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Investigating Cause and effect of delay þÿ i n E t h i o p i a s P u b l i c S e c t o r C o Projects by Structural Equation Modeling

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Investigating Cause and Effect of delay in Ethiopia's public sector construction projects by Structural Equation Modeling (SEM)

By:

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A Thesis in partial fulfillment of the requirements for the Degree of Master of Science in **"Industrial Management"**

Supervised by: Bereket Haile Woldegiorgis, PhD

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DECLARATION

This is to certify that the thesis entitled **"Investigating Cause and effect of delay in Ethiopia's Public Sector Construction Projects by Structural Equation Modeling",** submitted in partial fulfillment of the requirements for the degree of Master of Science in **Industrial Management** under the Faculty of Mechanical and Industrial Engineering, Bahir Dar Institute of Technology, is a record of original work carried out by me and has never been submitted to this or any other institution to get any other degree or certificates. The assistance and help I received during this investigation have been duly acknowledged.

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Approval of Thesis for defense

I hereby certify that I have supervised, read, and evaluated this thesis titled **"Investigating Cause and effect of delay in Ethiopia's Public Sector Construction Projects by Structural Equation Modeling",** prepared by **Getahun Borja Mekonnen** under my guidance. I recommend the thesis to be submitted for oral defense.

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Thesis Approval Sheet

I hereby confirm that the changes required by the examiners have been carried out and incorporated in the final thesis.

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As a member of the board of examiners, we examined this thesis entitled **"Investigating Cause and effect of delay in Ethiopia's Public Sector Construction Projects by Structural Equation Modeling"** by Getahun Borja. We hereby certify that the thesis is accepted for fulfilling the requirements for the award of the degree of Masters of Science in **"Industrial Management".**

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DEDICATION

To My Father

He passed away before seeing my success I have been now. For earning an honest living for us and for supporting and encouraging believe in me. May the Lord place your soul in Heaven!

To My Dear Mother

A strong and gentle soul who taught to trust in God, believe in hard work and that so much could be done with little…long live mom

To My all Family and My Friends

They have been a tremendous source of support during this work

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Furthermore, I would like to thank all those whose names have not been mentioned but have made valuable contributions while working on this study.

Finally, if the study appears to have merit, my sincere thanks were due to God, but if the fault was found it was mine.

ABSTRACT

Construction industry plays great roles in the development of any country in transforming the aspirations and the needs of its people into reality by implementing various physical structures. This study was analyzed different causes of public construction delay, and determines how critical delay causes are most influential in project progress. The objectives are to identify the most significant causes and the associated effects of delays in public construction projects in Ethiopia and to make overviews for possible future action related to the problem. The study is limited to cause and impacts of delay in public construction works only at randomly selected construction projects. This study adopted a mixed research design and two data collection methods i.e. questionnaires and semi-structured interviews (phone and in-person). As a result, purposive, snowball sampling techniques were applied. Using Structural Equation Modeling [SEM], this study examined relationship between 48 variables [41 factors and 7 effects], previously identified as contributing to public construction delay in the Ethiopian construction industry and the effects consequences of this delay. As per the path analysis with IBM SPPS Amos 23 a β-value (intercept estimate) the most dominant factor of Contractor related_CR factor 'Shortage of contractor's materials on site is estimated to be 3.405. On the other hand, External related_EX factors 'Environmental factors' have the least influence on delays in the construction field with a β-value of 3.132. And also this study identifies effects of delay on public construction projects found in Ethiopia as (from the most dominant effect to least effect); (1) Time overrun, (2) Cost overrun, (3) Dispute between parties involved, (4) Arbitration, (5) Litigation and court case, (6) Total abandonment of the project, and (7) Wastage and underutilization of resource. The researcher recommends to the scholars who want to conduct such study in the future needs to give time and do all iteration separately on the private construction sector. The findings of this study will contribute to enhancing the good awareness and the government/client at large by disclosing the core problems on the delay magnitude assessment and collection procedures to enable them to put their effort into success over the observed problems.

Key Words: *Delay, Public Construction Project, SEM, IBM SPSS Amos 23, delay effect*

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NOMENCLATURE

AMOS	Analysis of Moment Structures
BATCODA	Building and Transport Construction Design Authority
CEF	Construction Economic Forecast
EBCS	Ethiopian Building Code of Standards
ECC	Ethiopian Civil Code
FIDIC	Federation Internationale des Ingenieurs Conseils (International Federation of Consulting Engineers)
FY	Fiscal Year
GDP	Gross Domestic Product
LS	Lump sum
MoWUD	Ministry of Works and Urban Development
NBE	National Bank of Ethiopia
PLS	Partial Least Square
PPA	Public Procurement Agency
RII	Relative Important Index
SCL	Society of Construction Law
SEM	Structural Equation Modeling
SPSS	Statistical Package for the Social Sciences

CHAPTER ONE
INTRODUCTION

1.1. Background of the study

Construction industry plays great roles in the development of any country in transforming the aspirations and the needs of its people into reality by implementing various physical structures. Construction project is commonly acknowledged as successful when it is completed within budget, on time, and following specifications and stakeholder's satisfaction.

Wells, (1984) defined Construction as an execution of the physical creation of infrastructure, superstructure, and related facilities. It comprises all civil engineering works and all types of building projects including; housing, commercial building, offices projects as well as maintenance and repair of existing structures.

According to Aibinu, A., and Jagboro, G. (2002) also agree to Wells, (1984) definitions, and timely completion of a construction project is frequently seen as a major criterion of project success by owners/clients, consultants, contractors, and other related parties. However, due to uncertainties of events and its uniqueness most of the projects did not finish on the expected timetable rather after the schedule.

Modern construction projects are characterized by advanced technology, multiparty participation, new standards, and frequent owner-desired changes. Coupled with these inherent complexities and uncertainties in the financial, economic, and physical environment in which most projects are performed. Such condition have made completing projects within contract time and on a budget is difficult task to accomplish, often leading to claims on cost compensations and/or time extensions. This eventually leads to a delay in the completion of the project.

Due to facilitation of socio-economic growth and advancement of every economy construction industry is an essential sector. The industries all over the world spur growth of economies primarily due to the contribution the sector makes to the economies of these countries by providing the relevant infrastructure that spurs the growth of other industries (Ofori, 2012).

According to Annual Public Sector Debt Portfolio Analysis for the Year 2018/19 No. 20 page 3-4) GDP growth is broad-based sectors recorded positive growth rates, as a result

of the growth of the manufacturing industry and construction sectors significant expansion of 6.8 percent and 20.3 percent respectively in 2018/2019.

As stated on NBE Quarterly Bulletin (Volume 36, No.1 First Quarter 2019/20 FY Series, page 64-65) 9 investment projects with investment amount of Birr 60.7 million became operational. Both the number of investment projects and investment amount showed a 98.3 and 99 percent decline relative to last year the same quarter. All investment projects were private and domestic. These investment projects have generated employment opportunities for 112 employees of which 45.5 percent was permanent and 54.5 percent casual. As for sectorial distribution, manufacturing constituted 55.6 percent of the total investment projects while construction and real estate, renting & business activities took 22.2 percent share each. Of the Birr 60.7 million capitals invested, the share of the manufacturing sector was 66.4 percent, and that of real estate, renting & business activities 26.3 percent and construction 7.2 percent.

According to the African Economic Outlook (AEO, 2018), that stated in MOFED (ministry of finance and economic development) public construction projects in Ethiopia were part of the country's development initiatives. Public investments are the driving forces for growth and development in the short and medium-term with huge investments in infrastructure in the country. Similarly, the contribution of the construction sector to the Gross Domestic Product (GDP) in Ethiopia is very large (21.2%).

As the Ethiopian economy is based on agriculture, transport infrastructure allows the agricultural communities to access both domestic and international markets; connecting rural communities to basic services such as education, health, administrative offices, and markets throughout the year in a better way, thus it is an important requirement for their socio-economic development. Therefore, construction projects considered as an essential element for social and economic development as it provides the links required to make markets function.

As many scholars researched construction projects worldwide face significant delays due to different causes/reasons. From those scholars Haseeb, (2011), stated around 80% of construction projects in Pakistan faced delays, SA., (2006) stated about 70% of the large construction projects in Saudi Arabia experienced time overruns, Abatemam, 2006), stated about 94% of 52 surveyed public building projects constructed suffered delays in

Ethiopia, According to Koshe, (2016), stated only 8.25% of projects have been finished within contract period. The remaining 91.75% delayed 352% of its contractual time in Ethiopia.

Delays in a construction project are a common problem and it leads to a large cost overrun, time overrun, inferior quality deliverables, and contract abandonment. In the country this study conducted in (Ethiopia), construction projects were rare that completed within contract period. Public construction projects in Addis Ababa, and other regions that suffered delay due to different reasons.

This study was analyzed different causes of public construction delay, and it's in an integrated manner and determines how critical delay causes are most influential in project progress. This will provide stakeholders involved in construction projects by awaring on how to avoid delays and how can be developed in the future. This study was focused on public construction projects in Ethiopia that leads to assess for delay causes and analysis the corresponding effects identified and provide recommendations based on the findings to improve project performance within the public construction projects.

1.2. Statement of the Problem

The construction industry face delay problem in worldwide. This is a consequence of the non-performance of critical activities on a schedule (timely basis), which lags the completion date of the project. Many projects were delayed due to different cause related to the stakeholders (viz. client, contractor, and consultant) and other cause related.

According to the 2017 edition of African Economic Outlook (AEO), construction activities in Ethiopia accounted for 15.9% of GDP at current prices during the 2015/16 fiscal year which accounts that how the economy of the country lags whenever delay occurred.

As per National Bank of Ethiopia 2017/18 Fiscal year series Vol. 34, construction industry in Ethiopia is the major sector where public and private sectors are investing a huge amount of funds. The percentage share of the construction sector to GDP at the constant basic price has increased from 4.3 % in 1999/2000 to 11.4% by 2016/17. It takes a higher percentage of the annual budget of a country. But, a small number of construction projects were completed within contract period.

Ministry of Urban Development and Construction, (2012), states public infrastructure development projects by the Ministry of Education and Health and road infrastructure projects account for a significant portion of the investment outlay on construction activities. It contributes to the GDP at an average annual growth rate of 12.43%. Similarly, the percentage share of the construction sector to GDP at the constant price has increased from 4.5% in 2000/01 to 5.8% by 2009/10.

Shewaferahu (2016), in his study on the construction of educational projects, found that total delay ranges from 200% to 329% of the initial contract times excluding the time required to complete the projects which conducted on the educational building of Addis Ababa University that was government-run.

Ismeal (1996) reported that delays are endemic to construction projects in Ethiopia. His study indicates most of the projects are experience delays from 100% to 460% of the original contract time. The study shows how important it is to investigate and study on delay causing factors in construction projects of Ethiopia and find solutions to reduce the effect.

Regarding to African Economic Outlook, (2018) when construction sectors were productive, it contribute to sustain a country's economic growth, and therefore provide the financial resources to do everything else.

Delays were costly and often lead to disputes and claim, many projects suffer from extensive delays and that way exceed initial cost estimates and time. In addition to extensive delays provide a fertile ground for costly disputes and claims as an effect. Also in many studies find that the blame is always thrown at the contractor, but there are numerous types of delays that have been caused by other parties/stakeholders.

In Ethiopia, most construction projects subject to delays, especially some government-run projects while project success can be defined as meeting goals and objectives as prescribed in the project schedule, within budget limits, quality, and completion of a time. Due to this project delays lead to huge losses to states and individuals, and loss of investments, failure of the companies, and recourse to the judiciary to resolve disputes.

Therefore, in this study to minimize those delays and effects; delay causing factors have to be identified and analyzed by providing overviews on the subsequent impact of delay for randomly selected public construction projects in Ethiopia.

1.3. Research Questions

The research objectives are translated into the following research questions:

- ✓ What are the reasons that drive delay and its consequence in public construction projects?
- ✓ What are the associated impacts of delays in public construction projects?
- ✓ How to manage and reduce delays in public construction projects?

1.4. Research Objectives

1.4.1. General Objectives

- ✓ The objectives of this study are to identify the most significant causes and the associated effects of delays in public construction projects in Ethiopia and to make overviews for possible future action related to the problem.

1.4.2. Specific Objectives

- ✓ To analyze the causes of project delays in public construction projects.
- ✓ To identify the effects of delays on public construction project performance.
- ✓ To identify the major measures for mitigating delays in public construction projects.

1.5. Significance of the Study

The researcher hopes that this study was important for the following reasons. It is known that significant delays are costly and often result in disputes and claim, many public projects suffer from extensive delays and that way exceed initial time and cost estimates. This research analyzes the major causes and effects of delay in the public construction projects so that the stakeholders take action to minimize the causes to ensure the timely delivery and sustainability of the construction schedule.

The findings of this study will contribute to enhancing the good awareness of the selected public projects and the government/client at large by disclosing the core problems on the delay magnitude assessment and collection procedures to enable them to put their effort into success over the observed problems.

1.6. Scope of the Study

The study is limited to cause and impacts of delay in public construction works only at randomly selected construction projects which are found in Ethiopia. As far as the limitation is concerned many constraints can have an impact on the quality of the study.

Most of the constraints will arise from the case of the targeted population or respondents may not return the questionnaire and others filled the questionnaires carelessly. The targeted population of the study will not understand how one variable of the study is connected to other variables and that makes answers to be contradictory. And also the current world epidemic of COVID-19 limits the movement to gather data for the study which leads to additional data gathering technique like snowballing vie electronic for unreachable region in Ethiopia. Therefore, in the future, other researchers should explain how one variable is related to another before filling questionnaires and lack of experience in researching the side of researchers are the limitation of the study.

1.7. Research Design

A descriptive research design was used to conduct this study. A quantitative approach is adopted for this study for gathering rich data from which ideas are induced and the experiences of the participants are important. The literature reviews mainly focused on previous researches concerning delay issues on construction projects as a whole, and those factors that are relevant to public construction projects. Furthermore, a questionnaire was prepared and distributed to respondents to analyze the response and rank causes of delay and subsequent impact based on their relative importance. The questionnaires are distributed to stakeholders who have been involved in public construction projects in Ethiopia.

1.8. Limitation of the Study

There is an unorganized system toward construction project management and the project management practice and the project information was not documented. During the study process, most of the public construction projects were located in different regions of Ethiopia which is difficult to get in touch with all projects. However, there was inadequate information to those who get in touch with public project undertaking. Therefore, questionnaire distribution to randomly selected public project stakeholders, clients, contractors, and consultants were the main tools that were employed for the process of data collection.

1.9. Thesis Organization

In this thesis, chapter one introduces the background information about the research and its objectives, chapter two discusses the literature reviewed with the topics related to study. In the third chapter, the research methodology is described incorporating data collection and analysis methods, study approach, and study design. The fourth chapter analyzes the research findings while in the fifth chapter conclusions and recommendations are given. The last section cites all the reference materials used for the study. Besides, relevant data and information about the thesis are given in the appendices.

CHAPTER TWO
LITERATURE REVIEW

2.1. Introduction

This chapter covers previous studies on the topic being researched as per the objective of the study. According to Mok, et al., (2015) (on a page.447) a literature review is "a useful methodology to gain an in-depth understanding of a research topic and also a systematic examination of existing publications can help researchers in identifying the current body of knowledge and stimulating inspirations for future research". As per the objective the study tries to review prior studies related to the cause and effects of delay in public construction projects. Hence, construction activity is an integral part of a country's infrastructure and industrial development. The public project includes buildings (viz. schools, hospitals, townships, offices, residential houses, and other); urban infrastructure (involves sewerage, water supply, drainage); highways, roads, ports, railways, airports; power systems (hydropower or dam projects); irrigation and agriculture project; telecommunications projects, etc. Covering as it does such a wide spectrum, construction becomes the basic input for socio-economic development. Besides, the construction industry generates substantial employment and provides a growth impetus to other sectors through backward and forward linkages. It is, essential, therefore, that, this vital activity is natural for the healthy growth of the economy. And literature was reviewed as follows based on the stated issues.

2.2. Theoretical Reviews

2.2.1. Definition of project delay

Many researchers have different definitions and views for "delay". Rauzana (2016) defines the construction project delays as additional implementation time completion of projects that have been planned and specified in the contract documents. A construction project is commonly admitted as successful when it complete on time, with a budget, according to the specifications, and parties/stakeholder satisfaction. Delay was also defined by Zack (2003), as an "act event which extends required time to perform or complete works of the contract manifests itself as additional days of work".

Latif, (2019), identified the causes for the delay in completion were changed in project scope, shortage of labor, construction mistakes, lack of communication between the parties, and lack of design.

SA., (2006), define construction delay as the time overrun beyond a project completion date specified in a contract. And also other scholars said that it is a global phenomenon affecting not only the construction industry but the overall economy of countries as well (M., 2007); and (Parchamijalal & Shahsavand, 2016)

2.2.2. The legal Framework Regarding Construction Delay

The legal framework assigns obligations to stakeholders of a contract to share risks associated with a project delay. When an event that causes delay happens, it is possible to identify the responsible parties as per the contract provisions and the responsible party pays compensation in terms of time or cost to the non-responsible party. It also identifies certain conditions so-called force majeure which may cause delays in completion of projects, but whose occurrence is beyond the control of the contractor and the client and hence the delay is neither caused by the contractor nor by the client.

2.2.2.1. Delay related in Ethiopian Civil Code[1]

The Ethiopian Civil Code (ECC) book first edition was published during the 30th year of the reign of His Imperial Majesty Haile Selassie I, Emperor of Ethiopia on the 5th day of May 1960. And articles related to delay listed hereunder.

- ✓ Art. 1771. - Effect of non-performance.
- ✓ Art. I774. - Time for Performance.
- ✓ Art. 1784. - Cancellation of the contract by the Court.
- ✓ Art. 1790. - Damage arising out of non-performance:
- ✓ Art. 1791. - Damage when to be made good.
- ✓ Art. 1792. - Force majeure.
- ✓ Art. 1793. - Cases of force majeure.
- ✓ Art. 1794. - Absence of force majeure.

[1] civil code of the empire of Ethiopia proclamation no. 165 of 1960

2.2.2.2. Delay related in the FIDIC Standard Condition of Contract

Whereas in regards to International Federation of Consulting Engineers (FIDIC) standard condition of contract herewith discussed some clause that relates to the cause and delay in construction projects with its associated impacts.

Clauses 42.2: The Contractor is entitled to an extension of time and compensated for the incurred costs if the client fails to give possession of the site.

Clause 43.1 Times for Completion

The whole of the Works and, if applicable, any Section required to be completed within a particular time as stated in the Appendix to Tender, shall be completed in accordance with the provisions of Clause 48, within the time, stated in the Appendix to Tender for the whole of the Works or the Section (as the case may be), calculated from the Commencement Date, or such extended time as may be allowed under Clause 44.

Clause 47.1 Liquidated Damages for Delay

If the Contractor fails to comply with the Time for Completion following Clause 48, for the whole of the Works or, if applicable, any Section within the relevant time prescribed by Clause 43, then the Contractor shall pay to the Employer the relevant sum stated in the Appendix to Tender as liquidated damages for such default and not as a penalty (which sum shall be the only monies due from the Contractor for such default) for every day or part of a day which shall elapse between the relevant Time for Completion and the date stated in a Taking-Over Certificate of the whole of the Works or the relevant Section, subject to the applicable limit stated in the Appendix to Tender. The Employer may, without prejudice to any other method of recovery, deduct the number of such damages from any monies due or to become due to the Contractor. The payment or deduction of such damages shall not relieve the Contractor from his obligation to complete the Works, or from any other of his obligations and liabilities under the Contract.

2.2.3. Classification of Delay

According to Terry Williams (2003) delay classified as: Excusable or non-excusable delay, Concurrent or non-concurrent delay, and Compensable or non-compensable delay. And other scholars classified delay as shown in the Figure 2.1 below.

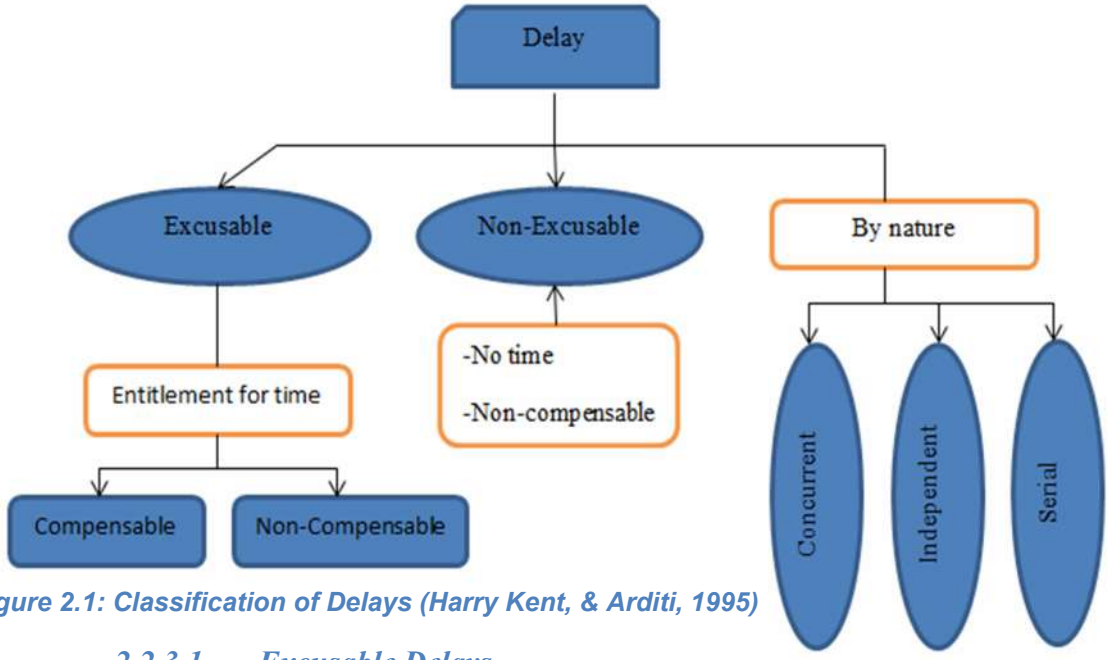

Figure 2.1: Classification of Delays (Harry Kent, & Arditi, 1995)

2.2.3.1. Excusable Delays

Known as "force majeure" delays, and commonly called "acts of God" because they are not the responsibility or fault of any particular party. It allows an extension of time for excusable delays, but no additional money offered (Alaghbari et al 2007).

Based the literature reviewed excusable (Inevitable) delays are the one that result from events that are beyond the contractor's control. Examples: sudden severe weather conditions, unanticipated site conditions, design errors, and change orders from owners.

2.2.3.2. Excusable Compensable Delay

According to Molner (2007) discusses, the client is responsible for both the cost and time effect of the delay. Moreover, the Contractor may claim the owner interfered with the activity, did not deliver owner-purchased equipment or supplies on site as promised, or that the owner's actions or inactions caused delays.

Alaghbari et al. (2018), also described excusable non-compensable delays as those, which are beyond the control of both the owner and the contractor. And excusable compensable delays are delays caused by the project owner (client). Non-excusable delays are those that are the responsibility of the contractor. Concurrent delays are those caused by both the owner and the contractor

2.2.3.3. Excusable Non-compensable Delay

According to Kent, (1995) study excusable but non-compensable delays includes: acts of God, unusually severe weather, fire, etc. Hence, the Contractor will not receive compensation for the cost of delay, but s/he will be entitled to an additional time to complete the work and is relieved from any contractually imposed liquidated damages for the period of delay.

2.2.3.4. Non-Excusable Delays

According to Ahmed, (2003), investigation such delays might be the results of underestimates of productivity, construction mistakes, equipment breakdowns, mismanagement, staffing problems, or bad luck. The contractor is inherently responsible for such delays and no relief is allowed.

Non-excusable delays are the one caused by contractor's own fault or his subcontractors or material suppliers (Adekunle and Ajibola, 2012).

2.2.4. Classification of Delay by Nature

According to Arditi, (1995); Stumpf, (2000) classifies construction delay based on their time of occurrence into three categories (viz. (a) concurrent delay, (b) independent delay, and (c) serial delay.

2.2.4.1. Concurrent delays

William Ibbs, (2011) defines concurrent delay as occurrence of delay about two or more at the same time, either of which would cause construction project delay. It is mostly refers to the situation where two or more delay activities occur at different times but the impact is felt at the same time. And also Alaghbari, (2007) elaborate it as more a complicated but also more typical situation is one in which more than one factor delays the project at the same time or in overlapping periods. These are called concurrent delays. Concurrent delays are delays which occur when both parties bear some of the responsibility for the construction delays or when there are multiple delays that occur during the same time of period. According to literature, in this type of delay both parties are at fault, in most instances neither party is entitled to monetary compensation.

2.2.4.2. Independent delays

According to Arditi, (1995) definition it is a particular delay occurring solely and without concurrency with other delays. It can be easily analyzed and identified, but it may cause serial delays. For instance, if a contractor was failed to supply the material solely independent delays were occurred.

2.2.4.3. Serial delays

According to Arditi, (1995); Stumpf, (2000) definitions it is a non-overlapping, series of sequential delays that are linked together. For example when a owners fails to pay the contractor and then the contractor fails to supply construction material to site sequentially (Arditi, 1995).

2.2.5. Category of Delays related to Stakeholders

Alaghbari et al (2018) indicated that there are two main types of causes which cause delays in construction projects, namely external and internal causes. According to Alaghbari et al. (2018) the internal causes of delay include the causes coming from four parties involved in the project, which are the owner, designers, contractors and consultants. And other delays are from external factors, for example, delays caused by government, public and society problems, suppliers or natural conditions such as weather. As per the study conducted by Bekr (2018) he classified delay causes under four categories, namely client-related, consultant-related, contractor-related and external-related.

Delay factors that are mostly categorized under owner related, consultant related, contractor related and external related delays are presented below based on Bekr (2018), Rausana (2016), Hishan and Yahya (n.d), and Hamzah et al. (2011):

2.2.5.1. Client – Related Factors

These are delays caused by the client, such as Delay in delivering construction site to the contractors, Lack of experience of owner, Delay in progress payments, Slow decision making process, Unrealistic contract duration and requirements imposed, Poor communication & coordination of the owner with other parties, Lack of coordination with the contractor and utility providers, Change orders by owner during construction,

Type of project bidding and award (selection based on least bidder), delay in right of way clearance(delay in fixing boundary issues), and delay in the payment process.

2.2.5.2. Consultant – Related Factors

These are delays caused by the consultant, such as Poor communication and coordination of the consultant with other parties, Delay in inspection and testing by the consultant, Lack of consultant's site staff, Inadequate experience of consultant, Mistakes, and discrepancies in design documents, Poor contract management, Delay in design documents preparation by consultant, Inaccurate site investigation, delay in inspection and testing construction materials.

2.2.5.3. Contractor – Related Factors

A contractor factor includes Poor qualification of the contractor's technical staff, Shortage of contractors' materials on-site, Mistakes during the construction stage, Inadequate contractor experience, Poor financing way for the construction project by the contractor, Inadequate planning and scheduling of work by the contractor, Conflicts with sub-contractors, Poor site management and supervision by contractors, Weak in follow up the planned work schedule by the contractor, Rework due to error during construction, Poor communication & coordination with other parties and Poor management skills

2.2.5.4. External-factor

These are delays caused by external factors such as Political instability, Foreign currency rate/Inflation, Inadequate funding, Environmental factors, Social factor effects of surface and ground conditions, weather effect on construction activities, delay in providing services from municipalities, delay in obtaining a permit from municipalities (bureaucracy), changes in government regulations, accidents during construction, other public works near the site, the effect of the local community, etc.

2.2.5.5. Other Factors

2.2.5.5.1. Material-related

These are delays caused by material-related factors such as Unavailability around a project, Change due to quality, Shortage, Change in material type.

2.2.5.5.2. Labor-related

These are delays caused by labor-related factors such as unavailability around the project, Efficiency.

2.2.5.5.3. Contract-related

These are delays caused by contract type factors such as inaccurate initial estimation, Form of contract.

2.1. Empirical Review

2.1.1. Causes of Delays

As discussed by different scholars construction delays were caused by several reasons. Ahmed, et al (2003) classified delays as internal causes (arise by stakeholders) and external causes (arises from beyond the control of stakeholders).

Alaghbari, et al (2007) grouped the factors into four major groups, such as (i) consultant factor, (ii) client factors, (iii) contractor factor, and external factors. The topmost factors considered were budget problems, scarcity of construction materials, and poor management on site.

2.1.2. Review of a prior study conducted on study areas

Here reviewed a related study of the factors and its associated effects of delay in public construction projects conducted worldwide and tends to cop up to concerning Ethiopian context.

Iman Suleiman et.al (2020), carried study in Oman with 210 samples of a well-defined questionnaire from the construction stakeholders (viz. the consultants, contractors, and the clients) who were selected on a random sampling basis. Smart PLS for Structural Equation Modeling (SEM) technique and analyzed the data to obtain the formative measurement models, the structured model, and the goodness of fit. The results of the study revealed that client-related factors, equipment-related factors, and material-related factors have a significant impact on the completion delay in construction projects. The study revealed that the client-related factors (viz. delayed decision-making process, delay in providing services, and allocation of insufficient time). Equipment related factors (viz. unskillful Equipment operator, breakdown of equipment and Outdated equipment, and low productive equipment,), and Material related factors (viz. Non-availability of construction materials, Non-availability of accessories and damaged materials, Delay in the supply of raw materials, and Change of materials during construction,).

According to research conducted by (Amin, et al., 2020) that carried initial survey at the Office of Public Works and Spatial Planning, the Office of Education and Teaching, and Regional Public Hospitals with a scope of 5 (five) years, namely from 2013 to 2018. They concluded that there are 6 (six) factors that lead to delays in building construction work in Morowali Regency, namely (1) location and equipment characteristic factors, (2) changes in work document factors, (3) material and equipment factors, (4) communication factors, (5) inspection system factors, (6) controls and job evaluation and managerial factors.

The research paper carried in Libya by (Amiruddin Ismail, 2018) through 256 completely responded and analyzed by a Structural Equation Modeling (SEM) Path Model of the relationship between delay factors and their associated effects in road construction was formulated and evaluated using [SEM] version 21 software which identifies 49 factors that classified into eight groups of factors and three groups of effects of delay. The contractor group in delay factors had the greatest impact on road construction delay with path coefficient β-values of 0.249, while financial groups in delay effects had the greatest impact on road construction delay with path coefficient β values of 0.88. The R2 value of the model is 0.48, indicating that the developed model substantially explains construction delay.

On the other hand, according to a study conducted by (Doloi, et al., 2012) in India through a total of 110 questionnaires sent to the pre-identified respondents located in 86 firms received 77 valid responses which analyzed using structural equation modeling (SEM) and a final structural model was derived based on the satisfactory criteria on the goodness of fit (GOF) measures. Based on the SEM results revealed that one of the most significant factors inducing construction delay is the client's influence.

D.Ayin, et. Al., (2018) conduct a study on a similar topic of this study in Edirne (Turkey) revealed a total of 58 delay factors under the 8 delay groups (viz. client, contractor, design, labor, finance, external, material-equipment, & project management related delays) and 8 delay effects. As a result, reveal that the top three delay reasons are: delays in municipality permits, changes in legal regulations, and difficulties in financing the project and paying the debt. On the other hand, they identified, bad reputation and loss of reliability, time overrun and cost overrun are the main effects of delays.

Sambasivan, (2007) found poor site management, inadequate experience, and poor subcontractors among the major causes of time delays on construction projects in Malaysia.

SA. et al., (2006) surveyed the time performance of different types of construction projects in Saudi Arabia to determine the causes of delay and their importance according to each of the project participants. The survey included 23 Contractors, 19 Consultants, and 15 Owners. Seventy-three cases of delay were identified during the research. 76% of the Contractors and 56% of the Consultants indicated that the Average time overrun is between 10% and 30% of the original duration. The most common cause of delay identified by all three parties is "change order". Surveys concluded that 70% of projects experienced time overrun and found that 45 out of 76 projects considered were delayed.

Another study made by Neal (2007) showed that 40% of the projects studied in the UK have over-run their original contract period.

Noman et al. (2018) report that 662 projects, estimated at 40 billion riyals in value, were found to have experienced significant delays, a number that seems large and frustrating at the same time. One of the significant reasons that led to delays in construction projects, by 82%, was the technical and material capability of the contractor. The second reason for delays, at 12.2%, was administrative and regulatory obstacles.

Hussain, (2018) identified 52 delaying factors through a detailed literature review, which they categorized into eight major groups, and conducted a pilot study with 16 experienced construction experts.

R. Shah, (2016) planned to discover the most influential factors causing project delays and cost overruns and recommend the possible measures by investigating case studies in three different countries. The most influential factors:-

(a) In Australia are (1) planning and scheduling deficiencies, (2) methods of construction, and (3) effective monitoring and feedback process,

(b) In Ghana, the most influential factors are (1) delay in payment certificates, (2) underestimating project cost, and (3) complexity of projects.

(c) In Malaysia, (1) contractors' improper planning, (2) poor site management, and (3) inadequate contractor experience are the most influential factors.

Parvaneh, (2018) revealed the main causes of delays in the projects are from the client (relative importance index (RII = 0.716), labor and equipment (RII = 0.701), and contractor (RII = 0.698). Hence determining the contractual responsibility of delay is the most likely source of dispute in construction projects and many techniques have been used in the courts to demonstrate the criticalities of a delay event on the project schedule. Therefore, the authors try to investigate all process-based techniques of delay claims and evaluated them, and confirm them with principles by the Society of Construction Law (SCL) protocol.

And also a lot of research efforts have been made to study delay causes in different countries. For example, Odeh, et al., (2002), and Vilventhan, (2016) explored that inadequate contractor experience, owner interference, financing and payments, labor productivity, slow decision making, improper planning, and sub-contractors are among the ten top most important factors causing a delay in Jordan.

According to Maura, (2007), revealed that client liability, design errors, project specification, and direct change order by the client are the major factors that cause the time and cost overrun in Portuguese.

Abdul-Rahman, et al., (2006), studied delay mitigation in the Malaysian construction industry; they proved that a financial problem is confirmed by the survey as the main causes of delay.

Ahmed et al. (2005) under his study of construction delays in Florida identified the six (6) most critical causes of delays in ascending order of criticality were found to be: (a) changes in specifications, (b) inspections, (c) Incomplete drawings, (d) changes in drawings, (e) change order, (f) building permits approval.

Amare, et al., (2017), a study conducted in Addis Ababa City Road Authority (AACRA) identified 65 different causes of delays and ranked based on their relative important index (RII). The research study identified and ranked the top ten factors causing delays in construction projects. (1) Poor financial control of the project (RII=0.905), (2) Difficulties in financing a project by a contractor (RII= 0.854). (3) Type of project bidding and award (lowest bidder) with RII of 0.850. (4) Poor site management and supervision of contractor with RII of 0.839. (5) Selecting inappropriate contractors (RII = 0.823). (6) Lack of high technology mechanical equipment with RII of 0.819. (7) & (8) in-accurate initial project scope estimate and Ineffective project scheduling with RII of 0.803. (9) Weak control of the project progress (RII = 0.788), and (10) the Contractor's staff is not adequately trained in professional construction management techniques (RII = 0.784).

Abatemam, (2006), surveyed delays in public building construction projects in Ethiopia. The result of the research indicated that 94% of the 52 surveyed public building projects undertaken by local Contractors between the years 1995 to 2005 have encountered delays. Moreover, the time extension ranges from 10% to 367%, and the Average delay is found to be 89.9%. The most frequent causes of delay which in ascending order of criticality were found to be: (1) failure to update schedules on time, (2) unrealistic schedule, (3) material and labor price escalation, (4) changes in design, (5) sub-surface condition, (6) less emphasis to planning, (7) late material supply, (8) scarcity of materials, (9) delayed payments, and (10) necessary variations.

Kuhil, et al., (2019) state on their study carried on delay in Public Building Construction Projects – a case of Addis Ababa administration**,** showed that all three groups of respondents positively agree on the rankings of 42 delay factors stated.

Accordingly, the research carried by (Al-Moumani, 2000) revealed that "from 130 public building projects constructed in Jordan during the period 1990-1997 founded the main

causes of delay in construction projects relate to designers, user changes, weather, site conditions, late deliveries, economic conditions and increase in quantities".

Public projects are a project executed by a public administration or with the participation of a public administration or implemented with the involvement of funds from the budget of such an administration (Gasik, 2014).

According to MoWUD, (2006) public construction projects in Ethiopia are parts of the country's development initiative. It shares a considerable amount of the country's scarce financial resources. In Ethiopia, the construction industry is the highest recipient of government budget in terms of a government development program. Consequently, public construction projects consume an average annual rate of nearly 60% of the government's capital budget.

2.1.3. Effects of Delays

By the study carried by D.Ayin, (2018) which the result of the rank based on RII, identified 8 (eight) delay effects includes (1) bad reputation and loss of reliability, (2) time overrun, (3) cost overrun, (4) total abandonment, (5,6) low quality work and dispute (7) Litigation and (8) arbitration.

According to Ashish and Wagh (2016), study delays and cost overruns have significant implications from an economic as well as political point of view. Accordingly, due to delays in project implementation, the people and the economy have to wait for the provisions of public goods and services longer than is necessary.

Sambasivan, (2007) identified the six most frequently observed effects of delays in his survey on the causes and effects of delays in the Malaysian construction industry. These were: (i) time overrun, (ii) cost overrun, (iii) disputes, (iv) arbitration, (v) litigation, and (vi) total abandonment.

Robel (2015) identified the effects of delays in the Ethiopian construction project. These are (i) time overrun, (ii) cost overrun, (iii) loss of political and economic value towards the project, arbitrations between the contracting parties are the effects of the delay encountered.

On the other hand, Shewaferahu, (2016), identified (8) eight effects of construction project delays in Ethiopia. These include (1) time overrun, (2) cost overrun, (3) wastage and underutilization of workforce & resources, (4) tying down of Clients' capital, (5)

abandonment of the project, (6) dispute among parties, (7) arbitration and (8) litigation and Court case.

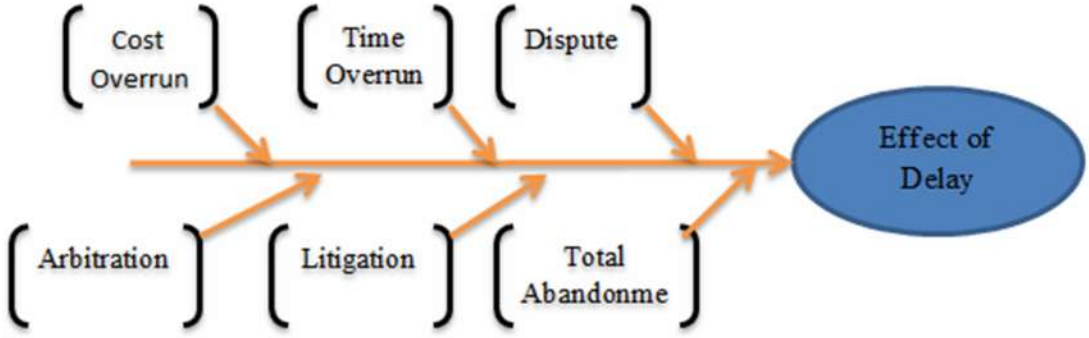

Figure 2.2: Fish-Bone Diagram of six effects of the construction delays. (Abedi M. 2012)

Accordingly, having understood the effect of delays, i.e., the prevalence and extent of delays in construction projects worldwide, a lot should be done to address the problem of construction delay to minimize or avoid the consequences imposed in terms of time overrun and cost overrun.

As understand from the previous study the researchers categorize the cause of delays, using the relative importance index (RII) and/or by methods appropriate to their particular studies. As the field has developed, it has become easier to conduct studies into the cause and effect of delay in the construction industry, since many categories of cause and effect of delay have already been identified. Consequently, most studies have relied on the categorization of the causes and effects of delay identified in the existing literature. Henceforth, many studies have also been expected to carry out to assess the causes of such delays and effects with anticipated mitigation measures.

From the above literature review, the following cause of delay and its associated effect has been identified.

2.2. Conceptual Framework

2.2.1. *Cause and effect of delay extracted from the literature*

To summarize the idea found in the literature and bring out the contribution to this study the literature shows identified delay factors and their effects. The building construction delay, their factors, and effects can be conceptualized as shown in table 2.1 below.

2.3. Research Gap

The gaps that have been observed in those researches that presented in the empirical review part of this study, literature show that a lot of studies have been carried out in different countries all over the world to find out the causes and effects of delay in the construction industry. This indicates that delay in construction projects is a world-wide phenomenon. The results of the studies are different depending on the specific project, the time in which the study is carried out, political and socio-economic condition of the country, and other conditions in which the project is being carried out, and this implies that there is a need of conducting more researches in order to find out more useful and near to the reality results. However, with the exception of a few studies, there were very few on causes and effects of delay in public construction projects in particular and in the construction industry in general in Ethiopia. This is the gap identified in previous researches, which this thesis could potentially fill.

Table 2.1: List of identified cause and effect of delay extracted from the literature

Researchers and year of study	Place of Study	Identified Cause and the associated effect of the delay
Shewaferahu, 2016	Ethiopia	(1) time overrun, (2) cost overrun, (3) wastage and underutilization of workforce & resources, (4) tying down of Clients' capital, (5) abandonment of the project, (6) dispute among parties, (7) arbitration and (8) litigation and Court case.
Robel (2015)	Ethiopia	(i) time overrun, (ii) cost overrun, (iii) loss of political and economic value towards the project, arbitrations
Sambasivan et al. (2007)	Malaysia	(1) time over-run, (2) cost overrun, (3) disputes, (4) arbitration, (5) litigation, and (6) total abandonment
D.Aydin and E.Mihlayanlar, (2018)		includes (1) bad reputation and loss of reliability, (2) time overrun, (3) cost overrun, (4) total abandonment, (5,6) low quality work and dispute (7) Litigation, and (8) arbitration.
Abdo (2006)	Ethiopia	(1) failure to update schedules on time, (2) unrealistic schedule, (3) material and labor price escalation, (4) changes in design, (5) sub-surface condition, (6) less emphasis on planning, (7) late material supply, (8) scarcity of materials, (9) delayed payments, and (10) necessary variations.
Yosef Amare, et.al (2017)	Ethiopia	(1) Poor financial control of the project (2) Difficulties in financing project by contractor (3) Type of project bidding and award (lowest bidder) (4) A poor site management and supervision of contractor (5) Selecting inappropriate contractors (6) Lack of high technology mechanical equipment (7) & (8) in-accurate initial project scope estimate and Ineffective project scheduling (9) Weak control of the project progress and (10) the Contractor's staff is not adequately trained in professional construction management techniques
Ahmed et al. (2005)	Florida	(a) Changes in specifications, (b) inspections, (c) Incomplete drawings, (d) changes in drawings, (e) change order, (f) building permits approval.
Abdul-Rahman et al. (2006)	Malaysia	Financial problem is confirmed by the survey as the main causes of delay.
Maura et al. (2007)	Portuguese	design errors, client liability, project specification, and direct change order by the client
Odeh and Battaineh(2002), Vilventhan and Kalidindi (2016)	Jordan	owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and sub-contractors

Researchers and year of study	Place of Study	Identified Cause and the associated effect of the delay
Shah (2016)	Australia	(1) planning and scheduling deficiencies, (2) methods of construction, and (3) effective monitoring and feedback process
	Ghana	(1) delay in payment certificates, (2) underestimating of project cost, and (3) complexity of projects.
	Malaysia	(1) contractors' improper planning, (2) poor site management, and (3) inadequate contractor experience
Hussain, et al (2018)	Saudi Arabia	52 delaying factors which they categorized into eight major groups,
D.Aydin and E.Mihlayanlar (2018),	Edirne (Turkey)	delays in municipality permits, changes in legal regulations and difficulties in financing the project and paying the debt & bad reputation and loss of reliability, time overrun and cost overrun are the main effects of delays
Hemanta D. et.al., (2012)	India	The most significant factors inducing construction delay is the client's influence
Amiruddin Ismail,et.al,(2018),	Libya	Identifies 49 factors that classified into eight groups of factors & three groups of effects of delay(viz. stakeholders)
Mohamad et al. (2020),	Morowali Regency	(1) location and equipment characteristic factors, (2) changes in work document factors, (3) material and equipment factors, (4) communication factors, (5) inspection system factors, (6) controls and job evaluation and managerial factors.
Iman Suleiman et.al (2020),	Oman	client-related factors, equipment-related factors, and material related
M.E.Abd El-Razek;H.A. Bassioni; nd A. M. Mobarak (2008)	Egypt	A compiled list of 32 causes was obtained and subjected to further quantitative evaluation in a questionnaire survey to confirm the causes and identify the most important causes of Project delay.

2.3.1. Summary of Reviewed prior study on Research Methodology

Table 2.2: Summary of reviewed prior study on research methodology

Author/s (Year)	Title of a study conducted	Research Methodology and Result identified
Yosef Amare, Emer T. Quezon, Mamuye Busier (2017)	Causes of Delays During Construction A phase of Road Projects due to The Failures of Contractor, Consultant, & Employer in AACRA	✓ Fifty-one (51) valid questionnaires received for analyzing data ✓ Spearman rank correlation coefficient from the Relative Importance Index (RII) analysis was used ✓ Identified and ranked top ten factors causing delays of construction projects in Addis Ababa City Road Authority
E.O. Ojoko, B.L. Tanko, M. Jibrin, O. Ojoko and W.L. Enegbuma (2016)	Project delay causes and effects in the construction industry	✓ The literature reviewed in conjunction with responses obtained through questionnaire from stakeholders ✓ Data were analyzed using the weighted mean score method ✓ Revealed a total of thirty-four delay causes and ten effects
Serdar Durdyev, Ph.D.; Syuhaida Ismail, Ph.D.; and Nurmurat Kandymov (2018)	Structural Equation Model of the Factors Affecting Construction Labor Productivity	✓ A quantitative method (experience-based feedback) was adopted in the primary data collection stage of the research ✓ Data collected via a questionnaire survey of 185 respondents consisting of government authorities and construction actors ✓ A structural equation modeling technique is used ✓ The final model adapts 29 attributes across six labor productivity factors
Werku Koshe, K. N. Jha (2016)	Investigating Causes of Construction Delay in Ethiopian Construction Industries	✓ a questionnaire was designed to assess the opinion of stakeholders ✓ The collected data was analyzed by using severity index, frequency index, and an important index ✓ Identified 88 causes of delay factors.
Amiruddin Ismail, Aboubaker. Y. Y. Alfakhri, Azry Khoiry, Hassan M Abdelsalam, B. Elhub, (2018)	Investigating Delays in Libyan Road Construction Projects Using Structural Equation Modeling (SEM)	✓ 256 completed questionnaire forms were received and analyzed ✓ tool utilized is SEM by utilizing a multivariate method through standardized regression modeling ✓ 49 factors classified into eight groups of factors and three groups of effects of delay
D.Aydin, E.Mihlayanlar (2018)	Causes and Effects of Construction Project Delays: A Local Case Study in Edirne City Centre	✓ Literature review, face-to-face Interviewing, and questionnaire were applied on the urban scale ✓ Relative Importance Index (RII) is used as a tool ✓ Reveal the top three delay reasons and effects of delays
N. Hamzaha, M.A. Khoiry, I. Arshad, N. M. Tawil and A. I. Che Ani (2011)	Cause of Construction Delay - Theoretical Framework	✓ from the previous international journal paper ✓ delay framework is constructed based on the literature review summary in the context of public higher learning institution

Author/s (Year)	Title of study conducted	Research Methodology and Result identified
ISAAC SAKYI DAMOAH (2015)	An investigation into the causes and effects of project failure in government projects in developing countries: Ghana as a case study (Ph.D. thesis)	✓ Ten (10) semi-structured interviews, questionnaire surveys of 265 (contractors=78, PMP=81, and general public=106) participants utilized in the study ✓ Thirty-two (32) and twenty-six (26) possible causes and effects of Ghanaian government project failure were identified, respectively.
Shewaferahu Tilahun (2016)	Thesis on Causes and Effects of Delay on Educational Building Projects in Addis Ababa University	✓ 52 questionnaire was designed to be a close-ended question including with few comment spaces ✓ The unstructured one-to-one interview was conducted with selected individuals ✓ The mixed research method used in the data collection process. ✓ Utilized data Analysis by RII and Ranking of factors
Adem Hussien (2018)	Causes of Delay in Construction Project of Private Real Estate	✓ 71 responses were obtained from 112 questionnaires sent to contractors and consultants in the Ethiopian building construction industry ✓ Snowball sampling was used for selecting samples ✓ Data Analyzed using RII and Ranking of factors ✓ Total of 29 delay causing factors and six effects of projects were identified
Eyasu Tolera (2018)	An assessment on causes of delay in road construction projects: the case of Ethiopian road authority	✓ Quantitative data was collected from clients, consultants, and contractors using questionnaires ✓ 80 engineers from the three target population ✓ Analysis of data consists of calculating the RII and Ranking of factors
Bedru Merhaba	Study of Construction Defects in Public Building Projects in Addis Ababa (A Case study of Federal Government Office Building Projects)	✓ the questionnaire was designed to be a close-ended questions ✓ Utilized data Analysis by Relative Importance Index (RII) and Ranking of factors
Sara Taha Mohammed Ahmed (2017)	Effects of delay in the Construction Industry Case Study: (Central Market Khartoum)	✓ Data from literature Review, personal investigations, phone interview, and site visit. ✓ Data analysis was discovered that most of the factors causing a delay in Sudan's construction industry are due to the clients

Author/s (Year)	Title of study conducted	Research Methodology and Result identified
Asmaa Mohammed Ahmed Farah (2020)	Evaluation of Cost and Time Control using Earned Value in Building Projects in Khartoum State	✓ Adopts a combination of quantitative and qualitative methods ✓ Total number of sample members used (83) individuals equivalent to (75%) of the distributed forms (110) questionnaire ✓ Used the coefficient of Alpha Kronbach, the degree of credibility of the answers to the hypotheses ✓ Analyzed by SPSS version 21.0; using reliability test, frequencies and factor analysis, Importance index, Spearman's ✓ The study hypothesized that there is a relationship between controlling construction projects
Maryam Alavi Toussi (2015)	Evaluation of Factors Influencing Delay in Construction/Civil Engineering, Ph.D. Thesis	✓ Research strategy adopts a qualitative approach, a semi-structured interview has been chosen to conduct the research ✓ Case-study of a US$14m library building project in Iran is assessed ✓ the literature of numerous scholars around the world investigated
FETENE NEGA (2008)	Causes and effects of cost overrun on public building construction projects in Ethiopia	✓ Project owners are selected from both the Federal and regional public agencies, project owners from Addis Ababa, Amhara, and Oromia were selected ✓ A questionnaire survey together with desk study was used to collect data ✓ Spearman rank-order correlation analysis was used to evaluate ✓ Both descriptive and inferential statistics are employed in the data analysis ✓ The most common effects of cost overrun identified
M. E. Abd El-Razek; H. A. Bassioni; and A. M. Mobarak (2008)	Causes of Delay in Building Construction Projects in Egypt	✓ The data were gathered in person. A snowballing technique was used to select participants; meaning potential participants were obtained from existing participants. ✓ A total of 88 questionnaires, representing 88 projects, were involved in this study, which was obtained from 74 participants ✓ To provide a degree of importance for each delay cause, an importance index was utilized.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1.Introduction

The reason for every piece of research is to reach findings that are not biased, but reliable and valid by conducting inquiry and investigation ((Simons, 1996); (Damoah, 2015) & Bryman, 2007; (Bryman, 2012).

According to Hussey, (1997), a research methodology is an overall approach to the research process from the theoretical underpinning to the collection and analyses of the data. And as per Bell & Bryman, (2007), it is the technique used for data collection, and this involves specific instruments such as structured interviews, participant observation, questionnaires, group focus discussions, etc. In essence, research methodology describes the whole processes and procedures used in the undertaking of research investigation (Bryman, 2012). In other words, research methodology tries to answer the following questions: (i) why certain types of data are collected; (ii) what data in it is collected; (iii) sources of data collected; (iv)how they are collected; and (v) how they are analyzed.

The problem and question stated in the introduction part of this study and the reviewed previous study carried in regards to the objective discussed in literature part were summarized and acquiring through required mechanism or in methodology part of the study. The study was conducted in Ethiopia to identify the most significant causes and the associated effects of delays in public construction projects and tried to suggest possible future actions related to the problem.

3.2.Research Design

According to Saunders et al., 2012), it is concerned with the general program of how a researcher goes about answering the research question(s). Research design can be grouped mainly into three categories – quantitative, qualitative, and mixed methods research. The next sub-sections discuss these three research types in detail; it will also explain and justify the choice of the design used in this research.

3.1.1. Quantitative Research

Bryman, (2012, p.36), argues that a quantitative strategy "can be construed as a research strategy that emphasizes quantification in the collection and analysis of data and (a) entails a deductive approach to the relationship between theory and research, in which the accent is placed on the testing of theories; (b) has incorporated the practices and norms of the natural scientific model in particular; and (c) embodies a view of social reality as an external, objective reality". This study also conducts such research design mechanism through collected questionnaires and analysis data by using engineering tools called SEM with integrated with SPSS and Amos software.

3.1.2. Qualitative Research

According to Bryman, (2012), it is a data collection in the form of words rather than numbers. And also provide rich of information from direct source, but data have been criticized for shortage of generalizability. In fact, such technique is often related with data collection methods such as interviews (Saunders, et al., (2012). Likewise, this study conducts semi-structure phone and face-to-face interview with eight interviewees. The figure below illustrates the extent to which a particular technique or method can be adopted.

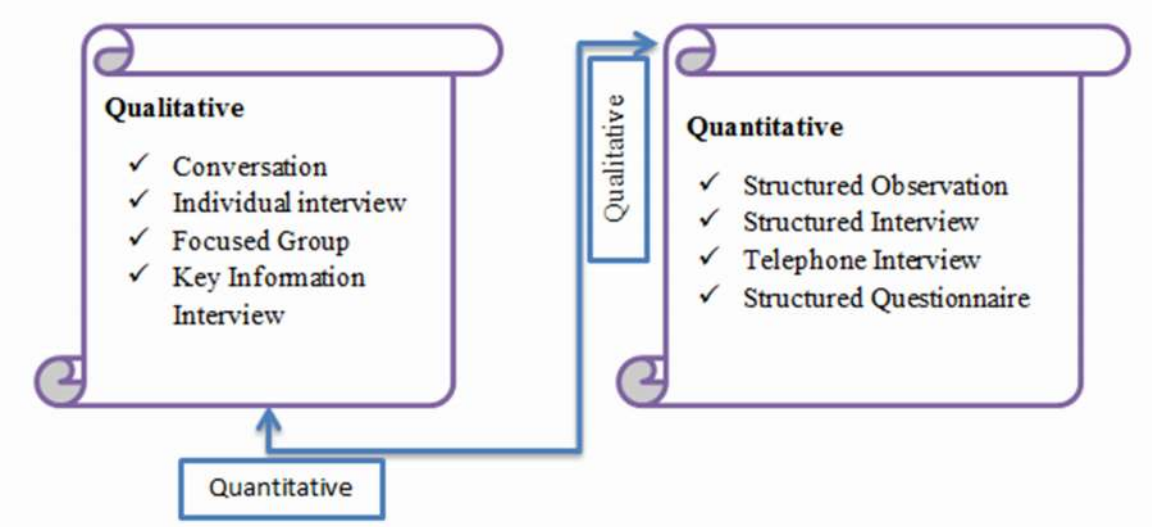

Figure 3:1 the extent to which a particular technique or method can be adopted in research design

3.1.3. Mixed Research

As per investigated by Bryan, (2012) and Saunders, et al., (2012) made a distinction within both research approaches, and argued on whilst the research strategy of a piece of research can either be qualitative or quantitative, the research method to be adopted is dependent on the research questions as a result at which this study focused on.

Mixed research approaches were adopted to examine the current situation of construction delay and effect in the study area. Employing these approaches was used to neutralize or cancel the biases of applying any of a single approach. This design was preferred because it enabled the researcher to collect enough information necessary for generalization and summarizes the essential features of data gathered from the study area. It was intended to adopt the qualitative data collection approach, which means obtaining facts and figures from uncompleted/delayed public infrastructure projects and not solely receiving the views of the respondents. The research was aimed to address the unclosed issue (Fellows & Liu, 2007) as per the aim to differentiate major factors to the delay of public construction projects in Ethiopia, to solve the problem and descriptive research was aimed to reveal the existing issue using the responses of a stakeholders (Z., et al;., 2009).

Nevertheless, the particular approach adopted for any piece of research influences the methodology to be used to carry out the research (Simons, 1996).

According to Damoah, (2015), a research technique for a given problem is not like the solution to a problem in algebra; there is no one best recipe which implies that there are several research approaches. And also the researcher of this study tried to construe the research technique as the mechanism of approaching to the anticipated result for the problem towards the objective of the study conducted by utilizing any tool that shows good output for decision making.

So, this study adopted a mixed research design which is used to describe the attitude, or opinions of participants to analyze the perception of respondents found in the public construction projects in Ethiopia. Utilizing this type of research was makes more validating rather than using single technique due that incorporating both qualitative and quantitative approaches. As a result, purposive, snowball samples were applied, the researcher contacted professionals and requested to complete the survey and recruit other

professionals in the same companies or in other stakeholders found anywhere in Ethiopia of public construction projects to complete the survey.

3.2. The data source for the study

3.2.1. Primary data

Both primary and secondary data were included in this study. Primary data is sourced through a questionnaire, observation, and semi-structured interviews. Through these interviews, relevant facts, as well as opinions, will be obtained. Questionnaires distributed to construction stakeholders (Client, Contractors, Consultants, and other participants) to get primary data. The questionnaire includes three parts: The first part contained general demography of respondents, type and projects status of the respondents work in, and project location. Part two of the questionnaire focused on the causes of delay to respective stakeholders in public construction projects in Ethiopia. The third section of the questionnaire concentrated on the effects of delay as per involved participants in Ethiopian public construction projects.

The data collected from the questionnaires were analyzed from the perspective of the developers. Every cause of delay based on stakeholders, and external factors, were computed for the overall analysis. The analysis computed by using IBM SPSS statics v23– Amos through engineering tools structural equation modeling (SEM).

3.2.2. Secondary Data

Secondary data utilized in this study include works of literature, Guidelines, proclamations and regulations, reference books, journals, company reports, previous studies, etc. written on a similar topic.

3.3. Data Collection Method

To address the objectives of the study, survey questionnaires, observation (site visit), Focused Group Discussion (FGD) through a phone interview and/or via different electronic media such as E-mail, Telegram, Imo, and other social media were used. The questionnaires prepared in the English language since it was distributed to the professional found in the stakeholders involved in public construction projects in Ethiopia. As there were more than one engineer or project managers found in stakeholders and difficulty to get in touch with all public construction found in Ethiopia, true random sampling is not feasible. As a result, purposive, snowball samples were applied, the researcher contacted professionals and requested to complete the survey and

recruit other professionals in the same companies or in other stakeholders found anywhere in Ethiopia of public construction projects to complete the survey.

Most important phases in conducting a research project is the methodology utilized (Saunders, et al., 2012). The data collection technique grouped as follows: (Jankowicz, 1999)

- Semi-Structured/Open-Ended Techniques: conversation, focus group discussion (FGD), individual interview, and repertory grid.
- Fully-Structured Techniques: structured questionnaire, structured face-to-face interview, postal & telephone variants.
- Other techniques: field experiments, repertory attitude scaling and observational techniques.

Hence, to achieve the research objectives, the study uses both questionnaires and semi-structured phone interviews as mentioned above to collect data from professionals involved in stakeholders of public construction projects in Ethiopia. They will provide raw data about the project and first-hand information which is from the source (Mingers, 2004a).

To discover common delay factors in the unreachable region of Ethiopia, primary research was undertaken in the form of eight semi-structured phone interviews [(Creswell, 2007) indicates 8 respondents as suitable] with managers and contract professionals within the engineering industry currently involved in public construction.

In this research, the semi-structured interview has been chosen to conduct the research.

Semi-structured phone interview questions were developed to elicit the best response from the participants without influencing or leading their answers. These were then followed by probing questions to clarify and elaborate on the participants' initial responses. Interview questions are shown in the Appendix of this study paper. These questions originated from literature review studies and on purpose to answer the objectives of the study. To avoid misunderstandings, the phone interview was translated into the language (Amharic) understandable for the interviewee conditionally.

Table 3.1: Interviewee Sample/Participants Profile Summary

Interviewee	Position	Experience (Years)	Client/ Contractor/ Consultant	Industry	Sector
1	Senior Project Manager	20	Consultant	Bridge	Public
2	Office Engineer	15	Client	One Wash WSP	Public
3	Site Engineer	7	Contractor	Hydropower	Public
4	Senior Budget officer	17	Contractor	Irrigation	Public
5	Resident Engineer	10	Consultant	Building	Public
6	Engineering section head	11	Client	Infrastructure	Public
7	Architectural Engineer	8	Consultant	Stadium	Public
8	Contract administration	16	Consultant	Building	Public

The interview result was also analyzed for each factor to identify the most significant causes and computed by using Structural Equation Modeling (SEM) with path analysis AMOS through IBM SPSS statics v23 software.

3.4. Sampling Techniques

The sampling techniques used in this research are non-probabilistic snowballing techniques to identify potential respondents from clients, contractors, and consultants through referral networks to respond to questionnaires accurately (Fellows, 2007). The research sampling design includes a detailed plan of the sample size, sample area, and sampling techniques. The analyses of the questionnaire were taken in two forms. First, to determine the level of agreement or disagreement by the respondents to each question within the questionnaire by counting the number of respondents who answered favorably or unfavorably? Judging by the response, each stakeholder were placed and categorized into client-related, contractor related, consultant-related, material-related, labor-related, contract-related, and Contract relationship-related and external factors in public

construction. Second, correlate each of the issues to time overrun, cost overrun, a dispute between parties involved, arbitration, litigation, and court case, total abandonment of the project, and wastage and underutilization of resource to take appropriate remedial or preventive steps.

3.5. Target population and Sampling Method

The research samples are taken from stakeholders in the construction industry which are clients (project owners), contractors, and consultants, that are selected depending on their direct exposure to public construction projects. The population of the research consists of different groups involved in the public construction sector in Ethiopia and the sample size is determined using statistical formula put hereunder considering the population and confidence level to estimate the number of questionnaires to be distributed to respondents considering the response rate. The sample size is determined by the following formula (Hogg, 2009)

$$n = \frac{m}{1+\frac{m-1}{N}}$$ ---------- [Eq. 3.1]

Where n, m, and N represent the sample size of the limited, unlimited, and available population respectively.

The value of m (unlimited population) is determined using the following equation:

$$m = \frac{z^2 * p * (1-p)}{\varepsilon^2}$$ ---------- [Eq. 3.2]

Where z=the statistical value for the confidence level used i.e. 2.575, 1.96 and 1.645 for 99%, 95% and 90% confidence level, respectively.

P=the value of the population proportion that is determined, take a conservative value of 0.5 (Snitch et al, 2002)

ε = the sampling error limit = 5%

So, let's assume that 95% level of confidence for the available population (N=161), then the sample size (n) for this study determined as follows:

First let compute m (unlimited population) by [Eq. 3.2] to find the sample of the study like:

$$m = \frac{1.96^2 * 0.5 * (1 - 0.5)}{(0.05)^2}$$

$$m = \frac{0.9604}{0.0025} = \mathbf{384.16}$$

Then, the sample size (n) for this study become;

$$n = \frac{m}{1+\frac{m-1}{N}};\ n = \frac{384.16}{1+\frac{(384.16-1)}{161}} = \frac{384.16}{3.38} = 113.66 \approx \mathbf{114}$$

This means that the lowest acceptable number of responses must be 114 at a 95% level of confidence with a level of error at 5%. Hence, in this study, the obtained sample size was 130 (including rejected responded questionnaire) which imply it attained above a 95% level of confidence. As part of the administered survey, there were 130 responses from the individuals within the companies (from professionals, working in public construction projects) which are above the required response threshold (Hogg, 2009). As a result of the sample size it was exceeding the estimate; the researcher adopted the following formula to determine the confidence level and limit of error for the actual responses received.

$$\varepsilon^2 = \frac{z^2 * p * (1 - p)}{n} - \frac{z^2 * p * (1 - p)}{N}$$

$$\varepsilon^2 = \frac{1.96^2 * 0.5 * (1 - 0.5)}{130} - \frac{1.96^2 * 0.5 * (1 - 0.5)}{161}$$

$$\varepsilon^2 = \frac{1.96^2 * 0.5 * (1 - 0.5)}{130} - \frac{1.96^2 * 0.5 * (1 - 0.5)}{161}$$

$$\varepsilon^2 = \frac{0.9604}{130} - \frac{0.9604}{161} = 0.007388 - 0.005965 = 0.001423$$

$$\varepsilon = \sqrt{0.001423} = 0.037723 = 0.037723 * 100 = \mathbf{3.8}\%$$

The results show that a 95% confidence level has an error limit of approximately 3.8%. According to Yin, (2009) a 95% confidence level with an error limit of 10% is acceptable. Therefore, having a lower error margin of 3.8% increases the validity of the data. On the other hand, the general public was selected using simple random sampling with a snowball strategy to get in touch with those unreachable public constructions found in Ethiopia. For the sample size, due to the large population of Ethiopia, the

formula could not be used and therefore quota sampling is applied here – thus, 130 samples (to regions and cities in Ethiopia) were used. The researcher has resided in the country since childhood and has also been employed in some of the public construction projects after getting a bachelor's degree in civil and urban engineering in 2013 (from Hawasa University Institute of Technology, IOT-HU) and still working in the construction sector. Further, it is practically and economically impossible to involve every member of the general public. Moreover, the use of 10 samples for each region was to ensure regional balance and improve representation (Saunders, Lewis, & Thorntonhill, 2012), as it was assumed that people from different regions might have different perceptions about the subject matter. Moreover, this is a validating method (validating the data from the phone interview) and therefore the researcher assumed that this number is appropriate.

3.6. Questionnaire Methodology

The questions were designed related to the research objectives especially on the causes and effects of public construction delays. The questionnaire provides an efficient way of collecting responses from a large sample size before quantitative analysis (Saunders et al. 2009, Saunders, et al., 2012). According to Jankowicz (2000, p.222) asserts that "Questionnaires are particularly useful when you want to contact relatively large numbers of people to obtain data on the same issue or issues often by posing the same questions to all". The purpose of conducting a questionnaire is that it helps the collection of data in a pre-arranged form which can be readily analyzed (Kumar, 2005). Moreover, the questionnaire is one of the most widely used data collection techniques within the survey strategy. This choice was made based on the objectives of the research to rank, to find out the most important extent, and causes and effects of Ethiopian Public construction projects through granted software (i.e. Structural Equation Modeling, SEM).

The Survey is designed based to use the Likert Scale on the objective of the study to find out the causes of delays in construction projects and the effect of the delays on the overall project. The Survey is framed in such a way that the personal view of different people involved in different projects is collected and analyzed. The questionnaire consists of three sections as detailed below.

i. Respondent Background - This is to collect the basic information of the respondent.
ii. Causes of Delays - This is used to collect the data on different causes of the delays that happened in that particular public construction projects.
iii. Effects of Delays - Using these questions the effects of the delays on the projects are identified.

The questionnaire is based on the Likert Scale of five ordinal measures from one (1) to five (5) according to level contributing. According to John F. (2001), the Likert Scale is easier to use for a respondent to express their level of opinion. For the frequency of cause's occurrence, each scale represents the rating for the occurrence of delay cause and the most influential effects of delay as shown in Tables 3.2 and 3.3, respectively.

Table 3.2: Likert scale for the frequency of occurrence of related delay causes

Category	Very low	Low	Average	High	Very High
Rating	1	2	3	4	5

Table 3.3: Likert scale for most influential effects of delay

Category	Strongly Disagree	Disagree	Slightly Disagree	Agree	Strongly Agree
Rating	1	2	3	4	5

3.7. Data Analysis Techniques

The study used descriptive analysis, which was discussed in the research design section of this study, for the data analysis, because it is less complicated and to avoid miss understanding/misinterpretation of the results. The procedure used in analyzing data was aimed at establishing identification of the various factors that contribute to causes of delays, effects of delays, and methods of mitigating or minimizing public construction delays.

The data were analyzed using Structural Equation Modeling (SEM) integrated with IBM SPSS statistics v23 – AMOS. The collected data were calculated for each question within the form using the tool for ranking and identify each element in the order of their result as seen or indicated by the respondents.

3.8. The model of data analysis techniques (Engineering tools) used for the Study

3.8.1. Structural Equation Modeling (SEM)

SEM is a multivariate statistical analysis technique that is used to analyze structural relationships. This technique is the combination of factor analysis and multiple regression analysis, and it is used to analyze the structural relationship between measured variables and latent constructs. And it includes confirmatory factor analysis, path analysis, confirmatory composite analysis, partial least square (LPS) path modeling, and latent growth modeling.

Structural equation modeling (SEM) belongs to the class of statistical analyses that examines the relations among multiple variables (both exogenous and endogenous). The methodology can be viewed as a combination of three statistical techniques: multiple regression, path analysis, and factor analysis. It has the purpose of determining the extent to which a proposed theoretical model, which is often expressed by a set of relations among different constructs, is supported by the collected data. (Web source www.ieeexplore.ieee.org assessed in September 2020)

According to Byrne (2011), SEM consists of a set of multivariate techniques that are confirmatory rather than exploratory in testing whether models fit data.

Structural equation modeling (SEM) is a form of causal modeling that includes a diverse set of mathematical models, computer algorithms, and statistical methods that fit networks of constructs to data. And also includes confirmatory factor analysis, confirmatory composite analysis, path analysis

Structural Equation Modeling (SEM) is a quantitative research technique that can also incorporate qualitative methods. It is used to show the causal relationships between variables. The relationships shown in SEM represent the hypotheses of the researchers.

SEM is not one statistical 'technique' it integrates a number of different multivariate techniques into one model fitting framework that consists of measurement theory, factor (latent variable) analysis, path analysis, regression, and simultaneous equations.

SEM is useful for research questions that:-

- Involve complex, multi-faceted constructs that are measured with error
- That specify 'systems' of relationships rather than a dependent variable and a set of predictors
- Focus on indirect (mediated) as well as direct effects of variables on other variables

3.8.2. IBM SPSS Statistics v23

IBM SPSS Statistics Base also provides a wide variety of dimension reduction, classification and segmentation techniques such as factor analysis, cluster analysis, nearest neighbor analysis and discriminant function analysis.

Additionally, it offers a broad range of algorithms for comparing means and predictive techniques such as t-test, analysis of variance, linear regression and ordinal regression.

3.8.3. Structural Equation Modeling (SEM) integrated with AMOS_ IBM SPSS Statistics v23

Amos is an easy-to-use structural equation modeling (SEM) program that tests relationships between observed and latent (unobserved) variables to quickly test hypotheses and confirm relationships.

According to Byrne, (2010), Structural Equation Modeling (SEM) is a graphical equivalent of a mathematical representation whereby a set of equations relates dependent variables.

3.8.4. AMOS and structural equation modeling procedures

The steps involved in constructing the model in SEM software included the following: construction of the model based on a hypothetical model; assigning names of the constructs or variables; connecting the independent variables to the dependent variable; and assigning indicators to the respective independent variables. The researcher first specifies a model based on theory, and then determines how to measure constructs, collects data, and then inputs the data into the SEM software package. The package fits the data to the specified model and produces the results, which include overall model fit statistics and parameter estimates.

The input to the analysis is usually a covariance matrix of measured variables such as survey item scores, though sometimes matrices of correlations or matrices of covariance and means are used. Data that are named and registered in SPSS software should be exported to AMOS V23 to develop the structural models and causal relations that are hypothesized previously. The variable name is given in the SPSS directly coded to AMOS without losing even a letter, so that we can see the correlational and causal relations of variables in the model by generating the estimated path coefficients (Aibinu AA, 2010). In practice, the data analyst usually supplies SEM programs with raw data, and the programs convert these data into covariance's and means for its own use.

The model consists of a set of relationships among the measured variables. These relationships are then expressed as restrictions on the total set of possible relationships and on the model rectangular box represent an observed and circular or elliptical box for latent variables.

As stated (Structural Equation Modeling Using AMOS tutor published by Texas University at Austin, August 2012), SEM has a language all its own. Statistical methods in general have this property, but SEM users and creators seem to have elevated specialized language to a new level.

Independent variables, which are assumed to be measured without error, are called exogenous or upstream variables; dependent or mediating variables are called endogenous or downstream variables.

Manifest or observed variables are directly measured by researchers, while latent or unobserved variables are not directly measured but are inferred by the relationships or correlations among measured variables in the analysis. This statistical estimation is accomplished in much the same way that an exploratory factor analysis infers the presence of latent factors from shared variance among observed variables.

SEM users represent relationships among observed and unobserved variables using path diagrams. Ovals or circles represent latent variables, while rectangles or squares represent measured variables. Residuals are always unobserved, so they are represented by ovals or circles.

Here in this study the researcher Connecting the dependent variable to the effects of delay; the constructed model consisted of 7 categories or constructs that incorporated the 48 [41 causes or factors and 7 effects of delay]. Input data for the consisted of a single value item of the paths in the diagram (dependent variable) are labeled with the number "1". This means that those paths' coefficients have fixed values set to 1.00. These fixed values are included by necessity: they set the scale of measurement for the latent factors and residuals. Alternatively, set the variances of the factors to 1.00 to obtain implicitly standardized solutions. And "0" indicating that the factor does not cause delay. Since it had been previously determined that all the factors cause delay, a value of 1 was assigned to each factor and was applied to the model.

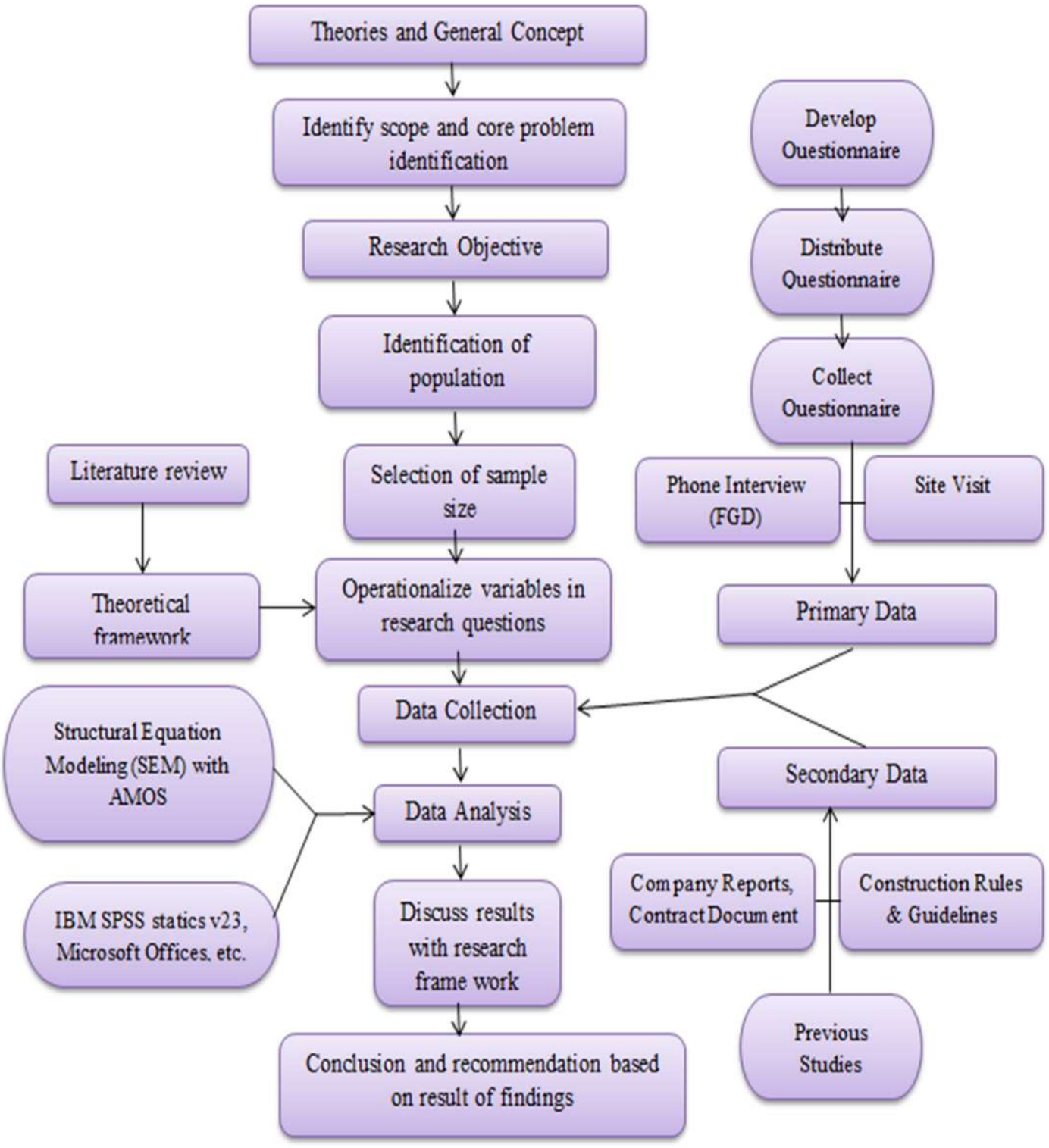

Figure 3.2: Overall research design and process (source: Researcher, 2021)

CHAPTER FOUR

4. CONCEPTUAL FRAMEWORK

4.1. Select the study variables

In this chapter the researcher aimed to summarize the idea found in literature and brings out the contribution to this study. Literature shows identified delay factors and their effects. The relationship between public construction delay, their factors and effects can be conceptualized as shown in the figure 4.1 below. The conceptual frame work is developed based on research objectives of the study and involves points stated in questionnaires and semi-structured interview conducted for this study that categorized delay causing factors in seven groups and identifies effects of delay.

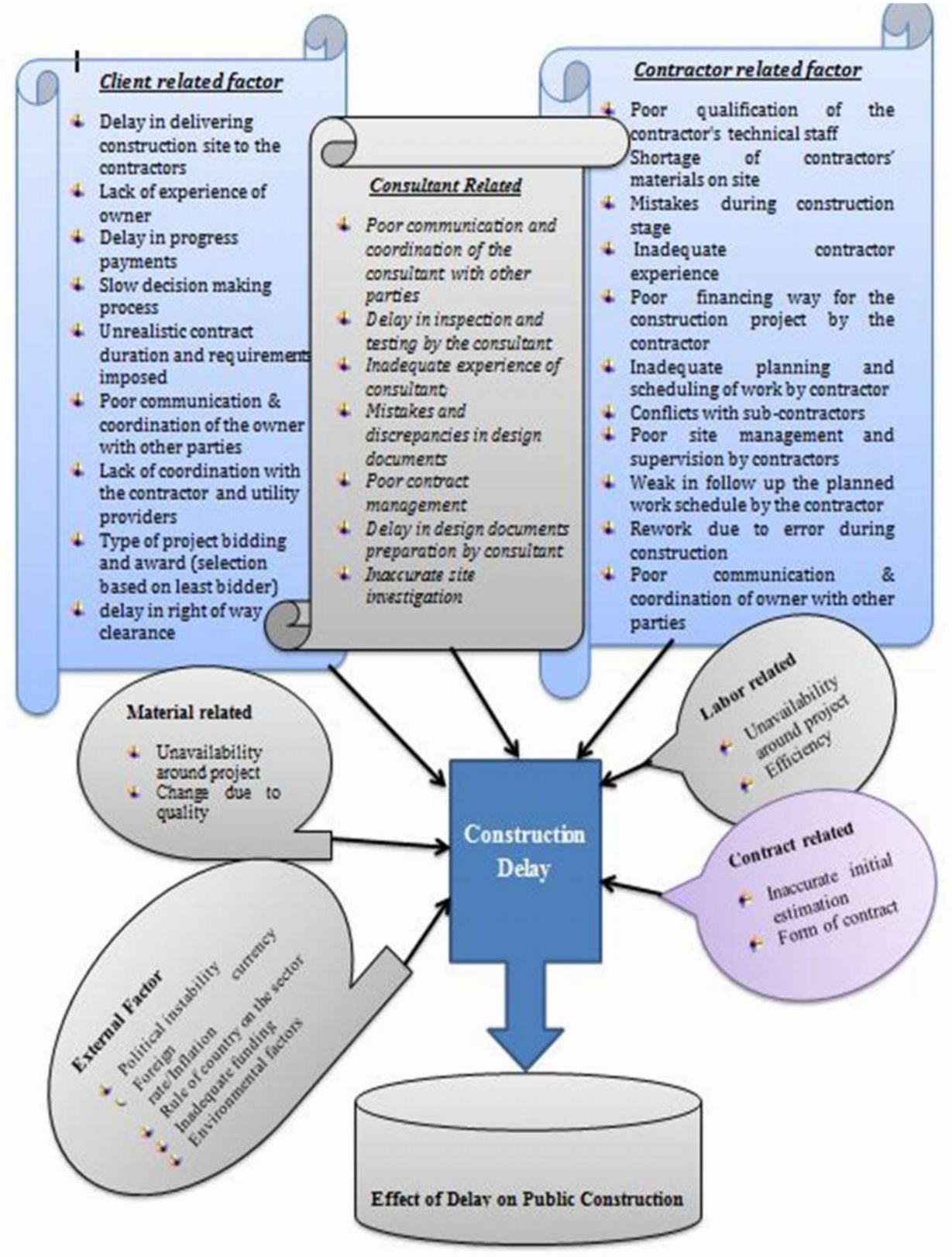

Figure 4 1 Conceptual framework for Cause of Delay

4.2. Model development and Research hypothesis

4.2.1. Model development

4.2.1.1. Variable labeling

The perspective of all parties that were participated in the public construction projects was first analyzed from each stakeholder's perspectives and then the overall result was computed. The causes of delay were discussed based on the Structural Equation Modeling (SEM) that integrated with IBM SPSS Amos software as depicted as follows.

The theoretical model is basis for testing the relationships of independent and dependent variables (Fellows R, 2008). Hence, a structural model of factors and effects of delay in public construction project is developed.

Each of the 14 variables [Delay Factors and Delay Effects] includes a number of separate indicators or sub variables which are as listed below (Table 4.1):

Table 4.1: Latent delay factor and delay effect with sub-variable on public construction delay

Latent Factor	Sub-variables	Observed variables
Client related factors[CL]		
	CL1	Delay in delivering construction site to the contractors
	CL2	Lack of experience of owner
	CL3	Delay in progress payments
	CL4	Slow decision making process
	CL5	Unrealistic contract duration and requirements imposed
	CL6	Poor communication & coordination of the owner with other parties
	CL7	Lack of coordination with the contractor and utility providers
	CL8	Change orders by owner during construction
	CL9	Type of project bidding and award (least bidder type)
	CL10	delay in right of way clearance(delay in fixing boundary)
Consultant related factors[CS]		
	CS1	Poor communication and coordination of the consultant with other parties
	CS2	Delay in inspection and testing by the consultant
	CS3	Lack of consultant's site staff
	CS4	Inadequate experience of consultant;
	CS5	Mistakes and discrepancies in design documents
	CS6	Poor contract management
	CS7	Delay in design documents preparation by consultant
	CS8	Inaccurate site investigation

Latent Factor	Sub-variables	Observed variables
Contractor related factors[CR]		
	CR1	Poor qualification of the contractor's technical staff
	CR2	Shortage of contractors' materials on site
	CR3	Mistakes during construction stage
	CR4	Inadequate contractor experience
	CR5	Poor financing way for the construction project by the contractor
	CR6	Inadequate planning and scheduling of work by contractor
	CR7	Conflicts with sub-contractors
	CR8	Poor site management and supervision by contractors
	CR9	Weak in follow up the planned work schedule by the contractor
	CR10	Rework due to error during construction
	CR11	Poor communication & coordination with other parties
	CR12	Poor management skills
Material-related[MR]		
	MR1	Unavailability around project
	MR2	Change due to quality
Labor related[LR]		
	LR1	Un availability around project
	LR2	Efficiency
Contract-related[CT]		
	CT1	Inaccurate initial estimation
	CT2	Form of contract
External factors[EX]		
	EX1	Political instability
	EX2	Foreign currency rate/Inflation
	EX3	Inadequate funding
	EX4	Environmental factors
	EX5	Social factor
Effects Of Delay[ED)		
	ED1	Time overrun
	ED2	Cost overrun
	ED3	Dispute between parties involved
	ED4	Arbitration
	ED5	Litigation and court case
	ED6	Total abandonment of the project
	ED7	Wastage and underutilization of resources

A theoretical model was constructed to represent delay factors in the Ethiopian public construction projects. Factor analysis was used to generate 41 delay indicators categorized into 7 latent delay factors and 7 effects of delay. The model demonstrates the concept with its key elements [i.e. constructed from collected valid data via questionnaire and semi-structured interview and make compatible for the engineering tool utilized viz. SEM integrated with IBM SPSS statistics version 23 Amos software].

4.2.2. Research hypotheses

In order to explore the influences of latent factors on construction delay, the research sets out seven hypotheses as follows:

Hypothesis H1: Frequency of occurrence of contractor-related factor [CR] influences overall impact on construction delay [CD].

Hypothesis H2: Frequency of occurrence of consultant-related factor [CS] influences overall impact on construction delay [CD].

Hypothesis H3: Client-related factors [CL] have significant effects on Construction delay [CD].

Hypothesis H4: Material-related factors [MR] have significant effects on Construction delay.

Hypothesis H5: Frequency of occurrence of External factor [EX] influences overall impact on construction delay [CD].

Hypothesis H6: In the constructions labor-related factors [LR], will have direct effect on construction delay [CD].

Hypothesis H7: Contract-related factors [CT] have significant effects on Construction delay [CD].

While testing the direct influences of the above seven key factors on construction delay, the interdependence and/or correlation of one factor with another in the structural equation model is also an important aspect for investigation. The interdependent relationships of these factors and their potential influence on one another have been reported in numerous other research works (Odeh and Battaine, 2002; Kumaraswamy et al., 2005; Lo et al., 2006). Thus the following additional hypotheses have been further developed to test the relative impacts of factors on one another:

Hypothesis H8: Frequency of occurrence of consultant-related factor [CS] triggers the frequency of occurrence of contractor-related factor [CR].

Hypothesis H9: Frequency of occurrence of consultant-related factor [CS] triggers the frequency of occurrence of client-related factor [CL].

Hypothesis H10: Frequency of occurrence of external factor [EX] triggers the frequency of occurrence of client-related factor [CL].

Hypothesis H11: Frequency of occurrence of material-related factor [MR] triggers the frequency of occurrence of contractor-related factor [CR].

Hypothesis H12: Frequency of occurrence of contract type factor [CT] triggers the frequency of occurrence of client-related factor [CL].

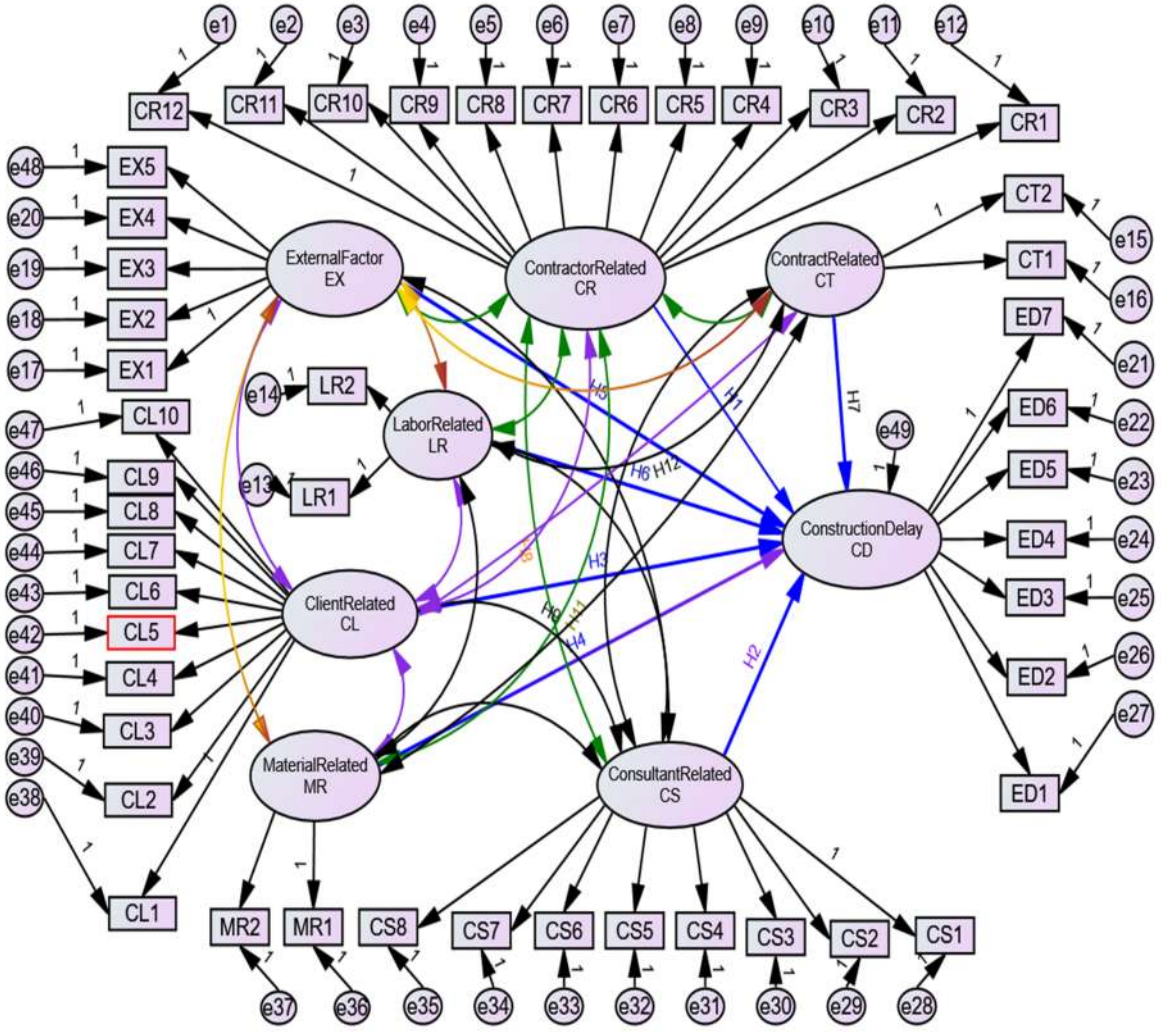

Figure 4.2 Hypothetical model of the factors impacts on construction delay

CHAPTER FIVE
RESULTS AND DISCUSSION

5.1. Introduction

This chapter is to shows the results and analyses of the primary data collection that was undertaken as a part of this research project. It is divided into two main parts: presentation of data results and analysis. For the analysis section, the collected data were processed by SPSS version 23 software and data analysis and modeling were also done by structural equation modeling (SEM) approach using statistical analysis software called AMOS version 23 which can be able to show the actual relationships between cause and effects of delay in public construction projects. The questionnaire distribution and response rates by sector organizations, respondents' designation, and work experience distribution, collection of the responses, and subsequent analysis of the responses from the professionals working in the three stakeholders' client, consultant, and contractor involved in the public construction sector. The findings from the data collection are presented based around the main objectives of the research study, which are: (i) to find out the reasons that drive delay and its consequence in the public construction projects; (ii) to find out the associated impacts of delays in public construction projects; and (iii) How to manage/mitigate and reduce delays in the public construction project. The results and discussion contain the findings of the questions directed towards identifying delay causes and ranking in the level of their importance/effects. Correlation and variances are modeled by AMOS V23 software and relations can be seen in number value so that it can be seen the relational strength of dependent and independent variables in the estimated model. Similarly, the most important and frequent effects of delay were analyzed by SPSS.

Thus, respondents were asked to rank delay causes factors in a five-point scale range from 1 to 5 based on the frequency of occurrence from '1=very low' to '5=very high'. In the second part, respondents were asked to identify the most important and frequent effect occurrences of construction delay from '1=strongly disagree' to '5=strongly agree'. A total of 161 questionnaires were distributed to the targeted sample population of which 130 were completed and returned. Before analyzing the data collected, questionnaires were checked for their response validity and reliability and accordingly 121 out of 130

questionnaires were properly filled and returned and found to be valid as shown in Table 5.1. The questionnaire response rate is 80.75%, which is considered adequate according to Moser and Kalton (1971), which stated that the result of any survey could be considered as biased and of little value if the return rate was lower than 30-40% of the respondents.

Table 5.1: Questionnaire Response Rate

S.No	Respondents Category	Distributed	Returned	Valid Response	Response rate (%)
1	Contractor	65	55	53	84.62%
2	Client	48	33	29	68.75%
3	Consultant	45	40	37	88.89%
4	Other	3	2	2	66.67%
	Total	161	130	121	80.75%

5.1.Data encoding accuracy and model fit

The model fit was also checked by both SPSS and AMOS, so that all estimated variables drawn in the model was fit, which the P value less than 0.05 (i.e. a "p value" for testing the hypothesis that the model fits perfectly in the population (Jöreskog, 1969) the P value for this study shows 0.00, and also the Goodness of Fit Index (GFI) and Adjusted Goodness of fit (AGFI) was achieved, which was referred from Jöreskog and Sörbom (1989), which was GFI less than 1 and greater than zero. "Practical experience has made us feel that a value of the RMSEA of about 0.05 or less would indicate a close fit of the model in relation to the degrees of freedom. This figure is based on subjective judgment. It cannot be regarded as infallible or correct, but it is more reasonable than the requirement of exact fit with the RMSEA = 0.0. We are also of the opinion that a value of about 0.08 or less for the RMSEA would indicate a reasonable error of approximation and would not want to employ a model with a RMSEA greater than 0.1." (Browne and Cudeck, 1993). The RMSEA value of the current study shows 0.067. The comparative fit index (CFI) of this study show 0.392 (accepted that the CFI is truncated to fall in the range from 0 to 1. CFI values close to 1 indicate a very good fit. The parsimony ratio (James, Mulaik & Brett, 1982; Mulaik, et al., 1989) expresses the number of constraints

in the model being evaluated as a fraction of the number of constraints in the independence model and the PRATIO of current study shows 0.895. Model fit summary of Amos V23 Software showed in appendix section of this study.

5.2.Demographic Details of the Respondents

The study wanted to find out the Characteristics of the respondents, bio data of respondents, gender distribution, age distribution, educational level, and work experience of respondents as shown in the Tables below.

5.1.1. Gender Distributions

The study found out the gender composition of the respondents as shown in Table 4.1 above. Of the majority of the respondents, 68.6% are male respondents while 31.4% are female population.

Table 5.2: Gender Distribution of Respondents (SPSS V23 software output)

Gender		Frequency	Percent	Valid Percent
Valid	Male	83	68.6	68.6
	Female	38	31.4	31.4
	Total	121	100.0	100.0

5.1.2. Age Distributions

The study sought to carry out the age brackets of the respondents in the study and the results were as shown in Table 5.3 below.

Table 5.3: Age Distribution of Respondents (SPSS V23 software output)

Age		Frequency	Percent	Valid Percent
Valid	18-30	33	27.3	27.3
	31-40	49	40.5	40.5
	41-50	25	20.7	20.7
	51-60	10	8.3	8.3
	over 61	4	3.3	3.3
	Total	121	100.0	100.0

Based on the result carried in this study shows the majority of the population that participated in the study was between ages 31-40 years (i.e. 40.5 %) which followed by ages 18-30 years and 41-50 years. And small number of participants observed by ages 51-60 years and ages over 61 years, respectively.

5.1.3. Educational Background of Respondents

From the respondents participated in this study a degree holders' in educational level dominated at 57.90%. They were followed by those with Master's degree (22.3%), diplomas (14.9%), Vocational training (4.1%), and PhD (0.8%) as graphically shown in Table 5.4 below.

Table 5.4: Academic Qualification of Respondents (SPSS V23 software output)

	Education level	Frequency	Percent	Valid Percent
Valid	Vocational Training	5	4.1	4.1
	Diploma	18	14.9	14.9
	Degree	70	57.9	57.9
	Master's Degree	27	22.3	22.3
	PhD	1	.8	.8
	Total	121	100.0	100.0

5.1.4. Work Experience

Table 5.5: Experience of Respondents (SPSS V23 software output)

	Work Experience (year)	Frequency	Percent	Valid Percent
Valid	1-5	22	18.2	18.2
	6-10	38	31.4	31.4
	11-15	28	23.1	23.1
	16-20	19	15.7	15.7
	Above 21	14	11.6	11.6
	Total	121	100.0	100.0

As shown above the respondents' percentage years of work experience shows that 38 (31.4% of the respondents have 6 – 10 years of work experience, 28 (23.1%) of the respondents have 11 – 15 years of work experience, 22 (18.2%) of the respondents have equal number for 1 – 5 years and 19 (15.7%) of 16 – 20 years of work experience, and 14 (11.6%) of the respondents have more than above 21 years work experience in the construction sector.

5.1.5. Project location and project type distributions

As per the snowball sampling technique utilized in this study the data collected throughout Ethiopia regional states of project type and project location were shown as follows:

Table 5.6: Project location distribution of data source (SPSS V23 software output)

Project Location		Frequency	Percent
Valid	Addis Ababa	15	12.4
	Dire Dawa	11	9.1
	Oromia	21	17.4
	Amhara	17	14.0
	Tigray	10	8.3
	SNNP	11	9.1
	Afar	8	6.6
	Gambela	4	3.3
	Somilia	3	2.5
	Harari	11	9.1
	Benshangul	2	1.7
	Sidama	8	6.6
	Total	121	100.0

Table 5.7: Public Project type considered in data analysis (SPSS V23 software output)

Project Type		Frequency	Percent
Valid	Building	37	30.6
	Road & Transport	31	25.6
	Water supply & Irrigation	31	25.6
	Other	22	18.2
	Total	121	100.0

5.1.6. Respondent's Organization/Company

Table 5.8 indicates that 43.8% of the respondents are professionals, and personnel's that work in the contractor's stakeholder, while those with the consultant, clients' and other population (i.e. respondent out of the those stakeholders) constitute 30.6%, 24.0% and 1.7% of the respondents respectively.

Table 5.8: Respondent's organization (SPSS V23 software output)

Respondent's company		Frequency	Percent
Valid	Contractor	53	43.8
	Client	29	24.0
	Consultant	37	30.6
	Other	2	1.7
	Total	121	100.0

5.1.7. Current job position of the Respondent's

Table 5.1B (Appendix B) shows that 33.1% of the respondents are site/office engineers, another 17.4 % of the respondents are Project managers, 15.7% of the respondents are contract administration professionals, 11.6% of the respondents are Resident Engineers and other professionals, 10.7% of the respondents are construction company owners.

5.1.8. Respondents' Perception on average delay percentage on projects

As per the first objective of the study is related to analyzing the causes of delays in public construction projects from various stakeholders' perspectives that have been identified. The respondents state the average delay percentage in each public project they incorporated in. The factors were analyzed by IBM SPSS Amos software version 23 to each contractor, owners, and consultant's viewpoint. The following is a brief description shown in Table 5.9 average delay percentage.

Table 5.9: Respondent's perception on average delay percentage (IBM SPSS V23 software output)

Average Delay Percentage		Frequency	Percent
Valid	0-10%	27	22.3
	11-50%	43	35.5
	51-100%	31	25.6
	Above 101%	20	16.5
	Total	121	100.0

5.2. IBM SPSS Amos version 23 Software detailed data analysis result

The perspective of all parties that were participated in the public construction projects was first analyzed from each stakeholder's perspectives and then the overall result was computed. The causes of delay were discussed based on the Structural Equation Modeling (SEM) integrated with IBM SPSS Amos software as depicted as follows.

The theoretical model is basis for testing the relationships of independent and dependent variables (Fellows R, 2008). Hence, the Amos V23 software output of a structural model of factors and effects of delay in public construction project is as presented in Figure 5.1.

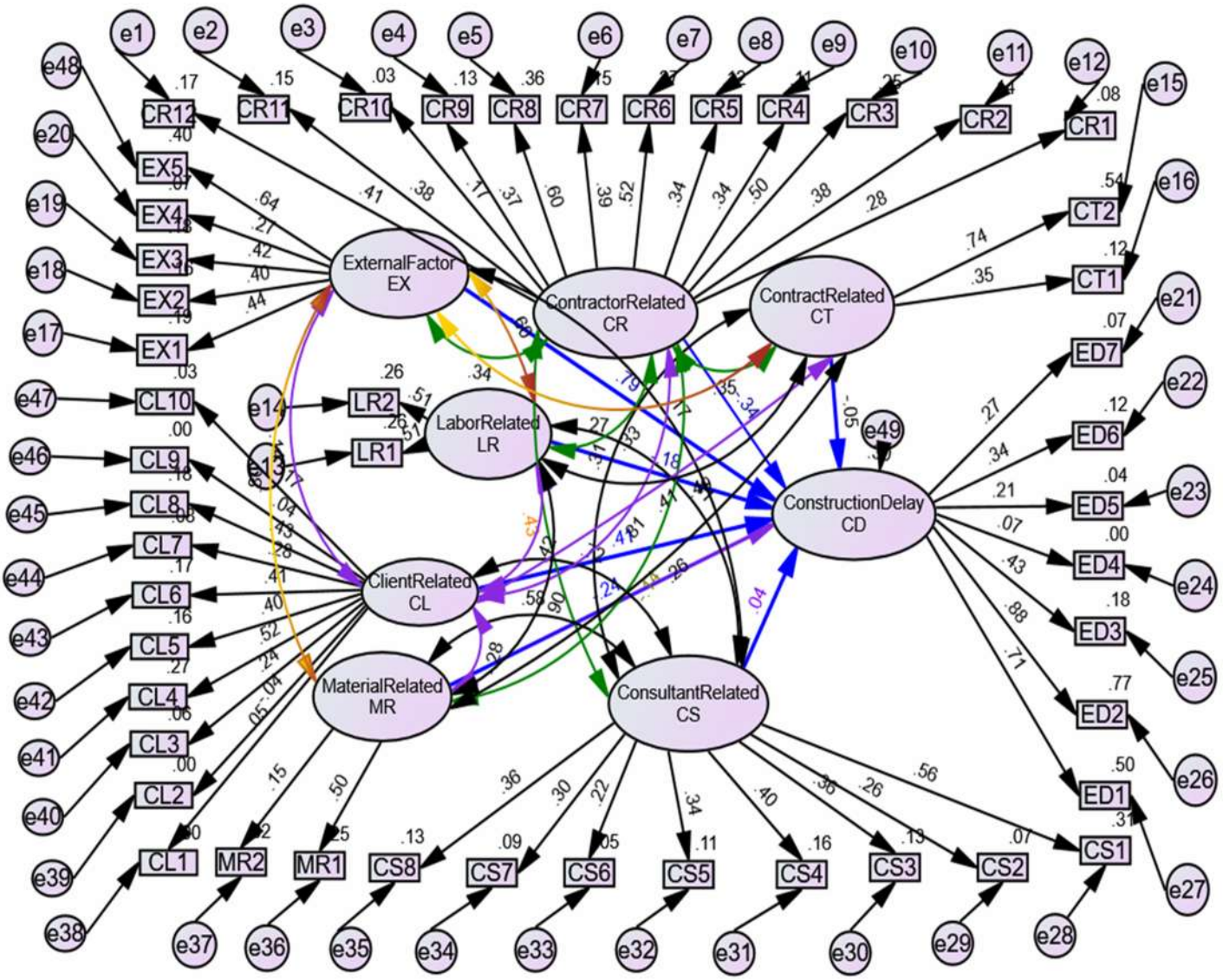

Fig. 5.1: Results from the simulation process for Covariance and regression weight model between each factor [source: SPSS Amos 23 output, Researcher (2021)]

Table 5.10: Input Summary of the Model [From SEM model estimation, Researcher (2021)]

Number of variables in the model:	105
Number of observed variables:	48
Number of unobserved variables:	57
Number of exogenous variables:	56
Number of endogenous variables:	49

5.2.1. Interpretation of the Model and test of hypothesis

Table 5.11 indicates Results of Examining Hypotheses in the Developed Structural Model. The standardized total (direct and indirect) effect of Material Related_MR on Construction Delay _CD is -.237. That is, due to both direct (unmediated) and indirect (mediated) effects of Material Related_MR on Construction Delay_CD, when Material Related_MR goes up by 1 standard deviation, Construction Delay_CD goes down by 0.237 standard deviations. This standardized regression weights shows; Material-related factors_MR have negative significant effects on Construction Delay_CD. This means ***Hypothesis_H4*** in the developed model is acceptable.

The standardized total (direct and indirect) effect of Consultant Related_CS on Construction Delay_CD is .040. That is, due to both direct (unmediated) and indirect (mediated) effects of Consultant Related_CS on Construction Delay_CD, when Consultant Related_CS goes up by 1 standard deviation, Construction Delay_CD goes up by 0.04 standard deviations, which implies the Frequency of occurrence of consultant-related factor [CS] direct positive influences overall impact on construction delay [CD]. Therefore ***Hypothesis _H2*** was accepted**.** The standardized total (direct and indirect) effect of External Factor_EX on Construction Delay_CD is .787. That is, due to both direct (unmediated) and indirect (mediated) effects of External Factor_EX on Construction Delay_CD, when External Factor_EX goes up by 1 standard deviation, Construction Delay_CD goes up by 0.787 standard deviations. This shows that Frequency of occurrence of External factor [EX] direct positive influences overall impact on construction delay [CD]. So that ***Hypothesis_H5*** was accepted. The standardized total (direct and indirect) effect of Contract Related_CT on Construction Delay_CD is -.048. That is, due to both direct (unmediated) and indirect (mediated) effects of Contract Related_CT on Construction Delay_CD, when Contract Related_CT goes up by 1

standard deviation, Construction Delay_CD goes down by 0.048 standard deviations. This standardized regression weights shows; Contract Related_CT has negative significant effects on Construction Delay_CD. This means ***Hypothesis_H7*** in the developed model is acceptable. The standardized total (direct and indirect) effect of Labor Related_LR on Construction Delay_CD is -.185. That is, due to both direct (unmediated) and indirect (mediated) effects of Labor Related_LR on Construction Delay_CD, when Labor Related_LR goes up by 1 standard deviation, Construction Delay_CD goes down by 0.185 standard deviations. So, that ***Hypothesis_H6*** was accepted which implies the constructions labor-related factors _LR, has indirect effect on construction delay _CD.

The standardized total (direct and indirect) effect of Contractor Related_CR on Construction Delay_CD is -.338. That is, due to both direct (unmediated) and indirect (mediated) effects of Contractor Related_CR on Construction Delay_CD, when Contractor Related_CR goes up by 1 standard deviation, Construction Delay_CD goes down by 0.338 standard deviations. The result implies frequency of occurrence of contractor-related factor_CR has influences indirectly on overall impact on construction delay_CD, so ***Hypothesis H1*** was accepted.

The standardized total (direct and indirect) effect of Client Related_CL on Construction Delay_CD is .414. That is, due to both direct (unmediated) and indirect (mediated) effects of Client Related_CL on Construction Delay_CD, when Client Related_CL goes up by 1 standard deviation, Construction Delay_CD goes up by 0.414 standard deviations. Which implies the Frequency of occurrence of Client-related factors [CL] direct positive influences overall impact on construction delay [CD]. Therefore ***Hypothesis _H3*** was accepted**.**

Table 5.11: Results of Examining Hypotheses in the Developed Structural Model [Researcher, 2021)]

Outcome	***Effect Direction***	***Cause of Delay***	***Estimate***	***Hypothesis***
Construction Delay_CD	<---	Labor Related_LR	-0.185	H6
Construction Delay_CD	<---	Material Related_MR	-0.237	H4
Construction Delay_CD	<---	Consultant Related_CS	0.040	H2
Construction Delay_CD	<---	Client Related_CL	0.414	H3
Construction Delay_CD	<---	External Factor_EX	0.787	H5
Construction Delay_CD	<---	Contractor Related_CR	-0.338	H1
Construction Delay_CD	<---	Contract Related_CT	-0.048	H7

The interdependent relationships of factors (i.e. exogenous latent variables) and their potential influence on one another have been studied in numerous other research works (Odeh and Battaine, 2002; Kumaraswamy et al., 2005; Lo et al., 2006). Thus in this study the following bi-directional relationships shows the interdependence estimated factors on one another (Table 5.12) and on the correlation of variable the hypothesis were estimated. The covariance between Contractor Related_CR and Consultant Related_CS is estimated to be .196. Which implies Frequency of occurrence of consultant-related factor_CS triggers the frequency of occurrence of contractor-related factor_CR, So, ***Hypothesis H8*** was accepted. The covariance between Client Related_CL and Consultant Related_CS is estimated to be .251. Which means frequency of occurrence of consultant-related factor_CS triggers the frequency of occurrence of client-related factor_CL; therefore, ***Hypothesis H9*** was accepted. The covariance between Client Related_CL and External Factor_EX is estimated to be .057. Frequency of occurrence of external factor_EX triggers the frequency of occurrence of client-related factor_CL. This hypothesis, ***Hypothesis_H10*** is accepted, because from the table 5.2.2 in the correlation on SEM path modeling, the correlation coefficient for Contractor Related_CR and Material Related_MR was 0.057, for the covariance between Contractor Related_CR and Material Related_MR is estimated to be -.057. Implies frequency of occurrence of material-related factor_MR had a negative correlation with contractor-related factor_CR. Therefore ***Hypothesis_H11*** *was rejected.* The covariance between Labor Related_LR and Contract Related_CT is estimated to be .261. So, ***Hypothesis H12*** accepted because frequency of

occurrence of contract type factor_CT triggers the frequency of occurrence of client-related factor_CL.

Table 5.12: Correlation on SEM path modeling [source: Amos V23 software (Researcher, 2021)]

Factor of delay cause	Path	Factor of delay cause	Estimate	Label
Contractor Related_CR	<-->	Consultant Related_CS	0.196	H8
Client Related_CL	<-->	Consultant Related_CS	0.251	H9
Client Related_CL	<-->	External Factor_EX	0.057	H10
Labor Related_LR	<-->	Consultant Related_CS	0.16	par_51
External Factor_EX	<-->	Consultant Related_CS	0.076	par_52
Consultant Related_CS	<-->	Material Related_MR	0.216	par_53
Contract Related_CT	<-->	Consultant Related_CS	0.171	par_54
Client Related_CL	<-->	Contractor Related_CR	0.32	par_55
Contractor Related_CR	<-->	Labor Related_LR	0.146	par_56
Contractor Related_CR	<-->	External Factor_EX	0.174	par_57
Contractor Related_CR	<-->	Material Related_MR	-0.057	H11
Contractor Related_CR	<-->	Contract Related_CT	0.22	par_58
Client Related_CL	<-->	Labor Related_LR	0.144	par_59
Client Related_CL	<-->	External Factor_EX	0.057	par_60
Client Related_CL	<-->	Material Related_MR	-0.092	par_61
Client Related_CL	<-->	Contract Related_CT	0.195	par_62
Labor Related_LR	<-->	External Factor_EX	0.262	par_63
Labor Related_LR	<-->	Material Related_MR	0.325	par_64
Labor Related_LR	<-->	Contract Related_CT	0.261	H12
External Factor_EX	<-->	Material Related_MR	0.332	par_65
Contract Related_CT	<-->	External Factor_EX	0.169	par_66
Contract Related_CT	<-->	Material Related_MR	0.133	par_67

Table 5.13 indicates Results of Examining intercept in the equation for predicting Shortage of contractors' materials on site is estimated to be 3.405 which means the probability of getting a critical ratio as large as 37.587 in absolute value is less than 0.001. In other words, the intercept in the equation for predicting Shortage of contractors' materials on site in is significantly different from zero at the 0.001 level and first rank delay causing variables in 'Contractor related factors_CR'.

The intercept in the equation for predicting 'Foreign currency rate/Inflation' is estimated to be 3.298 and, has a standard error of about .107. Dividing the estimate of the intercept by the estimate of its standard error gives z = 3.298/.107 = 30.721. In other words, the estimate of the intercept is 30.721 standard errors above zero. The probability of getting a critical ratio as large as 30.721 in absolute value is less than 0.001. In other words, the intercept in the equation for predicting 'Foreign currency rate/Inflation' is significantly different from zero at the 0.001 level; Where, "***" implies that the P value is less than 0.001. And it's the major delay causing variables in respect of 'External related_EX' factor. From those public construction delay factors, mostly delay causing were selected out by using AMOS standardized model estimation and intercepts. The significance level (P-value) of each intercept estimation of observed variables were less than 0.001.

Table 5.13: Intercept of scalar estimation on SEM path modeling [source: Amos V23 software (Researcher, 2021)]

Latent Factor	*Observed variable (Questions to respondents)*	*Estimate*	*S.E.*	*C.R.*	*P*	*Label*
Contractor related factors[CR]	Shortage of contractors' materials on site	3.405	0.091	37.587	***	par_79
	Inadequate planning and scheduling of work by contractor	3.322	0.104	32.008	***	par_75
	Poor management skills	3.273	0.102	32.199	***	par_69
	Poor qualification of the contractor's technical staff	3.256	0.105	30.917	***	par_80
	Rework due to error during construction	3.190	0.099	32.187	***	par_71
	Poor financing way for the construction project by the contractor	3.099	0.098	31.697	***	par_76
	Weak in follow up the planned work schedule by the contractor	3.008	0.108	27.885	***	par_72
	Poor site management and supervision by contractors	2.992	0.109	27.569	***	par_73
	Mistakes during construction stage	2.942	0.096	30.559	***	par_78
	Poor communication & coordination with other parties	2.917	0.099	29.587	***	par_70
	Inadequate contractor experience	2.884	0.101	28.532	***	par_77
	Conflicts with sub-contractors	2.711	0.101	26.952	***	par_74
Labor related[LR]	Un availability around project	3.281	0.109	30.107	***	par_81
	Efficiency	3.231	0.092	35.035	***	par_82
Contractrelated[CT]	Inaccurate initial estimation	3.355	0.102	32.825	***	par_84
	Form of contract	3.289	0.107	30.682	***	par_83
External factors[EX]	Foreign currency rate/Inflation	3.298	0.107	30.721	***	par_86
	Inadequate funding	3.182	0.096	33.121	***	par_87
	Environmental factors	3.132	0.097	32.378	***	par_88
	Social factor	3.099	0.102	30.41	***	par_116
	Political instability	3.017	0.112	26.946	***	par_85
Consultant related factors[CS]	Poor contract management	3.264	0.099	32.833	***	par_101
	Mistakes and discrepancies in design documents	3.223	0.099	32.711	***	par_100
	Delay in design documents preparation by consultant	3.207	0.093	34.445	***	par_102
	Inaccurate site investigation	3.116	0.101	30.821	***	par_103
	Poor communication and coordination of the consultant with other parties	3.017	0.104	29.105	***	par_96
	Delay in inspection and testing by the consultant	3.008	0.102	29.5	***	par_97
	Inadequate experience of consultant;	2.926	0.096	30.417	***	par_99
	Lack of consultant's site staff	2.917	0.104	28.04	***	par_98
Materialrelated[MR]	Unavailability around project	3.306	0.107	30.762	***	par_104
	Change due to quality	2.983	0.099	30.173	***	par_105

Latent Factor	*Observed variable (Questions to respondents)*	*Estimate*	*S.E.*	*C.R.*	*P*	*Label*
Client related factors[CL]	Type of project bidding and award (selection based on least bidder)	3.43	0.111	31.007	***	par_114
	Slow decision making process	3.372	0.097	34.807	***	par_109
	delay in right of way clearance(delay in fixing boundary issues)	3.306	0.112	29.553	***	par_115
	Unrealistic contract duration and requirements imposed	3.215	0.1	32.015	***	par_110
	Delay in delivering construction site to the contractors	3.198	0.102	31.338	***	par_106
	Delay in progress payments	3.132	0.095	33.118	***	par_108
	Lack of experience of owner	3.124	0.1	31.246	***	par_107
	Poor communication & coordination of the owner with other parties	3.124	0.087	35.707	***	par_111
	Lack of coordination with the contractor and utility providers	2.992	0.101	29.734	***	par_112
	Change orders by owner during construction	2.967	0.102	29.204	***	par_113

Hypotheses H1 to H12 were tested through evaluating the significance of the intercept path coefficients as well as standard regression weight for between the constructs in the structural equation model which had been specifically established for this research study [see table 5.14]. In addition, the paths among the variables were also scrutinized. In the hypothesized model proposed in this research study. As shown in Table 5.2.5, These path coefficient values of intercept of the model indicate that Type of project bidding and award (selection based on least bidder) [factor of client], with the highest intercept estimation value [3.43] has the greatest impact on public construction delay in Ethiopia, while the greatest impact of effects was Effects related to Time overrun_ED1 [3.975] due to the delay of public projects.

Table 5.14: Rank by Intercept of scalar estimation on SEM path modeling [source: Amos V23 software (Researcher, 2021)]

Rank	*Observed variable*	*Estimate*	*S.E.*	*C.R.*	*P*	*Label*
1	Type of project bidding and award (selection based on least bidder)	3.43	0.111	31.007	***	par_114
2	Shortage of contractors' materials on site	3.405	0.091	37.587	***	par_79
3	Slow decision making process by consultant	3.372	0.097	34.807	***	par_109
4	Inaccurate initial estimation on contract document	3.355	0.102	32.825	***	par_84
5	Inadequate planning and scheduling of work by contractor	3.322	0.104	32.008	***	par_75
6	Unavailability construction material around project	3.306	0.107	30.762	***	par_104
7	delay in right of way clearance(delay in fixing boundary issues)	3.306	0.112	29.553	***	par_115
8	Foreign currency rate/Inflation	3.298	0.107	30.721	***	par_86
9	Form of contract applied to specific project	3.289	0.107	30.682	***	par_83
10	Un availability of manpower/ labors around project	3.281	0.109	30.107	***	par_81
11	Poor management skills of contractors'/General managers	3.273	0.102	32.199	***	par_69
12	Poor contract management and administration by consultants	3.264	0.099	32.833	***	par_101
13	Poor qualification of the contractor's technical staff/key personnel	3.256	0.105	30.917	***	par_80
14	Efficiency of labor/ skilled manpower (under expected norm performance)	3.231	0.092	35.035	***	par_82
15	Mistakes and discrepancies in design documents	3.223	0.099	32.711	***	par_100
16	Unrealistic contract duration and requirements imposed	3.215	0.1	32.015	***	par_110
17	Delay in design documents preparation by consultant	3.207	0.093	34.445	***	par_102
18	Delay in delivering construction site to the contractors	3.198	0.102	31.338	***	par_106
19	Rework due to error during construction	3.19	0.099	32.187	***	par_71
20	Inadequate funding	3.182	0.096	33.121	***	par_87
21	Environmental factors	3.132	0.097	32.378	***	par_88
Rank	*Effect of Delay*	*Estimate*	*S.E.*	*C.R.*	*P*	*Label*
1	Time overrun	3.975	0.089	44.682	***	par_95
2	Cost overrun	3.934	0.102	38.516	***	par_94
3	Dispute between parties involved	3.14	0.1	31.469	***	par_93
4	Wastage and underutilization of resources	2.959	0.123	24.103	***	par_89
5	Arbitration	2.893	0.098	29.5	***	par_92
6	Litigation and court case	2.877	0.102	28.347	***	par_91
7	Total abandonment of the project	2.851	0.111	25.801	***	par_90

In Hypothesis_H11 (Table 5.2.3) the correlation coefficient for Contractor Related_CR and Material Related_MR was 0.057, for the covariance between Contractor Related_CR and Material Related_MR is estimated to be -.057. Implies frequency of occurrence of material-related factor_MR had a negative correlation with contractor-related factor_CR. Therefore Hypothesis_H11 was rejected Material Related_MR factors had no a direct significant impact on delay of construction projects directly. But the indirect effects remained.

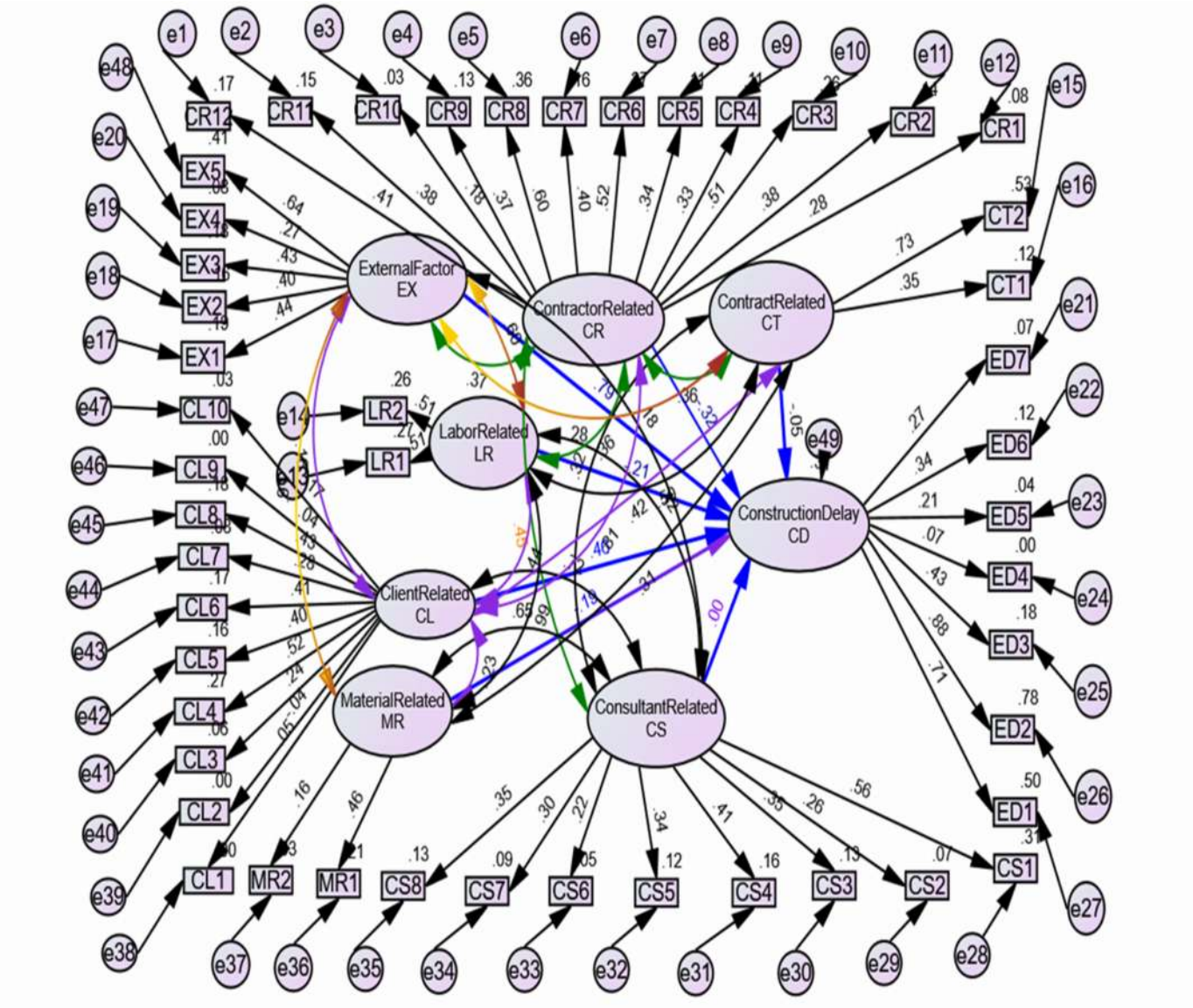

Fig. 5.2: Modified Structural Equation Model – [Cause-Effects] of Public Construction Delay

CHAPTER SIX
CONCLUSION AND RECOMMENDATION

6.1. Conclusion

Using Structural Equation Modeling [SEM], this study examined relationship between 48 variables [41 factors and 7 effects], previously identified as contributing to public construction delay in the Ethiopian construction industry and the effects consequences of this delay. The SEM path model which has been developed incorporated these factors and effects which are classified into forty eight observed variables (i.e. 41 factors and 7 effects) and eight unobserved or latent variables (i.e. client related (CL), consultant related (CS), contractor related (CR), external factor (EX), labor related factor (LR), material related factor (MR), contract related (CT), and cause of delay (CD). Evaluation of the model shows that all the sub-variables in the outer model are valid and reliable. As per the path analysis with IBM SPPS Amos 23 a β-value (estimate) the most dominant factor of Contractor related_CR factor 'Shortage of contractor's materials on site is estimated to be 3.405. On the other hand, External related_EX factors 'Environmental factors' have the least influence on delays in the construction field with a β-value of 3.132. And also this study identifies effects of delay on public construction projects found in Ethiopia as (from the most dominant effect to least effect); (1) Time overrun, (2) Cost overrun, (3) Dispute between parties involved, (4) Arbitration, (5) Litigation and court case, (6) Total abandonment of the project, and (7) Wastage and underutilization of resource. Therefore, the overall model can be generalized as a representation of the situation faced by the Ethiopian public construction sector. This model is useful to people in the construction sector especially in Ethiopia to analyze risk for delays, as well as for researchers in the field of construction.

6.2. Limitation of the study

It is not denial that any research papers from its initiation to completion perhaps encounter a limitation. Besides, there are some of the limitations that face in the preparation of this research thesis are limited only on the public construction project in Ethiopia and not cover all the construction sector including private which is open for other researchers to conduct study on private construction sector in Ethiopia or abroad with engineering tool SEM.

6.3. Recommendation

6.3.1. Recommendation for Parties to mitigate delay

As per the finding obtained through this study, there are some recommendations for stakeholders/ involved parties like- clients, consultants and contractors:

6.3.1.1. Client

Clients are one of the most important parties who invest their money for realization of public projects, and they are the key role players starting from conception through construction up to handover the project to the beneficiaries. The following recommendations are expected from clients to minimize the factors that cause delay in public construction projects: Delay in delivering construction site to the contractors, Lack of experience of owner, Delay in progress payments, Slow decision making process, Unrealistic contract duration and requirements imposed, Poor communication & coordination of the owner with other parties, Lack of coordination with the contractor and utility providers, and Change orders by owner during construction.

6.3.1.2. Consultant

The consultants are one of the vital players in construction industry and have roles in minimizing delay of task. Hence, the following recommendations are for consultants:- improve poor communication and coordination of the consultant with other parties, Delay in inspection and testing by the consultant, Lack of consultant's site staff, Inadequate experience of consultant, Mistakes and discrepancies in design documents, Poor contract management, Delay in design documents preparation by consultant, and Inaccurate site investigation.

6.3.1.3. Contractor

Contractors are one of the major risk takers and vital in concern of delay cause in public construction projects. Hence, the following recommendations are for contractors:- Poor management skills, Poor communication & coordination with other parties, Rework due to error during construction, Weak in follow up the planned work schedule by the contractor, Poor site management and supervision by contractors, Conflicts with sub-contractors, Inadequate planning and scheduling of work by contractor, Poor financing way for the construction project by the contractor, and Inadequate contractor experience.

6.3.2. Recommendation for future study

In this study the researcher utilized engineering tool called Structural Equation Modeling [SEM] integrated with IBM SPSS Amos 23 software. Even though the nature of the software needs in-depth iteration with bulky analysis in fixing the model for each observed and latent variables/factors, the model was developed and analyzed showed some outputs as per the iteration obtained for only public construction sector. So, the researcher recommends to the scholars who want to conduct such study in the future needs to give time and do all iteration separately on the private construction sector.

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APPENDICES

Appendix --A

I. Research Questionnaire

Dear Participant,

Dear participant, my name is Getahun Borja and I am a student undertaking a Master of Science Degree in ***Industrial Management*** at **Bahir Dar University Institute of Technology (*BiT*)**. To fulfill the completion of this course, I am carrying out a study on the **Investigating causes and effects of delays in Ethiopia's public sector construction projects by Structural Equation Modeling** in the case of randomly selected public projects in Ethiopia. I am inviting you to participate in this research study by completing the attached questionnaire. If you choose to participate in this research, please answer all questions as honestly as possible.

I solemnly assure you that the information you provide in this questionnaire will remain confidential, you do not have to include your name. The data will be for academic purposes only. I will be happy to share the finding of this research when it's completed.

Thank you in advance for taking your precious time to fill this questionnaire. Please try to answer the entire question openly, as your answers will have an influence on the outcomes of the research. I kindly ask you to please complete the questionnaire and return it to me within 7 days of receipt.

If you have any questions or comments, please don't hesitate to contact me via the following address:

E_mail: get12019@gmail.com/ iphony926@icloud.com/getboy0611@gmail.com

Tel.:- +251-916-02-05-30/+251-925-94-27-84

Thank you for your time and cooperation.

With Best Regards,

Getahun Borja

PART-I

Section I- Respondent and Company Profile/General Information

Direction: Please answer the following general questions by filling the blanks and marking "√" on the spaces provided as appropriate.

1. Gender: Male [ ] Female [ ]
2. Age: 18-30yrs [ ] 31-40yrs [ ] 41-50yrs [ ] 51-60yrs [ ] Over 61yrs [ ]
3. Level of education: Secondary [ ] Vocational Training [ ] Diploma [ ] Degree [ ] Masters [ ] PhD [ ]
4. Which of the stakeholder are you? (Please choose one).

Contractor [ ]	Client [ ]	Consultant [ ]	Other [ ]_____

5. For how long have you worked in construction industry? (In Years)
   1-5 [ ] 6-10 [ ] 11-15 [ ] 16-20 [ ] 21 above [ ]
6. What is your current position? _____
7. E-mail address/contact info.[for possible follow-up communication](optional):___
8. Name of Project _____
9. Location of Project _____
10. Project Commencement Date_____
11. Project Contract Time (Calendar days) or (completion date) _____
12. Additional Time Given in Days (if any)_____
13. How many construction project have you participated in? _____(Please specify)
    How many of them delayed? One [ ] Two [ ] All [ ] or please specify___
14. What is the average delay time of the delayed project/s?
    Less than 10% [ ] 11 to 50% [ ] 51 to 100% [ ] above 100% please specify _____

Section II: Causes of Delay in Public Construction projects in Ethiopia

15. Please tick the extent to which you believe that the following **Client related factors** that can contribute to causes of delays of public construction projects in your company. Using the following scale: 1 very low; 2 Low; 3 Average; 4 High and 5 very high.

Client related factors	1	2	3	4	5
a. Delay in delivering construction site to the contractors					
b. Lack of experience of owner					
c. Delay in progress payments					
d. Slow decision making process					
e. Unrealistic contract duration and requirements imposed					
f. Poor communication & coordination of the owner with other parties					
g. Lack of coordination with the contractor and utility providers					
h. Change orders by owner during construction					
i. Type of project bidding and award (selection based on least bidder)					
j. *delay in right of way clearance(delay in fixing boundary issues)*					

16. Please tick the extent to which you believe that the following **Consultant related factors** that can contribute to causes of delays of construction projects in your company. Using the following scale: 1 very low; 2 Low; 3 Average; 4 High and 5 very high.

Consultant related factors	1	2	3	4	5
a. Poor communication and coordination of the consultant with other parties					
b. Delay in inspection and testing by the consultant					
c. Lack of consultant's site staff					
d. Inadequate experience of consultant;					
e. Mistakes and discrepancies in design documents					
f. Poor contract management					
g. Delay in design documents preparation by consultant					
h. Inaccurate site investigation					

17. Please tick the extent to which you believe that the following **Contractors related factors** that can contribute to causes of delays of construction projects in your

company. Using the following scale: 1 very low; 2 Low; 3 Average; 4 High and 5 very high.

Contractor related factors	1	2	3	4	5
a. Poor qualification of the contractor's technical staff					
b. Shortage of contractors' materials on site					
c. Mistakes during construction stage					
d. Inadequate contractor experience					
e. Poor financing way for the construction project by the contractor					
f. Inadequate planning and scheduling of work by contractor					
g. Conflicts with sub-contractors					
h. Poor site management and supervision by contractors					
j. Weak in follow up the planned work schedule by the contractor					
k. Rework due to error during construction					
l. Poor communication & coordination of owner with other parties					
m. Poor management skills					

18. Please tick the extent to which you believe that the following **other factors** (viz. material-related, labor related, contract-related, and Contract relationship-related and external factors) that can contribute to causes of delays of construction projects in your company. Using the following scale: 1 very low; 2 Low; 3 Average; 4 High and 5 very high.

Other factors	1	2	3	4	5
Material-related					
a. *Unavailability around project*					
b. *Change due to quality*					
c. Shortage					
d. Change in material type					
Labor related					
a. *Un availability around project*					
b. *Efficiency*					
Contract-related					
a. *Inaccurate initial estimation*					
b. Form of contract					

External factors					
a. *Political instability*					
b. *Foreign currency rate/Inflation*					
c. Rule of country on the sector					
d. Inadequate funding					
e. Environmental factors					
f. Social factor					

19. If you have comments regarding the causes of delay in public construction projects, (please write):

_____

Section III: Effects of Delay in Public Construction projects

20. Please rank effects of delay below in what you consider to be the most important effect of delay.

1= Strongly Disagree, 2= Disagree, 3= Slightly Disagree, 4= Agree, 5= Strongly Agree

Effects Of Delay	1	2	3	4	5
1. Time overrun					
2. Cost overrun					
3. Dispute between parties involved					
4. Arbitration					
5. Litigation and court case					
6. Total abandonment of the project					
7. Wastage and underutilization of resources					

21. If you have comments regarding effects of delay in public construction project, please write here:

_____

What you want to say according to your experience regarding causes and effect of delay in public construction project?

_____

Thank you very much for your contribution to this study!!!

Getahun Borja Mekonnen

II. Semi-structured Interview Guide

Thanks in advance for taking time for the interview. This interview questions are a research instrument for the fulfillment of my MSc. program in Industrial Management and of the study on "***Investigating causes and effects of delays in Ethiopia's public sector construction projects by Structural Equation Modeling***". Your response will be completely anonyms and I assure you that information you provide shall be treated confidentially, and will not be identified by individual. All response will be compiled together and analyzed as a group.

1. General Information
    - 1.1. Name? And your age?
    - 1.2. What is your level of Education?
    - 1.3. What is your current position?
    - 1.4. For how long you worked in the construction industry?
    - 1.5. In which stakeholders are you working?
    - 1.6. What type of construction industry? Building/Road/Water related/Infrastructures?
    - 1.7. How many construction project have you participated in?
    - 1.8. How many of them delayed?
    - 1.9. What is the average delay time of the delayed project/s? (in percent)
2. Cause of delay in public construction projects in Ethiopia
    - 2.1. What are the causes of public construction delay in Ethiopia?
    - 2.2. Which construction stakeholders contribute to cause of delays of public construction as per your hosting company? Can you elaborate?
    - 2.3. Have you any comment regarding the cause of delay in public construction projects?
3. Effects of delay in public construction projects in Ethiopia?
    - 3.1. What are the effects of these delays on the stakeholders/ country's public construction industry?
    - 3.2. How would you explain the effects of public construction projects in Ethiopia?
    - 3.3. Have you any comment regarding the effects of delay in public construction projects?
4. Link between causes of Ethiopian public projects delay and their effects on stakeholders
    - 4.1. Is there any link between the cause and the effects of public construction projects in Ethiopia? If yes, how?
    - 4.2. Give your overall comment on the cause and effects of public construction projects in Ethiopia?

Thank you again for taking your time for the interview, if you have any questions/ suggestions please do contact me.

Appendix --B

Table 5.1B: Current position of Respondent's

	Current Position	Frequency	Percent
Valid	Resident Eng'r	14	11.6
	Contract Admin	19	15.7
	Project Manager	21	17.4
	Site/Office Eng'r	40	33.1
	Owner	13	10.7
	Other	14	11.6
	Total	121	100.0

III. IBM SPSS Amos 23 Analysis output

Table 5.2B: Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	172	1614.386	1052	0.00	1.535
Saturated model	1224	0	0		
Independence model	48	2100.773	1176	0.00	1.786

Baseline Comparisons

Model	NFI	RFI	IFI	TLI	CFI
	Delta1	rho1	Delta2	rho2	
Default model	0.232	0.141	0.464	0.32	0.392
Saturated model	1		1		1
Independence model	0	0	0	0	0

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	0.895	0.207	0.351
Saturated model	0	0	0
Independence model	1	0	0

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	0.067	0.06	0.073	0
Independence model	0.081	0.075	0.087	0

Table 5.3B: Case Summaries

Case Summaries[a]

S/N	Age	Gender	Education Level	Stakeholder are you?	Work Experience (yr)	Current Position	Project Type	Project Location	Average Delay Percentage
1	18-30	Male	Degree	Contractor	6-10	Site/Office Eng'r	Building	Amhara	Above 101%
2	31-40	Male	Masters Degree	Contractor	6-10	Contract Admin	Other	Tigray	51-100%
3	41-50	Male	Degree	Contractor	16-20	Owner	Road & Transport	Tigray	11-50%
4	31-40	Male	Masters Degree	Consultant	11-15	Resident Eng'r	Building	Tigray	51-100%
5	31-40	Female	Degree	Client	6-10	Site/Office Eng'r	Other	Tigray	Above 101%
6	18-30	Female	Degree	Consultant	1-5	Contract Admin	Building	Addis Ababa	51-100%
7	41-50	Male	Degree	Consultant	16-20	Owner	Other	Addis Ababa	11-50%
8	31-40	Male	Degree	Consultant	11-15	Site/Office Eng'r	Building	Addis Ababa	11-50%
9	31-40	Male	Degree	Consultant	6-10	Resident Eng'r	Building	Amhara	Above 101%
10	41-50	Male	Degree	Contractor	Above 21	Owner	Other	Amhara	Above 101%
11	41-50	Male	Diploma	Contractor	16-20	Owner	Road & Transport	Amhara	Above 101%
12	31-40	Male	Degree	Client	6-10	Site/Office Eng'r	Road & Transport	Afar	11-50%
13	41-50	Male	Degree	Client	16-20	Project Manager	Other	Afar	51-100%
14	31-40	Male	Degree	Consultant	6-10	Resident Eng'r	Building	Amhara	11-50%
15	31-40	Male	Masters Degree	Consultant	6-10	Project Manager	Water supply & Irrigation	Oromia	11-50%
16	51-60	Male	Degree	Client	Above 21	Project Manager	Water supply & Irrigation	Oromia	51-100%
17	41-50	Female	Diploma	Contractor	11-15	Other	Road & Transport	Oromia	11-50%
18	18-30	Female	Degree	Contractor	6-10	Site/Office Eng'r	Water supply & Irrigation	Oromia	11-50%
19	31-40	Female	Degree	Contractor	11-15	Site/Office Eng'r	Water supply & Irrigation	Dire Dawa	11-50%
20	31-40	Female	Degree	Contractor	6-10	Site/Office Eng'r	Road & Transport	Addis Ababa	0-10%
21	41-50	Male	Degree	Consultant	11-15	Project Manager	Road & Transport	Oromia	0-10%

S/N	Age	Gender	Education Level	Stakeholder are you?	Work Experience (yr)	Current Position	Project Type	Project Location	Average Delay Percentage
22	41-50	Male	Degree	Client	16-20	Site/Office Eng'r	Road & Transport	Oromia	0-10%
23	31-40	Female	Masters Degree	Consultant	11-15	Resident Eng'r	Water supply & Irrigation	Oromia	51-100%
24	18-30	Male	Degree	Client	6-10	Site/Office Eng'r	Other	Dire Dawa	51-100%
25	31-40	Male	Degree	Client	11-15	Site/Office Eng'r	Other	SNNP	11-50%
26	31-40	Male	Masters Degree	Contractor	6-10	Contract Admin	Other	Tigray	11-50%
27	51-60	Male	Degree	Contractor	Above 21	Owner	Other	Tigray	11-50%
28	over 61	Male	Diploma	Contractor	Above 21	Owner	Other	Tigray	0-10%
29	41-50	Male	Masters Degree	Contractor	16-20	Site/Office Eng'r	Other	Oromia	11-50%
30	41-50	Male	Diploma	Consultant	6-10	Site/Office Eng'r	Road & Transport	Oromia	0-10%
31	31-40	Male	Masters Degree	Consultant	6-10	Resident Eng'r	Building	Oromia	11-50%
32	31-40	Male	Degree	Consultant	11-15	Contract Admin	Other	Dire Dawa	51-100%
33	31-40	Male	Degree	Contractor	11-15	Site/Office Eng'r	Water supply & Irrigation	SNNP	51-100%
34	18-30	Male	Masters Degree	Consultant	1-5	Other	Road & Transport	Somilia	0-10%
35	18-30	Male	Degree	Consultant	1-5	Site/Office Eng'r	Other	Harari	0-10%
36	31-40	Male	Masters Degree	Consultant	11-15	Project Manager	Water supply	Harari	0-10%
37	18-30	Male	Masters Degree	Consultant	11-15	Site/Office Eng'r	Water supply & Irrigation	Oromia	11-50%
38	31-40	Male	Masters Degree	Consultant	11-15	Project Manager	Water supply & Irrigation	Oromia	11-50%
39	18-30	Female	Masters Degree	Client	1-5	Site/Office Eng'r	Building	Addis Ababa	0-10%
40	18-30	Female	Masters Degree	Consultant	1-5	Site/Office Eng'r	Building	Addis Ababa	0-10%
41	31-40	Male	Degree	Client	6-10	Site/Office Eng'r	Building	Addis Ababa	51-100%
42	18-30	Male	Masters Degree	Consultant	1-5	Other	Building	Oromia	0-10%
43	18-30	Female	Degree	Contractor	1-5	Site/Office Eng'r	Building	Addis Ababa	11-50%

S/N	Age	Gender	Education Level	Stakeholder are you?	Work Experience (yr)	Current Position	Project Type	Project Location	Average Delay Percentage
44	18-30	Female	Degree	Client	1-5	Site/Office Eng'r	Water supply & Irrigation	Dire Dawa	51-100%
45	31-40	Female	Degree	Client	6-10	Site/Office Eng'r	Road & Transport	Tigray	11-50%
46	31-40	Male	Degree	Client	6-10	Contract Admin	Road & Transport	SNNP	51-100%
47	31-40	Female	Masters Degree	Contractor	6-10	Site/Office Eng'r	Water supply & Irrigation	Amhara	0-10%
48	41-50	Female	Degree	Contractor	11-15	Contract Admin	Water supply & Irrigation	Afar	11-50%
49	51-60	Male	Diploma	Contractor	Above 21	Owner	Other	Gambela	51-100%
50	31-40	Male	Degree	Contractor	16-20	Project Manager	Other	Sidama	51-100%
51	31-40	Male	Masters Degree	Consultant	16-20	Project Manager	Other	Benshangul	51-100%
52	41-50	Male	Degree	Contractor	16-20	Other	Other	Somilia	11-50%
53	18-30	Male	Degree	Contractor	1-5	Site/Office Eng'r	Water supply & Irrigation	Dire Dawa	51-100%
54	41-50	Male	Masters Degree	Client	Above 21	Contract Admin	Building	Afar	51-100%
55	31-40	Female	Degree	Client	16-20	Site/Office Eng'r	Road & Transport	Addis Ababa	11-50%
56	18-30	Female	Degree	Contractor	1-5	Site/Office Eng'r	Water supply & Irrigation	Amhara	11-50%
57	18-30	Female	Degree	Consultant	6-10	Contract Admin	Road & Transport	SNNP	51-100%
58	18-30	Male	Degree	Consultant	1-5	Site/Office Eng'r	Water supply & Irrigation	Afar	0-10%
59	41-50	Male	PhD	Contractor	11-15	Project Manager	Water supply & Irrigation	Somilia	11-50%
60	31-40	Male	Diploma	Contractor	16-20	Site/Office Eng'r	Building	Afar	Above 101%
61	31-40	Female	Degree	Client	11-15	Other	Building	Amhara	0-10%
62	31-40	Male	Degree	Consultant	16-20	Resident Eng'r	Building	Amhara	51-100%
63	18-30	Female	Degree	Contractor	1-5	Site/Office Eng'r	Water supply & Irrigation	Gambela	51-100%
64	18-30	Male	Degree	Contractor	1-5	Contract Admin	Other	SNNP	0-10%

S/N	Age	Gender	Education Level	Stakeholder are you?	Work Experience (yr)	Current Position	Project Type	Project Location	Average Delay Percentage
65	31-40	Male	Diploma	Contractor	6-10	Other	Building	Harari	11-50%
66	31-40	Female	Degree	Consultant	6-10	Contract Admin	Building	Addis Ababa	Above 101%
67	31-40	Female	Degree	Consultant	11-15	Resident Eng'r	Building	SNNP	Above 101%
68	over 61	Male	Diploma	Contractor	Above 21	Owner	Water supply & Irrigation	Gambela	0-10%
69	51-60	Male	Masters Degree	Consultant	Above 21	Resident Eng'r	Road & Transport	Benshangul	11-50%
70	18-30	Female	Degree	Client	1-5	Site/Office Eng'r	Building	Sidama	0-10%
71	41-50	Male	Degree	Client	6-10	Contract Admin	Other	SNNP	0-10%
72	31-40	Male	Diploma	Contractor	11-15	Project Manager	Road & Transport	Afar	11-50%
73	18-30	Female	Degree	Consultant	6-10	Site/Office Eng'r	Building	Harari	51-100%
74	31-40	Female	Vocational Training	Contractor	6-10	Other	Road & Transport	Dire Dawa	11-50%
75	41-50	Male	Degree	Consultant	16-20	Resident Eng'r	Building	Addis Ababa	11-50%
76	31-40	Male	Masters Degree	Consultant	11-15	Contract Admin	Road & Transport	Gambela	0-10%
77	31-40	Male	Degree	Contractor	16-20	Project Manager	Water supply & Irrigation	Harari	11-50%
78	18-30	Female	Degree	Client	6-10	Contract Admin	Building	Dire Dawa	51-100%
79	41-50	Male	Degree	Client	16-20	Contract Admin	Building	Amhara	Above 101%
80	51-60	Male	Degree	Consultant	Above 21	Resident Eng'r	Building	Amhara	Above 101%
81	over 61	Male	Degree	Contractor	Above 21	Owner	Other	Tigray	11-50%
82	41-50	Male	Degree	Contractor	11-15	Project Manager	Other	Afar	Above 101%
83	31-40	Male	Degree	Consultant	6-10	Resident Eng'r	Road & Transport	Oromia	11-50%
84	31-40	Male	Degree	Contractor	11-15	Site/Office Eng'r	Road & Transport	Oromia	Above 101%
85	31-40	Male	Master's Degree	Contractor	6-10	Site/Office Eng'r	Road & Transport	Oromia	Above 101%
86	41-50	Male	Vocational Training	Contractor	11-15	Owner	Water supply & Irrigation	Dire Dawa	0-10%
87	18-30	Female	Diploma	Contractor	1-5	Other	Building	Harari	11-50%

S/N	Age	Gender	Education Level	Stakeholder are you?	Work Experience (yr)	Current Position	Project Type	Project Location	Average Delay Percentage
88	31-40	Male	Degree	Contractor	1-5	Site/Office Eng'r	Building	Dire Dawa	0-10%
89	31-40	Female	Master's Degree	Consultant	6-10	Resident Eng'r	Water supply & Irrigation	Harari	11-50%
90	41-50	Male	Diploma	Contractor	6-10	Other	Water supply & Irrigation	Oromia	0-10%
91	18-30	Male	Masters Degree	Contractor	6-10	Contract Admin	Road & Transport	Amhara	11-50%
92	51-60	Male	Diploma	Client	16-20	Other	Building	Amhara	Above 101%
93	31-40	Male	Degree	Contractor	1-5	Project Manager	Water supply & Irrigation	Oromia	0-10%
94	18-30	Female	Degree	Client	1-5	Site/Office Eng'r	Water supply & Irrigation	Dire Dawa	11-50%
95	18-30	Male	Degree	Consultant	1-5	Site/Office Eng'r	Road & Transport	Addis Ababa	51-100%
96	31-40	Male	Masters Degree	Client	6-10	Project Manager	Building	SNNP	Above 101%
97	41-50	Male	Diploma	Other	11-15	Other	Road & Transport	Harari	Above 101%
98	31-40	Female	Vocational Training	Contractor	11-15	Other	Building	Sidama	51-100%
99	18-30	Male	Vocational Training	Contractor	6-10	Other	Water supply & Irrigation	Sidama	11-50%
100	31-40	Female	Diploma	Contractor	6-10	Other	Road & Transport	Oromia	0-10%
Total	N	100	100	100	100	100	100	100	100	100
	Std. Error of Mean	.098	.04606	.07582	.09000	.12409	.15254	.11251	.31188	.10138
	Kurtosis	.619	-1.240	.775	-1.525	-.821	-.816	-1.363	-.518	-1.002
	Std. Error of Kurtosis	.478	.478	.478	.478	.478	.478	.478	.478	.478
	Std. Deviation	.982	.46057	.75819	.90000	1.24089	1.52541	1.12506	3.11884	1.01384
	Variance	.964	.212	.575	.810	1.540	2.327	1.266	9.727	1.028

a. Limited to first 100 cases.

Table 5.4B: Standardized Direct Effects (SEM output)

	MaterialRelated_MR	ConsultantRelated_CS	ExternalFactor_EX	ContractRelated_CT	LaborRelated_LR	ContractorRelated_CR	ClientRelated_CL	ConstructionDelay_CD
ConstructionDelay_CD	-0.237	0.04	0.787	-0.048	-0.185	-0.338	0.414	
Q41	0	0	0.635	0	0	0	0	0
Q10	0	0	0	0	0	0	0.175	0
Q9	0	0	0	0	0	0	0.045	0
Q8	0	0	0	0	0	0	0.428	0
Q7	0	0	0	0	0	0	0.281	0
Q6	0	0	0	0	0	0	0.411	0
Q5	0	0	0	0	0	0	0.399	0
Q4	0	0	0	0	0	0	0.522	0
Q3	0	0	0	0	0	0	0.236	0
Q2	0	0	0	0	0	0	-0.044	0
Q1	0	0	0	0	0	0	0.047	0
Q32	0.151	0	0	0	0	0	0	0
Q31	0.498	0	0	0	0	0	0	0
Q18	0	0.355	0	0	0	0	0	0
Q17	0	0.297	0	0	0	0	0	0
Q16	0	0.22	0	0	0	0	0	0
Q15	0	0.337	0	0	0	0	0	0
Q14	0	0.402	0	0	0	0	0	0
Q13	0	0.357	0	0	0	0	0	0
Q12	0	0.262	0	0	0	0	0	0
Q11	0	0.557	0	0	0	0	0	0
Q40	0	0	0.271	0	0	0	0	0
Q39	0	0	0.424	0	0	0	0	0
Q38	0	0	0.404	0	0	0	0	0
Q37	0	0	0.436	0	0	0	0	0
Q35	0	0	0	0.345	0	0	0	0
Q36	0	0	0	0.738	0	0	0	0
Q34	0	0	0	0	0.508	0	0	0
Q33	0	0	0	0	0.515	0	0	0
Q19	0	0	0	0	0	0.284	0	0
Q20	0	0	0	0	0	0.379	0	0
Q21	0	0	0	0	0	0.504	0	0
Q22	0	0	0	0	0	0.337	0	0
Q23	0	0	0	0	0	0.34	0	0
Q24	0	0	0	0	0	0.521	0	0
Q25	0	0	0	0	0	0.391	0	0
Q26	0	0	0	0	0	0.601	0	0
Q27	0	0	0	0	0	0.366	0	0
Q28	0	0	0	0	0	0.174	0	0
Q29	0	0	0	0	0	0.382	0	0
Q30	0	0	0	0	0	0.411	0	0

BiT
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Faculty of Mechanical and Industrial Engineering
የሜካኒካልና ኢንዱስትሪያል ምህንድስና ፋኩልቲ

ቁ፲ር/Ref.No: FMIE/614/2012
ቀን/Date: 07/09/2012

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አዲስ አበባ

ጉዳዩ:- ትብብርን ይመለከታል

ከላይ በርዕሱ ለመጥቀስ እንደተሞከረው በባህር ዳር ዩኒቨርሲቲ በቴክኖሎጅ ተቋም የሜካኒካል እና ኢንዱስትሪያል ምህንድስና ፋኩልቲ ውስጥ በ "Industrial Management" የሁለተኛ ዲግሪ ተማሪ የሆኑት አቶ ጌታሁን ቦርጃ የ"MSc Thesis" ማሟያ ምርምር እያደረጉ ይገኛሉ።

በመሆኑም በድርጅታችሁ በኩል ምርምሩን ለማካሄድ የሚያስፈልጉ መረጃዎችን በመስጠት አስፈላጊውን ትብብር ታደርጉላቸው ዘንድ በትህትና እንጠይቃለን።

ከሠላምታ ጋር

ሮቤል ንጉሴ ወርቅአለማሁ
Robel Nigussie Workalemahu
ፋኩልቲ ዲን
Faculty Dean

ግልባጭ//

ለሜካኒካል እና ኢንዱስትሪያል ምህንድስና ፋኩልቲ
ባ/ዳር ቴክኖሎጂ ኢንስቲትዩት