Causes of Delays in Large Scale Irrigation Projects in Ethiopia

By Alemayehu Dula

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Advisor: Abdurazak Mohammed (Ph.D.)

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Certificate of Originality

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted at any university for a degree.

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Abstract

This study identified major factors behind delay in large irrigation projects in Ethiopia. The study focused on irrigation schemes that are owned and are being financed by government entities like Ministry of Water, Irrigation and Electricity (MoWIE) and The Ethiopian Construction Works Corporation (ECWC). The study was aimed at identifying the major causes of delay, the most frequently cited delay groups and identifying the frequently used delay resolution techniques. A Mean Score (MS) analysis was employed and from the listed 48 (forty-eight) delay factors, poor planning and activity scheduling (MS=3.33), poor project management (MS=3.15), problems in material delivery on time (MS=3.10), poor monitoring and evaluation system (MS=3.08), poor site management (MS= 2.95), delay in payment (MS=2.93), unfinished designs (MS=2.93), error in estimating durations (MS=2.9), contractor financial problems (MS=2.88), Poor decision making (MS=2.85) and issues related to right of way (MS=2.85) were found to be the highest ranking delay causes. Out of the listed 11 (eleven) factors, 4(four) fall under contractor delay category, followed by 3 (three) which fall under consultants' category, 3 (three) under clients and 1 (one) under External category. When it comes to resolution methods forwarded by respondents, out of the 27 (twenty-seven) resolution methods, the 6 (six) top ranked resolution methods identified were estimating realistic cost and duration, making payment timely, Strategic planning, improving supply of materials and labor, developing systematic control mechanisms, and monitoring progress during control period. These resolution methods were listed by clients, contractors and consultants as top ranking as well.

Key words: large scale irrigation, Delay, Delay resolution, Contractors, Consultants, Clients

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Acronyms and Abbreviations

CH	Chainage
D&IMC	Dam and Irrigation Management Center
ECDSC	Ethiopian Construction Design and Supervision Corporation
ECWC:	Ethiopian Construction Works Corporation
EWWC	Ethiopian Water Works Corporation
EWWCA	Ethiopian Water Works Construction Authority
FIDIC	International Federation of Consulting Engineers
GTP	Growth and Transformation Plan
JWHC	Jiangxi Water and Hydropower Construction
MOFED	Ministry of Finance and Economic Development
MoWIE	Ministry of Water, Irrigation and Electricity
MS	Mean Score
NWRC	National Water Resources Commission and constructed by
SDCSE	South Design and Construction Supervision Enterprise
SMD	Sub Main Drains
SWWC	South Water Works Construction
TDIP	Tendaho Dam and Irrigation Project

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1 Introduction

1.1 Background of the study

Ethiopia has one of the largest arable land by land proportion (Tewdros K., 2017). And most of this land is suitable for a mechanized agriculture that can be served by irrigation. Moreover, the land is traversed by large rivers which can be easily used for irrigation. However, the agricultural sector is still dependent on seasonal rainfall (Awlachew S. and Ayana M ,2011).

Understanding the huge potential but the limited progress of the sector, the Ethiopian government has proposed large scale projects during the first phase of the growth and transformation plans (GTP). The projects were mainly in the area of developing land for sugar cane production. These projects were so huge that they were believed to quench the ever- growing demand for sugar internally and even produce surplus for export market (MOFED, 2010).

However, most of these projects, including the irrigation sector that were assumed to serve the projects were never completed on schedule. Delay in projects is among the most rampant problems that are frequent occurrences in any project. This problem of not meeting deadlines is common in the construction sector, of which irrigation schemes are the main ones (Morris, 1990). And the problem of time overrun, as it is called, is the main cause of cost overruns, and quality compromises.

The issues have been a subject of various research articles both published and unpublished. The context in which the overruns occur and the unique aspects of the conditions in different countries have been studied (Odeck, 2004, Ghenbasha M. R. R et. al., 2017, Muralidaran R.,2018).

1.2 Statement problems

The main objective of project management is to deliver projects in time, within the stated budget and with the required quality (Gbahabo and Ajuwon, 2017). The effect of delay in construction projects is very detrimental to the project if it is not tackled properly and in time (Alnuaimi and Moshin,2013). Delay in construction projects usually cost clients large sums of monetary resource as both material and labor costs are time sensitive. The damage becomes severe when projects are public projects, like irrigation schemes, made with tax payers' money.

The cost incurred due to delays are headaches to clients. Especially when it comes to Publicly funded projects, the problem becomes colossal. Public agencies, whose major source of funding is the tax payer need to be transparent and accountable to every bit of money they spend. The sad truth is that, the effect will not stop there. One thing is that quality will be compromised. Another is the public will not be served well.

Most large-scale projects including irrigation projects are built through cooperation loans which need to be repaid with interests. Thus, incurring additional cost on top of the already existing loan exerts a huge burden on the country's economy. Identifying the major causes behind delay in irrigation projects would be an initial step towards reducing these setbacks, if not eliminate them entirely.

1.3 Objective of the research

1.3.1 Main objective

The main objective of the research is to identify the factors behind delay in large scale irrigation projects in Ethiopia.

1.3.2 Specific objectives

The specific objectives of the research are:

- To rank factors causing delay according to their frequency
- To classify factors based on the party responsible
- To suggest the commonly used resolution methods when delay occurs

1.4 Research questions

The major questions to be answered undertaking the research are:

1. What are the main causes of delay in large scale irrigation projects in the Ethiopian context?
2. Which factors groups are more contributing to delay in the case of irrigation projects?
3. What is the preferred mode of delay resolution applied by responsible parties?

1.5 Significance of the study

This research is hoped to be very useful to all stakeholders involved in large scale irrigation projects. These people need to be very sure of major causes of delays before the commencement of a project at least in the planning phase. This will relive then from incurring additional cost and will also make them vigilant of their time.

Through identifying the factors that often cause these problems, measures can be put in place before hand. Even if there are some differences between construction projects, the findings of this research can also be used as a baseline in building, road or any other construction.

There have been several studies conducted in these regards within the construction sector. The same is true for the case of Ethiopia. There are studies that revolved around delay in construction projects, although it is very rare to find a research aimed at identifying the causes of delays in irrigation projects. This research will contribute in terms of filling this gap. The research is aimed at identifying the major factors, contractor-related, consultant-related or client related, that are the major contributors to these rampant problems.

The outcome the research will hopefully be an important milestone in solving the problems once and for all This problem of not meeting deadlines is common in the construction sector, of which irrigation schemes are the main ones (Morris, 1990). And a major impediment faced by these projects and preventing the projects from serving their intended purpose are time delays and the corresponding cost escalation. Therefore, studying the causes cannot be overlooked. It is a major stepping stone towards eliminating the setbacks.

1.6 Scope of study

The research only focued on large scale irrigation projects. According to Rahmeto (1999) and Awulachew and Gebremedhin (2007), a large-scale irrigation project is any irrigation project that serves more than 3000 hectares of land. Even if there are other classifications that are relevant, in this study the common classification, which is that large irrigation schemes are the ones that are aimed at developing more than 3000 hectares is used.

1.7 Limitation of the study

This study has limited its scope from the onset on large irrigation projects in Ethiopia. Most of the large irrigation schemes scrutinized in this project are funded by the Federal government of Ethiopia. And such projects are mainly constructed and supervised by Ethiopian construction works Corporation (ECWC) and Ethiopian Construction Design & Supervision Works

Corporation (ECDSC) respectively. ECWC also acts as a client in some of the projects. Thus, some of its employees have also participated in the research acting as a client.

1.8 Organization of the study

The research paper have five major chapters, the organization of which is as shown in the schematics below.

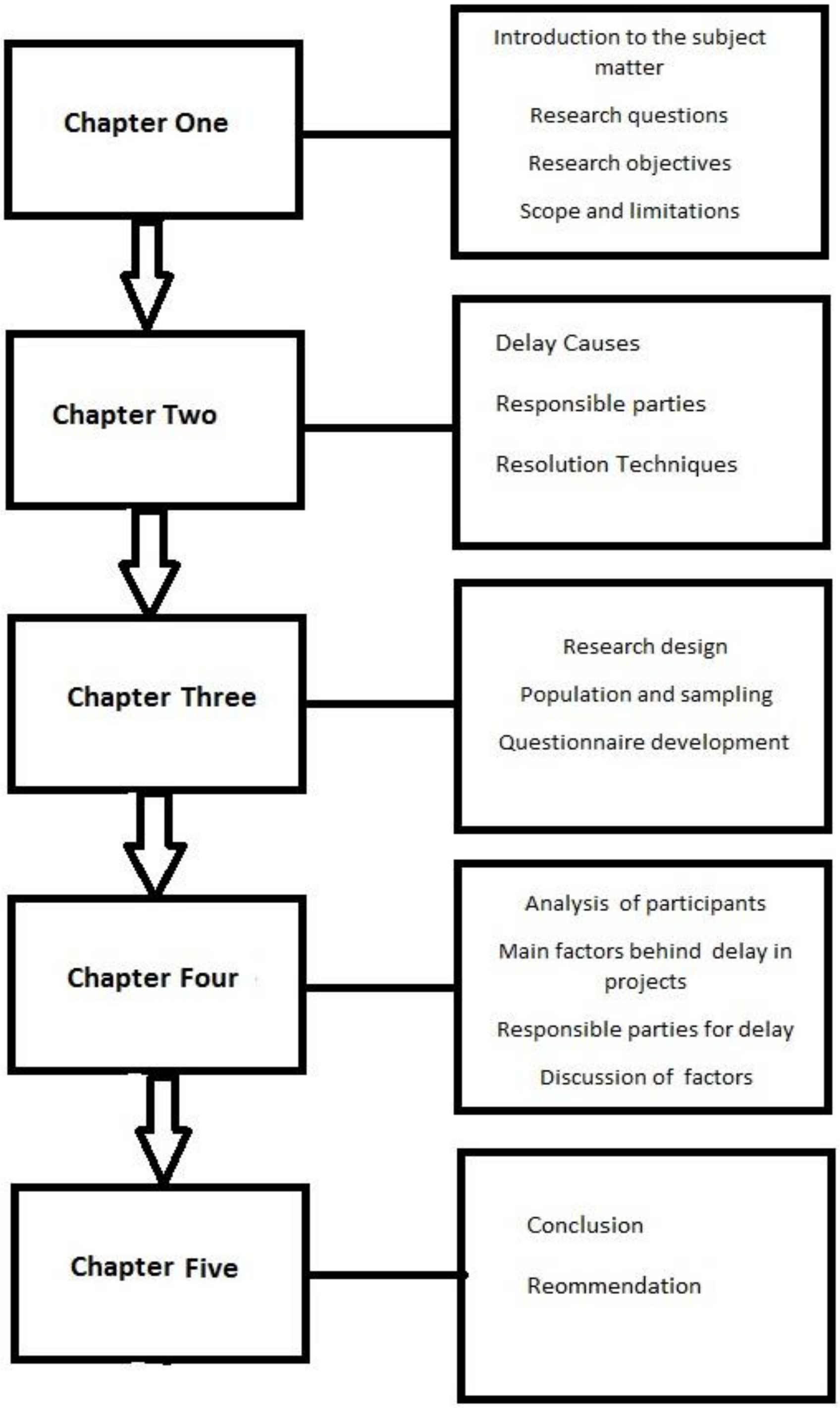

Figure 1: Schematics of the organization of the study

2 Literature review

2.1 Irrigation projects

2.1.1 Overview

Agriculture contributes significantly to the Ethiopia's economy in terms of creating cash crops for an export and employing a significant majority of its population (The world factbook, 2016). Even if poor in its production, a greater majority of Ethiopia's population, about 85% of it is dependent on it (Awlachew S. et.al., 2007).

The agricultural sector mainly uses rainfall as its main source of water (Awlachew S. and Ayana M.,2011). Thus, in cases of meagre rainfall and variable meteorological conditions, famine becomes eminent. The irrigation sector remains under performing with less than 2% of the cropped land being served by irrigation (Meja M. et. al., 2020). Even if Kedir Y. (2021) maintains that the irrigation potential of Ethiopia has not been established definitively, according to WAPCOS (1995), the twelve basins of Ethiopia have an irrigable land close to 3.7 million hectares of land. The irrigation potential of the different basins in Ethiopia is as presented below in table1.

Table 1: Irrigation potential of catchments in Ethiopia (source: WAPCOS,1995)

Basin	Catchment Area (Km^2)	Irrigation Potentials (Ha) (Respective recent master plan studies)				Irrigation Potential (WAPCOS 1995)		
		Small-Scale	Medium-Scale	Large-Scale	Total	Total Drainage Area (Km2)	Irrigable Area (Ha)	Percent Irrigable Area of the Country
Abbay	198,890.70	45,856	130,395	639,330	815,581	201,346	1,001,000	27
Tekeze	83,475.94	N/A	N/A	83,368	83,368	90,001	317,000	8.5
Baro-Akobo	76,203.12	N/A	N/A	1,019,523	1,019,523	74,102	985,000	26.5
Omo-Ghibe	79,000	N/A	10,028	57,900	67,928	78,213	445,000	12
Rift Valley	52,739	N/A	4000	45,700	139,300	52,739	139,000	3.7
Awash	110,439.30	30,556	24,500	79,065	134,121	112,697	205,000	5.5
Genale Dawa	172,133	1,805	28,415	1,044,500	1,074,720	117,042	423,000	11.4
Wabi Shebele	202,219.5	10,755	55,950	171,200	237,905	102,697	200,000	5.4
Denakil	63,852.97	2,309	45,656	110,811	158,776	74,102		
Ogaden	77,121.00					77,121		

Basin	Catchment Area (Km^2)	Irrigation Potentials (Ha) (Respective recent master plan studies)				Irrigation Potential (WAPCOS 1995)		
		Small-Scale	Medium-Scale	Large-Scale	Total	Total Drainage Area (Km2)	Irrigable Area (Ha)	Percent Irrigable Area of the Country
Ayisha (Gulf of Aden)	2,000					2,000		
Total	1,118074.53				3,731,222	982,060	3,715,000	100

Understanding the need for agricultural transformation in which irrigation is a major component, the Ethiopian government gave a much-needed emphasis in its Growth and Transportation Plan (GTP). In the GTP-II (2015) which had an implementation period between 2015 and 2020, around 560 potential sites for large and medium scale irrigation were identified. The overall potential revised in this report also amounted in terms of land size at 5.3 million hectares.

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Even if the sector has a huge potential in contributing to development of the country, the sector seems to be negatively affected by various factors. Meja M. et. al., (2020) identified the following as the major factors that affect irrigation development in Ethiopia.

- Environmental impacts
- Social and climate related impacts
- economic constraints
- poor project management

This has been reiterated by the works of Kedir Y. (2021). According to him, most of the irrigation projects in Ethiopia are either suspended or underperforming. The author's compilation of the status of large-scale irrigation projects is shown below.

Table 2: Status of major large scale irrigation projects after Kedir Y. (2021)

No	Dams and division weirs	Basins/Regions	Areas, 1000 ha	Started in	Purposes	Current Statuses	Areas used, 1,000 ha	Remarks
1	Gode	Shebelle/Somali	27.0	Previous government	Cereals and vegetables	Division and main canal constructed then terminated	2.0	Suspended
2	Alwero	Baro/Gambella	10.0	Previous government	Cereals and vegetables	Dam and main canal constructed then terminated	1.2	Suspended
3	TanaBeles	Abay/Benishangul Gumuz and Amhara	75.0	Previous government	Sugar Industry	Around 50,000 ha development started previously but completely abandoned. currently, under construction with new design	13	Under Construction
4	Tendaho	Awash/Afar	60.0	Current government	Sugar Industry	Dam and main for 60,000 ha and some secondary canals constructed for 25,000 ha then terminated. The factory is also completely abandoned.	0.0	Sugarcane was planted on 15,000 ha but terminated
5	Kessem	Awash/Afar	20.0	Current government	Sugar Industry	Dam, weir and main canals for 20,000 ha, and some secondary canals for 2,786 ha were constructed then terminated.	3.5	Suspended
6	Fentale Boset	Awash/Oromiya	18.0	Current government	Community cereals and vegetables	Division, main and secondary canal constructed for 6,000 ha then terminated;	5.6	Suspended
7	Welenchiti Bofa	Awash/Oromiya	15.0	Current government	Sugar Industry	Diversion, main and secondary canal constructed for 1,500 ha then terminated	1.5	Suspended
8	Megech	Abay/Amhara	17.0	Current government	Cereals and vegetables	Only the dam completed	0.0	Suspended
9	Ribb	Abay/Amhara	20.0	Current government	Cereals and vegetables	Only the dam completed	0.0	Suspended
10	Arjo Deddesa	Abay/Oromia	50.0	Current government	Sugar Industry	Only dam is under construction but main canal and	0.0	Under construction

No	Dams and division weirs	Basins/Regions	Areas, 1000 ha	Started in	Purposes	Current Statuses	Areas used, 1,000 ha	Remarks
						land development not started		
11	Gidabo	Omo/SNNP	13.5	Current government	Cereals and vegetables	Only the dam completed	1.5	Suspended
12	Kuraz	Omo/SNNP	175.0	Current government	Sugar Industry	Only left bank main canal constructed, and dam right bank main canal are under construction	16.0	Under construction
13	Welkayit	Tekeze/Tigray	50.0	Current government	Sugar Industry	Dam completed and portion of fields are under construction but main canal not started	0.0	Under construction
14	Meki Ziway	Rift Valley/Oromiya	3.0	Previous government	Cereals and vegetables	Pumping station, main canal and housing designed	1.0	Suspended
15	Alaba Kulito	Rift Valley/Oromiya	3.7	Previous government	Cereals and vegetables	Dam started then terminated	0.0	Suspended
16	Borkena	Awash/Amhara	3.0	Previous government	Cereals and vegetables	Dam started then terminated	0.15	Suspended
17	El-bahay (jijiga)	Shebelle/Somali	3.0	Previous government	Cereals and vegetables	Only the dam constructed	0.0	Suspended
18	Angelele	Awash/Afar	3.0	Previous government	Pasture	Designed	1.0	Suspended

2.1.2 Classification of irrigation schemes

Irrigation schemes can be classified based on various criteria. Scholars use criterion like water and energy sources, water abstraction, application methods, organizational setups, management styles and size are the most important ones (Kedir Y, 2021). However, classification of irrigation schemes based on the land they develop has continued to be a common practice in Ethiopia. Rahmeto (1999) referring to irrigated area-based classification system classified irrigation schemes into three as small scale, medium Scale and Large scale. This classification also included management systems as criteria of classification.

Table 3: Irrigation scheme classification [from Rahmeto (1999)]

Scheme classification	Size (ha)	Management and operation
Large Scale	Greater than 3000	National Water Resources Commission (NWRC) and constructed by Ethiopian Water Works Construction Authority (EWWCA) mainly for the benefit of state farms
Medium Scale	200 to 3000	by state farms and other enterprises
Small Scale	Less than 200	constructed by IDD mainly for the benefit of peasants organized in cooperatives)

2.2 The concept of scheduling in projects

A project's success can be attributed to a variety of factors, so is its performance measurement parameters. These parameters may range from the common ones like time, budget, quality to the others like customer satisfaction. However, researchers still maintain that the triple constraints of time, cost and quality are best measures of project success (Turner, 1993, Morris and Hough, 1987, Wateridge, 1988 and Dewit,1998). Barretta, A. (2006) also reiterates this notion by presenting what is known as the Iron triangle which has time at one of its important components.

The classical project management process establishes that once these three elements of a project are taken care of, a project is deemed successful. Among this the time aspect is very important given that it has a direct impact on both cost and quality (MacDonald, D. H.,1983).

Project time management is one among project management's areas of knowledge. Time management which usually deals with scheduling gives an elaborated plan on how and when specific deliverables are attained. Time scheduling also allows for the establishment of clear guideline on project communication among stakeholders (PMI, 2017).

The PMI establishes the following major activities as important part of time management. The major activities included are:

A) Plan schedule management
B) Define Activities

C) Sequence Activities
D) Estimate activity durations
E) Develop schedule
F) Control schedule

2.3 Delay in projects

2.3.1 Overview

According to Ghenbasha et.al. (2017), even if time is an important parameter against which project success is measured, most projects are not completed within the schedule. Delay in projects has been studied by various authors which have defined the concept in various ways. Here are given representative definitions of time overrun.

- According to T. Subramani et al. (2014) time overrun is defined as "extension of time beyond planned completion date specified in contract or beyond the date that parties agreed upon for delivery of projects".
- Choudhry (2004), on the other hand, defined time overruns as the "difference between the actual completion and the estimated completion time"
- Marzouk and El-Rasas, (2014) defined Construction delay as "a time overrun either beyond the contract date or beyond the date that the parties have agreed upon for the delivery of the project."

Delay in projects have several impacts on the projects themselves. Delays in projects are responsible for the extension of time, increased budget and claims (Ojoko E.O et.al., 2016). Common measures of schedule overruns and cost overruns constitute Cost Performance Index (CPI) and Schedule Performance Index (SPI) which have been widely used among project planners and executioners. According to Warburton, R. D. H. & Kanabar, V. (2008), the schedule performance index (SPI) is a measure of the conformance of actual progress (earned value) to the planned progress: SPI = EV / PV. On the other hand, the cost performance index (CPI) is a measure of the conformance of the actual work completed (measured by its earned value) to the actual cost incurred: CPI = EV / AC. In both indices, a value above 1 indicates that the project is exceeding the planned amount. An SPI less than 1 indicate that the project is going behind schedule. A cost overrun is also indicated by a CPI value less than 1.

2.3.2 Main causes of delay in projects

There could be different factors that could be cited as major factors behind delay in projects. However, Flyvbjerg (2005) and Siemiatycki (2015) categorized the major factors in to three broad groups. The first group comprises of technical factors, which are difficult to predict and be prepared for. These issues, due to their unpredictability, make the cost estimates very difficult. As unexpected happenings, technical glitches obviously cause budgetary escalation.

The second factor described by the author is optimism bias. This refers to overenthusiasm felt by planners to emphasize more on project prospects than project cost and schedules. Projects are sometimes used by politicians as a bargaining chip for election campaigns and distorting public views. Thus, they would be advertised as if they will likely be completed in a short time and with a smaller budget, contrary to what the preliminary designs show. Researchers like Tversky and Kahneman (1979) suggested that some people suffer from planning errors and optimism bias and exaggerate the prospects and undermine the schedule, cost and risks involved.

The third and final factor mentioned is systematic deception and misinterpretation. Such is sometimes used by planners and promoters. They deliberately want to deceive the public or clients so that they win contracts over fierce competitors.

The types of delays also differ. Ghenbasha et.al (2017) defined three sets of delays. These are Excusable delay, non-excusable delay and concurrent delays.

Excusable delay is delay that is due to an unforeseeable event beyond the Contractor's or the Subcontractor's control. Excusable delays can be categorized into two main types: compensable delays and non-compensable delays.

Excusable compensable delay: Such kind of delays are usually triggered by the owner or his/her agents. In such cases, the owner is liable to any damage that is incurred by the contractor. The owner will compensate the contractor with financial damages and other forms of compensation. These types of delays are explicitly stipulated in the contract that they will be compensated in case it occurs. Such include contradictory site situation and work variation which the owner agrees to compensate the contractor for.

Excusable Non-compensable delays are out of control of both the owner and other parties involved. These mainly include natural calamities, weather conditions, labor strikes and wars. In this case, the contractor will be given time extension but will not be compensated for the costs he/she incurs.

Non-executable Delay: these types of delays usually emanate from the contractor's side. The contractor may not supply materials or equipment in time, thus causing time delay. The owner should be compensated for the delay and the resulting financial damage incurred.

Concurrent delay on the other hand is not caused by a single factor. Several factors contribute in different degrees to the delay. This is the most common type of delay in construction projects.

When it comes to its occurrence, according to Ahmed et. al. (2002), overruns on construction projects are a universal phenomenon. Extensive studies done globally have indicated that the condition of time delays and cost overruns have not changed over the years. In a study that has gathered a massive data over 70 years, most projects suffered from time and cost overruns issues (Flyybjerg et.al, 2003 cited in Gbhabo and Ajuwon, 2017). The same author also noted that construction projects have an estimated cost overrun of 45% for rail projects, 34% for bridge and 20% for road projects. Others have also substantiated these findings by estimating that the time over run and cost overrun of construction projects could reach as much as 70% and 183% on average (Edward and Irani, 2012 and Odeck, 2004, cited in Gbhabo and Ajuwon, 2017).

A study conducted by Atif Ansar et.al. (2014) looked through delay and cost overrun condition on large dams and were able to conclude that:

- Large dams on average costed 96% more than their initial estimate upon their completion.
- The degree of overrun is proportional to the size of the dam. As the dam size grows, so that the cost escalation.
- Without accounting for the lengthy lead time before implementation, on average, large dams suffered delay was 44%.

The problem is more rampart and damaging in developing countries like most in Africa (Azhar, 2008). Omoregie and Radford (2006) found cost overruns of as much as 14% and time delays of 188% in infrastructure projects in Nigeria. In Kenya, a report on range of projects under the Constituency Development Fund indicated a 48% cost overrun and 87% time overrun (Ngacho and Das, 2013).

Projects in Ethiopia, especially construction projects, suffer from delays and time extension. According to Ismael (1996), out of 13 projects he studied, all of them were affected by this rampant problem.

There could be cited different causes for delays in construction projects. The major causes of scheduling delay as identified by Alnuaimi and Moshin, (2013), are as indicated in the box below.

Box 1: Major causes of delay after Alnuaimi and Moshin (2013)

1. **Design related delay:**
    - a. Possible change in initial design.
    - b. Complexity of the project.
2. **Construction related delay**:
    - a. Variations and claims.
    - b. Change of scope of project
3. **Financial/ economic- related delay**:
    - a. Financial ability of the owner
    - b. Not enough funds
4. **Management/ Administrative- related delay:**
    - a. Unavailability of suitable management team.
    - b. Unspecialized subcontractors.
    - c. Lack of project management.
    - d. Lack of experience of the consultant
    - e. Lack of experience of the contractor
5. **Regulations and code- related key delays:**
    - a. New legal instructions or rules.

In a study conducted in India specifically on irrigation projects, Baghat A and Patil (2017), found out the following are reasons for cost and time overruns.

- Large number of workers in comparison to the number of projects.
- Land acquisition problem.
- Unavailability of fund.
- Continued increase in material prices.

- Different work approval not taken on time.
- Design of construction not ready on time.
- Unstable political situation.

The various studies that have been conducted in several countries found the causes could also vary from country to country. Several studies have taken the issue as a subject matter and investigated the primary causes (Alamri N., 2017).

A research conducted by Shibni A. (2015) has listed low labor productivity, poor coordination among stakeholders, bribes, late payment, and change orders as the main causes of time overrun while cost overrun was majorly caused by scope changes, inaccurate review of designs, lack of feasibility studies, resource constraints and price escalation.

Other researchers in the middle east like that of Enshassi et.al. (2009) also reported factors like material shortage, unqualified labor, and poor equipment as major sources of delay in construction projects. In another middle eastern country, Oman, a study found regulations and policies are prominent reasons behind delays in construction projects (Aluaimi and Almohsin,2013).

Cost overruns are mainly derivates of time overruns. Extended time delays are the main reasons behind cost overruns. In Indonesia, studies revealed that inflation, price escalation and project complexity are main factors that greatly increase the budget of projects (Kaming, 1997).

When it comes to Africa, investigations into the issue found several reasons behind time cost overruns. A study conducted in Nigeria by Odusami and Olusanya (2000) studied projects in and around Lagos to find out that that the investigated projects have a cost overrun of about 51%.

However, most of these researchers are studied on construction projects. It is rather rare to find delay factors studied for dams and irrigation projects (Alamri N.et. al., 2017). Thus, conducting researches on irrigation projects is much more needed.

2.4 Responsible parties

The major parties responsible as with regards to construction delays can be classified as client, consultants, contractors and external. (Ghenbasha et.al ,2017) These various categories of parties may give various ranking matrix to the different factors that were assumed to cause delay in projects.

Client related factors that cause time and cost overruns are those factor that the client induces. James et. al (2014) identified variation orders and frequent design changes by the client as major sources of time delays. Such factors are mainly initiated by the client. The client may not have the full understanding of the scope of the project, thus forces the contractor to modify works by the middle of the project which in turn causes projects to be delayed. Other studies like that of Alinaitwe et. al. (2013) showed scope changes and payment delays as major causes of delays, which are both client-related factors.

Consultants also contribute to delays in projects by not submitting designs and specifications in time. consultants are like the middleman in construction projects. They are mostly representatives of the client act as a bridge that connect the client with the contractor. Thus, they should be effective in communication with they lack sometimes. Al Hadi et.al. (2009) found that poor communication culture on the part of consultants was responsible for delays in construction projects in Libya.

According to an investigation made by Atout (2016), a survey indicated that poor communication from consultants has contributed significantly for delays in projects. Consultants have been found not to provide designs in time; they were poor in identifying design errors in time and communicating them.

Alamri N.et. al., (2017) studied major factors that could cause delay in dam projects in Oman. The study identified 12 major responsible factors to cause extensive delays in projects. The study revealed that external related factors were the most responsible to cause delays (5 factors), followed by client (4 factors), consultant (2 factors) and contractor (1 factor) respectively.

Table 4: Delay groups after Alamri N.et. al., (2017)

External related factors
• Severe weather condition • Uncertainty in ground condition • Natural disasters • Delay in obtaining permit from authorities (Bureaucracy) • Land acquisition

Client related factors

- Change orders
- Executive bureaucracy in the client’s organization
- Difficulty of defining project requirement
- Slowness of decision-making process

Consultant related factors

- Feasibility Study did not cover all aspects
- Mistakes in Soil Investigation

Contractor related factors

- poor site management

2.5 Mitigation strategies

There could be various ways of resolving delays when they happen. Oko A. (2011), concluded that even if several attempts were made to resolve issues of time and cost overrun in construction projects, the issue of project delay still poses a major impediment.

According to Wang et. al. (2004), delay mitigation measures need to be developed taking the differing features of country, market and the project condition. The developed mitigation and resolution measures are incorporated in the risk management plan (Kim et.al, 2018). Pourrostam T. and Amiruddin B.I. (2010), in a study that tries to analyze measures to alleviate issues of delay in projects identified clear scope, accurate initial cost estimate, effective strategic planning, use of proper construction methods and commitment as the major resolution techniques to solve the issue of project delays.

Resolution methods can also be studied from successful projects, struggling projects can take a lesson or two from such projects and replicate them. In a study conducted in Vietnam, Nugeyen et.al. (2004) suggested main causes of success in construction projects were competent project management, adequate financing, availability of resources and commitment to the project. A different study which surveyed mitigation measures in power projects in Tanzania found close project supervision, conducting capacity building training Rank and proper logistics management as the top three delay resolution techniques (Edwin T.B and Wooyong J., 2019).

In the context of Ethiopia, Taye M. (2016) identified progress control, schedule and cost control, material delivery, personnel control, strategic planning as top ranked resolution methods in resolving delay issues

3 Methodology

3.1 Introduction

This chapter presents the methodology and the research designs used in the current research. It also presents sampling techniques used, the analysis employed and definitions of important statistical tools that are of interest in this research.

3.2 Research approach and design

3.2.1 Research approach

This research mainly used a quantitative approach. Data collected from stakeholders and respondents was analyzed through formulae and analysis that mainly employs quantitative analysis. The main form of data collection tool employed was a questionnaire. The questionnaire uses a five-point Likert scale where attitudes of respondents are measured in a range between 'Not significant' to cause delay to 'Extremely significant' to cause delays. The use of Likert scales has been proved to gauge respondent's attitudes better (Survey monkey, 2020). To make it simple for the researcher as well as respondents, the questionnaire was prepared in a Google form and was distributed by email. However, for participants who couldn't get it through email, it was handed over in a printed format.

The questionnaire had three sections.

Section 1 asked general information about each participant. The information collected included gender, participant's academic status and the company to which the participant affiliates to.

Section 2 asked participants to rank various factors that are deemed to cause delay in large scale irrigation projects. Participants rated each of the identified factors on a 5-point Likert. Overall, 48 (forty-eight) factors were identified. The identification of the factors depended on literature reviews and expert opinions. Each of the identified factor was assigned a delay group by identifying the likely responsible party among contractors, consultants, clients and external factors. This categorization is shown in table 5 below.

Table 5: Responsible parties for various causes of delay

Responsible parties			
Client	**Consultant**	**Contractor**	**External**
Issues related to right of way	Error in estimating durations	Contractor's lack of experience	Problems in material delivery on time
Variation orders	Inadequate designs specifications	Lack of skilled professionals	Accidents in construction
Delay in payment	Error in estimating Cost	Contractor having high number of contractors (high workload)	Labor strikes
Client financial problem	Poor communication among stakeholders	Improper methodology used by contractors	Employee turnover
Poor decision making	Unfinished designs	Poor site management	Political instability
Late site handover	Mistakes in preliminary site investigations	Poor planning and activity Scheduling	Interference of local authorities
Bureaucracy in client organizations	Late approval by consultants	Improper equipment deployment	Poor security
Poor scope definition	Delay in work orders	Contractor financial problems	Bureaucracy in procurement methods
Project termination by owner	Poor monitoring and evaluation system	Poor project management	Corruption
		Inappropriate/misuse of materials	Natural disasters
		Delay in mobilization	Lack of political commitment from government
		Poor risk management	Act of God
		Project complexity	Lack of quarry site
			Price escalation
			Unreliable Subcontractors
			Weather conditions
			Uncertainty in ground conditions

Section 3 asked participants to rate the significance of various mitigation techniques used in solving delays. Resolution techniques were developed from literature reviews and expert opinions

of professionals in irrigation projects. 27 (Twenty-seven) factors were identified. The identified resolution techniques were:

- Monitor progress during the contract period
- Conduct 3C meetings regularly
- Conduct weekly and monthly budget comparisons with the actual performance
- Develop systemic control mechanisms
- Improve contract award practices
- relying on technological time and budgetary control mechanisms
- improve construction methods
- realistic cost and duration estimation
- Timely and reasonable procurement
- improving the composition of teams
- strategic planning
- develop risk management plan
- Focus on use of machinery
- hire more professionals
- focus on training and development
- Avoid double handling, poor quality of work, timely progress control
- improve communication between stakeholders
- Work on leadership and management
- make sure designs are complete before construction contract award
- resolve disputes between stakeholders in time
- improve claim management
- Work on scope definition
- improve supply of material and labour
- Work on activity Sequencing
- Improve machinery management
- Make payment timely

In addition to questionnaires and primary data, a secondary data was also analyzed to put into perspective the case of delays in particular large-scale irrigation projects. The documents used in the case analysis are all obtained from Ethiopian construction Works Corporation (ECWC).

3.2.2 Research design

The research, as indicated in its objectives, tries to identify major factors that contribute to delay in large scale irrigation projects. It tries to rank factors that could be contributing to delays in various large-scale irrigation projects, which makes it mostly an analytical research that aims at identifying the main causes of delay. The study also aims at finding the main causes of delay in irrigation projects from the perspective of different actors in construction projects.

3.3 Population and sampling

As a study to be conducted on large scale irrigation projects, the study would target professionals which have worked on such projects on client, consultant and contractor sector.

$$sample\,size = \frac{\frac{z^2 p(1-p)}{e^2}}{1+\left(\frac{z^2 p(1-p)}{e^2 N}\right)} \qquad Equation\,(1)$$

Where N=population size, e=margin of error, z= z score (read from a separate table)

The confidence interval used in this research is 95% with error of margin of 0.05. When plugging in these figures with a population of 153 professionals, the above formula gives a sample size of 110 people. The population size of 153 is reached considering the project managers, senior survey engineers and team leaders working at ECWC and ECDSC.

3.4 Statistical Software

There are different statistical software packages that are used in the analysis of data collected using questionnaires. Mohd H.A. and Fadilah P. (2018) state that SPSS is becoming useful in most social study researches because it can perform both parametric and non-parametric analysis. Moreover, comparison studies and ranking of factors are better handled by the software package.

In addition to SPSS, the study also employed Microsoft's excel to some extent. Excel is a very powerful tool for analyzing qualitative data. It has a lot of functions and statistical analysis plugins suitable for such.

3.5 Statistical Parameters

3.5.1 Mean score

The main statistical parameter used in the research are the Mean Score (MS). The mean sore is a simple statistical parameter used in conjunction with frequency analysis. The formula for calculating the mean score is given by equation 2.

$$Mean\,Score = \frac{\sum_{i=1}^{4} F_i n_i}{N} \qquad Equation(2)$$

Where F_i is the frequency, N=Number of respondents n_i=1,2,3 or 4 [Not significant=0, significant=1, Moderately Significant=2, Very Significant=3, Extremely Significant=4]

3.5.2 Spearman's correlation coefficient

For parameters best described in ordinal scale, the spearman correlation coefficient measures directional and strength of conformity between two variables (Laerd statistics, 2021). The spearman's correlation coefficient is very suitable for attitude measuring scales like the Likert's. The spearman's correlation is here used in testing the validity of the questionnaires. A spearman correlation coefficient always lies between -1 and 1. These two values indicate strong correlation between the two variables while the values in between could have different meanings based on the magnitude of the coefficient (Patrick S. P. and Boer C, 2018).

Table 6: Spearman's Correlation coefficient after Patrick S. P. and Boer C (2018)

Absolute value of the correlation coefficient	Interpretation
0.00-0.10	Negligible correlation
0.10-0.39	Weak correlation
0.40-0.69	Moderate correlation
0.70-0.89	Strong correlation
0.90-1.00	Very strong correlation

The coefficient can easily be calculated from the equation given below,

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)} \qquad Equation(3)$$

Where ρ is the spearman's correlation coefficient, di is the difference between two ranks of each observation, n is the number of observations.

3.5.3 Cronbach's alpha

Reliability of the questionnaire test can also be calculated using statistical parameters. The most used parameter to test reliability of research instrument is the Cronbach's alpha parameter (Taber, K.S., 2018). The same author after going though academic papers reported an alpha factor 0.7 and above indicates a good measure of reliability.

$$\rho_T = \frac{k^2 \overline{\sigma_{ij}}}{\sigma_X^2} \qquad Equation(4)$$

where ρ_T = tau-equivalent reliability $\overline{\sigma_{ij}}$ covariance between Xi and Xj, k=number of items

and σ_X^2 =item variances and inter-item covariances

4 Results and Discussion

In this chapter, the results of the analysis and discussions thereof are presented. The presentation of results has two major sections. The first section is where results of the primary data collection be presented. In the second section, results of a case study are discussed.

4.1 Questionnaire Participant information

Based on sample calculation, a total of 110 questionnaires were distributed. From the questionnaires 70 were returned with a Response Rate (RR) of 64.2%. The questionnaire was distributed to 110 respondents, the affiliation of which is shown in table 6. The Response Rate (RR) achieved is 64.2%. Baruch Y. (1999) reported an average response rate of 55.6% by going through 175 published papers.

Table 7:Questionnaire distribution

Company affiliations	Total questionnaire distributed	Collected questionnaires		RR rate (%)	Overall RR
		Returned	Valid		
Contractor	50	32	30	60%	64.2%
Consultant	30	20	20	67%	
Client	30	20	20	67%	

A) Gender

The study participants are predominantly male subjects. Even if no special measure was employed to involve more males in the study, the results of the survey indicate that more males participate in irrigation projects than females.

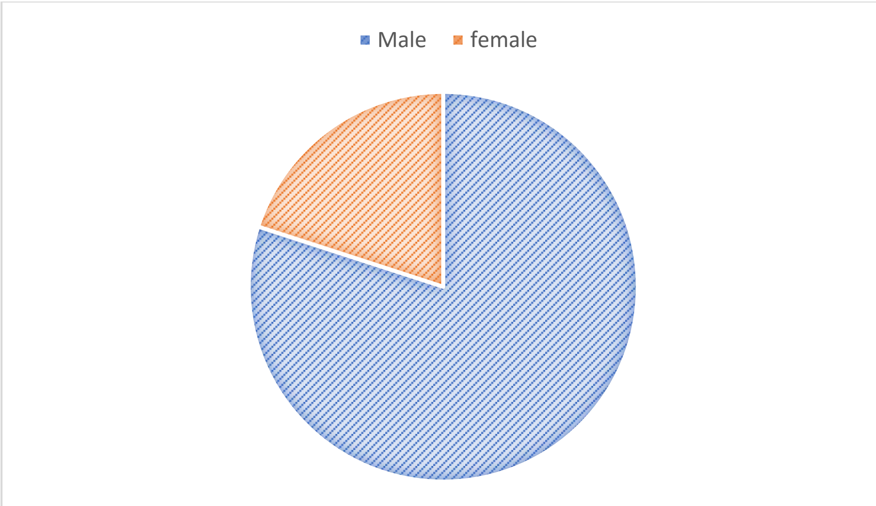

Figure 2: Gender composition of respondents

B) Educational status

When it comes to the participant's educational status, the predominant educational status is a master's degree, followed by BSc. There have been one Ph.D. and advanced diploma holder.

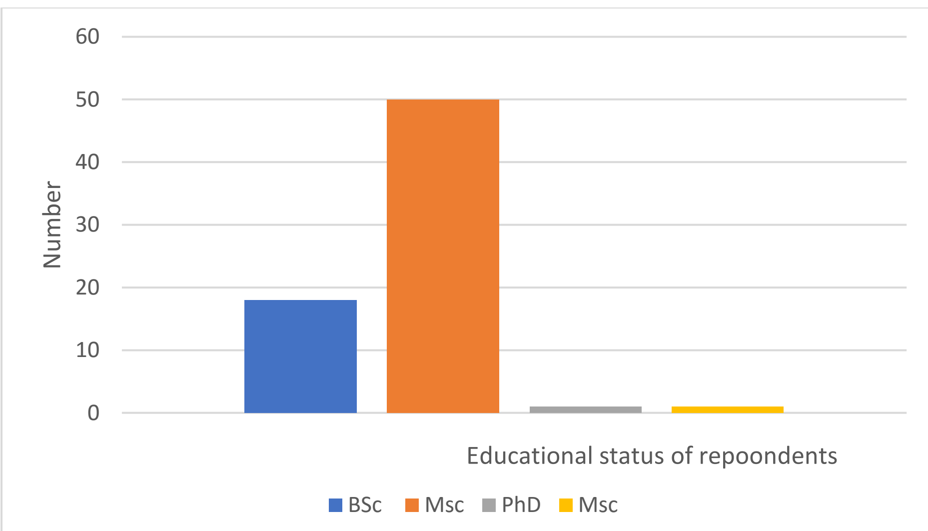

Figure 3: Educational status of Respondents

C) Participant organization type

Even if project managers were mostly targeted during questionnaires, their response rate was poorer as compared to irrigation engineers. The irrigation engineers who participated in the survey all worked on irrigation projects as seniors or team leading roles.

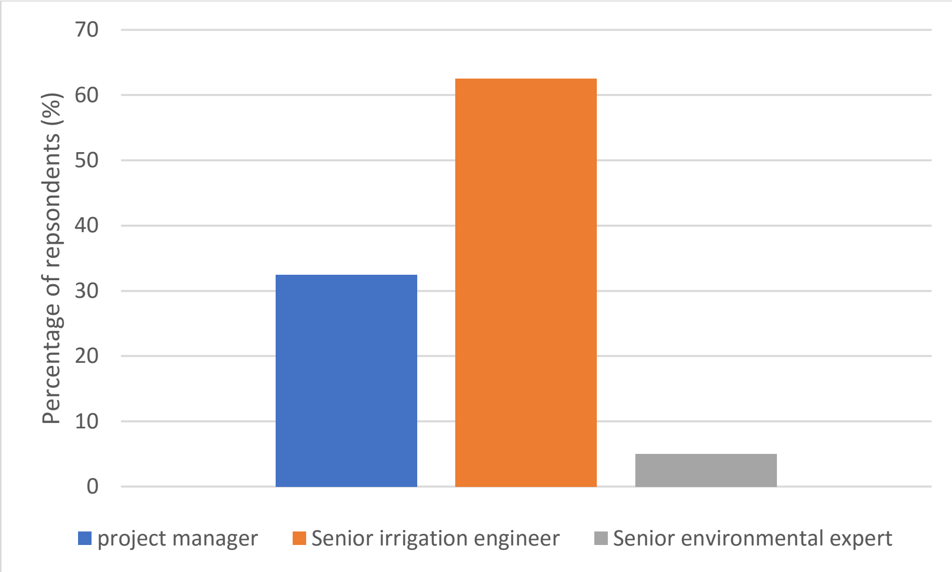

Figure 4: Professional title of participants

4.2 Validity and Reliability of questionnaire

Validity measures the scale of a questionnaire to measure what is intended and sought after (Prous M.J.G et.al, 2008). The validity of the responses of participants was checked using the spearman's correlation coefficient. There was a significant correlation observed for most of the delay causes and all of resolution mechanisms selected expect for those with p values higher than the significant level of 0.05. These factors included Contractor's lack of experience (P=0.274), Error in estimating Cost (P=0.053), Price escalation (P=0.154), poor communication among stakeholders (P=0.119), high work load (P=0.162), interference from local authorities (P=0.70) and act of God (P=0.09). Even if the is the case, none of these were among the top-ranking factors as is discussed below. The spearman's correlation coefficient for each item is shown in sections 7.2 and 7.3.

Reliability for the elements was also calculated. This time the Cronbach's alpha has been used. The overall alpha value of 0.881 was found which is way above than the usually cited value of 0.7. The alpha values for each variable in the questionnaire was greater than the threshold value of 0.7 as shown in section 7.4.

4.3 Causes of delay in large sale irrigation projects

To rank the various causes of delay identified in the questionnaire, a mean score analysis was mainly used. The more the mean score for a given delay factor, the higher the ranking of that factor. The mean score of each of the factors is as shown in the table below. The shaded rankings are for those ranks in the top five from each group.

Table 8: Raking of factors based on their mean score (MS)

Factor	Delay Group	contractor		Consultant		Client		Overall	
		MS	Rank	MS	Rank	MS	Rank	MS	Rank
Contractor's Lack of experience	Contractor	2.27	31	2.71	15	2.55	17	2.50	21
Improper methodology used by contractors	Contractor	2.20	34	2.86	10	2.45	19	2.50	21
Error in estimating durations	Consultant	2.93	7	3.07	4	2.64	14	2.90	8
Error in estimating project cost	Consultant	2.93	7	2.64	18	2.27	27	2.65	17
Poor site management	Contractor	2.93	7	3.00	6	2.91	6	2.95	5
Poor planning and activity scheduling	Contractor	3.13	4	3.43	1	3.45	1	3.33	1
Lack of quarry site	External	2.60	23	1.50	42	1.45	43	1.90	41
Price escalation	External	2.53	26	2.57	21	2.36	24	2.50	21
Unreliable subcontractors	External	1.80	43	2.07	36	1.82	34	1.90	41
Problems in material delivery on time	External	3.27	1	3.07	4	2.91	6	3.10	3
Improper equipment deployment	Contractor	2.87	13	2.71	15	2.73	11	2.78	13
Contractor financial problems	Contractor	2.87	13	3.00	6	2.73	11	2.88	9
Poor communication among stakeholders	Consultant	1.80	43	2.86	10	2.45	19	2.35	29
Variation orders	Client	2.80	17	2.29	30	2.36	24	2.50	21
Delay in payment	Client	3.27	1	2.79	13	2.64	14	2.93	6
Client financial problem	Client	3.13	4	2.50	26	2.82	9	2.83	12
Poor decision making	Client	2.60	23	3.00	6	3.00	3	2.85	10
Late site handover	Client	2.80	17	2.29	30	2.09	28	2.43	27
Issues related to right of way	Client	2.87	13	2.71	15	3.00	3	2.85	10
Unfinished designs	Consultant	3.13	4	2.64	18	3.00	3	2.93	6

Factor	Delay Group	contractor		Consultant		Client		Overall	
		MS	Rank	MS	Rank	MS	Rank	MS	Rank
Mistakes in preliminary site investigation	Consultant	3.20	3	2.14	35	2.55	17	2.65	17
Poor project management	Contractor	2.93	7	3.36	2	3.18	2	3.15	2
Bureaucracy in client organization	Client	2.00	39	2.57	21	2.09	28	2.23	31
Late approval by consultants	Consultant	2.67	21	1.93	37	1.82	34	2.18	32
Delay in work orders	Consultant	2.73	20	2.57	21	1.82	34	2.43	27
Accidents in construction	External	1.93	40	1.29	44	0.73	47	1.38	46
Lack of skilled professionals	Contractor	2.40	27	2.43	27	2.09	28	2.33	30
Labour strikes	External	1.73	46	1.07	47	0.91	45	1.28	47
Contractor having high number of contracts (high workload)	Contractor	1.93	40	2.36	28	1.73	40	2.03	38
Employee turnover	External	1.67	47	1.43	43	1.82	34	1.63	43
Inappropriate/ misuse of materials	Contractor	2.33	29	2.21	34	1.45	43	2.05	36
Poor monitoring and evaluation system	Consultant	2.93	7	3.36	2	2.91	6	3.08	4
Weather conditions	External	2.27	31	1.64	41	1.82	34	1.93	40
Delay in mobilization	Contractor	2.80	17	2.57	21	1.82	34	2.45	25
Political instability	External	2.87	13	2.36	28	2.36	24	2.55	20
Uncertainty in ground conditions	External	1.93	40	1.93	37	2.09	28	1.98	39
Interference of local authorities	External	2.33	29	1.79	40	2.00	32	2.05	36
Poor security	External	2.20	34	1.93	37	2.45	19	2.18	32
Bureaucracy in procurement methods employed	External	2.67	21	2.57	21	2.64	14	2.63	19
Corruption	External	2.07	38	2.86	10	2.45	19	2.45	25

Factor	Delay Group	contractor		Consultant		Client		Overall	
		MS	Rank	MS	Rank	MS	Rank	MS	Rank
Natural disasters	External	1.80	43	1.14	46	1.55	42	1.50	45
Lack of political commitment from Government	External	2.20	34	2.29	30	1.73	40	2.10	35
Inadequate design specifications	Consultant	2.93	7	2.64	18	2.45	19	2.70	14
Poor scope definition	Client	2.40	27	2.93	9	2.82	9	2.70	14
Poor risk management	Contractor	2.60	23	2.79	13	2.73	11	2.70	14
Project complexity	Contractor	2.20	34	2.29	30	2.00	32	2.18	32
Project termination by owner	Client	2.27	31	1.29	44	0.91	45	1.55	44
Act of God	External	1.60	48	0.71	48	0.73	47	1.05	48

4.4 Overall ranking

The Pareto principle is commonly applied to study cause and effect relationships and has been applied to study analytical studies where ranking is involved (Koch. R, 1991). The major assumption of the principle is that 20% of the causative agents are responsible for 80% of the effects.

Based on this principle, 20 percent of the 48 (forty-eight) causative factors are responsible for 80% of the delays in large scale irrigation projects. Thus, the ten (10) most influencing factors (i.e., 20% of 48=9.8) were identified based on the principle and are listed below. When analysing the top 11 (eleven) factors by the delay group, four (4) belong to the contractor group followed by consultant which has three (3) factors, then client group with three (3) and External with one (1).

Table 9: Top 11 causes of delay in large scale irrigation project

Factor	Delay Group	contractor		Consultant		Client		Overall	
		MS	Rank	MS	Rank	MS	Rank	MS	Rank
Poor planning and activity scheduling	Contractor	3.13	4	3.43	1	3.45	1	3.33	1
Poor project management	Contractor	2.93	7	3.36	2	3.18	2	3.15	2
Problems in material delivery on time	External	3.27	1	3.07	4	2.91	6	3.10	3
Poor monitoring and evaluation system	Consultant	2.93	7	3.36	2	2.91	6	3.08	4
Poor site management	Contractor	2.93	7	3.00	6	2.91	6	2.95	5
Delay in payment	Client	3.27	1	2.79	13	2.64	14	2.93	6
Unfinished designs	Consultant	3.13	4	2.64	18	3.00	3	2.93	6
Error in estimating durations	Consultant	2.93	7	3.07	4	2.64	14	2.90	8
Contractor financial problems	Contractor	2.87	13	3.00	6	2.73	11	2.88	9
Poor decision making	Client	2.60	23	3.00	6	3.00	3	2.85	10
Issues related to right of way	Client	2.87	13	2.71	15	3.00	3	2.85	10

I. Poor planning and activity scheduling

This has been found to take the tops spot with an overall mean score of 3.33. It has also been ranked the top cause of delay by both consultants and clients alike. Planning and activity scheduling is a major responsibility of contractors, so falls under the contractor group. So, it could be expected that contractors may not rank it at number one. This factor has also been found to be among the common delay causes by researchers like Khoshgoftar et al., (2010) and Al-Kharashi and Skitmore (2009) which have conducted research on construction works in Iran and Saudi Arabia respectively.

II. Poor project management

Poor project management with a mean score of 3.15 is ranked second on overall mean score. It is also ranked second by consultants and clients alike. However, contractors ranked it seventh, consistent with the logic that it could be ranked low by contractors as it is the responsibility of contractors. The same factor was found to rank third by a research conducted by Taye M. (2016) on construction projects of defence construction enterprise.

III. Problems in material delivery on time

Unavailability of materials leading to problems of delivery are major impediments to large scale projects. this factor is ranked third overall while it is ranked the number one problem by contractors. This factor was categorized under external delay group given that large scale projects don't have the flexibility to get their materials as private companies do.

IV. Poor monitoring and evaluation system

Monitoring and evaluation are important components of a project management life cycle. Lack of a strong monitoring and evaluation system thus will likely cause delays. This factor was ranked fourth with an overall mean score of 3.08. Tulu T. (2017) also ranked poor project monitoring and evaluation second among the many factors causing delay in projects financed by the development bank of Ethiopia.

V. Poor site management

Poor site management which falls under contractor delay group got an overall mean score of 2.95 and was ranked fifth. Contractors, due to lack of the proper knowledge of their sites or negligence sometimes fail to properly manage their sites. And this usually leads to contract delays. Other studies on dam projects conducted by Gasasira et al (2016) and Niazi and Gidabo (2012) found it to be the second and fourth ranking delay causing factors.

VI. Delay in payment

Making payment in time is a major responsibility of clients. but sometimes clients don't make them in time due to several reasons. This prevents contractors from making the necessary purchase of materials, thus leading to delays. Contractors have ranked this factor first given its implication to the normal working of contractors. Onyekachukwu G. et. al (2020) found it to be a major cause of delay in Nigerian projects. Borvorn I. N.A (2012) found the same in residential projects in Thailand.

VII. Unfinished designs

Designers and consultants are responsible for design of any construction projects. If designs are not completed in time, they will likely cause the contractor to wait for designs, thus delaying the project in the process.

VIII. Error in estimating durations

Consultants along with designs of irrigation schemes also present estimates of durations. However, in some cases, being over ambitions make unrealistic time estimates which are usually less than what the projects take. This has been cited as a fourth cause of delay by consultants. This could be in contrast with assumption that consultants which are responsible for estimating durations also ranked this factor higher than contractors and clients.

IX. Contractor financial problem

This has been ranked as the ninth rated factor. Abdul-Rahman, H et.al. (2009) studied financial causes of delays and concluded that contractors lacking finance to fund projects has affected the progress of several projects which has also been the case in some large-scale projects in Ethiopia.

X. Poor decision making

Clients may make poor decision making in financing projects which seem feasible at the beginning but may lack the will to finance them later. This will cause decline in motivation affecting every stakeholder and the project alike.

XI. **Issues related to right of way**

Right of way issues need to be taken care of clients before site handover. However, they are rarely solved by clients due to social issues. This has been a serious issue in large scale irrigation projects in Wolkayt and Arjo Dedessa irrigation projects (ECWC, 2020).

4.5 Responsible Parties

Based on the ranking made isolating each party (client, consultant and contractors), the top ranked factors according to each of the three parties is discussed below.

A) Contractors

From the top 12 factors identified by contractors, contractor tend to cite a consultant related factor more (6 factors), followed by consultant related factors (3 factors), client related factors (2 factors) and external factor (1 factor). According to contractors, the top ranked factors are:

I) **Delay in payments:** this had a contractor mean score of 3.27 and an overall mean score of 2.93. This is expected from the point of view of contractors, assuming that contractors would likely believe that they did not deliver in time because clients did not make payments in time

II) **Problems in material delivery on time:** this factor got a contractor mean score of 3.27. This factor can be best categorized under external groups. Inability to get construction materials in time possess a serious schedule issue on the contractor. Contractors involved in this study are government owned semi-autonomous organizations which would have to wait for materials to be provided by government vendors.

III) **Mistakes in preliminary site investigation:** this consultant related delay factor got a mean score of 3.2. Contractors signified that consultants don't make the necessary preliminary investigation of sites before continuing to the preliminary and final payment.

IV) **Unfinished designs:** This also falls under consultant groups. Consultants and designers don't finish deigns in time. This has been a common occurrence in many projects as in Tendaho, Kuraz, kesem and many more large-scale irrigation projects according to ECWC (2020)

V) **Poor planning and activity scheduling:** According to contractors, this was fourth ranked factor. However, this is the number one factor in its overall ranking. As delays are mainly tied to scheduling, it would be obvious that not making the necessary plans at the beginning of any project will result in time overruns at the end

VI) **Client financial problem:** client financial problem has had impacts on large scale irrigation projects. Clients, mostly being government entities rely on meagre budget for a project for which they may not get the necessary approval on time. For instance, ECWC's financial situation has led the contractor to stop work on major canal works at Kuraz and Arjo Dedehesa irrigation projects.

B) Consultant

When analyzing consultant responses, it can be discerned that out of the 12 (twelve)top ranked factors, 5(five) top ranked factors are contractor related, 3 (three) are consultant related, 2 (two) are client related and the rest 2 (two) are external factors. When it comes to consultants the top ranked factors are:

I) **Poor planning and activity scheduling:** these are also top ranked factors overall with an overall top score of 3.33 and a consultant mean score of 3.43.

II) **Poor monitoring and evaluation system:** having a robust monitoring and evaluation system is a duty of consultants. It is unlikely that consultants rank it higher (second rank), but it got a consultant and an overall mean score of 3.36 and 3.08 respectively.

III) **Poor project management:** this is also rated second according to consultants. It is a broad concept that is related to mismanagement in any or the whole of the project management cycles.

IV) **Problems in material delivery on time:** contractor may find it difficult to get the material they need for their projects. This has also been corroborated by consultants as a major cause of delay.

V) **Error in estimating durations:** This falls under the category of consultants and it has been cited among the top five causative factors of delay in large scale irrigation projects.

C) Client

Clients on the other hand mention client related factor (4 factors) as more causative of delays followed by contractor related (3 factors), consultant related factors (2 factors) and external related factor (1 factor) out of the top 10 (ten) factors ranked by clients. This seems unusual given that neither contractors nor consultants identified factors related to them as main causes of delays. The five most critical factors as cited by clients are listed here below.

I) **Poor planning and activity scheduling**: poor planning and scheduling prepared by contractors affect the whole progress of the project to its closure. This was calculated to have a client-mean score of 3.45.

II) **Poor project management:** with a client-mean score of 3.18, poor project management is also cited as the second most causative factor overall as well.

III) **Unfinished designs:** large scale irrigation projects being prone to the issue of designs being unfinished in time, this factor has been causing delays in most of the irrigation projects as described above.

IV) **Issues related to right of way:** right of way issues, even if they are client-related, unless resolved before the commencement of projects will sometimes pose serious social problems as the project progresses.

V) **Poor decision making:** this refers to cases where the client makes rush decisions to finance projects. Once the unfeasibility of the projects discovered, the client's effort to fund the projects decline and these will have a detrimental effect on other stakeholders thus causing delays.

4.6 Resolution Methods

When it comes to resolving delay issues, respondents were asked to rate 27 (twenty-seven) resolution techniques. The mean score of each of the resolution techniques is as shown in the table below.

Table 10: Mean score of resolution methods

Resolution Methods	Contractor		Consultant		Client		Overall	
	MS	Rank	MS	Rank	MS	Rank	MS	Rank
Monitor progress during the contract period	3.20	6	3.07	2	3.00	14	3.10	5
Conduct 3C meetings regularly	3.13	9	2.79	14	2.91	15	2.95	13
Conduct weekly and monthly budget comparisons with the actual performance	3.20	6	2.71	16	3.18	8	3.03	9
Develop systemic control mechanisms	3.00	15	3.00	4	3.36	2	3.10	5
Improve contract award practices	2.93	17	2.57	20	2.45	25	2.68	24
Relying on technological time and budgetary control mechanisms	3.20	6	2.79	14	2.82	17	2.95	13
Improving construction methods	3.33	4	2.57	20	3.36	2	3.08	7
Realistic cost and duration estimation	3.53	1	2.93	6	3.36	2	3.28	1
Timely and reasonable procurement	3.07	11	2.86	10	3.27	5	3.05	8
Improving the composition of teams	3.13	9	2.57	20	2.36	26	2.73	22
Strategic planning	3.47	3	3.14	1	3.09	11	3.25	3
Develop risk management plan	2.93	17	2.86	10	2.82	17	2.88	17
Focus on use of machinery	3.00	15	2.50	24	2.64	21	2.73	22
Hire more professionals	2.73	24	1.71	27	2.00	27	2.18	27
Focus on training and development	2.60	25	2.43	25	2.55	24	2.53	26
Avoid double handling, poor quality of work, timely progress control	3.07	11	2.86	10	2.64	21	2.88	17
Improve efficiency of workers	2.93	17	2.93	6	2.91	15	2.93	15
Improve communication between stakeholders	2.93	17	2.93	6	2.64	21	2.85	19
Work on leadership and management	2.87	22	2.93	6	3.18	8	2.98	12
Make sure designs are complete before construction contract award	2.80	23	2.64	19	3.45	1	2.93	15

Resolution Methods	Contractor		Consultant		Client		Overall	
	MS	Rank	MS	Rank	MS	Rank	MS	Rank
Resolve disputes between stakeholders in time	2.93	17	2.57	20	2.82	17	2.78	21
Improve claim management	2.53	27	2.43	25	2.82	17	2.58	25
Work on scope definition	2.60	25	2.71	16	3.27	5	2.83	20
Improve supply of materials and labour	3.33	4	3.00	4	3.09	11	3.15	4
Work on activity sequencing	3.07	11	2.86	10	3.09	11	3.00	10
Improve machinery management	3.07	11	2.71	16	3.27	5	3.00	10
Make payment timely	3.53	1	3.07	2	3.18	8	3.28	1

Using the Pareto principle discussed above, from the total of 27(twenty-seven) resolution techniques suggested, 6 factors (i.e.,0.2*27=5.4) are mainly used to solve 80% of issues related to delay. Accordingly, the six resolution methods with the highest mean scores are:

I) Realistic cost and duration estimation

This has been ranked the topmost resolution technique used when delays occur. This comes as no surprise since error in estimates of project duration was among the top ten factors that likely cause delay; thus, respondents will likely be inclined to suggest it as one of the resolution techniques.

II) Make payment timely

This resolution technique will likely solve delay issues that are often cited by contractors. That is why it got a mean score of 3.53 by contractors and ranked first by contractors and overall.

III) Strategic planning

Strategic planning with an overall mean score of 3.25 is ranked third overall and first by consultants as a likely feasible resolution technique. Once, contractors made the necessary strategic planning at the beginning of the project and follow them through, projects will likely be completed in time.

IV) **Improve supply of materials and labour**

Among the top ranked delay causes, one was lack of materials. Thus, improving supply of materials and labour in a timely basis will have greater impact in solving issues of delay.

V) **Develop systemic control mechanism**

This fifth ranked resolution technique with an overall mean score of 3.1 is mainly related to evaluation and monitoring. Lack of monitoring and evaluation has also been cited as a major cause of delay. It will be important to develop a strong and robust controlling system in place to realistically meet deadlines.

VI) **Monitor progress during the contract period**

Monitoring and evaluation which are closely tied to control mechanisms will have a pronounced effect on averting delays before they are caused. Putting in place a well-thought controlling, evaluating and monitoring practice will influence timely project completion.

When it come each party's responses, contractors suggested estimating realistic project cost and durations, making payment in time, strategic planning, improving construction methods, improving supply of materials and labour are the top ranked five resolution techniques.

Consultants on their behalf listed strategic planning, making payments on time, improving supply of materials, monitoring progress during contract period, improving supply of materials and labour as major resolution techniques.

What clients also listed is not far from the other two stakeholders when it comes to resolution methods. They listed making realistic cost and duration estimation, monitoring progress, developing systemic control mechanisms, strategic planning and improving supply of materials as major delay resolution methods.

4.7 Case Studies

For the purpose of this research and to highlight the major factors that could be deemed as causative factors of delay in large scale irrigation projects, two case studies were studied to further look into the major causes of delays in such projects. The case studies focused on the following two major large irrigation projects.

A) Kuraz irrigation project
B) Tendaho irrigation project

4.7.1 Case study one: Kuraz irrigation project: main canal construction

A) Project Description

Kuraz irrigation project is one of the largest, if not the largest of all the sugar estate projects being undertaken. Ethiopian sugar corporation manages the four large scale factories served by the irrigation scheme while the structures for diverting water and the conveyance channels, are owned and administered by the Ethiopian construction works Corporation (ECWC).

The system is designed in such a way that the sugar estate is expected to pay for water it uses. And that payment directly goes to ECWC, thus enabling it to operate and maintain the infrastructure.

Once fully realized, the project is expected to irrigate a gross command area of 175,000 hectares of sugar cane plantation. The construction of the diversion schemes as well as the main canal system is under construction and there are some remaining jobs.

Kuraz irrigation project is mainly a system of two canals (called the left bank main canal and the Right bank main canals). The right main canal is the longest of the two which runs for a total length of 152 kms up on completion. The Left main canal runs for 55 kms.

Both canals are intercepted by secondary and tertiary canals, which take water to the fields directly. The construction of these structures, mainly the main canal and the appurtenant structures is being done by three contractors, the Ethiopians construction Work corporation's Water Infrastructure Construction Sector (WICS), South Water Works Construction (SWWC) and Jiangxi Water and Hydropower Construction (JWHC).The consultant of the project is the government owned Ethiopian Construction Design and Supervision Corporation (ECDSC) and South Design and Construction Supervision Enterprise (SDCSE).

Currently, there are 13 active construction agreements on the right bank main canal and one maintenance construction agreement.

- Construction of head work (weir)
- Construction of main canal between CH 0+000 to 1+340
- Construction of main canal between CH 1+340 to 6+100

- Construction of main canal between CH 6+100 to 10+122
- Construction of main canal between 10+122 to 15+422
- Construction of access road between 0+000 to 42+000
- Construction of main canal between 65+451 to 84+022
- Construction of main canal between 84+022 to 110+908
- Construction of main canal between CH 110+908 to 133+791
- Construction of structures between CH 32+674 to 65+451
- Construction of structures between 65+451 to 133+791 and community bridge between 6+342 to 35+452
- Construction of structures between CH 15+422-24+173
- Construction of structures between CH 24+173-41+370
- Construction of structures between CH 41+682-65+826
- Construction of structures between CH 0+000-55+264 (Left bank canal maintenance)

B) Investigative methodology

The main technique used to gather data for this project included analyzing relevant project documents obtained from ECWC and interviews conducted with representatives of the client. The client was asked to reflect on some pre-prepared questions regarding the various projects pertaining to Kuraz project. However, the client was only able to disclose information on projects being done by WICS. WICS has a total of 8 (eight) projects at Kuraz.

C) Findings

Time over runs have been a common problem in this project. The contractors have not met the deadlines and was not observant of the schedules agreed upon. As seen from table 11, they were not able to finish their contract in an extended time let alone in the original end dates. As the result, WICS was forced to enter a liquidated damage. Out of 8 (eight) projects WICS has, 6 (six) projects have suffered from severe time overrun.

Table 11: Kuraz irrigation project: time delay summary for projects under WICS [source: D&IMC]

Contract Agreement	Contractor	Original duration	Contract signing date	Revised Contract end date	Progress by the end of 2020	Time overrun
Construction of main canal between CH 6+100 to 10+122	WICS	180 days	Jul 13,2016	Dec 31,2020	82.67%	823.33 %
Construction of main canal between 10+122 to 15+422	WICS	240 days	Mar 25,2017	Dec 31,2021	81.58%	473.75 %
Construction of access road between 0+000 to 42+000	WICS	300 days	Oct ,2017	Aug 28,2020	31.98%	295.67 %
Construction of main canal between 65+451 to 84+022	WICS	300 days	Mar 25,2017	Sep 22,2020	69.13%	359 %
Construction of main canal between 84+022 to 110+908	WICS	300 days	Sep ,2017	Dec, 2020	62.33%	305.67 %
Construction of main canal between CH 110+908 to 133+791 contract 1	WICS	150 days	Apr 04,2020	Sep 25,2020	No data	80.67 %
Construction of structures between CH 32+674 to 65+451	WICS	540 days	Aug 23,2019	Feb 14,2021	44.26%	NO overrun
Construction of structures between 65+451 to 133+791 and community bridge between 6+342 to 35+452	WICS	365 days	Apr 04,2020	Sep 4,2021	No data	NO overrun

D) Main causes of delay

The main causes of delay identified from the investigation include:

- The main canal design was amended several times due to faulty considerations used by the main consultant initially. The consultant mainly relied on Digital Elevation Data (DEM) collected though remote sensing for its preliminary designs. Even if such type of data is valuable for preliminary studies that ted to use coarser gridded data, their application in detailed designs, as required for such studies has not been proven to be enough. However, knowingly the consultant used these remotely sensed digital elevation model without doing the proper calibration with the ground truth. Surveying needed to be used to offset this discrepancy but was not done at the design stage which led to a major design and scope change. There was a substantial fill and cut to be made, a rerouting and construction of more cross drainage structures.

- The Variation change was different for several lots. In some cases, exceeding the 25% limit set by FIDIC, which required a signing of a new deal. Generally, the scope change was not in the acceptable range, which has significantly impacted the time and financial budget.
- The Dam and irrigation management sector within ECWC acts as the client of the project. This sector has been mandated to own dams and administer the selling of water by EWC and the council of Ministers. At the same time, one of the contractors, the Water Infrastructure Construction Sector (WICS) within ECWC participates in the project as a contractor. Both the client and the contractor being from the same organization has created a discernible conflict of interest. One such area has been in the system of control. The kind of control the client has over the contactor is loose. The consultant has also been observed to be not that strict on the contractor as both the client and the contactor are from the same company.
- The Kuraz irrigation project is mainly financed by government loans. The loans were processed taking into assumption the fact that the irrigation scheme provides water to the sugar corporation on pay. This hasn’t materialized yet. The water tariff law hast been ratified by the FDRE house of representatives. This has made it impossible for the banks to continue financing. Thus, loans were suspended in April, 2020. This has forced the contractors to suspend work and thus a prolonged delay.
- Designs were not completed in time. The consultant mainly focused on the designs of the man canals while the designs of the Sub Main Drains (SMD) were ignored. Lack of construction in these crucial structures led to damages on the canal which has to be rebuilt.

- The Project has a lot of variations due to erroneous procedures used during the design phase. The data used in the design of canal alignment were not accurate and has a lot of discrepancy with the surveying data.
- Some works are done without going through the normal contracting procedures. the client is sometime seen to influence the contractor to carry out some jobs without it signing a formal contact.

4.7.2 Case studies two: Tendaho irrigation scheme

A) Project description

The Tendaho dam and irrigation project is one of the largest irrigation schemes in Ethiopia. The project aims at providing water for a gross area of 60,000 hectares of land. The project is in Afar National regional state, at 600 Kms from the nation's capital. The irrigation area to be supplied is found in the regional municipalities of Dubti, Ferity, Det Bahry and Assayita.

Even if around 10,000 hectares of land is dedicated to community farming, the bulk of the irrigated land is reserved for sugar plantation. The Tendaho sugar production plant was projected to produce 7.02 million tons of sugar annually, even if it has not reached that capacity yet.

The project was originally initiated and owed by the Ministry of water, irrigation, and Electricity (MoWIE), but ownership of the project has been transferred to the Ethiopian Construction works Corporation since June,2018. The man contractor who has done the major civil works is the formerly Ethiopian Water Work Corporation, now part of the Ethiopian construction works corporation. The main consultant on the project was the Ethiopian construction Design and the supervision works corporation.

The engineering work comprised of impounding the rainy season's inflow of the lower awash catchment and diverting this flow in the dry seasons. According to the original contract agreement, the construction of Tendaho Dam and irrigation Project consist of the following works:

- Main dam and coffer dams, earth works and structural works. That would also include excavation, filling and backfilling, slope protection, riprap, masonry works, dam toe-drain, dam seepage control, dam rain gutter and pipe work, steel structure, concrete works, re-bar, dam crest pipe culvert excavation, masonry, concrete and backfill and dam instrumentation.

- Diversion Tunnel outlet, approach, tail race, and by pass channel, intake towers, spillway chute section, siphon earth work, and structural works
- Dam access road; excavation (soft and hard work), fill and red ash
- Grouting work for the left and right abutment, that is boring, drilling works, water pressure tests, installing and casing plastic and grouting equipment and consolidation.

B) Contract Agreement

The contract agreement for the construction works was signed between the Ministry of Water, Irrigation, and Electricity (MOWIE) and the former Ethiopian Water Works Corporation (EWWC) on August 2004. The construction agreement has two components.

- Original Contract for Tendaho Dam and Irrigation Project (TDIP)
- Contract amendment on the original contract agreement. i.e., amendments number 1 to 5.

Later in April 12th, 2005 a subcontract work was awarded to China's Jiangxi corporation. the scopes of work described in the original contract are as discussed in the previous section. And the five amendments signed are summarized below.

Amendment Number 1

This amendment was signed on February 2011. The amendment has increased the agreed contract price from 840,254,247.70 Birr (original contract price) to 2,272,435,130.99 Birr. The original agreement was prepared on preliminary designs and later, as the detailed designs came about, this has led to the increase in the volume of work and thus in price escalation.

Amendment Number 2

This amendment was signed on July,2012. This amendment has not changed the contract price much. But unit rates for some works have been decreased. Moreover, for some units of work, whose price was stated in lump sum in the original agreement, was revised to have unit rate prices.

Amendment Number 3

This amendment was signed on July,2014. There is no change in the price on this amendment as well. The increment on quantities of primary canals 5, 7 and the main canal has been made. Unit rate prices for some items of work was revised pertaining to the inflation.

Amendment Number 4

This amendment was signed on January 2015. On this amendment the price of the contract was increased from 2,272,435,130.41 Birr to 3,042,070,072.19 Birr. The price escalation described in this amendment is mainly due to change in the scope of work.

Amendment Number 5

This amendment was signed on June 2015. There was some revision in the unit rate prices on this amendment. But the total price of the project has not changed from the one agreed on amendment 4.

C) Findings

The schedule of the project was divided into 7 sections. Each section was given a duration of completion as agreed in August 2004. The tasks in each program and duration of completion for each program is as given in table 12.

Table 12: estimated project completion time (As stated in the original signing of contract)

Program ID	Works included there of	Estimated duration
Section 1	Mobilization, camp construction	4 months
Section 2	Outlet works	10 and ½ month
Section 3	Channels (approach, tail race, and bypass)	15 and ½ month
Section 4	Main and coffer dam and grouting works	18 months
Section 5	Spillway	11 and ½ months
Section 6	Hydroelectric station	4 months
Section 7	Demobilization	½ months
Total project time		**64 months**

However, as the project progressed, the completion time for each section was revised. Significant delays were observed. The observed delay along with the major cause of the delay is described in sections below.

A) It took more time than what is stated for section one to be completed. The contractor was initially unable to identify sources of materials in due time and was also unable to develop the appropriate concrete mix.

B) The works in sections 2,3,4, and 6 were not completed in due time because the contractor was under staffed. The contractor was not able to mobilize the needed machinery and human resource in time. Moreover, the contractor was new to some of the work items, thus delaying their completion within schedule.

C) Section 6 was not completed in time because the purchase for the required inputs was not made in time. The materials required, especially the small hydroelectric power units needed international purchase agreements which were not made in time due to foreign currency issues. Moreover, there were frequent rejection of submissions by the consultant as the materials delivered were not up to standard.

Overall, Tendaho Dam and irrigation project was delayed by 105% and has costed the client to allocates more than three folds than originally assumed.

D) Causes of delay

Generally, the man reasons for the delay in completion, as identified in the project's completion report are:

- Very poor, project management on the contractor's side
- Lack of materials (Cement, fuel…) on site
- Financial problems of the client
- Late payments
- Understaffing from the contractor's side, unqualified human resource
- social unrest and problems in the construction area.
- poor planning in procurement of materials and plant. This is especially rampant in procurements which involve international suppliers
- The contractor's hesitation to deploy the required machinery in time.
- Inappropriate and tradition working scheme. The contractor was not skilled enough to try new and improved ways of doing some units of work.
- Frequent scope and design changes. The project was entered with preliminary designs which were later refined as the project progresses.

5 Conclusion and Recommendation

5.1 Conclusion

Large scale irrigation projects in Ethiopia mainly suffer from rampant delays due to several factors. The factors responsible for delay are caused by different stakeholder who participate in the sector. This study based on the Pareto principle identified ten major causes of delays as being the major causes that result 80% of the delays in such projects

The identified factors are poor planning and activity scheduling (MS=3.33), poor project management (MS=3.15), problems in material delivery on time (MS=3.10), poor monitoring and evaluation system (MS=3.08), poor site management (MS= 2.95), delay in payment (2.93), unfinished designs (2.93), error in estimating durations (2.9), contractor financial problems (2.88), Poor decision making (2.85) and issues related to right of way (2.85).

The investigation also encompassed analysis of respondent's response in relation to the respondent's affiliation. Of the top ranked causative factors, contractors tend to mention consultant related factors more as causative factors mor than any other group. Consultants on the other hand mentioned contractor related factors more as delay causing and ranked consultant related factors second. Clients surprisingly enough themselves as more responsible to cause delays more than any other group.

Desk study analysis conducted as part of the research also confirmed the fact that delays are very common problems in large scale irrigation projects. The case of Kuraz and Tendaho dam and irrigation project is a good testament to this. Both projects suffered tremendous delays, even forcing some of the contracts to enter liquidated damages. Tendaho Dam and irrigation project was by significant amount up to 105% and has increased the original cost by about three times.

When it comes to resolution methods forwarded by respondents, the 6 (six) top ranked resolution methods identified were realistic cost and duration estimation (MS=3.28), make payment timely **(**MS=3.28), Strategic planning (MS=3.25), improve supply of materials and labor (MS=3.15), develop systematic control mechanisms (MS=3.10), and monitor progress during control period (MS=3.10).

The resolution techniques suggested are not that different among the different stakeholder when it comes to resolution techniques. All of them listed estimating realistic cost and durations, strategic planning and improving supply of materials as top ranked and most useful delay resolution techniques.

5.2 Recommendations

From the findings of the primary data analysis as well as secondary data analysis, we can see that there should be some ways that could be suggested to alleviate problems of delays in large scale irrigation projects.

- There should be a comprehensive project planning and activity scheduling which should be done by the contractor before the commencement of the project. These plan needs to be agreed upon by all stakeholders before being final and binding.
- The project management areas should be well planned for. There should be systemic time, quality, cost, and communication, evaluation and monitoring plans in place. That goes hand in hand with solving the issues of por project management.
- The issue of payment also needs to be solved by clients. Clients need to be able to make payments in time once they are approved by consultants.
- The issue of incomplete design has also been found out to have profound effect on work progress. Even if large scale irrigation projects are complex in their nature, maximum effort needs to be put in to solve this issue before it makes its way into disrupting project progress.
- Conflict of interest has to be avoided as much as possible. ECWC being a client and a contractor at the same time has created multifaceted problems in project progress control and contract administration. Such type of issues needs to be solved by separating the two entities in to two different organizations.

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7 Annex

7.1 Questionnaire prepared using Google forms

Causes of delay in large scale irrigation projects in Ethiopia

Dear respondent,

This questionnaire is prepared as a data collection tool for a research called "Factors behind Time and cost overruns in large scale irrigation projects in Ethiopia". As indicated in the title, the research aims at finding the major causative agents behind these overruns and suggest resolution mechanisms.

As a professional engineer, you are invited to rate factors listed below based on their ability to cause delays. The questionnaire will have three main parts. Section one asks few personal questions; Section two lists the probable causative factors and asks the questionee to rate these factors. The third and final section lists resolution methods that could be applied.

Thank you so much for being part of this research and I am hopeful your responses will be of very much value to the research being conducted. For any inquiries, please contact the researcher at his phone number 0985237869 or personal email address alemayehudula@gmail.com.

NOTE: Make sure you have the entire page before starting to fill the questionnaire. Please click on "view entire message" at the bottom of this page before continuing.

Alemayehu Dula

Section 1: participant information

A) Gender [Make ✓ sign where it applies]

Male ☐

Female ☐

B) Professional Title

____

C) Educational Status [Make ✓ sign where it applies]

B.Sc. ☐

M.Sc. ☐

Ph.D. ☐

Other ___________________________________

D) To which of the following you likely affiliate to?

Client ☐

Consultant ☐

Contractor ☐

Section 2: How do you rate the following possible causes of delay in Large Scale irrigation Projects? Make ✓ sign under the item you rate the factor to belong to.

Factor	I don't know	Not significant	Slightly significant	moderately significant	very significant	Extremely significant
Contractor's Lack of experience						
Improper methodology used by contractors						
Error in estimating durations						
Error in estimating project cost						
Poor site management						
Poor planning and activity scheduling						
Lack of quarry site						
Price escalation						
Unreliable subcontractors						
Problems in material delivery on time						
Improper equipment deployment						
Contractor financial problems						
Poor communication among stakeholders						
Variation orders						
Delay in payment						
Client financial problem						
Poor decision making						
Late site handover						
Issues related to right of way						
Unfinished designs						
Mistakes in preliminary site investigation						
Poor project management						
Bureaucracy in client organization						

Late approval by consultants						
Delay in work orders						
Accidents in construction						
Lack of skilled professionals						
Labor strikes						
Contractor having high number of contracts (high workload)						
Employee turnover						
Inappropriate/ misuse of materials						
Poor monitoring and evaluation system						
Weather conditions						
Delay in mobilization						
Political instability						
Uncertainty in ground conditions						
Interference of local authorities						
Poor security						
Bureaucracy in procurement methods employed						
Corruption						
Natural disasters						
Lack of political commitment from Government						
Inadequate design specifications						
Poor scope definition						
Poor risk management						
Project complexity						
Project termination by owner						
Act of God						

Section 3: What are the possible resolution methods?

Resolution Methods	I don't know	Not significant	Slightly significant	moderately significant	very significant	Extremely significant
Monitor progress during the contract period						
Conduct 3C meetings regularly						
Conduct weekly and monthly budget comparisons with the actual performance						
Develop systemic control mechanisms						
Improve contract award practices						
Relying on technological time and budgetary control mechanisms						
Improving construction methods						
Realistic cost and duration estimation						
Timely and reasonable procurement						
Improving the composition of teams						
Strategic planning						
Develop risk management plan						
Focus on use of machinery						
Hire more professionals						
Focus on training and development						
Avoid double handling, poor quality of work, timely progress control						
Improve efficiency of workers						
Improve communication between stakeholders						
Work on leadership and management						
Make sure designs are complete before construction contract award						
Resolve disputes between stakeholders in time						
Improve claim management						

Work on scope definition						
Improve supply of materials and labor						
Work on activity sequencing						
Improve machinery management						
Make payment timely						

7.2 Spearman's Coefficient for Resolution Mechanisms

			TotaL_RES
Spearman's rho	Monitor progress during the contract period	Correlation Coefficient	.598**
		Sig. (2-tailed)	.000
	Conduct 3C meetings regularly	Correlation Coefficient	.654**
		Sig. (2-tailed)	.000
	Conduct weekly and monthly budget comparisons with the actual performance	Correlation Coefficient	.698**
		Sig. (2-tailed)	.000
	Develop systemic control mechanisms	Correlation Coefficient	.699**
		Sig. (2-tailed)	.000
	Improve contract award practices	Correlation Coefficient	.452**
		Sig. (2-tailed)	.003
	relying on technological time and budgetary control mechanisms	Correlation Coefficient	.740**
		Sig. (2-tailed)	.000
	improve construction methods	Correlation Coefficient	.677**
		Sig. (2-tailed)	.000
	realistic cost and duration estimation	Correlation Coefficient	.770**
		Sig. (2-tailed)	.000
	Timely and reasonable procurement	Correlation Coefficient	.652**
		Sig. (2-tailed)	.000
	improving the composition of teams	Correlation Coefficient	.572**
		Sig. (2-tailed)	.000
	strategic planning	Correlation Coefficient	.591**
		Sig. (2-tailed)	.000
	develop risk management plan	Correlation Coefficient	.790**
		Sig. (2-tailed)	.000
	Focus on use of machinery	Correlation Coefficient	.657**
		Sig. (2-tailed)	.000
	Hire more professionals	Correlation Coefficient	.638**
		Sig. (2-tailed)	.000
	focus on training and development	Correlation Coefficient	.827**
		Sig. (2-tailed)	.000
		Correlation Coefficient	.769**

	Avoid double handling, poor quality of work, timely progress control	Sig. (2-tailed)	.000
	improve communication between stakeholders	Correlation Coefficient	.718**
		Sig. (2-tailed)	.000
	Work on leadership and management	Correlation Coefficient	.785**
		Sig. (2-tailed)	.000
	make sure designs are complete before construction contract award	Correlation Coefficient	.704**
		Sig. (2-tailed)	.000
	resolve disputes between stakeholders in time	Correlation Coefficient	.486**
		Sig. (2-tailed)	.001
	improve claim management	Correlation Coefficient	.632**
		Sig. (2-tailed)	.000
	Work on scope definition	Correlation Coefficient	.589**
		Sig. (2-tailed)	.000
	improve supply of material and labor	Correlation Coefficient	.603**
		Sig. (2-tailed)	.000
	Work on activity Sequencing	Correlation Coefficient	.759**
		Sig. (2-tailed)	.000
	Improve machinery management	Correlation Coefficient	.686**
		Sig. (2-tailed)	.000
	Make payment timely	Correlation Coefficient	.581**
		Sig. (2-tailed)	.000
	TotaL_RES	Correlation Coefficient	1.000
		Sig. (2-tailed)	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

7.3 Spearman's coefficient for causes of delay

			Total_cause
Spearman's rho	Contractor's lack of experience	Correlation Coefficient	.180
		Sig. (2-tailed)	.274
	Improper methodology used by contractors	Correlation Coefficient	.505**
		Sig. (2-tailed)	.001
	Error in estimating durations	Correlation Coefficient	.440**
		Sig. (2-tailed)	.005
	Error in estimating Cost	Correlation Coefficient	.313
		Sig. (2-tailed)	.053
	Poor site management	Correlation Coefficient	.565**
		Sig. (2-tailed)	.000
	Poor planning and activity Scheduling	Correlation Coefficient	.551**
		Sig. (2-tailed)	.000
	Lack of quarry site	Correlation Coefficient	.393*
		Sig. (2-tailed)	.012
	Price escalation	Correlation Coefficient	.230
		Sig. (2-tailed)	.154
	Unreliable Subcontractors	Correlation Coefficient	.415**
		Sig. (2-tailed)	.009
	Problems in material delivery on time	Correlation Coefficient	.687**
		Sig. (2-tailed)	.000
	Improper equipment deployment	Correlation Coefficient	.583**
		Sig. (2-tailed)	.000
	Contractor financial problems	Correlation Coefficient	.709**
		Sig. (2-tailed)	.000
	Poor communication among stakeholders	Correlation Coefficient	.257
		Sig. (2-tailed)	.119
	Variation orders	Correlation Coefficient	.385*
		Sig. (2-tailed)	.015
	Delay in payment	Correlation Coefficient	.561**
		Sig. (2-tailed)	.000
	Client financial problem	Correlation Coefficient	.541**
		Sig. (2-tailed)	.000
	Poor decision making	Correlation Coefficient	.383*
		Sig. (2-tailed)	.015
	Late site handover	Correlation Coefficient	.560**
		Sig. (2-tailed)	.000
	Issues related to right of way	Correlation Coefficient	.315*
		Sig. (2-tailed)	.048

	Unfinished designs	Correlation Coefficient	.307
		Sig. (2-tailed)	.054
	Mistakes in preliminary site investigations	Correlation Coefficient	.540**
		Sig. (2-tailed)	.000
	Poor project management	Correlation Coefficient	.602**
		Sig. (2-tailed)	.000
	Bureaucracy in client organizations	Correlation Coefficient	.481**
		Sig. (2-tailed)	.003
	Late approval by consultants	Correlation Coefficient	.785**
		Sig. (2-tailed)	.000
	Delay in work orders	Correlation Coefficient	.554**
		Sig. (2-tailed)	.000
	Accidents in construction	Correlation Coefficient	.416**
		Sig. (2-tailed)	.008
	Lack of skilled professionals	Correlation Coefficient	.627**
		Sig. (2-tailed)	.000
	Labor strikes	Correlation Coefficient	.416**
		Sig. (2-tailed)	.008
	Contractor having high number of contractors (high workload)	Correlation Coefficient	.226
		Sig. (2-tailed)	.162
	Employee turnover	Correlation Coefficient	.327*
		Sig. (2-tailed)	.040
	Inappropriate/misuse of materials	Correlation Coefficient	.448**
		Sig. (2-tailed)	.004
	Poor monitoring and evaluation system	Correlation Coefficient	.590**
		Sig. (2-tailed)	.000
	Weather conditions	Correlation Coefficient	.542**
		Sig. (2-tailed)	.000
	Delay in mobilization	Correlation Coefficient	.588**
		Sig. (2-tailed)	.000
	Political instability	Correlation Coefficient	.475**
		Sig. (2-tailed)	.002
	Uncertainty in ground conditions	Correlation Coefficient	.592**
		Sig. (2-tailed)	.000
	Interference of local authorities	Correlation Coefficient	.293
		Sig. (2-tailed)	.070
	Poor security	Correlation Coefficient	.580**
		Sig. (2-tailed)	.000
	Bureaucracy in procurement methods	Correlation Coefficient	.720**
		Sig. (2-tailed)	.000
	Corruption	Correlation Coefficient	.536**

		Sig. (2-tailed)	.000
	Natural disasters	Correlation Coefficient	.404**
		Sig. (2-tailed)	.010
	Lack of political commitment from government	Correlation Coefficient	.520**
		Sig. (2-tailed)	.001
	Inadequate design specifications	Correlation Coefficient	.513**
		Sig. (2-tailed)	.001
	Poor scope definition	Correlation Coefficient	.393*
		Sig. (2-tailed)	.012
	Poor risk management	Correlation Coefficient	.485**
		Sig. (2-tailed)	.002
	Project complexity	Correlation Coefficient	.320*
		Sig. (2-tailed)	.044
	Project termination by owner	Correlation Coefficient	.484**
		Sig. (2-tailed)	.002
	Act of God	Correlation Coefficient	.338
		Sig. (2-tailed)	.091
	Total_cause	Correlation Coefficient	1.000
		Sig. (2-tailed)	

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.4 Cronbach's Alpha value for each variable

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
IntervieweeID	196.12	1169.985	-.083	.944
Gender	219.76	1197.941	-.080	.882
Educational status	219.18	1208.404	-.287	.883
Company affiliation	218.59	1195.632	.006	.882
Contractor's lack of experience	218.29	1176.596	.210	.881
Improper methodology used by contractors	218.35	1159.493	.495	.878
Error in estimating durations	217.59	1179.632	.433	.880
Error in estimating Cost	217.94	1171.559	.333	.880
Poor site management	218.06	1166.184	.417	.879
Poor planning and activity Scheduling	217.59	1177.632	.357	.880
Lack of quarry site	218.76	1149.941	.654	.877
Price escalation	218.18	1170.529	.282	.880
Unreliable Subcontractors	218.71	1171.221	.360	.880
Problems in material delivery on time	217.65	1184.993	.198	.881
Improper equipment deployment	217.94	1162.059	.466	.879
Contractor financial problems	217.82	1170.154	.313	.880
Poor communication among stakeholders	218.12	1170.985	.394	.879
Variation orders	218.35	1167.243	.413	.879
Delay in payment	217.88	1195.110	.007	.882
Client financial problem	218.18	1167.904	.312	.880
Poor decision making	217.94	1190.184	.088	.882
Late site handover	218.59	1143.882	.581	.877
Issues related to right of way	217.76	1160.316	.580	.878
Unfinished designs	217.76	1188.191	.136	.881
Mistakes in preliminary site investigations	218.41	1164.632	.453	.879
Poor project management	217.71	1170.721	.429	.879

Bureaucracy in client organizations	218.65	1166.243	.454	.879
Late approval by consultants	218.53	1154.140	.667	.877
Delay in work orders	218.29	1168.846	.389	.879
Accidents in construction	219.65	1179.118	.255	.880
Lack of skilled professionals	218.47	1162.390	.434	.879
Labor strikes	219.41	1182.257	.170	.881
Contractor having high number of contractors (high workload)	218.59	1168.007	.368	.879
Employee turnover	218.71	1163.596	.509	.879
Inappropriate/misuse of materials	218.88	1162.985	.585	.878
Poor monitoring and evaluation system	217.71	1174.221	.408	.880
Weather conditions	219.06	1163.559	.387	.879
Delay in mobilization	218.47	1159.765	.529	.878
Political instability	218.29	1188.221	.127	.881
Uncertainty in ground conditions	219.00	1171.250	.499	.879
Interference of local authorities	219.12	1175.985	.314	.880
Poor security	218.65	1151.243	.645	.877
Bureaucracy in procurement methods	218.35	1147.243	.709	.877
Corruption	218.82	1185.904	.099	.882
Natural disasters	219.35	1185.368	.193	.881
Lack of political commitment from government	218.47	1176.515	.262	.880
Inadequate design specifications	218.12	1198.985	-.048	.883
Poor scope definition	218.12	1149.985	.684	.877
Poor risk management	218.18	1160.279	.560	.878
Project complexity	218.35	1162.368	.431	.879
Project termination by owner	219.35	1184.243	.144	.881
Act of God	219.41	1196.632	-.022	.884
Monitor progress during the contract period	217.65	1181.743	.288	.880
Conduct 3C meetings regularly	218.00	1172.125	.431	.879

Conduct weekly and monthly budget comparisons with the actual performance	218.06	1157.809	.538	.878
Develop systemic control mechanisms	217.59	1160.257	.699	.878
Improve contract award practices	218.06	1149.184	.625	.877
relying on technological time and budgetary control mechanisms	217.94	1159.184	.540	.878
improve construction methods	217.71	1157.721	.498	.878
realistic cost and duration estimation	217.59	1152.382	.616	.877
Timely and reasonable procurement	217.88	1162.610	.382	.879
improving the composition of teams	218.24	1165.066	.359	.879
strategic planning	217.71	1158.846	.512	.878
develop risk management plan	217.88	1160.735	.469	.879
Focus on use of machinery	218.29	1173.346	.414	.879
Hire more professionals	218.88	1144.110	.698	.877
focus on training and development	218.29	1135.096	.644	.876
Avoid double handling, poor quality of work, timely progress control	217.94	1152.559	.568	.878
improve communication between stakeholders	217.76	1156.941	.521	.878
Work on leadership and management	218.06	1151.059	.569	.877
make sure designs are complete before construction contract award	217.76	1156.316	.561	.878
resolve disputes between stakeholders in time	217.53	1159.265	.481	.878
improve claim management	218.12	1167.985	.411	.879
Work on scope definition	218.18	1164.529	.534	.879
improve supply of material and labor	217.76	1158.566	.664	.878

Work on activity Sequencing	217.59	1167.757	.394	.879
Improve machinery management	217.82	1154.029	.613	.878
Make payment timely	217.88	1151.485	.632	.877