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Cause of Delay in Medium Town Water Supply Projects: the Case of Ethiopian One WASH National Program

By

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June 2021
Addis Ababa, Ethiopia

Cause of Delay in Medium Town Water Supply Project: the Case of Ethiopian One WASH National Program

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St. Mary's University
School of Graduate

June, 2021
Addis Ababa

Declaration

I, Undersigned, declared that this thesis is my original work, prepared under the guidance of Dr. Chalachew Getahun (PhD). All sources of materials used for the thesis have been duly acknowledged. I further confirm that this thesis has not been submitted either in part or in full to any learning institution for the purpose of earning any degree.

Derege Mengistu

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Date _____

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the Case of Ethiopian One WASH National Program

By Derege Mengistu

Certification

As member of the examining board, we certify that we have read and evaluate the research project prepared by Derege Mengistu entitled “Cause of Delay in Medium Town Water Supply Project of Ethiopian One WASH National Program” and complies with the University and meets the accepted standards with respect to originality and quality.

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Addis Ababa, May 2021

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Abbreviation

GDP	Growth Domestic Product
NCE	No Cost Extension
OWNP	One WASH National Program
PMU	Program Management Unit
RII	Relative Importance Index
SNNP	South Nation Nationality People
WASH	Water Supply Sanitation & Hygiene

Abstract

Construction delays are common problems in water supply projects in Ethiopia. The delays in construction projects are the major causes of project failure. Construction delays are caused by many factors. The aim of this paper is to identify delay factors on construction projects and analyze these factors with the relative importance index method. For this purpose, 57 different delay factors were identified, categorized into eight major groups. The relative importance of these delay factors were quantified by the relative importance index method. The ranking of the factors and groups were demonstrated according to their importance level on delay. The findings show that the main critical factors that cause construction delays in water supply project of One Nation Program in Ethiopia are: (1) fluctuation of price/rising cost of material , (2) late material supply, (3) scarcity of material in the market, (4) delay payment to the contractor, (5) ineffective planning and scheduling, (6) less emphasis to planning, (7) client's finance shortage, (8) unrealistic contract duration (9) delay payment to the suppliers and subcontractors and, (10) underestimating the complexity of the project. In addition, cost revision; effective planning and scheduling; estimating realistic project duration; on time delivery of material and plan for payment of contractors are some recommendations made to minimize and control delays in construction projects.

Key words: *Water supply project, construction delay, cause of delay*

CHAPTER ONE

INTRODUCTION

1.1 Background

The construction industry has an impact on the economy of all countries (Leibing, 2011). It is one of the sectors that provide crucial ingredients for the development of an economy. According to Chitkara, (2004), the construction industry in many countries accounts for 6-9% of Gross Domestic Product (GDP); and according to Bhimaraya, (2001), it reaches up to 10% the GDP of most countries. In Ethiopia its percentage of GDP amounts 3%, considerably lower than the Sub-Saharan average of 6% (MoWUD, 2006). The construction industry is vital element of the economy and has a significant effect on efficiency and productivity of other industry sector. One cannot think of widespread investment in manufacturing, agriculture or service sector unless the construction result of infrastructure facilities are in place.

The industry also serves as a fundamental pillar for the economic and social development of a country and is usually reflected by its sensible contribution to the gross domestic product (GDP). Construction projects in Ethiopia are parts of the country's development initiative. It shares considerable amount of the country's scarce financial resources. In Ethiopia, the construction industry is the highest recipient of government budget in terms of government development program. Consequently, public construction projects consume an average annual rate of nearly 60% of the government's capital budget (MoWUD, 2006).

Most of the infrastructure developments are carried out on project basis and construction projects frequently suffer from delay. Delay is a situation when the contractor and the project owner jointly or individually contribute to the non-completion of the project within the original or the stipulated or agreed contract period (Levy, 1994). Delays in construction projects are frequently expensive, as they are usually involved with construction loans which charges interest, management staff dedicated to the project whose costs are time dependent and ongoing inflation in wage and material prices (Trauner, 2019).

Thus the performance and success of projects are measured by the triple project constraints (Cost, time, and quality). Project success is measured by completing on time within the estimated cost and quality. Because the industry is a full of project activities, tasks and constraints that requires additional budget and cost. According to Faridi *et al.* (2006) delays have impact on success project in its cost, time, safety and quality. The consequences of delay are not restricted to only construction industry but also impact the whole country's economy. According to Rajakumar (2016), cost and time overruns are common in developing countries and impacts more for developing country than developed once. Ethiopia is a developing country where its construction sector is affected by cost and time overrun. Water supply projects in Ethiopian are victims of this problem.

Water supply projects are vulnerable to delay more than others for the fact that they are taking place in public road, streets, vicinity areas farm areas etc. which requires significant provision. There is also high uncertainty, because the construction by its kind associated with excavation and trenching works in different soil type, geological formations and most of the works performed with machineries, equipment that demands continuous repair and maintenance so it require the approval of official at different level.(AL-Khalil & AI-Ghafly, 1999).

According to Mathiwos (2018), the three top major factors causing construction delays in water supply construction projects in Ethiopia are adverse weather condition, delay in approval of documents and equipment Failure. Likewise all water supply projects in Ethiopian One WASH program suffered from exhibited a delay ranges from 104 % - 270%, (National WASH Coordination Office (NWCO), 2019).

The purpose of the study is to identify causes of delays in construction of medium town water supply schemes in Ethiopia One WASH National Program. A survey was conducted using standard questionnaire to identify and rank the causes of delays in construction of drinking water supply projects in Ethiopia One WASH National Program. In addition it used appropriate index to rank the importance of the factors.

1.2 Statement of the problem

Delays in a construction project is counted as a common problem and became a cause for projects completion with huge cost overrun (requiring higher budget than estimated), extended completion time, inferior quality deliverables and contract termination. In recent time it was an accepted phenomenon to have delays in construction projects completion time. Ethiopian News Agency (2018)reported that Ethiopian Construction Project Management Institute found that completion of the projects within time frame and budget become increasingly difficult due to lack of effective construction management capacity. According to Ethiopian Construction Project Management Institute (2018), projects budget and time overrun reached 76% and 124% respectively.

Shewaferahu (2016), in his study on construction of educational projects found that none of the case study projects completed within the contract period and consultant and contractor caused delay factors are the two most responsible factors for most delays. The total delay ranges from 200% to 329% of the initial contract times excluding the time required to complete the projects.

Project delay was mainly associated with absence of programming expert with the client and contractor, attention to preparation and timely submission, lack of commitment from the contractor and consultant to act on time, contractors' unrealistic project, absence of sufficient and enforceable contractual remedies (Abebe, 2015).

In Ethiopian construction practice, it is very rare that water supply scheme construction projects are completed on the time specified or agreed upon. Despite lack of empirical evidences specific to the sector, the water supply construction projects are also suffering from a massive delay. The same holds true in Ethiopian One WASH National Program. i.e. water supply construction in medium town are suffered in delay or in some cases suffered suspension or abandonment. Out of 20 medium town water supply projects, only three completed with a delay of 200 – 270% (National WASH Coordination Office, 2019).

The major factors that contributed to implementation delays of medium town water supply construction project of the program are high cost escalation and the complexity of urban water

schemes that require large quantities of imported goods such as electromechanical equipment, steel casings, pipes and fittings (NWCO, 2019).

In addition, a study conducted by Mathiwos (2018) showed that the main critical factors that cause construction delays in water supply sector in Ethiopia are: (1) adverse weather condition, (2) delay in approval of documents, (3) equipment Failure, (4) scarcity of material in the market and (5) poor supervision. However, the study focused on water supply construction projects in rural settings and did not represent the cases of town water supply construction projects.

In view of the above, there is a need for having better understanding of the cause of delay in the construction specific to medium town water supply projects in order to avoid or minimize them and complete the project successfully.

Identifying the main causes of town water supply project delay is the main concern of this study paper as project delay affects the counters' economic growth with all its other adverse effects.

The purpose of this study is therefore to identify the major causes of delay in medium town water supply projects of OOWNP and recommend remedies for delay in completion of town water supply construction.

1.3 Research Question

The study was guided by the following research questions:

- What are the existing water supply construction delay mitigation practices of Ethiopian OOWNP?
- What are the major causes for the delay in medium town water supply construction projects of Ethiopian OOWNP?
- What measures required to avoid or minimized delay in medium water construction projects?

1.4 Research Objectives

1.4.1 General objective:

The general objective of this study is to assess the major causes of delays on medium town water supply projects in the Ethiopian One WASH National Program.

1.4.2 Specific objectives:

- To describe the existing water supply construction projects delay mitigation practice of Ethiopian OOWNP
- To identify and rank the causes for delay in completion of medium town water supply construction in Ethiopian OOWNP
- To propose action to avoid or minimize delays in the construction of medium town water supply construction projects of Ethiopian OOWNP.

1.5 Significant of the study

Project planning and scheduling is a basis for smooth execution and successful completion of the project. Proper planning, execution and monitoring will save the life of the project and reduces the risks associated with delay, cost overrun and quality issues. Failure to manage delay causes and their factors accordingly hamper the project completion and the stakeholders' relationship. So, this research will give good picture to those working on in the sector about the causes and effects of project delays.

In addition, in most cases, water supply scheme construction project are vulnerable for cost overrun, delay to complete as scheduled, inferior quality products and disputes caused by unmet responsibilities by either party. All these and other unstated conditions are aggravated by poor time management and improper planning besides from other causes. So, this research will contribute to fill the gap in the water supply construction management and based on the output of this study, the researcher will provide practical mitigation strategy in controlling delays in the water supply project. Therefore, this research contributed to fill the gap related to project delays in the industry.

The research will also help project managers and policymakers to consider the effects of these delays during project implementation and hopefully improve the efficiency of project management and contract administration in Ethiopian construction sectors. It will also provide academicians and other experts in the water supply construction to further investigate delay causes in the construction industries in Ethiopia.

Finally, this research contributed in the field of construction management. It added more information on the most frequent and critical causes of delay and to tackle the problems as early as possible.

1.6 Scope of the study

The study considered and is limited to investigating the cause of project delay of medium town water supply project of OOWNP which has been implemented in six regions in Ethiopia namely Oromia, Amhara, Tigray, SNNP, Benshangul Gumuz and Gambela. In addition, the study mainly used closed-ended questionnaires. In addition the respondent for this research involves only PMU staffs of the program and assesses the cause of delay based on the perception of client.

1.7 Limitation of the study

The study didn't consider relationships between variables. Thus no correlation or regression analysis was used. The study also is limited to opinion of implementing organization because the organization carryout most construction in its own. However, it invited contractors where the need may be. It gave more emphasis only on medium town water supply projects.

The study was further limited by assessing perception of clients of which only the PMU staffs and missing to get the idea of the finance people which might result in omission of important information to identify the perceived reason for program delay from finance perspectives.

1.8 Organization of the Research

This research report was presented in five chapters as described below;

- Chapter One is an introductory part containing discussions on background, research problems, objective of the research, significance of the research, scope and limitation of the research and organization or layout of the research
- Chapter Two presents literature review with general descriptions by different researchers on construction, contract, planning, control and delay.
- Chapter Three details the methodology employed in the study, characterizes the population and ethical considerations
- Chapter Four presents the result and discussion.
- Chapter Five presents the Conclusion and Recommendation based on what is discuss in the previous chapters.

CHAPTER TWO

LITERATURE REVIEW

This chapter discussed the literature related to causes of delay in construction projects and the way to avoid or minimize the effects of them. It described how various researchers approached the problem and different tools and techniques used to identify and analyze the cause of delay in the construction project of various countries.

2.1 Conceptual & operational definition

2.1.1 Operational Definition

Project: a temporary endeavor undertaken to create a unique product, service or result. The temporary nature of projects indicates a definite beginning and end. The end is reached when the project's objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists (PMBOK, 2017).

Project Delay: A project that is requiring any time more than what is actually needed to complete a project is considered as a delayed project (Fugar and Agyakwah-Baah, 2010).

Effects of delay: Any consequence directly attributed to the project delay based on the perception of the clients, contractors and consultants is taken as effect of delay (Werku and Jha 2016).

Water supply projects: Water supply projects in this study context refer to the medium town water supply projects of Ethiopian OWP.

2.1.2 Concept of Project & Project Delay

Several authors and books have defined project in various ways. Thus, project is temporary endeavor undertaken following specific cycle of Initiation, Definition, Planning, Execution and Close to create a unique product, service, or result through novel organization and coordination

of human, material and financial resources PMBOK (2004). A Project is: A group of tasks, performed in a definable time period, in order to meet a specific set of objectives. It is likely to be a one-time program. It has a life cycle, with a specific start and end. It has a work scope that can be categorized into definable tasks. It has a budget. It is likely to require the use of multiple resources. Many of these resources may be scarce and may have to be shared with others. It may require the establishment of a special organization, or the crossing of traditional organizational boundaries Harvey (2002). It is a sequence of unique, complex, and connected activities that have one goal or purpose and that must be completed by a specific time, within budget, and according to specification. In general, a project is a unique, well-defined effort to produce specified results within a set timeframe, at a given cost, in a multifunctional environment and under special management Berry and Duhig (1987). The PMBOK Guide has defined a project as “A temporary endeavor undertaken to create a unique product or service” (PMBOK, 2017).

According to Aibinu and Odeyinka (2006), construction projects still continue to face the challenge of delays even in this current phase of knowledge in technology as well as organization management.

Project delay can be defined as execute later than intended, planned, or later than specific time or the prolonging of the implementation period that all the concerned parties agreed for the project. Delay in project is counted as a common problem. The project’s success depends on meeting objectives within time and budget limits. The major factor of project problems is project’s delay. On time completion of project is an indicator of efficiency. But there are many unpredictable factors and variables resulting from various sources affecting projects. Some of the main sources are the involvement and performance of parties, contractual relations, environmental and site conditions, resources availability etc. It is very rare to see that a project is completed on time (Haseeb *et al.*, 2011).

The construction industry in many countries faced with challenges when it comes to construction project delivery and this may be due to various factors, which are identified in the research. (Memon, *et al* ,2010), categorized the challenges faced in the construction industry as; delays in completing projects on time, expenditure exceeding budgets as well as poor quality.

2.2 Theoretical Review

2.2.1 Project Delay

Delay could be defined as the time overrun either beyond completion date specified in a contract or beyond the date that the parties agree upon for delivery of a project. (Divya & Ramya2015)

According to Dinakar, 2014, Delay is the slowing down of work without stopping construction entirely and that can lead to time overrun either beyond the contract date or beyond the date that the parties have agreed upon for the delivery of the project.

Delay was also defined as an act or event which extends required time to perform or complete work of the contract manifests itself as additional days of work (Zack, 2003). Majid (2006) interpreted delay as a loss of time. 'Time' refers to the duration for completing the construction project. When the project period is delayed, it means the project cannot be completed within original schedule.

Most importantly, delays can be seen in these four major categories as

- A. Critical or Non Critical
- B. Executable or Non-Executable
- C. Compensable or Non-Compensable
- D. Concurrent or Non-Concurrent. (Trauner, 2009)

A. Critical or Non-Critical Delay

Delays that affect the project completion or in some cases a milestone date are considered as critical delays and delays that do not affect the project completion or a milestone date are considered as noncritical delays. If these activities are delayed, the project completion date or a milestone later will be delayed. The determining which activities truly control the project completion date depends on the following:

1. The project itself
2. The contractor`s plan and schedule (particularly the critical path)
3. The requirement of the contract for sequence and phasing
4. The physical constraint of the project, i.e. how to build the job from apractical perspective. (Dinakar 2014)

B. Excusable or Non-Executable Delays

Excusable delays are occurrences over which neither the owner nor thecontractor have any control, e.g. extreme weather conditions, acts of Godand other unforeseen future events. (Srdić & Šelih 2015)

Non-excusable delays are events that are within the contractor`s control orthat are foreseeable.

These are some example of non-excusable delays:

- Late performance of subcontractors.
- Untimely performance by suppliers.
- Faulty workmanship by the contractor and subcontractors.
- A project specific labor strike caused by either the contractor`s unwillingness to meet with labor representatives or by unfair labor practices. (Ahmed2017)

C. Compensable or Non-Compensable

A compensable delay is one where a contractor is entitled to financial recovery in the form of direct and indirect time related costs arising from an employer risk event. (Keane &Caletka 2008)

D. Concurrent or Non-Concurrent.

Concurrent or parallel delays occur when there are two or more independent delays during the same time period. Concurrent delays are significant when one is an employer risk event and the other a contractor risk event, the effects of which are felt at the same time. When two or more delay events arise at different times, but the effects of the mare felt (in whole or in part) at the

same time, this is more correctly termed ‘concurrent effect’ of sequential delay events. (Keane *et. al*, 2008)

2.2. 2 Effects of Delays

The desire to finish a project on time, under the planned budget, and with the highest quality is common goals for all contracting parties, including the Owner, Contractor and Consultant. Delay usually result in losses of one form or another for everyone. Murali *et.al*, (2007) studied the effects of construction delays on project construction industry. The six effects of delay identified were:

1. Cost overrun
2. Time overrun
3. Dispute
4. Arbitration
5. Abandonment

Sunjka, and U. Jacob, (2013) stated that poor quality completed projects and bad public relations are also the effects caused due to delay in construction projects in addition to the above six effects.

Cost, time, and quality have proven their importance as the primary success factors of a project.

According to Ahmed, *et al*. (2002) delays on construction project is a universal phenomenon. They are usually accompanied by cost overruns. Delay has a negative effect on clients, contractors, and consultants in terms of growth in adversarial relationships, mistrust, litigation, arbitration, and cash-flow problems. A project may be regarded as a successful endeavor until it satisfies the cost, time, and quality limitations applied to it. However, it is not uncommon to see a construction project failing to achieve its goal within the specified cost, time, and quality.

Aibinu and Jagboro (2002) studied the effects of construction delays on project delivery in Nigerian construction industry. The six effects of delay that were identified includes: time overrun, cost overrun, dispute, arbitration, total abandonment and litigation. Koushki and Kartam (2004) concluded that time and cost overrun were the impact of the material selection time, their

availability in the local market and the presence of the supervising engineer. It is important to improve the estimated activity duration according to the actual skills levels, unexpected events, efficiency of work time, mistakes and misunderstanding (Lock, 1996). Delays influence negatively on the contractors performance and contribute to adverse impacts in construction projects such as contract disputes, low productivity and increase in construction costs that will also influence on the pre-determined of construction project objectives. From the comprehensive literature review, six major effects of delay in the construction projects were identified as follows:

Similarly, Sambasivan *et al.* (2007) identified six most frequently observed effects of delays in his survey on causes and effects of delays in Malaysian construction industry. These were: (A) time over-run, (B) cost overrun, (C) disputes, (D) arbitration, (E) litigation, and (F) total abandonment.

A. Time Overrun

Murali *et al.*, (2007) argued that contractor related factors and client related factors such as inadequate contractor experience and owner interference have impact on time overrun. On the other hand, Aibinu and Jagboro (2002) studied the effects of construction delays on project delivery in Nigerian construction industry. They identified time overrun as one of the major effects of delay.

B. Cost Overrun

Regarding cost overrun Koushki *et al.*, (2005) identified three main causes that were contractor related problems, material-related problems, and owners' financial constraints, whereas Wiguna and Scott (2005) identified the most critical factors included: high inflation/increased material price; design change by client; defective design; weather conditions; delayed payment on contracts and defective construction work.

C. Disputes

Disputes are the effects of major causes of delays in construction projects such as causes of Client related, Contractor related, Consultant related and external related that may be arisen during the construction projects among the project parties. Lack of communication may also leads to misunderstandings, conflicts and disputes. Hence it necessitates the project managers to have effective communication skills which are one of the significant soft skills (People skills) with the project parties involving in construction projects. Based on Murali *et al.*, (2007) the factors such as lack of communication between the various parties, problem with neighbors, unforeseen site conditions, delay in payments for completed work, improper construction method, delay caused by the subcontractor and discrepancies in contract documents will give rise to disputes between the various parties. Furthermore, if the disputes cannot be solved amicably or easily it can lead to arbitration or litigation.

D. Arbitration

According to Murali *et al.*, (2007) delays caused by either client or contractor related factors such as change order, delayed progress payment, contractor's non-performance and lack of communication between parties which may rise disputes will be settled through arbitration process. For these circumstances, it is necessitate having a competent third party that can settle the disputes amicably or easily without going to court.

E. Litigation

Based on Murali *et al.*, (2007) when the delays caused by client related, contract related, labor related and external related factors such as delay in payment for completed works, problems with site conditions and less labor supply where eventually rise the disputes to be settled by the litigation process. The parties involved in the construction projects use litigation as a last alternative to settle the disputes.

F. Total Abandonment

The most critical adverse effect of delays in construction projects is abandonment that could be temporary or in worse condition for permanent duration. The major causes of client related, consultant related, contractor related and external related may lead to project abandonment that will lead to delays in construction projects. Aibinu and Jagboro (2002) studied the effects of construction delays on project delivery in Nigerian construction industry. They identified total abandonment as one of the major effects of delay.

2.2. 3 Mitigation Measure of Construction Delays

Acceleration of site activities with improved clients' project management procedure and inclusion of appropriate contingency allowance in pre contract estimate should assuage the adverse effect of construction delays (Aibinu and Jagboro, 2002).

For successful projects, it required realistic project schedules and cost estimates and they should be mentioned throughout the project. Further they stated that when a project is behind the schedule, the project team accelerate the subsequent activities to catch up the delays, but in most case failed to make up for lost time due to mainly the deficiency in project management procedure of clients. And all of these efforts involve increase in cost to the contractor and only for the client responsible cost increase will be paid. Normally 5-10% contingency margin is included in the construction contracts as a provision for unforeseen variances. Aibniu and Jagboro (2002) recommended a 17 – 34% of project cost estimate in a pre contract estimate as contingency in Nigeria Building Projects.

Researchers such as (Abdelnaser, 2005) cited that implementation of adequate planning during the inception and design phases of the project can be a strong measure of avoiding delay during the construction phase. In another survey was conducted by (Nguyen, 2004) in an attempt to establish measures to minimize delay in large construction project in Vietnam. He recommended five important measures were; availability of sufficient resources, multidisciplinary or competent project team, competent project managers, accurate first cost estimates and accurate initial time estimates.

The effective use of project management application should use to enhance project performance and to avoid or minimize the causes and effects of cost escalation and schedule delays (Frimpong *et al.*, 2003). They studied that the project delays are possible at any stage of the projects but they are most probable at construction stage where a lot of uncertainties comes into effect.

There are different perceptions of major parties involved in construction projects of the causes of delay. But there is very strong agreement between the contractor and the consultant for some of the most significant causes of the delay (Faridii and El-Sayegh, 2006). They carried out a study with the participation of 93 constructions professional from the Unite Arab Emirate construction industry and recommended the following steps to mitigate or avoid delay in United Arab Emirate construction project:

- There must be an agreed schedule (between contractors and consultants) for preparation, submittal and approval of drawings, which should be strictly followed
- Owners should incorporate requirements for scheduling and schedule control in the contact document.
- There is an urgent need for the involvement of construction management companies to help minimized delays or their impact.
- Better human resource management can help improve labor skills and productivity. Companies should invest in the training and development of their employees
- Contractor need to act early to obtain permit and approval from different government agencies.

On the other hand Koushki *et al.*, (2005) identified thirty methods of avoiding or minimizing construction delays. There are:

- Accurate initial cost estimates
- Adopting a new approach to contract award procedure by giving less weight Prices and more weight to the capabilities and past performance of contractors
- Perform a preconstruction planning of project tasks and resource needs
- Selection of a competent consultant and are liable contractor to carry out the work

- Allocation of sufficient time and money at the design phase
- Resource Availability
- Commitment to projects
- Competent project manager
- Comprehensive contract documentation
- Ensure adequate and available source of finance until project completion
- Frequent progress meeting
- Enforcing liquidated damage clauses
- Offering incentives for early completion
- Hire an independent supervising engineer to monitor the progress of the work
- Multidisciplinary/competent project team
- Make use of current technology
- Absence or less bureaucracy
- Accurate initial time estimates
- Adopting new approaches to contracting such as Design-Build (D/B)
- Construction management (CM) type of contracts
- Clear information and communication channels
- Developing professional and skillful of human resources in the construction industry through proper training and classifying of craftsman
- Effective strategic planning
- Ensure timely delivery of materials
- Proper emphasis on past experience
- Community involvement
- Systematic control mechanism
- Acceleration of site activities
- Contingency allowance

2.3 Empirical review

2.3.1 Causes of delay

Many researches in different countries conducted research to find delay causes and identified most affected causes on delaying the projects. Al-Momani (2000) found that the main causes of delay in construction of public projects in Jordan were related to designer and user changes, weather, site conditions, late deliveries, economic conditions and increase in quantities. Odeh and Battaineh (2002) showed that owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and sub-contractors are among the top ten most important factors causing delay in Jordan.

Frimpong *et al.* (2003) revealed that project management tools and techniques play an important role in the efficient and effective completion of a project. Activity schedules and monitoring frameworks are typical management tools. While some projects are effectively and efficiently managed others are mismanaged leading to failure to meet their set deadlines for completion.

Sambasivan and Soon (2007) identified 10 most important causes of delay as: (1) contractor's improper planning, (2) contractor's poor site management, (3) inadequate contractor experience, (4) inadequate client's finance and payments for completed work, (5) problems with subcontractors, (6) shortage in material, (7) labor supply, (8) equipment availability and failure, (9) lack of communication between parties, and (10) mistakes during the construction stage.

Ndungu (2014) after reviewing a number of articles concluded that poor communication, inexperienced project managers, contract variations and inadequate resources as being some of the major contributors to poor time performance of public sector projects. As a result, many major projects fail to meet scheduled deadlines. Predicting a likelihood of schedule delay thus plays a key role in overall project success Luu *et al.* (2009).

According to WASHplus (2009), the political unrest and violence during the project period has served to slow progress against not only WASHplus but also national development objectives

and prevent essential movement in-country to implement, monitor, and follow up on project activities. In fact, these delays were the impetus behind the no-cost extension (NCE) request—to ensure all timely follow up and monitoring was completed as proposed (WASHplus, 2016).

Financing provides the monetary resources required to meet the project budget as represented by the project's bill of quantities. Ndungu (2014) obtained that poor financing arrangements, inadequate construction funding and budgets, bad cash flow that may be occasioned by contractor's and client's financial difficulties, and inaccessibility to formal structured finance have a heavy bearing on the project smooth running leading to delayed completion of a project. Thomas (2002) also identified financing as a major success criterion of construction projects.

Similarly, effective project monitoring helps the project manager ensure that the project is on track to completion by certain deadlines by comparing actual performance with planned performance and taking timely corrective action to yield desired outcomes when significant deviations exist. Making allowances for adequate monitoring and feedback mechanisms therefore gives the project manager the ability to anticipate problems, to oversee corrective measures, and to ensure that no deficiencies are overlooked. Monitoring therefore informs forecasting and planning during the implementation phase of a project. The plans are then communicated to the workers for execution (Navon, 2005).

Furthermore, projects are fulfilled through the efforts and skills of people, with the help of systems. It is noted that employees' capacity for effective construction management is paramount during the construction stage if the project's stipulated targets are to be achieved. Moreover, there should be a capacity to carry out project management functions which typically include: (1) Specifying project objectives and plans including delineation of scope, budgeting, scheduling, setting performance indicators and selecting project participants. (2) Maximizing the resource efficiency through procurement of labor, materials and equipment. (3) Implementing various operations through proper coordination and control of planning, design, material estimation and sub-contracting in the entire construction process. (4) Developing effective communication and mechanism for resolving conflict an aspect of directing and motivating people towards attainment of project objectives Chris Hericksson (2008). Contractor's

incompetence/inadequacy attributed to problems such as lack of experience, poor methods of construction and delayed procurement of equipment and materials, cash flow problems, labor shortages or engaging inadequate labor skills and unrealistic budget fronted by the client is a key factor contributing to time overruns in construction projects globally (Chan and Kumaraswamy, 2002).

Other researchers investigated delay factors in construction projects. Chan and Kumaraswamy (2002) identified principal delay factors as: poor supervision, unforeseen site conditions and slow decision making.

Abebe (2015) noted that project delay was mainly associated with absence of programming expert with the client and contractor, disagreement with the assumptions and considerations and consultants and client's unlimited demand or request. In addition, the following factors were identified to contribute for the delay recorded in submission and approval: no attention was given to its preparation and timely submission; lack of commitment from the contractor and consultant to act on time; contractors submit unrealistic project; absence of sufficient and enforceable contractual remedies.

Moreover, work projects submitted and updated by the contractors were identified to have low contribution to progress monitoring because the submitted projects were not realistic or already delayed. Abebe (2015) further identified factors that contribute to the failure of projects for tracking of deliverables such as: failure to update work projects; failure to define project deliverables; failure of the contract to show defined project deliverables. In addition, Abebe (2015) revealed that work projects submitted by contractors did not assist for review of remedial rights or delay analysis and evaluation of claims due to: failure to use appropriate method of programming; failure to use realistic work breakdown structures and failure to use realistic project link.

According to Endale (2016), the causes of delay in the construction of 40/60 saving houses project were financial difficulties faced by the contractor, delayed payments to contractors,

ineffective planning and scheduling, late design review and approval and slowness in decision making process.

Habtemariam (2016) noted delays were due to the failure that more than half of the schedules prepared by the contractor didn't show the activity relationship which force consultants to evaluate time claim in subjective and personal manner. Furthermore, most of consultants took the contractors request date as a baseline and some approved time claim based on the contractor's requested date.

Koshe & Jha (2016) studied causes of delay in construction of Ethiopia. They have identified 88 delay causing factors under eight broad categories namely: client related, consultant/supervisor related, contractor related, designer related, labor related material related equipment, and external related.

Accordingly, major causes of project delay in Ethiopian construction industry were identified as follows (Koshe&Jha, 2016)

1. Difficulties in financing project by contractors
2. Escalation of materials price
3. Ineffective project planning
4. Delay in progress payment for completing work
5. Lack of skilled professional in construction management
6. Fluctuating labor availability season to season
7. Late delivery and shortage of materials
8. Low productivity of labor
9. Unqualified/inadequate experienced labor
10. Insufficient data collection and survey before design

According to Mathiwos (2018), the top ten factors causing delay of water supply construction project in Ethiopia were

- Adverse weather condition
- Delay in approval of documents

- Equipment failure
- Scarcity of materials in the market
- Poor supervision
- Poor site management
- Fluctuation of prices/rising cost of materials
- Change in subsurface conditions
- Slowness in decision making process
- Low skills of labor

2.4 Synthesizing the Reviewed Literature

In general, the project delay can be defined as execute later than planned or the prolonging of the implementation period. Some of the main sources of project delay factors include: contractual relations, environmental and site conditions, resources availability, bureaucratic approval procedures, the lack of qualified and experienced personnel, contractor's improper planning, contractor's poor site management, inadequate client's finance and payments for completed work, problems with subcontractors, lack of communication between parties and poor supervision.

Some of the project delay factors in the Ethiopia water supply construction sector include: Adverse weather condition delay in approval of documents, equipment failure, scarcity of materials in the market and poor supervision (Matheios, 2018). However, these delay causing factors are mainly related to rural water supply projects. Thus it required to identify factors that cause delay in medium town water supply construction project.

Table 2-1: Summary of cause of delay by different researcher

Author	Year	Country	Type of project	Cause of delay
Al-Momani H. A.	2000	Jordan	Public project	1. Design & user changes
				2. Weather
				3. Site condition
				4. Late delivery
Odeh A.M.and Battaineh H.T	2002	Jordan	Traditional contract	1. Owners interfirance
				2. Inadequate contractor experience
				3. Financing and payments
				4. Labor productivity
Chan D.W.M. and Kumaraswamy M.M.	2002	Review of different countries	Building	1. Lack of experience
				2. Poor methods of construction
				3. Delay procurment of equipment & materials
				4. Cash flow problems
Sambasivan M. and Soon Y.W	2007	Malaysian	Construction Industry	1. Contractors improper planning
				2. Contractors poor site management
				3. Inadequate contractor experience
				4. Inadequate client's finance & payment
Abebe N.	2015	Ethiopia	Road	1. No attention was given to its preparation and timely submission
				2. Lack of commitment from the contractor and consultant to act on time
				3. Contractors submit unrealistic project
				4. Absence of sufficient and enforceable contractual remedies
Koshe W. & Jha K.N.	2016	Ethiopia	Construction industry	1. Difficulties in financing project by contractors
				2. Escalation of materials price
				3. Ineffective project planning
				4. Delay in progress payment for completing work
Endale M.	2016	Ethiopia	Building 40/60 housing	1. Financial difficulties faced by the contractor
				2. Delay payment to the contractor
				3. Ineffective planning & scheduling
				4. Late design review & approval
Mathiwos T.	2018	Ethiopia	Water supply	1. Adverse weather condition
				2. Delay in approval of documents
				3. Equipment failure
				4. Scarcity of materials in the market

Source: owner survey (2021)

However, as seen in table 2.1 causes of delay differ among countries and types of construction. This is therefore very important to assess causes of delay for specific projects in order to devise a mechanism to mitigate the problems that would otherwise face by the construction projects.

2.4 Conceptual Framework

The aim of this section is to summarize the idea about past literature and to bring out the contributions for this study area. Thus, this part starts with the idea generated and the contribution follows.

A conceptual framework is a representation of the main concepts or variables under study and their presumed relationship with each other. The general idea of the past studies revealed that there are a number of factors causing delay. These factors can be grouped in to eight. These are design /changes-related, material-related, labor-related, equipment-related, finance- related, management-related, contractual-related and external factors.

The conceptual framework is used from works of Mathiwos (2018) who categorized delay causing factors in eight groups.

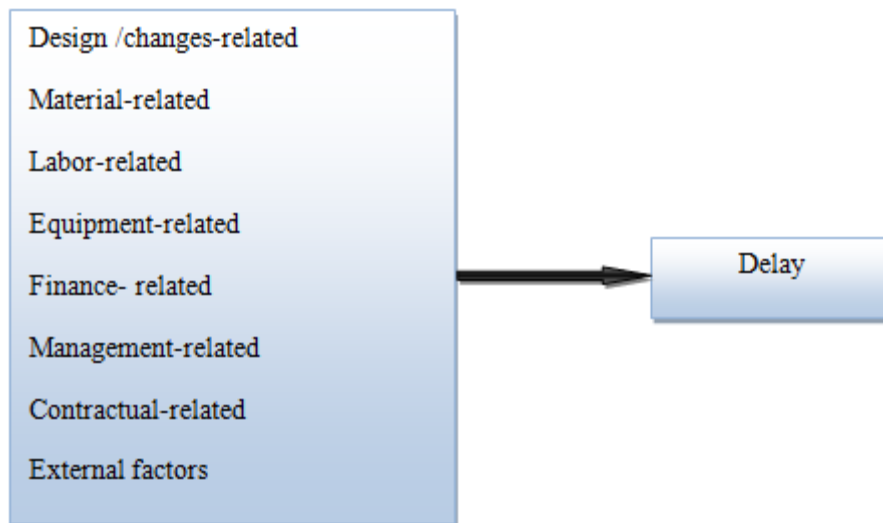


Figure 2.1: Conceptual framework, (Mathiws, 2018)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Approach

A combination of both quantitative and qualitative research methods was employed in this study. Qualitative method helped to measure opinion, knowledge or attitude of respondents related to the perceived reasons for program delay which were organized in Likert scale and multiple choices with single response. Such methodologies answer questions related to how much, how often, how many, when, and who.

The qualitative aspect of the study provided an in-depth analysis of the factors responsible for delay and their impact on the construction projects whereas quantitative design provided consistent results of the collected data as the data gathered was quantified using statistical tools.

3.2 Research Design

A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. In fact, it constitutes the blueprint for the collection, measurement and analysis of data.

The research design of this study was descriptive design in which data was collected from respondents with questionnaire. Major causes of project delay in water supply construction projects were identified from implementing organization perspective.

When in-depth, narrative descriptions of small numbers of cases are involved, the research uses description as a tool to organize data into patterns that emerge during analysis. Therefore, the researcher utilized and applied it to this study.

3.3 Data Source and Data Collection Method

3.3.1 Population and Sampling

The research considered the entire 30 PMU staffs who are working directly in the program mainly as the population which is less than 200 and basically small in size Zemenu (2017). Hence, the use of census eliminates sampling error and provides data on all the individuals in the population. Finally, the entire population was studied in order to achieve a desirable level of precision and it offered the opportunity to generalize the findings to the population of interest. In addition, the method is appropriate for explanatory, descriptive, and causal studies (Donald and Pamela, 2014).

Therefore study targeted all 20 Medium water supply projects that were implemented by the One WASH National Program and all 30 PMU staffs (program coordinators, water supply engineering technical specialists & contract administrators) who were working directly in the program were targeted.

3.3.2 Data Source and Types

Both primary and secondary data sources are used. Primary data involve collection of data for the first time from the key respondents of the research. A questionnaire was designed to assess the opinion of the program coordinator, Water Supply Engineers and Contract Administrators on the causes of delay in construction of water supply projects in in OWNPN. Secondary data from related researches and annual reports of the organization were also used and supplement the missing data from questionnaire survey.

3.3.3 Data Collection Techniques and Procedures

The required data were collected using a well prepared and pretested questionnaire. Questionnaire was developed in order to assess the perceptions of different parties involved in the construction process of medium town water supply project in Ethiopia One WASH National Program, for the evaluation and importance of the identified causes. Data gathering was made online using SmartSurvey– Online Survey Software and Questionnaire and Tool. The questionnaire was designed to be a close ended questions including with few open ended questions. These types of questions have a number of choices of possible answers and the respondents selected whatever they feel is most appropriate. The reason for selecting a questionnaire method for this research is because it has a merit of giving adequate time for informants to respond, not easily approached respondents can be reached conveniently, large sample members can be addressed, and economically cheap. Similarly, the closed ended questions were also used because they are easier to assess and answer considering how busy the respondents were.

The questionnaire focused on the causes of delay in construction projects. The interviewees were asked to check the questionnaire form about delay factors and groups prepared through a detailed literature review and complete the questionnaire form by assigning values to the factors ranging from 1 (very low important) to 5 (very high important) considering their relative importance. It was assured that respondents had significant information about delay factors in construction projects allocated necessary time to performing required tasks, and were experts on construction projects.

3.4 Data Analysis Techniques

The procedure used in analyzing of data was aimed at establishing the relative importance of the various factors that contribute to causes of delays. There are two steps used in analyzing the data: calculating the relative importance index and ranking of each factors based on the relative importance index.

The data analysis was determined to establish the relative importance of various factors that contribute to causes. Analysis of data consists of calculating the Relative Importance Index (RII) and Ranking of factors in each category based on the Relative Importance Index (RII).

$$RII = \frac{1n_1+2n_2+3n_3+4n_4+5n_5}{AN}, \dots\dots\dots\text{Equation 1}$$

Where,

- RII = Relative Importance Index, , , , = Number of respondents answer each factor
- 1, 2, 3, 4, 5 = weight given for each factor (ranging from 1 to 5),
- A = highest weight (i.e. 5 in our case),
- N = total number of respondents.

The importance indices were calculated for all delay causes and the delay causes were ranked accordingly. In order to identify how project delay can be mitigated, it is important to identify the responsible party.

3.5 Validity and Reliability of the Research

3.5.1 Validity

Validity is an essential criterion for evaluating the quality and acceptability of research.” Generally, researchers use different instruments to collect data. Therefore, the quality of these instruments is very critical because “the conclusions researchers draw is based on the information they obtain using these instruments” (Fraenkel & Wallen, 2003, p. 158). To this end the researcher validated the research instruments in terms of content analysis by forwarding the research instruments and the data to be reviewed by the advisor. Based on his review & comments the unclear and obscure questions were revised integrated. Moreover, the internal validity has been done which deals with the degree to which the researcher observes and measures what is supposed to be measured. To strengthen its internal validity data collected and the findings were triangulated using different sources like that of questionnaires, interviews and

observations. Therefore, information was collected from a variety of sources and with a variety of techniques and confirmed the findings. The similarity of results obtained indicated that the data are valid.

3.5.2 Reliability

Cronbach's alpha is used in this study to assess the internal consistency of the research instrument, which is developed questionnaire. Cronbach's α (alpha) is a coefficient of reliability used to measure the internal consistency of a test or scale; it resulted as a number between 0 and 1. As the result approaches to 1 the more is the internal consistency of the items, which means all the items measure the same variable.

The result of the coefficient alpha for this study's instrument was found to be 0.957 (Table 3.1), as indication of acceptability of the scale for further analysis since all the eight groups of factors related to delay (Design - change related, Material related, Labor related, Equipment related, Finance related, Management related, Contractual and External factors) measure the same variable, which is cause of delay. Besides the overall reliability test, the items under each of the eight causes of delay are also tested to check if they measure the same result or not. All factors consistency test result was greater than 0.7. Reliability measures clearly exceed the usual recommendation of $\alpha = 0.70$.

Table 3.1: Scale reliability (Cronbach's alpha)-for factors causing delay

Reliability Statistics for all 57 items of Factor causing delay		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.957	.956	57

Source: own survey result, (2021)

3.6 Ethical Consideration

While assessing the information, the respondent's perception was respected. The participants' consents were solicited and they are told that their personal answers would be kept confidential. Moreover, the responsibility on scientific research was maintained to the level best possible.

CHAPTER FOUR RESULT AND DISCUSSION

This chapter provides summary of the analysis on information obtained from the questionnaires. This data was used to achieve the objective of this study by the application of the above methodology. The data was collected through a survey questionnaire which was administered to 30 respondents but had a feedback of 26 respondents. The data analysis method used in this chapter present the statistical analysis of the responses given by the different stakeholders from the survey questions as explained in the research methodology.

4.1 Background Characteristic of the Respondent

4.1.1 Respondents position in the organization

Program coordinators, engineers, and regional contract administrators took part in the survey. 62% of the respondents were engineers followed by program coordinators (23%) who engage in a daily routine of the projects.

Table 4.1: Respondent position in the organization

Position	Number	Percentages
Program Coordinator	6	23
Water supply engineer	16	62
Contract management & administrator	4	15
Total	26	100

Source: Own survey (2021)

4.1.2 Familiarity with construction delay

All respondents were familiar with construction delay. They responded that that all encountered project delay. This shows that project delay is a common phenomenon that requires attention.

4.1.3 Experience in water supply construction project

Most of the respondent (61%) had grater or equal to 10 year experience, 35% of them had work experience of between 5 and 10 years ($5 \leq X < 10$) and 4% of the respondent had less than 5 years experiences in water supply project.

This showed that most of the respondents were well experienced on water supply construction projects.

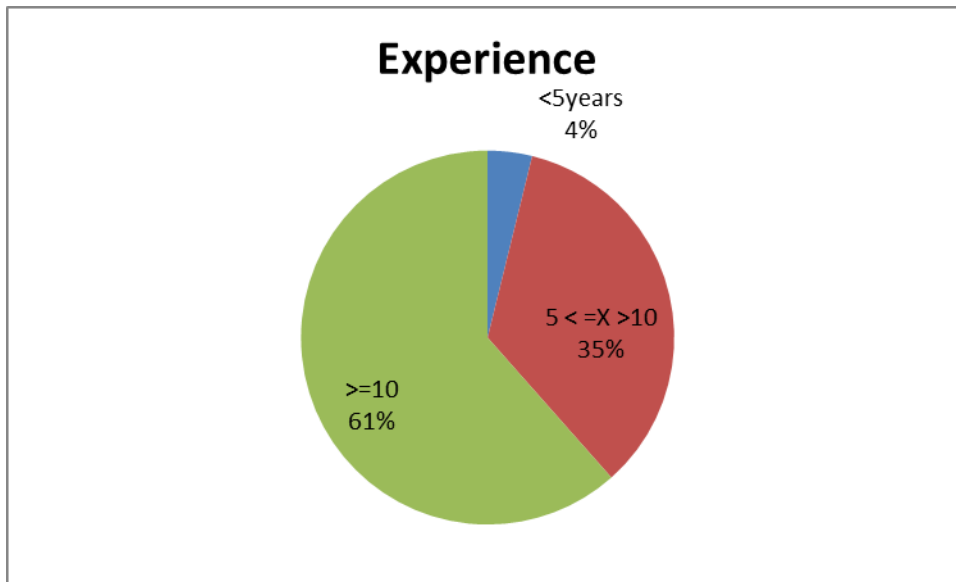


Figure 4. 1: Respondent Experience

4.2 Descriptive Results on the Existing Water supply Construction Projects Delay Mitigation Practice of the Program

Medium town water supply construction is one of the components of OOWNP of Ethiopia. There was a plan of 20 medium town water supply schemes construction in the beginning of the program in 2014. Currently the plan revised to eleven (11) water supply schemes due to the construction cost rising. Only three of them are completed namely AbiAdi, Sekota and Bambasi water supply schemes which are found in Tigray, Amhara and Benshangul Gumuz regions respectively. All the three experienced delay. For instance AbiAdi water supply scheme was completed with delay of 270%. Chenchu water supply scheme construction was terminated and the rest seven schemes are under different construction stages.

Table 4.2: Water supply projects and their status

No	Region	Medium Town Water Supply Schemes	Estimated Population	Implementation Progress May 2021	Status End of May 2021
1	Amhara	Sekota	50,334	Completed	100%
2	B gumuz	Bambasi	35,041	Completed	100%
3	Oromia	Bedeno	23,487	Active	92%
4		Gobessa	48,620	Active	78%
5		Hasassa	98,494	Active	91%
6		Robe	140,655	Active	30.5%
7		Sendafa-Beke	72,890	Active	87%
8		Sire	40,975	Active	96%
9	SNNP	Boditi	96,505	Active	90%
10		Chenchu	34,881	Terminated	26%
11	Tigray (MT)	AbiAdi	37,364	Completed	100%

Source: own survey (2021)

Though the seven water supply schemes constructions are active but they are all behind the schedule that ranges from a delay of 107% to 185%. The program will be closed in July 2021 and there is no guarantee to complete the water supply schemes constructions of the seven remaining active constructions before closure of the program.

Table 4.3: Water supply schemed contract days & delay

Sr.no	Town	Contract signed date	Commencement date	Total Contact day	Progress till March 2021 (%)	Total Day spend till March 2021	Delay (%)
1	Bedeno	5-Nov-18	01-Dec-2018	540	92	810	150
2	Sendafa	19-Feb-19	7-Mar-2019	540	87	713	132
3	Sire	4-Dec-18	28-Dec-2018	540	96	813	151
4	Gobessa	24-Jan-19	15- Feb-2019	540	78	705	131
5	Hasasa	11-Feb-19	01-Mar-2019	540	91	720	133
6	B.Robe	1-Jun-19	July-22-2019	540	30.5	578	107
7	Bodity	1-Mar-19	15 –Mar-2019	382	90	705	185

Source: NWCO (2019)

4.2.1 Existing delay mitigation practice of the program

Mitigation efforts are necessary to minimize losses due to major problems. Previous analysis on the causes of delay is crucial as to recommend the appropriate action or method to mitigate delay and minimize the effect that might be raised. Project delays have been a topic of concern in the construction industry. Delays can be minimized only when their causes are identified. Knowing the cause of any particular delay in a construction project would help avoiding the effects.

The program implemented different activities in order to avoid or minimize days in the causes of construction. The program tried to devise different mechanisms to minimize the above mentioned problems which would address some of the problems of delays in the medium town water supply construction projects. Due to this, the delays in completion of projects on time become the common phenomena in the course of implementation. The mitigation practices were

- approval of document on time
- solve right of way early
- good communication with contractors

- on time site handover
- effective planning and strong supportive supervision
- make revision when needed as soon as possible

The delay causing factors were categorized in to eight groups. However, these mitigation practices could only be able resolve some of the delays causing factors that are found in to only three group factors namely contractual related, management related and design related as shown in table 4.2 below.

Table 4.4: Categories of delay factors addressed by existing mitigation practice

Categories	Existing mitigation practices
Contractual related	Approval of document on time
	Solve right of way early
	Good communication with contractors
	On time site handover
Management related	Effective planning and strong supportive supervision
Design related	make revision when needed as soon as possible

4.3 Factors Influencing Water Supply Construction in the Program

The construction delay is counted as a common problem in construction project. Delays in construction projects happen because of various factors and causes. A total of 57 delay causing factors were identified and classified in to eight factor groups: design related, material related, labor related, equipment related, finance related, management related, contractual related and external factors.

In this respect the respondents were asked to rank the importance of delay causes using five points' scales. The importance and ranking of delay causes resulted by the research methodology of questionnaire survey using RII. The RII value had a range of 0 to 1 (0 not inclusive); the higher the RII, the more important was the cause of delays. Calculating the average RIIs of the causes in each group gives the RIIs of the mean groups. The mean RIIs and the ranking of all groups are shown in Table 4.5.

The relative important index of the data shows the level of significant the factors are to construction delay. The ranking were determined by the highest value of the RII.

The study revealed the top 10 causes of delay in water supply construction projects are:

- Fluctuation of prices/rising cost of materials
- Late material supply
- Scarcity of material in the market
- Delay payment to the contractor
- Ineffective planning and scheduling
- Less emphasis to planning
- Client finance shortage
- Unrealistic contract duration
- Delay payment to the suppliers and subcontractors
- Underestimation of the complexity of the project

Fluctuation of price/rising cost of material

Table 4.5 shows fluctuation of prices/rising cost of materials had the highest value of RII of 0.815 and the respondent ranked first which indicates that the respondent consider fluctuation of price / rising cost as the most significant factors among all the causes of delay of medium town water supply construction projects. This is may be due to the change in currency that results in the devaluation of Birr. The rising of the cost of construction material due to the fast & ever changing of exchange rates can result in a project costing way more than its original budget. This has also implication on delivery of materials on time. If there is a rise in cost of construction materials, it will be difficult to deliver materials in the required. So delay is imminent in such condition.

Late material supply and scarcity of material

Late material supply was also considered to be significant by the respondents with RII value of 0.708 and ranked second. Scarcity of material in the market was ranked third with RII 0.677. Both factors are related since if there is scarcity of material, the supply of material, would take long time to get the required material which will have an impact on the completion time of the project. Materials delivery is among the critical issues that need to be appropriately controlled. Material procurement is one of the major elements of managing a construction project. If it is not managed appropriately, it could lead to delay for the project. A study by Koushki *et al.*, (2005) revealed that nearly one-fourth of the total project delays were due to the late delivery of materials.

Delay payment to contractors, ineffective planning & schedule of project and less emphasis to planning

Delayed payment to the contractors, ineffective planning and less emphasis to planning were all ranked fourth with the RII value of 0.662.

Delay in paying construction contractors has impacted negatively on the effectiveness of the contractor and as such affect project delivery schedule. Delayed payment of the contractor affected the project by causing: loss of productivity and efficiency; increase in time-related costs; re-scheduling and re-sequencing of works; extension of time and acceleration; as well as prevention of early completion. The study concluded that timely payment of contractors is crucial for ensuring the continuity of works and completion of infrastructural projects within time, budget, and quality specifications (Paul *et al.*, 2015). But regular monthly payment to the contracts for work done remove constraints which otherwise may have impend project progress cast delay and cost overrun (Frimpong *et al.*, 2003).

It should therefore be important to take necessary step to minimize the payment delays of contractors' progress payment by developing a mechanism to expedite certification, approval and payment process.

Planning in the construction industry involves establishing the most effective sequence of events necessary to accomplish a project in time. Project failure is mostly as a result of inadequate use of formal contract planning and management principles and techniques by contracting organization. Contract planning in construction projects is bedeviled with chronic inefficiencies that influence the performance of project delivery. In addition, ineffective planning and scheduling was one of the severe causes of delay in large construction projects as identified by (Assaf & aL-Hejji, 2006).

Client's financial shortage, Unrealistic contract duration, Delay payment to the supplier and subcontractor

Client's financial shortage ranked seventh based on the RII value of 0.646 as shown in Table 4.5. It is one of the factors in the finance-related category. Shortage of client's financial resources has multiple effects on the performance of the projects. This will result in late payment, poor cash flow management, and insufficient financial resources. In addition, the projects may face difficulties in obtaining loans from financiers.

Abdul-Rahman *et al.* (2006) addressed that lack of funds may affect the project's cash flow and lead to delay of site possession which consequently causes delays to the project as a whole. The factors that would cause insufficient financial resources are: 1) difficulties in getting loans from financiers and 2) allocation of government budget not in place.

Unrealistic contract duration similarly ranked seventh with an RII value of 0.646. Depending on the type of project, different stakeholders determine this construction duration, using the available information at the time. Where the available information is insufficient, the scheduler will determine the duration using their own individual experience on similar projects. Inexperienced professionals often underestimate the project duration, resulting in project delay.

In addition, the construction scheduling impacts a project where unrealistic dates are provided on the initial planning. This is mainly due to the use of unrealistic baseline dates since the duration of

to complete a project is estimated a base line date. Where the baseline dates are not realistic, the contractor’s critical path will be affected. Where the activities on the critical part are affected, there is due to be a delay, unless the contractor mitigates the delay on time.

Table 4.5: Top ten important delay causing factors

Number	Most important factors	Factor group	RII	Rank
1	Fluctuation of prices/rising cost of material	Finance related	0.815	1
2	Late materials supply	Material related	0.708	2
3	Scarcity of material in market	Material related	0.677	3
4	Delayed payments to contractors	Finance related	0.662	4
5	Ineffective planning and scheduling of project	Management related	0.662	4
6	Less emphasis to planning	Management related	0.662	4
7	Client’s finance shortage	Finance related	0.646	7
8	Unrealistic contract duration	Management related	0.646	7
9	Delayed payments to suppliers and subcontractors	Finance related	0.646	7
10	Underestimation of the complexity of the project	Management related	0.615	10

Source: own survey (2021)

Delay payment to the supplier and subcontractor is one of the factors of finance related category and ranked seventh similar to client’s finance shortage and unrealistic duration.

Delayed payment of the supplier and subcontractor had the same effect with delay payment to the contractor that would affect the project by causing: loss of productivity and efficiency; increase in time-related costs; re-scheduling and re-sequencing of works; extension of time and acceleration; as well as prevention of early completion.

The 10 least important delay causing factors

The least important factors causing delay were change order, laws – regulation and natural disaster based on the RII with the value of 0.338, 0.385 and 0.400 of RII respectively as shown in the Table 4.6.

Table 4.6: Ten least important delay causing factors

Number	Least important factors os causing delay	Factor group	RII	Rank
1	Improper equipment	Equipment Related	0.431	48
2	Old technology	Management related	0.431	48
3	Poor supervision	Management related	0.415	50
4	Quality of materials	Material related	0.415	50
5	Equipment unavailability	Equipment Related	0.415	50
6	Organizational changes	Management related	0.415	50
7	Incomplete contract document	Design change related	0.400	54
8	Natural disasters	External related	0.400	54
9	Laws – regulations	External related	0.385	56
10	Change order	Design change related	0.338	57

Source: own survey (2021)

4.4 Category of Delay Factors

According to the ranking of the groups (Table 4.7), finance related factors with the mean value of 0.635 RII were the most significant causes of water supply construction projects. Factors of each groups that contribute most to delays are discussed in as follow.

Table 4.7: Mean RII & ranking category of delay factors

<i>Group Factors</i>	<i>RII</i>	<i>Rank</i>
Finance related	0.635	1
Material related	0.600	2
Contractual	0.523	3
Management related	0.519	4
External	0.489	5
Design change related	0.480	6
Labor related	0.456	7
Equipment related	0.431	8

Source: own survey (2021)

Finance Related factors (RII=0.635)

The finance related group of delay factors was the most important group to cause delays. This was due to the factors fluctuation of price/rising cost of materials (RII = 0.815), delay payment to the contractor (RII=0.662), client financial shortage (RII=0.646), and delay payment to the suppliers (RII=0.646).

This will affect delivery of material to the site; increase the cost of materials and equipment, raise conflict and slow progress of the work. According to Ahmed *et al.*, (2003), the possible financial related factors that lead to delays in Malaysian construction projects are financial problems of clients such as delayed payments, financial difficulties and economic problems; financial and cash flow problems of contractors; and external factor of poor economic conditions such as currency and inflation rate.

Table 4.8: RII & rank of finance related cause of delay

Cause of Delay	RII	Rank
Delayed payments to contractors	0.662	2
Delayed payments to suppliers and subcontractors	0.646	3
Client's finance shortage	0.646	3
Financial difficulties faced by the contractor	0.600	5
Difficulty in accessing credit	0.569	6
Ill-financed project	0.508	7
Fluctuation of prices/rising cost of material	0.815	1

Source: own survey (2021)

Among others, a financial-related factor is one of the most critical factors that cause delays in construction projects (Alaghbari *et al* , 2007). The statement is supported by Sweis *et al* (2007) stating that in Jordan, financial difficulties faced by many contractors cause delay in construction projects.

Material Related Factor (RII=0.600)

The second most important group was the contractual related group whose most significant factors were late material supply and scarcity of material with RII value of 0.708 & 0.677 respectively.

The selection time-period, the type of construction materials and their availability at the local market all affected the quantity of time-delays and cost overruns associated with the delivery of materials to construction sites.

In addition to materials-related components, the hiring of an engineer to independently supervise and monitor the progress of the construction work also contributed positively and significantly to on-time delivery of materials to construction sites.

Type of project and complexity of the project affects the delivery of construction material. The larger and costlier projects experienced longer time delays and higher cost increases due to the later delivery of their construction materials.

Table 4.9: RII and rank of material related delay

Cause of Delay	RII	Rank
Quality of materials	0.415	3
Late materials supply	0.708	1
Scarcity of material in market	0.677	2

Source: own survey (2021)

Contractual Related Factors (RII=0.523)

After the material related group, the contractual-related group of delay factors came in as the third most important group. The significant factors were duration of inspection procedure (RII=0.600), delay in approval of document (RII=0.569), slowness indecision making, non-utilization of contract management (RII=0.554) and delay in delivering project site to contractor (RII=0.554).

Water supply construction project of the program required to get various types of approval from government and donor side. The delay getting approval of documents like right of way from government and no object from donors for pipe excavation, construction of reservoirs and booster stations are causes of delay in the construction of water supply projects.

Table 4.10: RII and rank of contractual related delay

Cause of Delay	RII	Rank
Non utilization of professional construction/Contractual management	0.554	3
Delay in delivering site project to contractor	0.554	3
Delay in approval of documents	0.569	2
Unsmooth internal and external communications	0.446	10
Lack of communication between parties	0.492	7
Slowness in giving instruction	0.492	7
Slowness in decision making process	0.554	3
Duration of inspection procedure	0.600	1
Delay in performance of subcontractors	0.462	9
Problems with subcontractors	0.508	6

Source: own survey (2021)

Management Related Factors (RII=0.519)

Following the contractual, material related delay factors ranks as the fourth most important group. The notable factors were in effective planning & scheduling and less emphasis to planning both had the value of RII=0.662, unrealistic contract duration (RII = 0.646), underestimating the complexity of the project (RII=0.615) and inaccurate cost estimation (RII=0.569).

Table 4.11: RII and rank of management related cause of delay

Cause of Delay	RII	Rank
Organizational changes	0.415	14
Old technology	0.431	13
Poor supervision	0.415	14
Poor site management	0.492	6
Mistakes in construction	0.446	12
Unrealistic contract duration	0.646	3
Inaccurate cost estimation	0.569	5
Not Preparing the method statements	0.492	6
Inappropriate organization management	0.492	6
Less emphasis to planning	0.662	1
Ineffective planning and scheduling of project	0.662	1
Inadequate contractor experience	0.492	6
Inadequate consultant experience	0.492	6
Underestimation of the complexity of the project	0.615	4
Many Provisional Sums and Prime	0.462	11

Source: own survey (2021)

External factors (R=0.489)

The fifth most important group was the external-related group. The prominent factors were adverse weather condition (RII=0.600), regulatory change (RII=0.585) and building permit approval (R=0.477).

Table 4.12: RII and rank of external factor related delay

Cause of Delay	RII	Rank
Regulatory changes	0.585	2
Laws – regulations	0.385	5
Building Permits Approval	0.477	3
Adverse weather condition	0.600	1
Natural disasters	0.400	4

Source: own survey (2021)

Design Change Related Cause of Delay (RII=0.480)

After external, the design change related group of delay factors was the sixth most important group. The significant factors were decision during development stage (RII=0.615) and variation (RII=0.569).

Table 4.13: RII and rank of design change related delay

Cause of Delay	RII	Rank
Change order	0.338	11
Change in drawings	0.446	8
Change in specification	0.477	5
Incomplete contract document	0.400	10
Decision during development stage	0.615	1
Design development	0.538	3
Shop design approval	0.508	4
Mistakes and description in design documents	0.462	7
Change in subsurface condition	0.477	5
Change in the scope of the project	0.446	8
Variation	0.569	2

Source: own survey (2021)

Labor Related Cause of Delay (RII=0.456)

The labor related group of delay factors ranked as the seventh most important groups. The notable factors were shortage, low skill and low productivity of labor with RII value of 0.462, 0.462 and 0.446 respectively.

Table 4.14: RII and rank of labor related delay

Cause of Delay	RII	Rank
Shortage of labors	0.462	1
Low productivity level of labor	0.446	3
Low skill of labor	0.462	1

Source: own survey (2021)

Equipment related delay (RII=0.431)

Table 4.15 : RII and Rank of Equipment Related Cause of Delay

Cause of Delay	RII	Rank
Improper equipment	0.431	2
Equipment unavailability	0.415	3
Equipment labor	0.446	1

Source: own survey (2021)

The eighth most important group was the equipment-related group. The prominent factors were equipment labor (RII=0.446), improper equipment (R=0.421) and equipment unavailability (RII=0.415).

Summary

The five important factors causing delay in the medium water construction projects of the program were identified to be fluctuation of prices/rising cost of materials, late materials delivery, scarcity of material in the markets delay payment to the contractors and ineffective planning scheduling.

Koshe and Jha (2016) also identified escalation of cost of materials (fluctuation of prices/rising cost of materials) was one of the major causes of project delay in Ethiopian construction industry. Late material delivery was identified the second most important factor by the respondents of this research and similarly Chan and Kumaraswamy (2002) considered late material delivery to be the key factor contributing to time overruns in construction projects globally and Al-Momani (2000) found as the main causes of delay in construction of public projects in Jordan.

Scarcity of material was identified as the third most important factors by the respondent and it was also considered as the five important factors causing delay (Mathios, 2018).

Delay payment to the contractor was ranked fourth and similarly Endale (2016) also identified as the delay causing factor in 40/60 housing construction in Ethiopia.

Ineffective planning and scheduling was found to be the fifth important factors in the contraction of medium town water supply in Ethiopia and other studies conducted by Endale (2016) supported the result as the causes of delay in the construction of 40/60 saving houses project in Ethiopia and Koshe and Jha (2016) also identified the factor as the most influential.

Table 4.16: Comparison of studied delay factors with previous study

	Major Factors				
	1	2	3	4	5
Present study	Fluctuation of prices/rising cost of material	Late materials supply	Scarcity of material in market	Delayed payments to contractors	Ineffective planning & scheduling
Al-Momani H. A (2000).	Design & user changes	Weather	Site condition	Late delivery	Economic condition & increase in quantity
Odeh A.M.and Battaineh H.T (2002)	Owners interference	Inadequate contractor experience	Financing and payments	Labor productivity	Slow decision making process
Chan D.W.M. and Kumaraswamy M.M. (2002)	Lack of experience	Poor methods of construction	Delay procurement of equipment & materials	Cash flow problems	Labor shortage
Sambasivan M. and Soon Y.W (2007)	Contractors improper planning	Contractors poor site management	Inadequate contractor experience	Inadequate client's finance & payment	Problem with subcontractors
Abebe N. (2015)	No attention was given to its preparation and timely submission	Lack of commitment from the contractor and consultant to act on time	Contractors submit unrealistic project	Absence of sufficient and enforceable contractual remedies	
Koshe W. & Jha K.N. (2016)	Difficulties in financing project by contractors	Escalation of materials price	Ineffective project planning	Delay in progress payment for completing work	Lack of skilled professional in construction management
Endale M. (2016)	Financial difficulties faced by the contractor	Delay payment to the contractor	Ineffective planning & scheduling	Late design review & approval	Slow decision making process
Mathiwos T. (2018)	Adverse weather condition	Delay in approval of documents	Equipment failure	Scarcity of materials in the market	Poor supervision

Source: own survey (2021)

4.5 Measures Required to Avoid or Minimized Delay in Medium Water Supply Construction Projects

The water supply projects practiced important delay mitigation activities which were important for the purpose. However, those practices were not able to address all relevant delay causing factors identified in this study. Therefore, based on the existing practice, project document and literature review, the researcher proposed the following measure to avoid or minimize delay including the existing practices.

- Perform a preconstruction planning of project tasks and resource needs
- Allocation of sufficient time and money at the design phase
- Frequent progress meeting & Clear information and communication channels
- Effective strategic planning
- Ensure timely delivery of materials
- Contingency allowance
- Accurate initial time estimates

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

This section presents an overall summary and the conclusion drawn from the study in accordance with the research objective and finally the recommendation will be discussed.

5.1 Summary of Major Findings

Delays can be avoided or minimized when their causes are clearly identified. The aim of this paper was to identify the delay factors in water construction projects because delays are considered to be a serious problem in the OWNP water supply construction project.

The program annual reports, aide memoires and evaluation reports were reviewed in order to get information about the existing water supply construction delay mitigation measures exercised in water supply projects of the program.

One or combination of the following activity was practiced to minimize delay in the medium water supply construction projects of the program. The activities were approval of document on time; solve right of way early without delay; good communication with contractors; effective planning and strong supportive supervision; make revision when needed as soon as possible; on time site handover and enforcing liquidation damage. However all water supply projects experienced delay. This is may be the measures would not address all the problems the projects encountered and were not the results of the detailed assessment.

The water supply projects were reduced from 20 to 11; three of them were completed; one terminated and the rest seven were at different stages of construction. In addition, all medium town water supply projects of the program were experienced delay which ranges from 104% to 270%.

Through a detailed literature review, a total of 57 different delay factors were identified and categorized into eight groups. The paper then quantified the relative importance of delay factors and demonstrated the ranking of the factors and groups according to their importance level for delays. This objective was achieved through analysis of interview outcomes. According to the

computed RIIs, all factors and groups were ranked. The paper addressed the most significant factors and groups of causes of delays. The most and least important factors and groups were achieved through ranking results.

The top ten most important causes of delay in the water supply construction were in their descending order are: fluctuation of price/rising cost of materials; late materials supply; delayed payment to the contractor; ineffective planning and scheduling; less emphasis to planning; clients financial shortage; unrealistic contract duration; delayed payment to suppliers & subcontractors and underestimating of the complexity of the project.

The major delays groups identified are: Finance related delays; Material related delays; Contractual related delays and Management related delays.

5.2 Conclusion

In OOWNP medium town water supply construction projects where time truly equals money, the management of time is critical, thus predicting the likelihood of schedule delay may play a key role towards project success. Even though, the projects practiced some mitigation activities without assessment, could not solve all problems related to delay.

There are delays in all projects of medium town water supply construction of the program. As per the overall view fluctuation of price, late supply of materials, scarcity of materials in the market, delay in payment to the contractors and ineffective planning are the first five important factors causing delay in the program of water supply project. A proper understanding of these causes of delays and their consequences will help the relevant project professionals to better manage delay situations in construction of medium town water supply projects of the program.

This is therefore very important to use project management tools and techniques in order to avoid or reduce delay in the medium water supply construction projects of Ethiopian OOWNP.

5.3 Recommendation

In general water supply construction projects should use project management tools and techniques since they play an important role in the efficient and effective completion of a project

in order to manage the projects effectively and efficiently that would otherwise mismanaged leads to failure to meet their set deadlines for completion.

- Fluctuation of price/rising cost of materials due to cost escalation of construction material results in serious budget deficit. This will affect the overall performance of the project by affecting the time of completion and scope. Therefore, the implementer should be aware of this ahead and revise its cost estimation if it occurs.
- The implementer should devise a mechanism in order to have effective procurement planning system and effective construction planning. Translation of physical and financial plan to procurement plan should be done properly and implement it according to the plan in order to overcome the problem of late material supply and scarcity of materials. Delivery of construction materials to a site should not be late so that work may be executed in the planned order.
- Attention should be given for effective planning and scheduling. During construction, planning and scheduling may be revised if necessary conditions occur. Only a project that is well planned and scheduled can be well executed. The planning and scheduling of the project should be done properly and the revision of the schedules has to be done as required.
- It is necessary to decide realistic project duration considering various aspects
- Appropriate total cost estimates should be prepared at the initial stage of projects and the client should settle the contractors' claims without delay.
- Delivery of construction material to the site should not be late.
- Appropriate funding levels should always be determined at planning stage so that regular payment should be made to contractor for work done.
- Payment of contractors should be planned properly by initiating appropriate mitigation measures against potential risks, such as delayed disbursement of funds by external financiers and delayed approval of contractors' payment requests

5.4 Recommendation for Further Study

One of limitation of this research was it identified the cause of medium water supply construction project base on the perception of only the client. Therefore similar studies can be conducted considering the perception of all parties involved in the construction project namely client, contractor and consultant.

In addition, material price fluctuation is found to be the most important factor of causing delay in water supply construction as per the result of this study. It is therefore good to conduct the causal relationship between material price fluctuation and project time over run.

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APPENDIX

1. RII, Ranking of Delay Factors & Response Scores

Factor Group	Number	Factor causing delay	Response score					W	A = 5	RII	Rank
			1: Very low	2: low	3: average	4: high	5: very high				
1. Design - change related	1	Change order	12	10	4	0	0	44		0.338	57
	2	Change in drawings	8	8	6	4	0	58		0.446	43
	3	Change in specification	8	6	6	6	0	62		0.477	35
	4	Incomplete contract document	12	6	4	4	0	52		0.400	54
	5	Decision during development stage	4	2	8	12	0	80		0.615	10
	6	Design development	4	6	10	6	0	70		0.538	24
	7	Shop design approval	6	6	10	2	2	66		0.508	25
	8	Mistakes and description in design documents	8	6	8	4	0	60		0.462	38
	9	Change in subsurface condition	6	8	10	0	2	62		0.477	35
	10	Change in the scope of the project	8	8	6	4	0	58		0.446	43
	11	Variation	6	6	4	6	4	74		0.569	17
2. Material related	1	Quality of materials	12	2	10	2	0	54		0.600	12
	2	Late materials supply	4	2	4	8	8	92		0.708	2
	3	Scarcity of material in market	4	4	2	10	6	88		0.677	3
3. Labor related	1	Shortage of labors	8	8	4	6	0	60		0.462	38
	2	Low productivity level of labor	10	6	6	2	2	58		0.446	43
	3	Low skill of labor	8	8	6	2	2	60		0.462	38
4. Equipment related	1	Improper equipment	12	2	8	4	0	56		0.431	49
	2	Equipment unavailability	8	4	10	2	0	54		0.415	51
	3	Equipment labor	8	8	6	4	0	58		0.446	43
5. Finance related	1	Delayed payments to contractors	6	2	2	10	6	86		0.662	4
	2	Delayed payments to suppliers and subcontractors	4	4	4	10	4	84		0.646	7

	3	Client's finance shortage	4	4	4	10	4	84	0.646	7
	4	Financial difficulties faced by the contractor	6	2	8	6	4	78	0.600	12
	5	Difficulty in accessing credit	6	4	6	8	2	74	0.569	17
	6	Ill-financed project	8	4	8	4	2	66	0.508	25
	7	Fluctuation of prices/rising cost of material	2	2	4	2	16	106	0.815	1
6. Management related	1	Organizational changes	12	4	6	4	0	54	0.415	51
	2	Old technology	8	10	4	4	0	56	0.431	49
	3	Poor supervision	12	2	10	2	0	54	0.415	51
	4	Poor site management	8	6	6	4	2	64	0.492	28
	5	Mistakes in construction	8	10	2	6	0	58	0.446	43
	6	Unrealistic contract duration	4	4	4	10	4	84	0.646	7
	7	Inaccurate cost estimation	6	4	6	8	2	74	0.569	17
	8	Not Preparing the method statements	6	6	10	4	0	64	0.492	28
	9	Inappropriate organization management	6	4	14	2	0	64	0.492	28
	10	Less emphasis to planning	2	8	2	8	6	86	0.662	4
	11	Ineffective planning and scheduling of project	4	4	4	8	6	86	0.662	4
	13	Inadequate contractor experience	8	4	10	2	2	64	0.492	28
	14	Inadequate consultant experience	8	4	10	2	2	64	0.492	28
	15	Underestimation of the complexity of the project	6	4	6	2	8	80	0.615	10
	16	Many Provisional Sums and Prime	8	6	8	4	0	60	0.462	38
	7. Contractual	1	Non utilization of professional construction/Contractual management	6	4	8	6	2	72	0.554
3		Delay in delivering site project to contractor	4	6	10	4	2	72	0.554	21
5		Delay in approval of documents	6	2	10	6	2	74	0.569	17
6		Unsmooth internal and external communications	10	4	8	4	0	58	0.446	43
7		Lack of communication between parties	8	6	6	4	2	64	0.492	28
8		Slowness in giving instruction	8	4	8	6	0	64	0.492	28

	9	Slowness in decision making process	6	4	8	6	2	72		0.554	21
	10	Duration of inspection procedure suppliers	4	4	8	8	2	78		0.600	12
	11	Delay in performance of subcontractors	8	4	4	8	0	60		0.462	38
	12	Problems with subcontractors	8	4	8	4	1	61		0.508	25
8. External	1	Regulatory changes	0	10	10	4	2	76		0.585	16
	2	Laws – regulations	4	8	10	0	0	50		0.385	56
	3	Building Permits Approval	8	6	6	6	0	62		0.477	35
	4	Adverse weather condition	4	4	10	4	4	78		0.600	12
	5	Natural disasters	10	10	4	0	2	52		0.400	54

2. Questionnaire

The aim of this questionnaire is to gather information about the Assessment of Causes of Delay in Construction of Water Supply Projects. This questionnaire is required to be filled with exact relevant facts as much as possible. All data included in this questionnaire will be used only for academic research and will be strictly confidential. After all questionnaires are collected and analyzed, interested participants of this study will be given feedback on the overall research results. Please respond to each question by adding a tick in the appropriate response or filling in the relevant information.

SECTION A- Background and Knowledge of Respondents on construction delay

1. What is the Name of the Project Site? _____

2. Which of the stakeholder are you? (Please choose one).

Contractor Consultant Client

3. What is your position in the organization? _____

4. What is your length of experience in construction of water supply projects? _____

5. Have you been involved in projects that were delayed? _____

6. How long was the project delayed? _____

SECTION B – Causes of construction delay

Please tick the causes of the delay on the performance of the project you have been working on. Using the following scale: 1 very low; 2 Low; 3 Average; 4 High and 5 very high.

Category of Cause of Delay	Main cause of delay	Very low	low	average	high	very high
1.Design change related	Change order					
	Change in drawings					
	Change in specification					
	Incomplete contract document					
	Decision during development stage					
	Design development					
	Shop design approval					
	Mistakes and description in design documents					
	Change in subsurface condition					
	Change in the scope of the project					
	Variation					

2.	Material related	Quality of materials							
		Late materials supply							
		Scarcity of material in market							
3.	Labor related	Shortage of labors							
		Low productivity level of labor							
		Low skill of labor							
4.	Equipment related	Improper equipment							
		Equipment unavailability							
		Equipment labor							
5.	Finance related	Delayed payments to contractors							
		Delayed payments to suppliers and subcontractors							
		Client's finance shortage							
		Financial difficulties faced by the contractor							
		Difficulty in accessing credit							
		Ill-financed project							
		Fluctuation of prices/rising cost of material							
6.	Management related	Organizational changes							
		Old technology							
		Poor supervision							
		Poor site management							
		Mistakes in construction							
		Unrealistic contract duration							
		Inaccurate cost estimation							
		Not Preparing the method statements							
		Inappropriate organization management							
		Less emphasis to planning							
		Ineffective planning and scheduling of project							
		Inadequate contractor experience							
		Inadequate consultant experience							
		Underestimation of the complexity of the project							
		Many Provisional Sums and Prime							
		7.	Contractual	Non utilization of professional construction/Contractual management					
				Delay in delivering site project to contractor					
Delay in approval of documents									
Unsmooth internal and external communications									
Lack of communication between parties									
Slowness in giving instruction									
Slowness in decision making process									
Duration of inspection procedure									

		suppliers				
		Delay in performance of subcontractors				
		Problems with subcontractors				
8.	External	Regulatory changes				
		Laws – regulations				
		Building Permits Approval				
		Adverse weather condition				
		Natural disasters				