has been made with our resident Engineer letter Ref No: **ECO/FKDPO/123/2016** dated on **03/12/2016** notification to proceed dam instrumentation.

However, still now it is not started. But, most of the project activities are completed. Except the following remaining works listed below:

- Dam instrumentation
- Movable crane and 50 KVA Generator supply and fix
- Spillway back fill not completed
- Exit channel next to impact basin boulder riprap placement
- As-built drawing, operation and maintenance manual

Accordingly, your esteemed corporation notify you to finalize the remaining activities contractually and hand over to our respected Client.

With Regards,

**C/C**

- Oromia Irrigation and Pastoralist Development Bureau
- Finna Oromia Dam Projects Cluster -2 Project manager

**Finfinne**

- Bale Cluster-2 Coordinator Office File

**Bale Robe**

ኮሌት /Lakk bilbila/ + 251-11- 439-21-62/2470  
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Website [www.ecoet.org](http://www.ecoet.org)

*Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative*

**Appendix I. Progress Report of Projects in Phase 1 of the Finna Oromia Initiative**

FINNA PROJECTS' PROGRESS UP TO OCTOBER 28, 2022GC										
Cluster	Project Name	Woreda	Zone	Contractor	Todate Physical Plan (%)	Todate Physical Progress (%)	Todate Financial Plan (%)	Todate Financial Progress (%)	Machinery Mobilisation (%)	Encountered problems
CLUSTER-2	Finnaa Becho	Gedebé Asasa	West Arsi	Gutema Firisa Construction	84.79	33.83	95.04	15.62	9.5	Right of Way issues on Quarry site of Sand, Poor contractor's Mobilisation
	Finnaa Keta Dibe	Sawena	East Bale	Oromia Construction Corporation	94.31	35.88	91.34	27.83	102.38	Bill No. 7 Missed from Category
	Finnaa Kalle	Delo Mena	Bale	Oromia Construction Corporation	99.33	64.03	95.24	67.68	61.9	Right of Way issues on Quarry site, Rainfall case and failing of material at laboratory tests, Unavailability of sand and aggregate from nearby areas
	Finnaa Mekala	Adaba	West Arsi	Oromia Construction Corporation	97.85	68.4	98.61	60.32	102.38	Raincase
	Finnaa Uru Gimbiachu	Sude	Arsi	Anwar seid Construction	99.32	31	88.75	15.03	19.04	Right of way problems on Clay quarry and waste areas, Poor mobilisation and Rainfall case disturbed works
	Finnaa Semira Kolba	Limu Bibilo	Arsi	Samket Engineering and Con. PLC	100	22.84	100	17.9	35.71	Right off way issues for production of sand filters F1 and Shortage of shell materials around the project site(massive rock) which need blasting
	Finnaa Goider	Ginnir	East Bale	Mulugeta Benti WWC	43.39	14.12	33.09	6.33	38.09	No encountered problems
	Finnaa Nuna Raba	Siraro	West Arsi	Walif Construction Sh.Co.		5.88		2.51	0.00	SITE IS OFF
	Finnaa Warga	Digelu Tijo	Arsi	East Horizon GC-1	59.33	10.1	57.98	10.1	9.52	Right of way problem and community totally demolished GPS marks and machinery is idle due to this ROW on project area
	Finnaa Chiticha Kuntufa	Kuntufa	West Arsi	Jaleta Dessalegn WWC-1	71.78	11.07	62.37	8.07	2.38	Right of way issues and poor contractor's machinery and manpower mobilisation
Finnaa Dhofa	Sawena	East Bale	Nayama Construction WWC-1	62.8	19.45	52.34	13.42	59.5	Right of way issues on Clay Quarry site, Tomb and existing road Presence at dam position	
Baki Haro		East Bale	YONAS DEGEFA GC-2							

CLUSTER-3	Finnaa Ija lencha	Burqa Dimtu	West Hararge	OBM Construction Company	100	57.14	97.46	40.08	92.85	No encountered problems
	Finnaa Kufa Bobasa	Fadisi	East Hararghe	OBM Construction S.C	99.28	46.79	99.75	34.06	85.71	Fuel scarcity
	Finnaa Hayyu Kenteri	G/ Bordode	West Hararge	OBM Construction Company	99.37	42.35	99.1	21.28	73.8	Steep feature at the left side and poor man power mobilisation
	Finnaa Goda Chale	Gumbii bordode	west hararge	Alenyahu Tefern GWWC	79.6	65.3	99.92	60.74	176.2	Progress of work is currently in good shape, i.e clay fill, shell material fill and riprap and etc...Intake tower and outlet works just started
	Finnaa Anaba	Burqa Dimtu	West Hararge	MCG Construction PLC	99.37	49.32	99.88	33.96	119	
	Finnaa Merer			OBM Construction S.C		0.58		0.47		Project is OFF due to boundary problem with Somalia Region
	Finnaa Hirye	Chinaksan	E/Hararghe	Abraham Tesfaye WWC	47.095	9.91	55.87	2.44	19.28	Fuel scarcity and Rainfall cases stipped the work and Poor contractor's mobilisation
Finnaa Doroba	Mayu Muluke	E/Hararghe	Girma Assef WWC-1	58.59	18.23	81.49	10.46	26.19	Poor machinery mobilisation	

CLUSTER-4	Finnaa Hiddi Romso	Dire	Borena	Girma Tafesse WWC	99.35	53.74	97.14	45.88	52.38	Deleyance in Key personnel mobilisation, Machinery and Fuel Scarcity
	Finna Burkuke	Dembi Hara	Borena	Belete Megersa WWC	98.22	73.72	99.01	77.19	66.66	Poor machinery and manpower mobilisation, Fuel scarcity
	Finna Worbate	Gomole	Borena	Walabu Construction SC	100	48.13	90.95	41.72	52.38	Delay in construction material supply, Poor work program administration, Unavailability of F-2
	Finna Liso Project	Dillo	Borena	Werkineh Guday	77.19	29.34	81.9	27.22	28.57	Deleyance of Crushed work schedule submission,Warning letter on key persone, Machinery About Camp to free which is occupied by contractor as per agreement
	Finna Fula Bura	Elewaya	Borena	Walabu Construction SC	96.63	54.38	96.63	59.23	97.19	Fuel Scarcity and Damaged machineries, Poor project administration
	Finna Kersa Yai	Mivo	Borena	Tinsae Ashok GC	98.03	50.33	99.74	53.05	40.47	Deleyance in machinery mobilisation, Hard bedrock existence
	Finna Bokossa	Dubuluk	Borena	KidCon Engineering	98.28	80.04	99.82	79.19	59.52	Fuel Scarcity, Cement Scarcity and Poor mobilisation
	Finna Qoa Dhanota	Guchi	Borena	Yot Construction	99.22	43.63	99.43	42.48	59.52	Poor work program administration, Poor machinery and Man power mobilisation
	Finna Haya Guracha	Gomole	Borena	Walabu Construction SC	93.15	48.52	99.68	33.04	92.8	Shortage of Aggregates materials, F-2 and Fuel scarcity
	Finna Jigessa	Dugdga Dawa	West Guji	Tilahun Abebe Construction	90.71	22.45	87.71	6.86	78.57	Right of way Issue and Security problem around project area
	Finna Kundhi	Elewaya	Borena	Mikada Engineering and Trading plc	47.99	17.34	40.39	9.61	83.33	Machinery shortage, Delay in supply of construction material and poor work program administration
	Finna Kukuba	Yabello	Borena	Fanta Daba WWC/GC	51.87	11.94	48.39	10.56	45.23	Poor Machinery and manpower mobilisation and poor work program administration
	Finna Dukanoftu	Gomole	Borena	Desalegn Mulugeta Benti WWC	25.27	23.36	17.64	17.18	30.95	Poor machinery and manpower mobilisation
	Finna Biressa	Arero	Borena	NARUCON CONSTRUCTION PLC	24.32	36.55	15.68	20.51	111.9	
	Finna Hadha Harbu	Melka Soda	West Guji	DUGASA FULFA WATER AND BUILDING C.						Project is not started due to security problems in the area
	Finna Mata Arba		West Guji	Temesgen Sori GWW Construction						Project is not started due to security problems in the area
Finna Dibe Adama	Liben	Guji	Gashaw Benti WWC	6.66	3.97	5.14	2	21.4	Poor machinery and manpower mobilisation	

## **Appendix J: Manuscript**

### **Causes and Mitigation Strategies for Construction Delays in Small- and Medium-scale Dams: The Case of Phase 1 of the Finna Oromia Initiative**

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#### **ABSTRACT**

*The Finna Oromia Initiative is an ambitious regional development program launched by the Oromia National Regional Government to enhance water storage capacity through the construction of small- and medium-scale multipurpose dams in four phases. However, projects in Phase 1 of the Initiative have experienced significant delays, undermining their intended benefits. This study investigates the causes of these delays. Employing a sequential explanatory mixed-methods research design, the research collected quantitative data using structured surveys from key project stakeholders across 24 dam projects and an in-depth qualitative case study of the Finna Oromia Keta Dibe Dam. The findings of the survey revealed that unrealistic initial time and cost estimations, the contractor's inadequate experience and limited capacity, and price escalations compounded by lack of timely adjustments are the most critical factors causing delays in the studied projects. Other significant contributors are: design modifications, the contractor's lack of commitment, political instability/security issues, shortage and late mobilization of resources, unfavorable weather conditions, and delays in land acquisition/Right-of-Way issues. The*

*qualitative case study of the Finna Keta Dibe Dam further underscored how foundation-related design modifications and unforeseen site conditions led to extended time overruns. The study concludes that construction delays in Phase 1 projects of the Finna Oromia Initiative are multifactorial, resulting from the interaction of technical, financial, managerial, logistical, and external factors. Based on the findings, the study develops practical and stakeholder-specific recommendations on mitigation strategies for the identified causes of delay.*

**Keywords:** Finna Oromia Initiative, causes of delay, sequential explanatory mixed-methods design, delay mitigation strategies

#### **1. INTRODUCTION**

Ethiopia is widely described as the 'water tower of Africa' because of its significant share of Africa's water resources, located at its high altitudes (Swain, 1997). Reports show that the country generates an estimated 122 billion cubic meters (BCM) of surface runoff annually [1], [2]. Its groundwater potential ranges from 25 – 40 BCM [3].

Despite this abundance, the country's water resource utilization remains limited, due to the inadequate hydraulic infrastructure development [2].

As a result, the country, despite being described as the ‘water tower of Africa’ for its generous surface and groundwater potential, is highly susceptible to droughts and food insecurity because it depends heavily on rain-fed agriculture. This makes it ‘hostage to its hydrology’ [4], [5].

To overcome these challenges, significant investment in water storage and infrastructure development is crucial. Through its *Ten-Year Strategic Development Plan (2020 – 2030)* [3], Ethiopia aims to build resilient infrastructure, including dams, to ensure sustainable water access in the country.

Following this strategic plan, the Oromia National Regional Government has launched the Finna Oromia Dam Initiative, an ambitious program for the improvement of water storage capacity through the construction of multiple small- and medium-scale multipurpose dams in four phases [6]. These dams are designed to collect rain and river water, supporting activities such as irrigation, flood event regulation, fishing, navigation, and water supply for various uses.

Despite continuous efforts to develop and enhance water infrastructure to meet increasing demand, its construction frequently faces significant challenges, particularly delays [7], [8].

The construction of dam projects globally is frequently delayed, with 80% of 245 large dam projects experiencing an average 44% schedule overrun [9]. This issue is more acute in developing nations like Ethiopia, where numerous projects, including the Megech Dam, Dhidhessa Dam, Tendaho Dam, Kuraz Irrigation project, Gibe III Hydroelectric

Power Project, and the Grand Ethiopian Renaissance Dam, have faced significant setbacks [10], [11], [12], [13].

In line with the general trend of delays in project delivery nationwide, a recent report by the Engineering Corporation of Oromia (ECO) shows that the dam projects being implemented in Oromia National Regional State under the ‘Finna Oromia Initiative’ are also experiencing huge delays.

The delayed implementation of these projects poses great challenges in realizing the objectives of Ethiopia’s Ten-Year Strategic Development Plan (2020-2030), jeopardizing water security, economic growth, and livelihoods [3]. This, in particular, affects farmers who rely on water for irrigation and other purposes.

Given these implications, a thorough understanding of the causes of these delays is, thus, a vital step in implementing necessary preventative measures and minimizing their detrimental consequences, thereby ensuring the timely completion of the projects [14], [15], [16].

Even though several studies have addressed the causes of dam construction delays in Ethiopia, they focused on large-scale dams [10], [12], [13]. Small- and medium-scale dams have not been thoroughly investigated, leaving a notable gap in the literature regarding the causes of delays in such projects.

This study closes this gap by examining the causes of delays in Phase 1 of the Finna Oromia Initiative. It also looks into how different delay factors manifest in a specific

project within the same Initiative. Based on the findings, the study develops practical and literature-based strategies to mitigate the identified causes.

## **2. LITERATURE REVIEW**

### **2.1. Delays and Their Prevalence in Dam Construction**

Construction delay can be defined as the time overrun in the specified completion date, on which all parties agreed [17], [18].

Delays occur in all infrastructure projects. It has been found that the construction of dam projects takes an even longer time [19]. A study conducted on 245 dam projects implemented in different countries revealed that 80% of the projects suffered an average schedule overrun of 44% [9].

For instance, 6 hydro power (multipurpose dam) projects implemented in Pakistan were completed with an average time overrun of 5 years [20]. Similarly, 35 irrigation and hydropower projects in Vietnam experienced an average time delay of 2.3 years [21]. Moreover, evidence from 11 projects in Pakistan indicates that small-scale dam projects experienced schedule overruns ranging from 10 to 43 months [22]. Other studies [23], [24] also showed similar trends.

Delays in the construction of dam projects are also common in Ethiopia. For example, the construction of Megech Dam project showed a time overrun of 100% [10]. Didessa Dam project is also among the delayed projects. The project was scheduled to be completed in 18 months, but only 23.98% was completed even after 42 months [11]. Similarly, the construction of Tendaho and Kuraz irrigation

projects was delayed by 105% and 292% time overruns, respectively [12]. The delay experienced by the Gibe III Hydroelectric Power project was another case worth mentioning. The construction of the project was launched in July 2006 and was planned to be completed in September 2013 [13], experiencing a delay of 3.5 years. Last but not least, the Grand Ethiopian Renaissance Dam (GERD), which was expected to be completed in July 2017, is still under construction as of March 2025, meaning that it has already suffered a delay of more than eight years.

### **2.2. Previous Studies on Causes of Delay in Dam Construction Projects**

Delays in the construction of dams have been the focus of international research, and numerous studies have identified the factors leading to these delays.

For instance, [23] studied the causes of delay in dam construction in Oman using a quantitative survey methodology, identifying severe weather conditions, change orders, uncertainty in ground conditions, poor site management, executive bureaucracy in the client's organization, poor feasibility study, and mistakes in soil investigation as the main delay factors.

Studies in Pakistan [20], [22], [25], [26], [27] frequently identify material supply issues, financial difficulties faced by contractors, inadequate site management, inexperienced contractors, design changes, and challenges related to land acquisition and resettlement as critical.

In addition, [24] investigated the causes of delay in dam projects in Iran. Based on the Analytic Hierarchy Process (AHP), their findings revealed that inappropriate selection of contractors, delay in the design preparation, budget deficit, unqualified personnel, economic issues, and poor site management by the contractors were among the major causes of delays in the country.

Similarly, [28] investigated delay factors influencing the construction of Tugu Dam in Indonesia using a survey methodology. This research used factor analysis and multiple linear regression, deriving two dominant variables of delays: the situation factor (i.e., land acquisition, social and cultural factors), and the change factor (design changes, planning design errors, and soil investigation errors).

In Vietnam, [21] conducted a study to explore the primary causes of construction delays in reservoir projects, identifying 32 causes of delay. As per the findings of the study, the most influential factors are technical factors (unreasonable construction schedule, inefficient use of equipment, unreasonable testing methods, low productivity level of labor, change in material cost, etc.) and external factors (slowness in decision-making process by owner, hydrological and flow factors, slowness in supplying materials from distributors, accident during construction due to lack of safety measures, geological factors and extreme weather conditions).

Furthermore, [29] also cited factors such as financial challenges, incompetence of contractors, unrealistic timelines, dissatisfaction with the workforce, and legal

obstacles as the reasons for delays in dams globally.

Last but not least, recent empirical research from Peru by [30] provides new insights on the factors responsible for delays and cost overruns in the construction of water infrastructure projects. Their study on 318 project contracts revealed such critical parameters as COVID-19 pandemic, delayed change order approval, adverse weather conditions, inadequate site information, and inaccurate cost estimates at the design stage.

A few studies have been conducted on construction delays in Ethiopian water infrastructure projects (particularly dams), even though most of them focused on large-scale projects.

For instance, [31] used a mixed methods approach consisting of stakeholder interviews, questionnaires, and project document analysis to study factors influencing mega sugar construction projects in Ethiopia in terms of time and cost overruns. Based on this study, the delays in irrigation infrastructure parts of these projects resulted from improper planning and scheduling, unrealistic contract duration, and lack of coordination among stakeholders.

In a study of large-scale irrigation projects in Ethiopia, [12] found poor planning and activity scheduling, poor project management, problems in material delivery on time, poor monitoring and evaluation system, poor site management, delay in payment, unfinished designs, error in estimating durations, contractor financial problems, poor decision-making and issues

related to Right-of-Way to be the highest-ranking causes of delay.

[10] also conducted a case study on the Megech Dam using a mixed-methods approach. The findings revealed mistakes in the planning stages, lack of risk management plan, poor management of scope changes, inadequate financing, political unrest, poor estimation, and the complex nature of irrigation projects as the main factors affecting the construction of the project.

Similarly, the investigation on the Arjo Dhidhessa Dam project revealed that design changes, limited capacity of local contractors, and unanticipated weather conditions were the major causes of delays in dam projects [11].

Furthermore, [13] explored delays in the Gibe III Hydroelectric Power Project and concluded that a shortage of finance, poor planning, inadequate quality procedures, design changes, and unexpected circumstances were the major causes of construction delays.

Last but not least, [32] investigated the delays in small-scale irrigation development in Ethiopia and pointed out that the main hindrance to the timely implementation of these projects was a lack of communication and coordination among stakeholders.

### **2.3. Common Mitigation Strategies**

Prevention and mitigation of construction delays require both proactive and reactive solutions. Well-developed plans that address the root causes of delays will make mitigation effective. There are several key strategies to achieve this:

- Effective planning and scheduling
- Design management
- Proactive risk assessment and management
- Effective resource management
- Improved communication and collaboration
- Efficient project management, monitoring, and control
- Effective change management
- Efficient decision-making processes
- Regulatory compliance
- Effective supply chain management
- Technology adoption
- Optimized contractual practices.

## **3. METHODOLOGY**

### **3.1. Research Type and Approach**

This study employs a mixed-methods research approach involving quantitative and qualitative aspects to fully address the research problem [33]. It combines descriptive and explanatory goals [34], [35].

The descriptive part aimed to summarize stakeholder responses about the significance of different delay factors on project progress. The results were used to determine the ranks of these factors across the surveyed projects [36].

The explanatory aspect intended to further explain the factors identified by the descriptive part by understanding how and why they manifested in a specific project. It was used to identify the underlying reasons for the observed phenomena by creating causal links between different factors [33], [36], [37].

### **3.2. Research Design and Strategy**

The study used a non-experimental research design [34], starting with the observed effect (project delays) and going backwards to identify contributing factors. Considering the time horizon, it employed a cross-sectional design [36], [38], collecting data at a single point in time to obtain a snapshot of the current conditions without tracking changes over time.

In terms of the strategy used for data collection and analysis, this research employs the multi-strategy research design [35], involving a survey (primary strategy) and a case study (complementary strategy).

The survey strategy was used to quantify the prevalence and significance of different delay factors across multiple projects. The case study strategy was used to investigate the issue in greater detail, helping to explore the ‘why’ and ‘how’ behind the patterns observed in the survey and revealing new relationships within the data.

Within this design, the sequential explanatory mixed-methods design was utilized [35]. With this, quantitative data were collected and analyzed first using survey, and, building on these results, the qualitative data were used to explain them in more detail through a case study. Overall, the multi-strategy design gave the study the breadth and depth, thereby increasing the overall validity and richness of the findings [39].

### **3.3. Methods of Data Collection**

#### ***3.3.1. Quantitative Data Collection***

The first phase involved quantitative data collection using a structured survey. The survey focused on 24 small- and medium-scale dam projects implemented in Phase 1 of the Initiative. The projects are located across 3 of the 5 geographical clusters within the initiative: Arsi-Bale (Cluster 2), Harerghe (Cluster 3), and Guji-Borena (Cluster 4).

All of these projects are owned by a single Client (Oromia Irrigation & Pastoralist Development Bureau) and solely consulted by the Engineering Corporation of Oromia. However, there are multiple contractors involved in the execution of the projects.

Three key roles were purposively selected from each project to participate in the survey (Project Manager, Resident Engineer, and Site Engineer), for their ability to provide informed opinions about the issue [40]. In addition, Cluster Coordinators who were assigned to supervise multiple projects were included.

A closed-ended questionnaire was used as a quantitative data collection instrument for its ability to collect data from large samples and geographically dispersed populations cost-effectively and efficiently [41]. It provides a standardized way to collect data and thus reduces the possibility of interviewer bias and increases the consistency of responses [36], allowing a meaningful comparison of the responses of participants.

The questionnaire was developed in Microsoft Word based on a thorough review of existing literature on construction delays in dam projects, project reports, and expert inputs. It contained a list of 26 pre-identified delay factors and was administered to 78

participants from the Contractor, Consultant, and Client organizations via Telegram. Respondents were asked to rate the level of the impact of each factor on delays in their projects, using a 5-point Likert scale [42].

### **3.3.2. Qualitative Data Collection**

For the qualitative part, the Finna Oromia Keta Dibe Dam Project was selected as a critical or extreme case [43], due to its significant delay with many complexities compared to other projects in the initiative. A holistic single-case design was used [44] with the entire project as the unit of analysis, facilitating analytical generalization.

Two key qualitative data collection instruments were utilized:

- a) Semi-Structured Interviews:** conducted with two participants (resident engineer and counterpart engineer). This allowed the researcher to delve into the reasons behind the delay factors identified in the survey, while being open to uncovering other project-specific issues of the selected project.
- b) Document Review:** A range of official project documents (contract agreement, feasibility study and detailed engineering report, geotechnical report, progress reports, price adjustments and contract amendments, meeting minutes, and extensions of time granted) were reviewed.

This integration of interviews with document review provided a triangulated, in-depth understanding of delay factors, which increased the validity of findings [45], [46].

In order to ensure methodological rigor and improve transparency, a case study protocol was developed [47]. The case study protocol was designed following a sequential explanatory research strategy, where qualitative inquiry builds on quantitative results. Specifically, it was informed by the top ten delay factors identified through the survey of 24 dam projects, themes from literature on dam project delays, and document reviews of the case study project.

The case protocol formed the basis for conducting semi-structured interviews, designed to confirm or deepen the understanding of the causes of delay. The interview guide was also flexible enough to allow for exploration of emergent themes that may not have been covered in the structured questionnaire [47], [48], [49].

### **3.4. Data Analysis and Interpretation**

The quantitative data collected through a structured survey were analyzed using statistical methods. The responses (perceptions) were summarized employing descriptive statistics such as means and standard deviations [50]. The delay factors were then ranked based on the mean scores as rated by the stakeholder groups separately. Finally, the overall ranking was performed using equal weighting approach.

The audio recordings from the interviews were transcribed word-for-word to maintain the depth and essence of the participants' responses [51]. Then, coding was conducted to categorize data systematically and look for patterns and themes following [52].

The document review entailed the systematic scrutiny of the documents to extract information related to decision-making, communication, and project implementation challenges. This information was then incorporated into the interview results to get a better view of the delay factors.

Data integration was achieved during the interpretation phase. The quantitative component was prioritized, and the qualitative phase was used to interpret, contextualize, and provide deeper insight into the delay factors identified through the quantitative phase [53]. This integration allowed the identification of convergence, complementarity, and divergence of both datasets through interpretive linking [54], [55].

### **3.5. Measures to Ascertain Research Quality**

To ensure research rigor, this study adopted strategies to enhance the reliability, validity, and overall trustworthiness of both quantitative and qualitative components:

**a) Reliability and Dependability:** Reliability was ensured by pre-testing the survey instrument and calculating Cronbach's alpha [56]. For qualitative data, dependability was reinforced by documenting procedures, using consistent interview protocols, and triangulating sources [57].

**b) Content Validity:** was ensured in the quantitative part, using literature foundation, expert panel review, and item revisions [58].

**c) Construct Validity:** was ensured in the quantitative phase through theoretical structuring within a conceptual framework and pilot testing [59].

**d) External Validity and Transferability:** In the quantitative phase, analytical generalization was achieved [49]. In the qualitative component, transferability was supported by thick description, providing rich, context-sensitive details of the project for applicability in a similar context [57].

**e) Confirmability and Transferability:** in the qualitative component, confirmability was enhanced through direct quotation, reflexivity, and verifiable data record [57].

**f) Credibility:** in the qualitative component, this was enhanced through member-checking, triangulation, and thick description [60], [61], [62].

**g) Ethical considerations:** were adhered to through ethical approval from academic and project parties, informed consent, voluntary participation and right to withdraw, anonymity, and confidentiality as well as transparency and accountability.

In summary, the study's rigor was maintained through methodological consistency, expert-reviewed instruments, and ethical conduct, enhancing the credibility and utility of the findings. Figure 1 presents the methodological flowchart that illustrates the sequential and iterative phases of the research design.

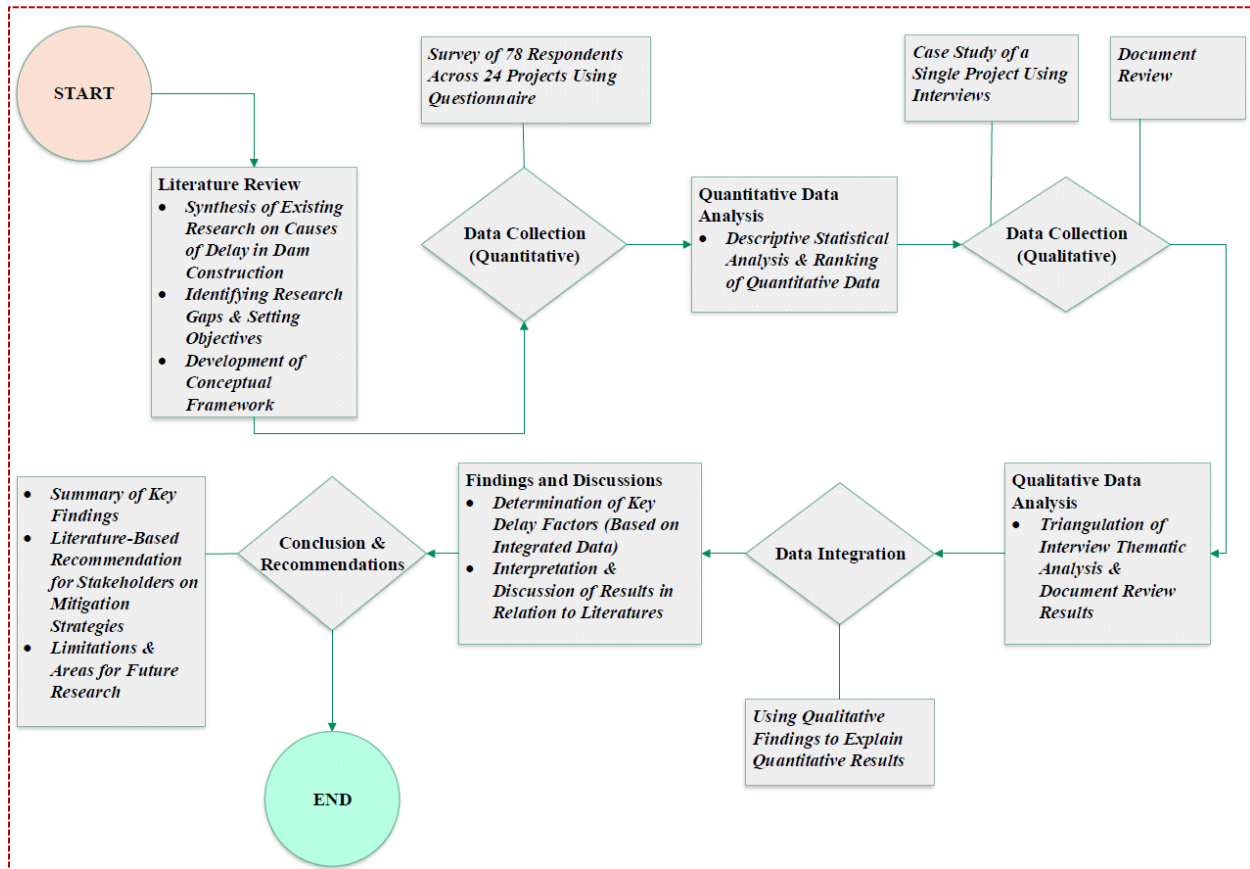


Figure 1: Diagrammatic Representation of the Research Process Followed

## 4. RESULTS AND DISCUSSION

This section presents and interprets the findings of the study, drawing on data obtained through both a quantitative survey and a qualitative case study.

### 4.1. Survey Results

Analysis of stakeholder responses revealed some variations in perceived causes of delays. Contractor groups (n=37) identified unrealistic initial time and cost estimations and price escalations as their primary concerns, reflecting the practical challenges faced during project execution. In contrast, both the consultant group (n=22) and client group (n=6) rated contractor's inadequate

experience and limited capacity as the most critical factor, highlighting their focus on governance and oversight issues.

When integrating all stakeholder perspectives through equal-weighted aggregation [63], five dominant delay factors emerged: unrealistic initial estimations, contractor's inadequate experience and limited capacity, price escalations, design modifications and contractor's lack of commitment. The reliability of these findings was confirmed by strong Cronbach's Alpha values (Contractor  $\alpha=0.874$ ; Consultant  $\alpha=0.866$ ), indicating high internal consistency in the survey instrument [50].

*Table 1: Top 10 Delay Factors Identified by the Survey*

Delay Factor	Contractor		Consultant		Client		Overall	
	Mean Score	Rank	Mean Score	Rank	Mean Score	Rank	Mean Score	Rank
Unrealistic initial time and cost estimations	4.73	1	4.09	3	4.67	2	4.49	1
Contractor’s inadequate experience and limited capacity	3.68	7	4.77	1	4.83	1	4.42	2
Price escalations and lack of timely adjustments	4.62	2	4.36	2	4.17	5	4.38	3
Design modifications/changes	4.22	3	3.55	7	4.00	6	3.92	4
Contractor’s lack of commitment	3.68	6	3.73	6	4.33	4	3.91	5
Political instability/security issues	3.73	4	3.41	8	4.50	3	3.88	6
Late mobilization (delivery) of materials/equipment	3.35	8	3.82	5	4.33	4	3.83	7
Shortage of materials/equipment	3.7	5	4.05	4	3.50	9	3.75	8
Unfavorable weather conditions	3.3	9	3.23	10	3.33	10	3.28	9
Delays in land acquisition/Right-of-Way issues	2.81	11	2.5	18	4.00	6	3.10	10

#### 4.2. Case Study Results

The in-depth examination of the Finna Oromia Keta Dibe Dam project through interviews and document analysis revealed several critical insights into the causes of delay. Design modifications emerged as the most significant challenge, with the discovery of unexpected geotechnical conditions forcing major revisions to the project’s foundation design. Initial assumptions of a 3-5m firm foundation depth were dramatically revised to 15m. This discrepancy led to delays by necessitating core drilling and

reevaluation of foundation treatments. In addition, the absence of suitable shell materials and the abundance of clay at the site necessitated a complete shift from a zoned to a homogeneous dam structure. These changes required structural re-design and revised construction methodology, which introduced delays and required contractual adjustments. It also influenced material selection, treatment methods, and sequencing of works. There were also some iterations of the spillway redesign to address water infiltration risks.

Another significant cause of delay in this project was related to dam instrumentation works. The system was originally planned to be installed during foundation compaction. However, this method was later deemed impractical and changed to post-compaction drilling, leading to miscommunication and a prolonged pricing dispute between the Client and Contractor. This created a complex project environment, where specification changes and financial delays converged to hinder timely execution.

External factors, including a major flood event that caused structural damage and required some rework, added further complexity to project delivery.

Last but not least, it was found that the time and budget *allocated* for the project were not based on a realistic assessment of the specific scope and complexity of the project, leading to inaccurate estimations. This was yet another source of delay.

Overall, these challenges ultimately necessitated a change in the original design, altering the project's scope, schedule, and cost structure. They led to extensions of time, price adjustments, and contract amendments.

#### **4.3. Integrated Findings (Survey and Case Study)**

The integration of quantitative survey data with qualitative case study findings revealed both convergences and divergences in understanding the causes of delay in the Finna Oromia Dam Initiative. The findings from both datasets converge on issues such as unrealistic initial time and cost estimations,

design modifications, price fluctuations/ lack of timely adjustments and adverse weather conditions. For example, the survey ranked *unrealistic initial time and cost estimations* as the highest, and the case study explained that feasibility studies were rushed, and all the projects in Phase 1 were allocated the same duration without considering their actual scope and complexity.

Similarly, *design modification* was the fourth top-ranked cause of delay in the survey, and the case study confirmed that design-related revisions contributed the most to delay in the selected project. These revisions were caused by challenges in getting a firm foundation, dam type change, foundation treatment methodologies, spillway design modifications, and instrumentation installation approaches.

There were also some differences between survey and case study findings. For instance, the survey's identification of *contractor's inadequate experience and limited capacity* as a major concern (ranked second overall) was not borne out in the case study, where the contractor demonstrated sufficient technical capability, indicating that this issue may be project-dependent. Similarly, *security issues/ political instability*, ranked sixth in the survey, was notably absent in the case study, emphasizing the context-dependent nature of some delay factors.

Some complementarities were also observed between the two datasets. The case study highlighted additional significant contributing factors, such as the administrative and accountability issues,

which were not explicitly listed in the survey questionnaire. Interviewees mentioned a lack of clear enforcement mechanisms in a project where the contractor and the client are both public entities. These findings offered deeper insight into institutional inefficiencies that extended beyond individual project teams.

#### 4.4. Discussion

This study’s findings align with both global and Ethiopian research.

*Unrealistic initial time and cost estimations* align with international findings on underestimating risks and complexities [31], [64]. *Contractor’s inadequate experience and limited capacity* is consistent with research citing insufficient experience, inadequate technical qualifications, and contractor

incompetence [22], [23], [30], [65], [66], [67]. *Price escalations and lack of timely adjustments* are supported by studies on market fluctuations and inflation [68], [69]. *Design modifications* due to unforeseen technical site conditions also align with global and national observations [10], [12], [30], [70]. However, unlike global experiences [29], [30], [71], and national large-scale projects [72], *public opposition* played a limited role in the Finna Oromia projects, potentially reflecting project scale or effective community engagement.

#### 4.5. Mitigation Strategies

This study proposes practical, literature-informed mitigation strategies based on the findings of both the quantitative survey and the qualitative case study.

*Table 2: Proposed Mitigation Strategies for the Identified Causes of Delay*

Identified Cause of Delay	Proposed Mitigation Strategy	Supporting Literature
Unrealistic initial time and cost estimations	Develop detailed scopes, apply WBS/ABC, involve experienced estimators, and use past project data.	[64], [68], [73], [74], [75]
Contractor’s inadequate experience and limited capacity	Use multi-criteria evaluation, encourage joint ventures, facilitate professional development, and monitor performance.	[22], [31], [76], [77]
Price escalation and lack of timely adjustments	Include escalation clauses, allocate contingency budgets, and regularly update budgets with time-cost buffers.	[17], [69], [73], [78]
Design changes/modifications	Conduct comprehensive early investigations, establish design review panels, implement change management systems, and ensure local material availability.	[13], [29], [67], [68], [79]
Poor contractor commitment	Link payments to milestones, discourage overcommitment, and improve internal planning with regular reviews.	[68], [69], [75]
Political instability/security issues	Conduct project-specific political risk assessments, form joint coordination teams with security forces, and develop site-specific contingency plans.	[9], [72], [75]
Late mobilization (delivery) of materials/equipment	Develop detailed pre-construction mobilization schedules, include early procurement in WBS, and implement strong procurement/logistics strategies.	[17], [80], [81], [82]

Shortage of materials/equipment	Strengthen procurement, use local supplier networks, maintain buffer stocks, and adopt multi-sourcing.	[66], [68], [69], [82]
Unfavorable weather conditions	Provide seasonal climate forecasting, schedule critical works during drier seasons, and integrate weather risk buffers into schedules.	[83], [84], [85]
Delays in land acquisition/Right-of-Way issues	Begin land clearance/compensation early, engage community leaders, establish grievance redress mechanisms, and resolve RoW before mobilization.	[27], [70], [75], [86], [87]

## 5. CONCLUSION AND RECOMMENDATIONS

### 5.1. Conclusion

The study investigated construction delays in small- and medium-scale dam projects under Phase 1 of the Finna Oromia Initiative, employing a mixed-methods design (quantitative survey of 24 projects and a qualitative case study of the Finna Oromia Keta Dibe Dam).

The top ten delay factors identified by the quantitative survey, based on stakeholder perceptions (contractor, consultant, client), are: unrealistic initial time and cost estimations, the contractor’s inadequate experience and limited capacity, price escalations/lack of timely adjustments, design modifications, the contractor’s lack of commitment, political instability/security issues, shortage and late mobilization of resources, unfavorable weather conditions, and delays in land acquisition/Right-of-Way issues.

The case study of Finna Keta Dibe Dam deepened understanding, showing that design modifications, the most significant factor in this case, stemmed from issues like differing foundation depths, dam type changes, and spillway modifications. It also highlighted the impact of poor initial estimations, weather,

reworks due to flooding, and administrative bottlenecks.

Both datasets confirm that construction delays result from the interaction of technical, managerial, financial, logistical, and external factors, consistent with previous global and Ethiopian studies.

### 5.2. Recommendations

Actionable, stakeholder-specific recommendations are proposed to enhance the planning, execution, and resilience of ongoing and future dam projects.

#### For Client:

- Improve planning accuracy and early estimations.
- Implement price adjustments and contingency frameworks.
- Improve contractor selection process and strengthen their capacity.
- Proactive land acquisition and stakeholder engagement.

#### For Contractor:

- Improve resource mobilization and supply chain management
- Improve work planning and commitment

#### For Consultant

- Conduct comprehensive early-stage site investigations
- Proactively identify risks

- Execute preconstruction design reviews and validate designs with independent panels
- Implement strict change management systems with formal protocols.
- Create a learning repository of delay cases, formalize risk registers/mitigation plans, and train all parties on adaptive project delivery.

**For Regional and Local Authorities**

- Provide seasonal climate forecasting
- Ensure project security and public safety

**Multi-Stakeholder Recommendations**

- Systematically reuse and refine data from Phase 1 for future projects.

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