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SCHOOL OF MECHANICAL & INDUSTRIAL ENGINEERING

Identifying Root Causes of Delay and Modeling Metal Industry Projects from Owners' Perspective: A Case of Selected Metal Industry Projects

A thesis submitted to the School of Mechanical and Industrial Engineering Studies of Addis Ababa University in partial fulfillment of the requirement for degree of Master of Science in Industrial Engineering

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Addis Ababa Institute of Technology
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By

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Declaration

I hereby declare that the work which is being presented in this thesis entitled “Identifying Root Causes of Delay and Modeling Metal Industry Projects from Owners’ Perspective: A case of Selected Metal Industry Projects” is original work of my own, has not been presented for a degree of any other university and all the resource of materials used for this thesis have been duly acknowledged.

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This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.

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TABLE OF CONTENTS

List of Tables

List of Figures

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ABSTRACT

Being behind schedule is a familiar case in the manufacturing sector that challenges the overall progress of projects resulting in poor performance and an inability to keep up with the dynamics of the business environment. Project delivery in the metals industry depends not only on its schedule but also on the performance of many stakeholders and the external environment that positively or negatively affects them. In this study, critical causes of delay were identified and feedback loop diagram is used to indicate effect of major causes of delay variable Interaction. Therefore, the study uses a causal loop diagram to show how the major causes of metal industry project delay factor interacts with in and with other system variable. Primary data was collected through questionnaires, group discussion and observations by the researcher. The questionnaires consist of 32 causes of delays which were distributed to project owners, the project managers, and Governmental staff researchers at the Manufacturing Technology and Engineering Industry Research and Development Center. Whereas; the secondary data were obtained from the literature reviewed and reported documents. The study aims at identifying the critical cause of project delay, then further models to understand the effect of factors interaction related to the causes of delay by the System dynamics model. accordingly, the critical factors that were identified in this research are; Effect of Inflation, Inadequate foreign currency, Bureaucracy, Unavailability of an infrastructure facility (interruption of electric power), Inadequate raw material, Difficulty in financing the Project, Existence of corruption, Unacceptable level of change orders by clients, Late material delivery, Unavailability of supply chain management, Inaccuracy submitted bid document and Late procurement of items. These causes are used to model the causal loop diagram. The study contributed to the metals industry projects by determining the critical factors of delay and the effects of system variable interaction on project delay system. and finally, devise mitigation strategies that potentially reduce project delays.

Keywords: Project delay, System dynamics, Root causes of project delay, Metal industry projects

Chapter One

1. INTRODUCTION AND PROBLEM JUSTIFICATION

1.1 Introduction

Projects in the manufacturing industry experience recurring delays during the project cycle, resulting in time and cost overruns, conflicts, and abandonment (Gebrehiwet & Luo, 2017). Many local projects have difficulty repaying the loans granted by commercial banks because the bank's interest rate keeps rising regardless of the delay; after realizing this, owners make decision without making clear and precise considerations. Arantes & Ferreira (2020) stated that delay is caused by idealistic estimates of the duration of activities and unrealistic schedules that lead to delays in the project. Other researchers define delay as an action that prolongs the time needed to complete a task in a given time. It usually manifests in additional work days to complete a task or a delayed start to an activity (G. Sweis et al., 2008). The lagging of work interrupting construction projects can also cause a delay that results in a time overrun. This is either exceeding the contract date or using time beyond the end date of the projects (Lo et al., 2006).

According to Assaf & Al-Hejji (2006) a delay is a time overrun that can exceed the deadline set by the client. The authors further illustrated delay in the perspective of stakeholders; for the owner a delay means loss of revenue due to a lack of production facilities and rental space; for the contractor, a delay means higher overhead costs due to longer work duration, higher material costs due to inflation, and due to increases in labor costs. The dynamic change over time is reflected in the escalation of material costs, the exchange rate, the change in demand for the product, and the evolution of similar products in the marketplace, which pose challenges for both the owner and the contractor. The mental model could not be able to model this, since the mental model of a complex system is often simplistic and unreliable; The project management tool could not explain the dynamic and complex system also (Wang & Yuan, 2017). The different factors that cause project delays are complex and non-linear. The interaction of these factors changes over time, making it difficult to identify delays in advance. Most often, project stakeholders rely on a linear

model. In reality, however, the projects operate in a complex and nonlinear environment. In such a scenario, system dynamics better represent the interrelationship among variables by causal loop and feedback system. Manufacturing industry projects that make raw materials available for construction projects operate in a highly dynamic environment. Due to advancements and a shift in business concepts, the introduction of a new variant has made the existing product outdated within a short period of time (Muhammad et al., 2016).

Technology dynamism and involvement of many stakeholders make the manufacturing industry project complex and non-linear. Particular metals and engineering projects are capital-intensive and highly technology dependent. In today's world, technology changes now and then which urges for dynamics capability. On top of this, the project's implementation involves many stakeholders as well as a multi-factor that urges for dynamic capability. Such a scenario is more easily explained by system dynamics because it demonstrates how different factors influence one another by using feedback loop. Our mental model is not sufficient to analyze feedback, time delays, accumulations, and nonlinearities. But system dynamics shows their interdependence and how they influence prior behavior and future consequences. As a result, this study provides strategies, specifically by utilizing a system dynamics Causal loop diagram to design techniques to alleviate metal industries project delays by identifying the core cause of delay and their interdependence. System dynamic used in this study to explore how the variable impacts or how it is impacted by other variables in complex and dynamic situation; those variables are critical causes determined from chosen industries.

The metal industry project is one of several other industries that contribute significantly to a country's progress. Metal industry projects produce engineering goods, automotive, machinery and equipment, and electrical and electronic items. The value addition of metal and engineering in Ethiopia during the first growth and transformation plan (GTP1) was a 32% annual growth rate on average (Tadesse.,2018) and the manufacturing industry contributed 6.9% of Ethiopian GDP during 2019/2020 (Industry minister 10-year plan, 2022/23). The subsector projects are supposed to be a source of employment, foreign currency exchange, technology, product development,

import substitution, and input for infrastructure construction. Furthermore, being a developing country with limited resources, Ethiopia is also interested in projects to contribute to the technological advancement and development of innovative technology. The Government expects the project to transfer the technology to the next level to make the country competitive in the global market and improve the livelihood of the people in the country by giving more job opportunities and technology transfer to the citizens who have little exposure to industrialization. However, projects struggle with complexities and challenges that lead them to delay. The leading challenges of the manufacturing industry in Ethiopia as reviewed in the industry minister's ten-year plan are; foreign currency shortage, raw materials, political instability, delay of projects, weak linkage among manufacturing industries, inadequate infrastructure, lack of productivity of workers with low work execution abilities and under capacity utilization of the manufacturing industry which only accounts 50% capacity utilization on average. Koshe & Jha (2016) investigated construction projects delays in Ethiopia and discovered that only 8.25 percent of construction projects have been finished as initially indicated in their feasibility studies, which resulted in cost and time overrun. The cause of delay assessed by Gebrehiwet & Luo (2017) found that the construction projects' causes of delay in Ethiopia were: corruption, inflation, inability to monitor the site utility, less quality material, inappropriate designing of the drawing, and design documents, slow delivery of material, late agreement contract and receiving of completed project work, poor site management and performance, late release budget, inadequate project preparation, and scheduling. Due to the mentioned cause and many other reasons, projects in Ethiopia suffer delays. Researchers focused on construction projects for the last many decades. However, it is obvious that every construction project necessitates the use of materials, and these materials are manufactured by industrial projects. A delay in the delivery of specific materials may cause the project to be delayed overall this indicates that construction projects use input from manufacturing industries. For instance, building projects employ manufacturing sector output as inputs (Muhammad et al., 2016). Implementation of manufacturing industry projects consists of the erection of the building, machinery installation, commissioning, and operation process. In addition to this, while erecting manufacturing industry buildings, designers should consider the loading

capacity of the building beams to withstand the vibration of the machines for heavy machinery and maneuver areas for material handling. A study conducted in Pakistan on original equipment manufacturer causes of delay concluded that obsolescence is the most significant factor and the subsequent factors are supply chain, resources management, and project management which are taking a toll on project delay (Muhammad et al., 2016). Studies on factors of delay and cost overruns in the construction of groundwater projects in developing countries showed the major factors of delay and cost overruns in construction of groundwater projects included: monthly payment difficulties from agencies; poor contractor management; material procurement; poor technical performances; and escalation of material price (Frimpong et al., 2003). In order to deficit metal manufacturing industry project delay this study identifies the root cause of delay in metals industry projects and uses system dynamics to comprehend the complex essence of the variable. Because system dynamics reveal how the factors are related, how they impact one another, and how decision-making policies and their linkages influence previous behavior and future results.

1.2 Problem Statement

Metal industry projects primarily produce products such as electronics and electrical products, engineering products, equipment and machineries, and automotive. The metal industries engaged in manufacturing metal products are capital-intensive and dynamic by their nature, and the dynamism expose them to delay frequently. As the result, those projects experience a delay that negatively affects their performance throughout their project life cycle. But, regardless of the type of Project, project delays are a worldwide problem (Arantes & Ferreira, 2020). According to Koshe & Jha (2016) only 8.25% projects have completed the project as compared to the original targeted completion dates in Ethiopia while the remaining experienced delays. This mostly has an impact on their budget and schedule performance, which deters investors and potential investors. As indicated in table 1, metal industry project is not exceptional for delay. Manufacturing Technology and Engineering Industry Research and Development Center catagorized the delays. Accordingly the Manufacturing Technology and Engineering Industry Research and Development Center organanized datas indicated in Table 1 that is from the report and feasibility study of the projectcts.

Table 1: Delayed project by category

Projects by Category	**>3 years delay (%)**	**Between 1 and 3years delay (%)(1<=x<=3)**
Machinery and spare part	80	18
Automotive	33	59
Electrical and electronics	22	40
Fabrication	30	45

Source: Project and engineering service desk report 2022

Because of the aforementioned problem, the researcher collects data from project owners, project managers, and Governmental staff researchers using primary and secondary data by a mixed research approach in which both qualitative and quantitative research methods. this study focused on identifying the causes and modeling them using the system dynamics model. The system dynamics is used to show the impact of the interaction of the main causes of delays on the project duration. The main causes of delays whose interaction affects project progress in the metals industry have been identified. The model helps build causal loops and shows how they interact and are affected by system variables. Much research has been done on the causes and consequences of delays in construction projects. However, very few studies model their influence on each other through the perspective of system dynamics. Therefore, in this study, the researcher identified, analyzed, and systematically modeled delays to end or mitigate the problem. Much research has identified the causes and consequences of delays, but how one variable affects another remains a future study (Zidane & Andersen, 2018). As the result of the mentioned problem, this study focuses on the identification of root causes and modeling the causes using the system dynamics model. System dynamics is used to indicate the effect of major causes of delay interaction on project delay. There are major identified causes of delay that their interaction affects the metal industry project progress. The model helped to build a causal loop, showing how they influence each other and are influenced by system variables.

1.3 Research Questions

a. What are the root causes of delay in metals industry projects and how do they impact one another?
b. Why do delays exist with the current advanced technology and skilled human power in metal industry projects?
c. How does the interaction of major causes of delay with in and with project system component affect the delay of metal industry projects?
d. What is the strategic and technical approach to minimize delays in metal industry projects?

1.4 Objective of the Study

1.4.1 General Objective

This study investigates the root causes of delay and models the impact of factors' interaction over metals industry projects delay based on the system dynamics.

1.4.2 Specific Objectives

The study has the following specific objectives

- To identify the root causes of project delay in metal industry projects
- To develop a Causal loop diagram for major causes of project delay
- To make analysis considering the interaction between system components including causal factors of Metal industry projects delay
- To devise strategic and conceptual frame work model to minimize delays in metal industry projects

1.5 Scope of the study

This study mainly emphasizes determining and inspecting the root causes and impacts of the root causes of delays on metals industry projects. It only includes metal and engineering sector projects supported by the Manufacturing Technology and Engineering Industry Research Development Center. Particularly, implemented in Addis Ababa and its catchment areas. The study consists of projects in Manufacturing Technology and Engineering Industry Research and Development Center. Therefore, the researcher selects a sample from the project that involved in implementation process under the support of Manufacturing Technology and Engineering Industry Research and Development Center.

1.6 Limitation of the study

While conducting this research, there were two major pitfalls related to coverage and access to information, which are taken as limitations of the studies; these barriers are discussed in this section so that the research results are viewed and interpreted from the perspective of the limitation.

The first limitation faced during the study was that few manufacturing companies' respondents involved in the research were not convinced to act on a timely basis and were reluctant to cooperate in the data collection process. This is because they were working hard and did not understand the benefits of scientific studies since scientific knowledge helps you to work smart. Therefore, the researcher was forced to rely only on those who were cooperative to give the required data and information. The other limitation related to coverage is that the researcher's focus is on projects supported by the Manufacturing Technology and Engineering Industry Research and Development Center and did not include the other sector metals industry projects. However, the finding of this study minimizes the occurrence of delays in other sectors of metal industry projects.

1.7 Significance of the study

The study intends to contribute to metal industry projects by identifying the causes of delay and introducing a mitigation strategy so that the project actors and governmental organizations better understand the causes and consequences of project delays. The findings of the study enable metal industry project stakeholders to get a clear understanding of the underlying cause of delay and make adjustments accordingly. The analysis presented in this study helps the industry enhance systems and procedures based on the results of the findings. Likewise, the Manufacturing Technology and Engineering Industry Research and Development Center and other governmental organizations can use this study to adjust their strategy toward improving the metal industry project's delay. Furthermore, the study may serve as a valuable source for upcoming researchers interested in exploring Project delays.

1.8 Organization of the paper

This thesis paper is structured into Five chapters. The first chapter includes, background, issue description, aims, research questions, significance of the study, scope of the study, and limitations of the study. The second chapter is a literature review discussing the review of previous research on the causes, and effects of delay around the world and in Africa. On top of this, it also discusses system dynamics and its components, and factors in detail. The research identifies existing gaps and discusses how to fill these gaps. The third chapter is the research methodology. This chapter explains the methodology used. It comprises the details of the method used in data collection and analysis. The method chosen for data collection is also shown here. Additionally, this chapter presents the data analysis techniques. Chapter four is data analysis and research findings. The chapter presents an analysis of gathered data presents data with tabulated results. The interpretation of the results is also discussed with additional qualitative and quantitative models developed. The final chapter concludes the results of the research and highlights a few suggestions.

Chapter Two

2. LITERATURE REVIEW

2.1. **Introduction**

This literature review addresses delays in different manufacturing and construction projects in Ethiopia as well as some projects around the world. Mainly it focuses on different studies and article papers done on the area of delays, their causes, and effects on the projects.

The completion of a project on schedule is an indicator of efficiency, but project activities involve many unpredictable factors and variables that arise from a variety of sources (Assaf & Al-Hejji, 2006) which result in failure to finish on time, within budget, and according to specifications. Delay was described by researchers as an act or event that increases the time necessary to complete responsibilities under a contract, which manifests as extra days of labor or a delayed commencement of activity (G. Sweis et al., 2008). Delays can have undesirable effects on project stakeholders. To the client, a delay can be perceived as implying a loss of revenue due to a lack of rentable space or lack of production facilities. To the contractor, delay can mean higher overhead costs higher material costs, and higher labor costs. To the owner, delay results in losses by missing out on the potential revenues from the use of the project and by increased overhead costs for contract administration and supervision (Al-Khalil & Al-Ghafly, 1999)

Assaf and Al-Hejji(2006) explained the delay as a time overrun that extends ahead of the date agreed upon by the parties to deliver a project or beyond the scheduled time of completion within a contract. Delays also can occur in the lagging of work without halting project work entirely which can lead to time overrun either beyond the contract date or ahead of the date that the parties have settled upon for the handover of the project (Lo et al., 2006)

According to Durdyev & Hosseini (2020), a delay occurs due to unpredicted events that are ahead of the contractor's control and considered compensable or excusable and non-excusable which is within the control of the contractor. On the other hand, internal delay arises from project stakeholders whereas external delay emanates from the third parties involved in the project delivery process. According to Jongo et al., (2019) there are four categories of delay, namely:

- Excusable delay and non-excusable delay
- Concurrent delay and non-concurrent delay
- Excusable delay and non-compensable
- Critical and non-critical delay

An excusable delay is defined as a delay caused by unforeseeable events over the contractor's control other hand, in an Excusable non-compensable delay the contractor gets additional time but not money. On the contrary; for the non-excusable delay, the contractor does not get additional time and money but in the concurrent delay the contractor may or may not get either time or money. The other category is critical and non-critical delays. Critical delays are delay claims that affect progress time and compensation. Non-critical delays have no impact on the project completion date. In the study by Jongo et al., (2019), it was found that project stakeholders do not use project management tools that would be useful for proper resource allocation. Although project management has been researched for many years, projects have either failed or have cost or schedule overruns. These overruns are a critical problem in the delivery of projects because they represent a loss of money for contractors and owners.

In summary, a delay is the late completion of an activity or the completion of a project beyond the contractually scheduled time. The delay has serious consequences for the project owner, the project contractor, and the project consultant. Therefore, project time management is critical to project success and the success of the various project stakeholders involved, as it guarantees the completion of activities and projects within the originally planned time. The consequences of delays among project stakeholders have been described in the article "Risks Leading to Cost Overrun in Building Construction from Consultants' Perspective" Mahamid, (2013) as negatively impacting project stakeholders in the form of growing adversarial relationships, distrust, litigation, arbitration, cash flow problems, and a general sense of trepidation among themselves. Finally, delay can be seen as an unrecognized and unacknowledged problem that manifests itself in the form of time and cost overruns that damage the project.

2.2.Causes of project delay

According to Gebrehiwet & Luo (2017), the greatest level of delay in Ethiopian construction unlike other country project delay is corruption. Through their research, they were able to identify the fundamental factors that contributed to the Ethiopian construction project's delay, including inflation, poor site management and performance, late budget release, ineffective project preparation and scheduling, low-quality material, late design and design documents, slow material delivery, delayed contract agreement and receipt of completed work. In particular, this research suggests that time and cost overruns are the two main consequences of delays in Ethiopian building projects. The 10 main significant reasons for Ethiopia's building delays were determined by Koshe & Jha (2016). Financial difficulties experienced by the contractor, rising material costs, inefficient project planning and scheduling, delayed payment for finished work, a shortage of qualified professionals within the contractor organization, erratic labor availability, and delayed material delivery low labor productivity, underqualified or insufficiently experienced workers, and inadequate survey and data gathering. The development of mitigating mechanisms or minimizing techniques is greatly aided by an understanding of those reasons of delay. The ten most common causes of construction project delays were identified by Durdyev & Hosseini (2020) after conducting a literature review of 97 chosen studies. These included weather/climate conditions, poor communication, a lack of coordination and conflicts between stakeholders, ineffective or improper planning, material shortages, financial issues, payment delays, a shortage of equipment/plant, a lack of experience, qualification, or competence among project stakeholders, labor shortages, and poor site management. Another study in India through the use of factor The most important variables, according to the analysis, were: poor site coordination, inadequate planning, ineffective commitment, unclear project scope, inadequate contract, and bad communication. (Doloi et al., 2012).

Other scientific articles published on construction project delay in Norway figured out the top ten causes of delay which are: inadequate planning and scheduling, sluggish decision-making and design modifications, internal administrative processes and bureaucracy in the project

management framework, insufficient human force, and equipment resources, inadequate coordination and communication among stakeholders, sluggish quality inspection of finished work, design modifications during construction/change orders, Absence of dedication, incorrect design, tardiness, incompletion, and office problems (Zidane & Andersen, 2018).

Most metal and engineering projects in our country suffer from delays. The influence of these delays has a significant impact on project efficiency that undermines the efforts of manufacturers involved in these activities and their potential investments in this subsector. The cause of delay identified by different researcher is summarized in figure1

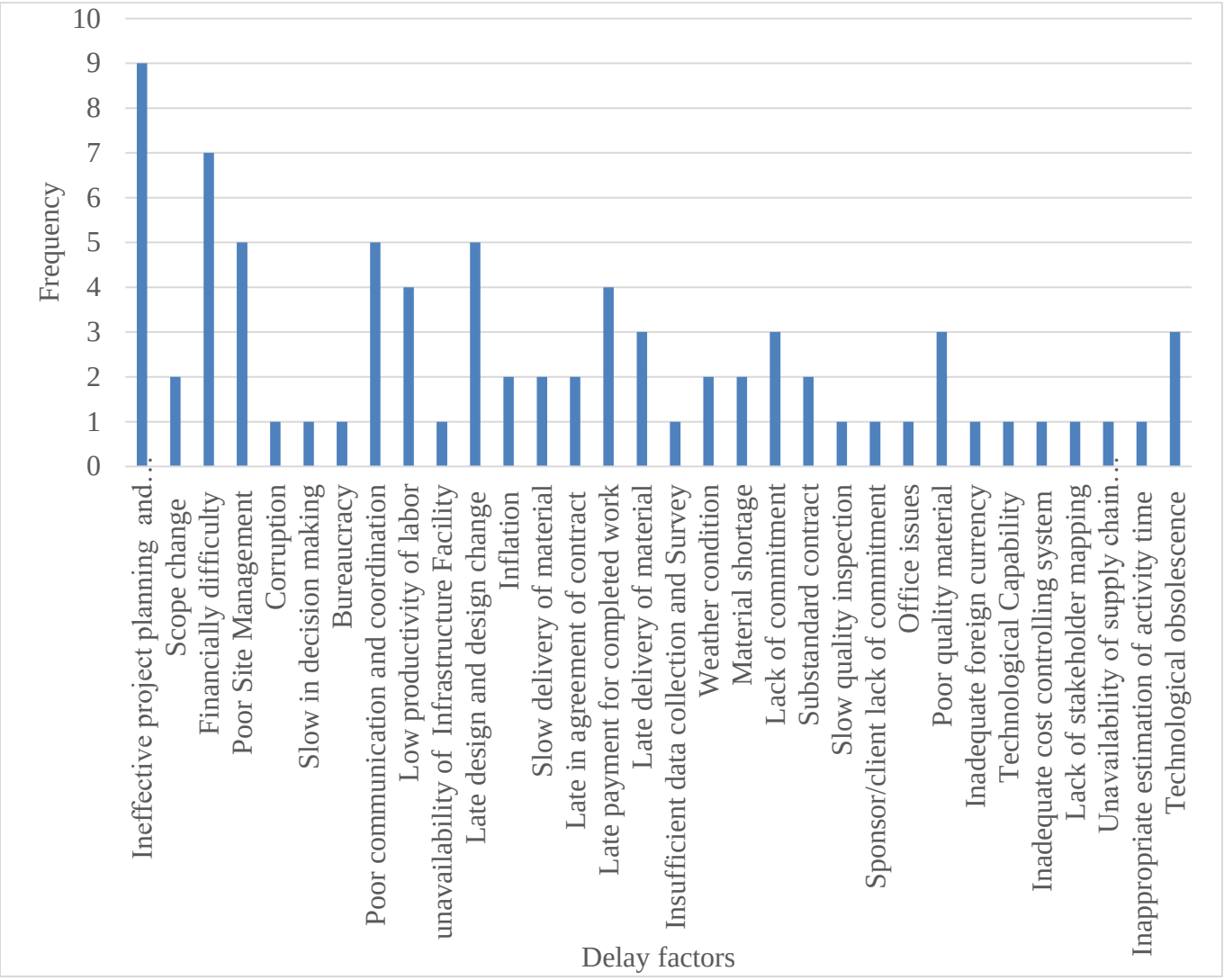


Figure 1: Causes of delay identified by different researchers

2.3.Effect of project delay

According to Abebe & Germew (2021), Industrial projects are very important for developing countries like Ethiopia in that it ensures continual growth. They argued that it is undeniable the behind schedule completion or termination of projects affect social wellbeing in different situations. Because, delay in completion time of project negatively affect the opportunity people could get. It has been seen as the world wide challenge that affects time delivery, budget, and quality of the projects (Adeboye et al., 2021). A study by Kikwasi (2013) indicates five highly ranked effects as time overrun, cost overrun, negative social impact, idling resources and disputes. Other findings in Malaysian construction project further explained the most common possible effects arising in most projects were: time overrun, cost overrun, disputes, arbitration, litigation, and total abandonment (Sambasivan & Soon, 2007). This possibly occurred due to the fact that factors causing project delay are intricate and complex. So, addressing those causes systematically alleviates the effect of project delay

2.4. Worldwide project delay causes

Comprehensive literature research on the crucial universal delay variables was conducted by Zidane & Andersen (2018) using 103 previously published studies covering 46 different nations. Out of the 33 most frequently mentioned delay issues in building projects, they identified the critical universal delay factors in their survey. It includes modifications to the design made during construction or change orders, delays in contractor payments, inadequate planning and scheduling, incompetent site management and oversight, inadequate contractor experience and building techniques, financial difficulties faced by the contractor, lack of sponsor, lack of resources (manpower, machinery, equipment), low labor productivity, and a lack of skilled labor. Using factor analysis, additional research conducted in India determined that the following were the most important variables: inadequate contract, bad communication, inadequate planning, ineffective site management, lack of commitment, unclear project scope, and poor site coordination (Doloi et al., 2012). According to their frequency of occurrence and severity in the overall context, other studies found that the following are the main causes of building project delays in Malaysian construction

projects: inadequate planning and scheduling; an excessive number of change orders from clients; inept site management and supervision; inept subcontractors; and financial difficulties of the contractor (Yap et al., 2021). According to a study conducted in Saudi Arabia, just 30% of construction projects were finished as planned, with the remaining 70% experiencing time overruns over their project life cycle. As a result, the cost overrun was between 10% and 30%, leaving the government with a serious financial burden (Assaf & Al-Hejji, 2006). In Tanzania, construction project study done by Kikwasi(2013) determined that there are still a variety of factors that might cause delays and interruptions, and that these factors put construction projects at risk and affect how well they work. These include modifications to the design, hold-ups in contractor payments, information delays, finance concerns, subpar project management, pay discrepancies, and disagreements regarding the estimated value of completed work. Delays have the following effects: disagreements, idling resources, bad social impact, time and expense overruns. Study conducted by Samarah & Bekr (2016) found that the ten top major causes of delays in construction projects in Jordan were inadequate management and supervision by the contractor, client's changes of the design, inadequate planning and control by the contractor, using lowest bid that lead to low performance, changes in the extent of the project, errors in design and contract documents, progress payments are not made in time by the client, rework due to mistakes during construction, changes in the original design and low level productivity. The top five causes of delay in industrial projects in Saudi Arabia are:- difficulty in financing projects, late procurement of materials, late delivery of materials, delay in progress payments, and delay in progress payments (Abdellatif & Alshibani, 2019). Studies were done by Sweis, Moarefi, Hoseini-Amiri, et al., (2019) on factors that are responsible for delays in the schedule of strategic industrial projects in Iran and found Sanctions, Cash flow, equipment availability and failure, project manager competence, material procurement, and unqualified workforce. According to (Mbala et al., 2019), Poor site management, a lack of skilled labor, an unrealistic project schedule, worker absenteeism, design changes or rework brought on by construction errors, accidents caused by inadequate site safety, delays from subcontractors, a lack of materials on site, delayed delivery of construction materials, and the impact of inclement weather on construction activities are the top factors that cause delays. The ten most common causes of construction project delays were identified by Durdyev & Hosseini

(2020) after conducting a literature review of 97 chosen studies. They included weather/climate conditions, poor communication, a lack of coordination and conflicts between stakeholders, ineffective or improper planning, material shortages, financial issues, payment delays, a shortage of (equipment/plant, a lack of experience, qualification, or competence among project stakeholders), labor shortages, and poor site management. As a case study, Kumar & Ashok, (2015) looked into the factors and techniques of alleviation of steel plant delays in Asia. They found that the main causes were delays in site selection, scope changes, delay in arrange work process, delays caused by engineers, delays in the construction of pre-engineered buildings (PEB), and delay in utility decision-making. In Ethiopia, the prevalent consequences of project delay were identified as; using resource more than the amount budgeted, lag behind the schedule, not executing the project that sometimes led to legal cases. In the same study, construction projects experienced 70% cost overrun and in average time over run 10% to 30% from the original duration that cause 50% of cost over runs as a result of which a significant adverse effect on projects and its stakeholder occurred (Gebrehiwet & Luo, 2017). Similarly, study done by Koshe & Jha (2016) confirmed that in Ethiopia only 8.25% projects have completed as compared to the original targeted completion dates while the rest were delayed. In summary, the main areas of the researchers are; competence related to skill, schedule management relate to late delivery, attitude of responsible body related to coordination and communication, management skill related (supplier, material, site, labor), decision related (slow/clarity in scope of the projects), commitment and financially difficulties. Finally, globally both developed and developing countries face delays differently according to their context. It varies based on socio-economic status, political situation, environmental context, cultural differences, geographic setting, parties involved, laws and regulations, and financial climate, working culture, access to resources, political situation, and perspective of the researcher (Zidane & Andersen, 2018). According to Akogbe et al (2013), factors such as national income and the growth of GDP growth have a significant influence on project delay; comparisons between developing countries and developed countries show that financial difficulties are the common factors of delay. Other causes of delay in poor nations are quite similar and are connected to a lack of technology, managerial skills, and project participants'

competencies. Therefore, the delay occurred due to many factors interacting which affects project schedule performance in a complex way.

Ramanathan et al., (2002) reviewed 41 studies around the world to indicate who is responsible for time delay and cost overrun in projects and concluded that owner (ranked 1), contractor (ranked2), design-related plant and equipment (ranked 3), labor (ranked 4), consultant and contractual relationship (rank 5). Consequently, the highest rank is owner and contractor for project time delay and cost overrun. A study conducted by Banobi & Jung, (2019) on the gap between owner and contractor in successful and unsuccessful projects, classified factors attributed to different responsible bodies as owner related cause of delay, contractor related cause of delay, design related cause of delay, infrastructure and socially related causes of delay which are indicated in table 2

Table 2: Causes of delay related to project actors

Causes S.N	Owner related cause of delay	Contractor related cause of delay	Design related cause of delay	Infrastructure and socially related causes of delay	External related causes of delay
1	Scope change	Poor-quality construction materials and equipment	Design changes during construction	Worker absenteeism	Force majeure related to natural disasters
2	Poor owner supervision	Poor cost control	Inappropriate data collection	Low motivation and morale	Unexpected geological conditions
3	Poor communication and coordination	Poor project planning and scheduling	Errors and delays in providing design documents		Political instability or control
4	Approval delay	Poor contractor's supervision	A failure in planning and designing risk	Strike	
5	Delay in procuring items	Additional work due to construction defects	Poor resource estimation and allocation	Poor working condition	
6	Determining minimum bids	Pre-bid misrepresentation		Unskilled or inexperienced workers	
7	Inadequate allocation of funds or budgets	Inadequate cost estimation		Delayed delivery of materials and equipment	
8	Equipment damage during construction	Late payment for suppliers or contract's work		Delays in obtaining regulatory approval	
9		Late procurement		Conflicts and vandalism with neighbors	
10		Late orders for material and equipment			
11		Change in type and specification			

Source: (Banobi & Jung, 2019)

2.5.Project delay in Africa

Many projects were implemented in developing countries by foreign contractors and those projects were completed beyond schedule. The delay has various reasons; the lack of management, technology, skills, experience and competencies of the construction firms (contractor, owner, consultant and architect) most of the projects were finished out delay. Nonetheless, when completed on time within budget, and of acceptable quality, it is a sign of well completed job (Akogbe et al., 2013). According to Sambasivan & Soon, (2007). The following factors were the main contributors to the delays in the Malaysian project: the contractor's poor site management, poor planning, insufficient experience, inadequate client financing and payments for finished work, issues with subcontractors, shortages of (labor, materials, and equipment), equipment failure, poor communication between parties, and errors made during the construction stage. After researching the causes of construction delays in Egypt, Elhusseiny et al. (2020) determined who was in charge of each delay, as shown in Table 3

Table 3: Responsible bodies for each delay causes

No	Causes	Responsibly body for causes of delay
1	Slow decision making	Owner
2	Variation orders/change of scope during construction	Owner
3	Delay in payments by owner	Owner
4	Difficulty coordination between party	Consultant
5	Poor site management and supervision	Contractor
6	Delay in reviewing and approving the design documents by the owner	Consultant
7	Financial difficulty	Contractor
8	Inappropriate planning and scheduling	Contractor
9	Unavailability / slow delivery of construction materials and equipment	Contractor
10	Lack of productivity of labors	Contractor

11	Contractor Delay related to shop drawings and material samples	Contractor
12	Force majeure by man-made problem	None
13	Unexpected subsurface conditions	Consultant
14	Errors / clashes in project documents	Consultant
15	Delays in sub-contractors' work	Contractor

Source: Elhusseiny et al.,(2020)

In the Malaysian construction project, Sambasivan & Soon, (2007) identified causes of project delay; the most important causes were: contractor's improper planning, contractor poor site management, inadequate contractor experience, inadequate client finance and payments for completed work, problems with subcontractors, shortage in material, labor supply, equipment availability, and failure, lack of communication between parties, and mistakes during the construction stage, in Malaysian also other researcher identified the five leading causes as lack of proper planning and scheduling, too many change orders by clients, lack of competent site management and supervision, lack of competent subcontractors and financial problems of contract (Yap et al., 2021). In Somaliland, one study identified Contractor-related delays are the most significant category that causes construction delays, followed by owner-related delays, consultant-related delays, and material-related delays as the second most significant groups, respectively. The least significant categories are labor-related delays, equipment-related delays, and external factor-related delays, respectively (Adeboye et al., 2021). In Kenya study done by Maurice Paul Okeyo et al., (2015) on infrastructure projects stated that effective project managers should be aware that without financial flow, delays, abandonment, and the ensuing waste of resources are unavoidable in infrastructure projects.

In Ethiopia, the prevalent consequences of project delay were identified as; using resources more than the amount budgeted, lagging behind the schedule, and not executing the project which sometimes led to legal cases. In the same study, construction projects experienced 70% cost overrun and an average time overrun of 10% to 30% from the original span of time that cause 50%

of the cost overruns as a result of which a significant negative effect on projects and their stakeholder occurred (Gebrehiwet & Luo, 2017). Similarly, a study done by Koshe & Jha (2016) confirmed that in Ethiopia only 8.25% of projects have completed as compared to the originally targeted completion dates while the rest were delayed.

In summary, main areas of the researchers are; competence related to skill, schedule management relate to late delivery, an attitude of the responsible body related to coordination and communication, management skill related (supplier, material, site, labor) decision-related (slow/clarity in the scope of the projects), commitment and financial difficulties.

2.6. Root causes of project delay

In the Literature reviewed by (Yap et al., 2021) the root cause mentioned are: Lack of appropriate planning and scheduling, too many change orders by clients, incompetent site management and supervision, incompetent subcontractors, and financial problems of the contractor (according to their frequency of occurrence and severity in the overall context). Investigating significant industrial project delay factors Abebe & Germew, (2021) found electric power shortage and finance approval progress as root causes of delay of industrial projects.

Other conducted by (Doloi et al., 2012) in India found the root cause as: inefficient site management, lack of commitment, improper planning, poor site coordination, lack of clarity in project scope; substandard contract and lack of communication. On the other hand, the effects by Kikwasi(2013) in the literature reviewed are: time overrun(delay),cost overrun, negative reputation, idling resource and disputes. accordingly, this research identifies the root causes of metal industry project delay and minimize their negative out come by modeling delay in the system dynamics perspective. according to Sweis et al (2019)

- ✓ Market Turbulence
- ✓ Contractor's capabilities (Financial and Operational)
- ✓ Skilled workforce

- ✓ The political situation and the foreign affairs playing very important role

The lack of technical staff to properly estimate the cost and duration of the project, and the handover of the project to an incompetent contractor put the "unrealistic project duration" in second place; this is often the case with many similar projects. However, research has found that many projects lack a proper perspective on project activities and tasks, lack technical staff to properly estimate project costs and times, and fail to deliver. Many projects admit that their lack of perspective in estimating activity durations and inability to allocate costs to project tasks is due to a lack of technical staff let alone not using the system dynamics approach for a moment. It is reported that project managers do not use project management tools during project execution, which makes them suffer from risk factors.

2.7. System dynamics

According to a basic principle in system dynamic, the structure of the system gives rise to the behavior. Unexpected events and uncertainty often initiate a series of dynamics that can create substantial cost and schedule overruns. System dynamics represent the situation by mimicking the real world, which helps project actors to consider the problem ahead of time (Lyneis et al., 2001). Many researches have been done on the factors and consequences of construction project delays focuses on identifying these causes and consequences rather than going further into the interdependence of these elements. Interpretative character of knowledge and the existence of connections between system components that tie in with systemic approach makes it complex.
Causal dependence in the system variable creates complexity and non-linearity in the system to address such kind of problem Jay Forester in 1950 introduced system dynamics that consists of four variables.

There are four variables in developing and running system dynamics model according to Wang & Yuan (2017) the four are:-

1. Level variable, which describes the current state or condition of the system.

2. Rate variable, which represents dynamic changes in the system over a specific period; rate variables serve as inputs and outputs of the level variables.
3. Auxiliary variable, which is computed from other variables at a given time; auxiliaries are typically the most. Numerous variable types, and an auxiliary variable has an expression involving other variables in its equation.
4. Constant, whose value does not change over time. Constants have numbers on the right side of their equations. A constant can be temporarily changed prior to simulating a model.

The causal link in the system dynamics is represented in either a negative or positive sign in the arrowhead as a plus or minus sign. The positive sign indicates that the variables tend to show a direct relationship. Whereas; the negative indicates that the variable shows indirect relationships. That means, if the cause increases the consequence decreases Vice versa, there are two feedback systems positive and negative feedback system. The positive one generates growth and amplification effects. On the other hand, the negative one is equilibrium seeking.

In conclusion system dynamics better address the underlying problem and indicate how the management desirably sustains the system by taking into consideration the non-linearity and complexity of the system and implementing different policy issues. This study investigates the critical causes of delay and uses them to build causal loop diagram in order to understand the causes and effects of the variable qualitatively. The interrelation indicates that the initial attempt to balance the problem with time delay further worsens the problem by reinforcing what has been happening in the manufacturing industry projects which clearly shows management should understand how the interaction influences the progress of the project as a whole not separate component in the system. The feedback loop in this study indicated as reinforcing and balancing which is the effort and the consequences. System thinking and system model support the inability of the mind to capture the whole scenario of the given situation since in reality there exists uncertainty and complexity in the current time and in the future which the mind model alone could not comprehend. In this study, the causes of metals industry delay interaction were indicated by VENSIM software since it clearly shows interrelation among system variables by using a plus and

a minus and by a diagrammatic representation of the relation, so that the project implementer understands the nonlinearity of causes and effect of system variable interaction effect on project delay. Interpretative character of knowledge and the existence of connections between system components that tie in with system.

2.7.1 Comparison between different tools and system dynamics

when we compare the system dynamics with the tools of project management system. System Dynamics represents the cause-and-effect feedback loop by diagramming the relationships between factors or system variables. It is a dynamic and nonlinear increase from a system with positive and negative feedback. The negative loop is self-correcting or balancing. The positive loop, on the other hand, amplifies and perturbs the system. The interaction of system variables affects other variables. However, the traditional project models Critical Path Method and Program Evaluation and Review Technique (CPM and PERT) describe the process, resources, goal, and scope in a static way with estimated activity durations and precedence relationships that cannot indicate changes over time and dynamics (Ford & Sterman,1998). In CPM and PERT first work break down is done, logical dependence (successor, precedence relationship, concurrent), activity network diagram, then final estimation of resources for each activity. In this model, iteration and cycle time is not considered and also the change over time. The main goal of system dynamics is to improve systems thinking in a complex environment that is difficult to capture with the mental model because system variables change over time and one variable affects another. Hence, this character is not easily traced by managerial experience and mental model. To depict this, the system dynamic takes into consideration the complexity of the system and changes that occur in the future. As the result, project stakeholders can see their effect by changing the variables. Explicit modeling and integration of the effects of processes, resources, scope, and target on performance are also necessary for a comprehensive causal dynamic model. It has the following elements: -

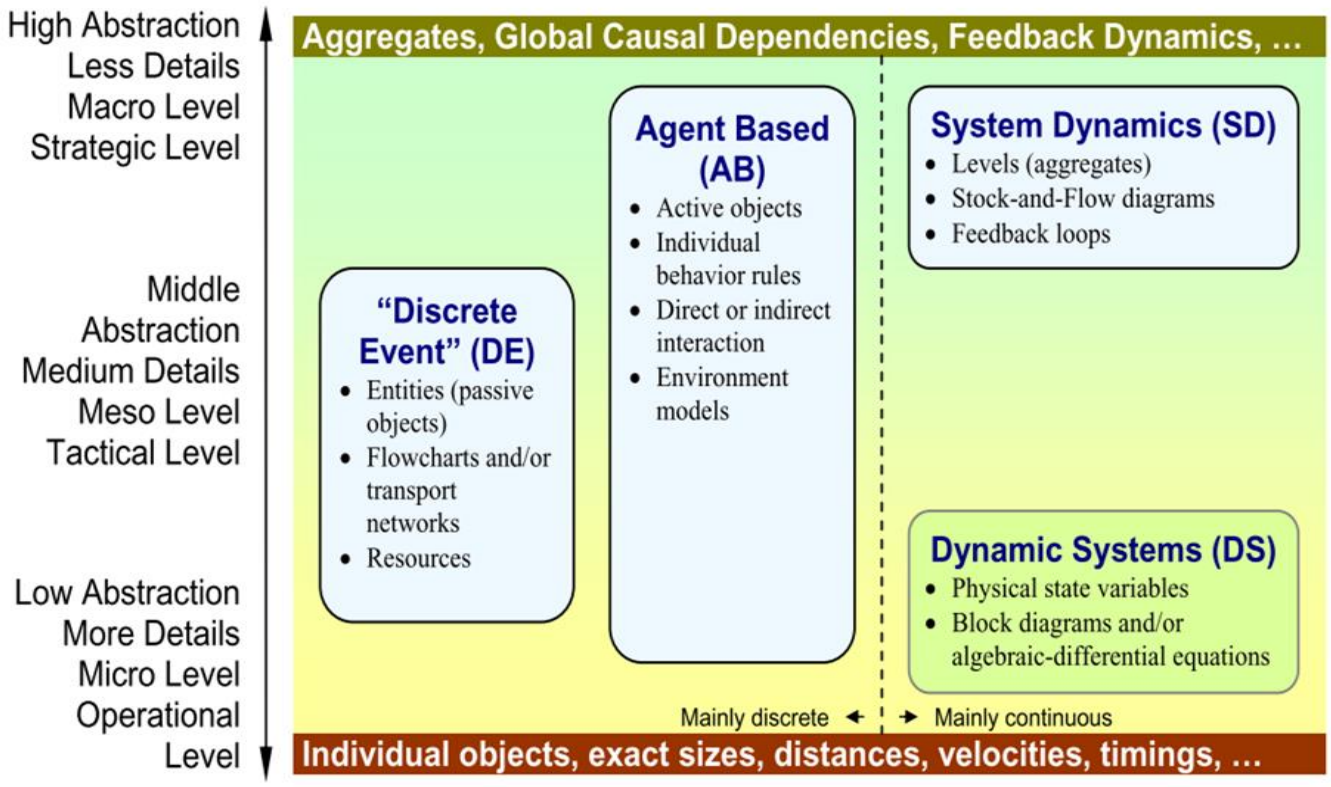
Stock: Quantities of things or materials that exist or it is a state of a system. It accumulates something

Flow/flow rate: which causes the stock increase or decrease in that the value of stocks can be modeled considering the rates of inflows and outflows.

Causal loop diagram: feedback system that represents an interaction of the variable**.** Causal relationship generates system behavior and those behavior should be investigated to understand how process derive performance**.** For example, the causal

loop diagram can be represented diagrammatically by VENSIM. VENSIM is a software that is used in system dynamics that helps to develop Causal loop diagram. Considering the interactions between system components, the model predicts the future outcomes of a system. it provides a clear view of the project behavior in a dynamic environment. Since the system is dynamic, it does not consider separate elements for the specific problem. A holistic approach shows how one variable influence or is influenced by other variables.

Studies have shown that system dynamics has been used to comprehend and enhance the behavior of complicated projects (Lyneis et al., 2001).These researchers evaluated the interaction of the variable to consider the system behavior and this indicates that it is possible to apply system dynamics in a different context as many researchers admitted that factor and variable that affects the project varies depending on national income and the growth of GDP growth (Economic level), politically situation, technological capability and project management skill of the project stakeholders (Zidane & Andersen, 2018) on the other hand, The dynamic system considers the agent-based model considers the Stock as a moving ball when entities or objects in state; A transition to state B (inventory A + inventory B). The agent-based model also accounts for the behavior of individual variables by allowing a separate variable that later acts locally and contributes to more complex and aggregate behaviors. Although the agent-based model is a tool for solving a real-world problem, as stated by Borshchev & Filippov (2004), it is not a substitute for the System dynamics model and the Discrete event model. Both have their own specific applications. System dynamics first models the relationships between individual variables and then perceives the overall perspective, i.e., the events and entities that arise in the system and are represented as a cause-effect diagram that affects the stock variable.



Source: Borshchev & Filippov (2004)

Comparison of Discrete Event (DE), Agent Based System (AB), Dynamics and Dynamic System (DS). System dynamics is appropriate in this study to represent causes and effect of the variables. Since it has capacity to capture the interrelation of system component qualitatively in feedback loop systems.

2.8. Literature gap

Most of the researchers determined the factors and effects of delay, very few developed the mitigation measure and their interaction with each other in construction projects. But many other researchers did not indicate the relationship among the factors and how they influence one another. For more than the last two-decade, Extensive researches conducted on the cause of delay in construction projects. However, the researcher looks over the causes of delay in the manufacturing industry. The manufacturing industry is highly technology intensive that highly affected by technological dynamic high engineering precision work. The technology is sometimes large in quantity and sophisticated. According to the literature studied, few researchers focused on the effect of factor interactions, whereas the majority of their studies focused on determining the reasons for construction project delays and some included mitigation strategies. Most of the causes of delays that were examined focused on construction projects. Particularly, researches that have been done in Ethiopia focuses on Causes of delay in construction projects but not in manufacturing industries. As project affecting factor varies based on socioeconomic status, political situation, environmental context, cultural differences, geographical context, entities involved, public policies, economic environment, working culture, access to resources, and perspective of the researchers. It is worth investigating the cause of projects delay in metal industry projects in Ethiopia. Research Conducted in Ethiopia on the cause of delay by Gebrehiwet & Luo (2017) and Koshe & Jha (2016) identified the cause of delay & its effect on a construction project in Ethiopia. But they did not formulate Mitigation as well as how those variables affect each other over time was not indicated.

2.9. Dependent and independent variable of delay causes

The independent variable is delaying contributing variables of metals industry projects. But the dependent variable will be the direct or indirect effect of the independent variables. From the literature reviewed the causes are related to Finance and resource, project competency, Managerial skill, planning and scheduling, factor related to material, Governmental counterpart. Factor related to technology and machinery; factor related to labor productivity. On the other hand,

In this conceptual frame work figure 2 the mediating variable are the variables that show the independent variable do not impact dependent variable directly they are used as intervening variable between the dependent and the independent variables. whereas the moderate variable is the situational support for the dependent and independent variable they modify they either improve the situation or worsen the detail is indicated in conceptual frame work

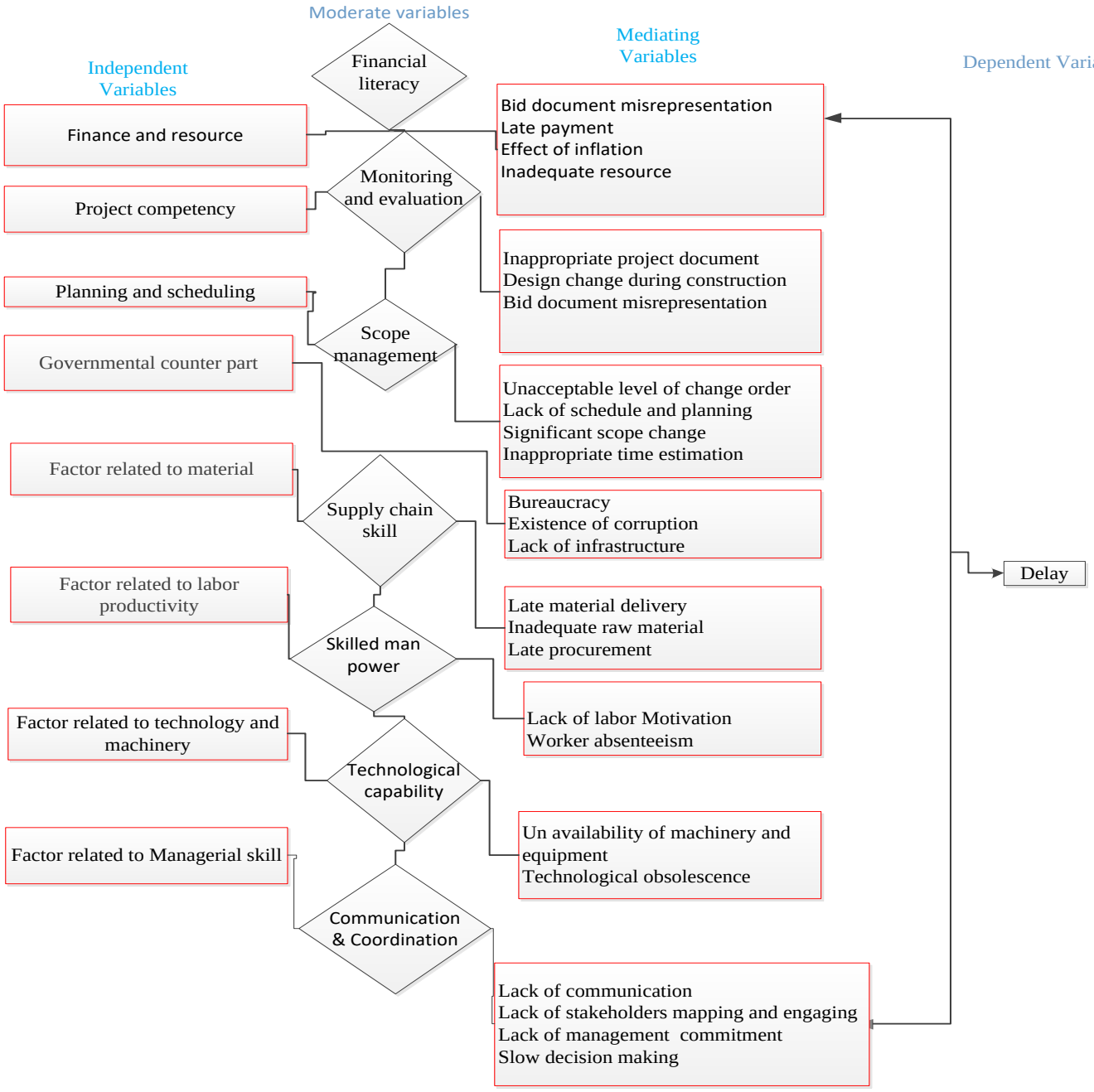


Figure 2: Conceptual framework

Chapter Three

3. RESEARCH METHODOLOGY

3.1. Introduction

This research methodology blueprints the methodologies and designs that were utilized to carry out the study. It discusses and explains the procedure based on the study's objective and goals. This study focused on a questionnaire created using information from the literature review and the research question. The questionnaires were provided to project owners, project managers, project researchers. Both primary and secondary data collected. The researcher used Questionnaires to collect primary data. The researcher applies a purposive sample strategy to determine the sample that represents the population because this method is appropriate for the target group those directly engaged in the execution process of the projects.

3.2. Research design

The study collected and distributed data by using methods such as google form, telegram, hand to hand by going to the place where the industries are found. The researcher prepared Questionnaires that includes closed ended questionnaire and open ended one. The closed-ended questionnaire was designed to keep the respondents in scope. Whereas, the open-ended questions were designed to provide respondents to express what they believe important for the study; as a result, the study used a mixed research approach in which both qualitative and quantitative research methods are applied. Moreover, the research steps shown in a figure 3

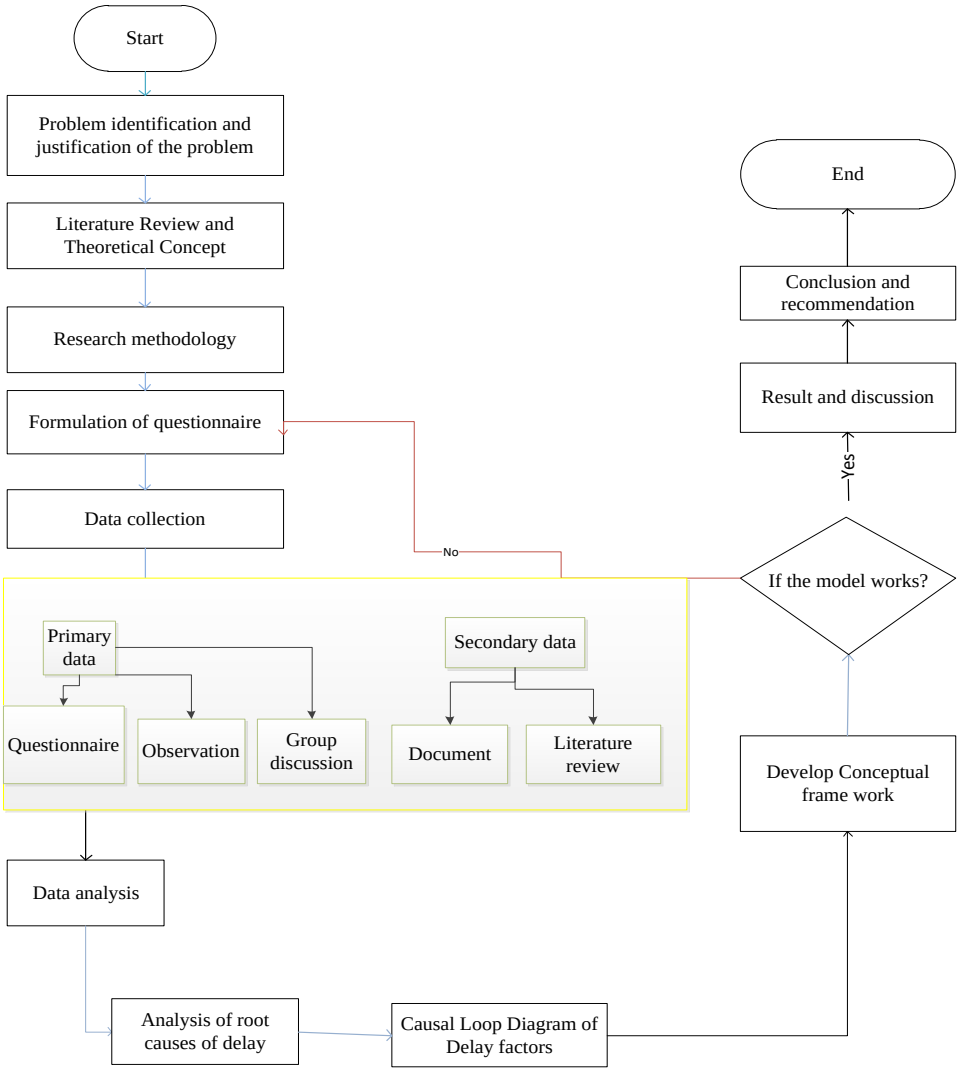


Figure 3: Methodology procedure

3.3. Population and sample size

In this study, researchers used purposive sampling technique accordingly, questionnaire were distributed to projects in manufacturing technology and engineering industry research and development center. Questionnaires have been distributed to 18 project owners and project managers found in Addis Ababa and its surrounding areas from 25 projects. Since reliable information about the project is only received from higher position holders of the clients and those who are involved in the execution process of the project. Data was gathered from project managers and project owners of each project and staff researchers to get the causes of project delays. Then the data was analyzed and Conceptual modeled to mitigate project delays in the Manufacturing Technology and Engineering Industry Research and Development Center.

3.4. Data analysis

To analyze the data, the researcher used data analysis tools such as; Relative importance index to identify the major causes of metal industry project delay, SPSS for descriptive statistics, and VENSIM software to build causal loop diagram to understand how system variable influence and influenced by system components. On the other hand, to identify the underlying cause of delay the researcher used a cause-and-effect diagram or Fishbone diagram and pareto analysis tool.

3.5. Ethical consideration

The researcher is committing to conducting ethical research by not altering or misrepresenting data, avoiding bias and careless errors, understanding and managing conflicts of interest, and giving proper credit to the work of other researchers. The researcher shares data, results, and ideas openly. The researcher acts in the best interest of humanity and the community. In this research, questionnaires were distributed to project owners, project managers, and staff researchers. In addition to this group discussions were done to gather their perspective on metals industry project delays and observations carried out during site visits and secondary data were gathered from documents and literature reviews in an ethical manner.

3.6. Reliability analysis

The researcher uses Cronbach's alpha for reliability analysis. Essentially, the alpha coefficient measures how closely related all the items within a measure are. The closer the alpha value is to 1, the more reliable the measure. The value of Cronbach's alpha ranges from 0 to 1, with 0 being the lowest and one being the highest. Generally, the value of alpha should be equal to, or higher than, 0.7 for a reliable construct assessment (Jilcha, 2019).The Cronbach's Alpha values of 32 delay factors extracted from descriptive statistics is indicated in table 4 below that have Cronbach's Alpha Value .922 since this value is greater than 0.7 it has high reliability. In addition to this the factors were extracted from literature reviews

Table 4: Reliability Statistics

Cronbach's Alpha	.922
Number of delay factors	32

3.7. Result dissemination mechanism

The finding of this research is presented to the Addis Ababa Institute of Technology School of Mechanical and Industrial Engineering. Manuscripts will be published based on this study and the finding of this study will be disseminated to project implementing stakeholders and Manufacturing industry Technology and research and development center. This research paper is will be an input for other researchers

Chapter Four

4. DATA PRESENTATION AND ANALYSIS

4.1. Introduction

In this research, a purposive sampling method was used to select respondents based on their position and roles within the projects. Respondents involved in the process of planning, execution, and technical supporters of the project were selected due to their valuable information on the delay of projects. Accordingly, the questionnaire was distributed to 18 Mental Industry projects and 13 staff researchers of the Manufacturing Technology and Engineering industry research and development center in order to get their perspective on the causes of project delays. accordingly, responses were received from 14 owners, 16 project managers, and 13 staff researchers. All respondents have adequate knowledge of project and project delays as we can see in Table 7 that 93% of respondents have more than 4 years of experience on the projects and 74.4 % have degrees and above which is indicated in Table 6 based on the descriptive analysis below.

Table 5: Title of Occupation

Title of Occupation		**Frequency**	**Percent**	**Cumulative Percent**
Valid	Owner of the project	14	32.6	32.6
	Project manager/Project engineer	16	37.2	69.8
	Staff Researcher	13	30.2	100.0
	Total	43	100.0	

Most of the respondents have adequate knowledge and understanding of the project delay that they have the good educational background

Table 6: Level of Education

Level of Education		**Frequency**	**Percent**	**Cumulative Percent**
Valid	Diploma	6	14.0	14.0
	Degree	21	48.8	62.8
	Masters and above	11	25.6	88.4
	High school and below	5	11.6	100.0
	Total	43	100.0	

Most respondents have experience in the project that increase their insight into project difficulty and the project's underlying problem due to their exposure to the process.

Table 7: Respondents' year of experience on this project or other related projects

Respondent's year of experience		**Frequency**	**Percent**	**Cumulative Percent**
Valid	1-4 years	3	7.0	7.0
	between 4&8 years	16	37.2	44.2
	8-12 years	6	14.0	58.1
	Greater than 12 years	18	41.9	100.0
	Total	43	100.0	

4.2. Time overrun of respondents' projects

Data collected from 18 Projects supported by manufacturing technology and engineering industry research and development center, which involved in machinery and spare part, Electrical and Electronics, Automotive and fabrication, and spare part projects. Their planned time and actual performance are indicated in Table 8

Table 8: Time Overrun of Each Projects

Project ID	Planned time	Actual time	Time overrun
P01	12 months	12 months	0
P02	12months	60 months	48 months
P03	24 months	84 months	60 months
P04	15 months	9months	6 months
P05	24 months	33 Months	9 months
P06	12 Months	24 Months	12 Months
P07	12 months	21 months	9 months
P08	12 months	12 months	0 year
P09	24 months	60 months	36 months
P 10	12 months	12 months	0 Month
P11	24 months	84 months	60 months
P12	12 months	12 months	0 month
P 13	24 months	60 months	36 months
P 14	12 months	12 months	0 month
P 15	12 months	12 months	0 month
P 16	12 months	12 months	0 month
P 17	24 months	60 months	36 months
P18	24 months	48 months	24 months

61 % of the metals industry projects that included in this study showed delay that they delayed in average 30 months and 15 days.

4.3. Relative importance index

The next part contains perspective of respondent on delay factors by the Likert scale rating 1=very low,2=low,3=Medium,4=high,5=very high; after gathering the respondents' idea on the questionnaire. The Relative importance index for each factor was calculated. Based on relative importance index the most critical factor of delay in metals industry projects were identified,

$$RII = \frac{\sum a*n}{YxN}$$

RII is the relative importance index, A is constant range from 1 to 5 whereas n is frequency of each answer. Y is a highest weight and N is total number of respondents the RII runs from 0 to 1, the higher the value of RII, the more important the causes of delay.

Table 9: Ranking of delay factor based on their RII (Relative Importance Index)

No	Description	**Rating number**							
		1	2	3	4	5	**RII**	**Rank**	**Average of RII**
	Factors related to planning and scheduling								
1	Lack of comprehensive and detailed project scheduling and planning	9	10	8	10	6	0.572	19	
2	Un acceptable level of change orders by clients	5	4	18	10	6	0.637	8	
3	Significant scope change	9	2	20	11	1	0.567	21	
4	Inappropriate estimation of activity time	7	13	7	14	2	0.558	22	
5	Lack of accurate cost estimation	9	9	7	11	7	0.591	16	
6	Inadequate cost control system	8	6	13	9	7	0.605	13	
									0.588
	Factors related to project Competency								
1	Lack of site management and supervision/lack of monitoring of project activity	8	14	7	10	4	0.544	25	
2	Inappropriate project documents/feasibility study	9	8	10	12	4	0.572	19	
3	Design change during construction	9	12	13	7	2	0.512	29	
4	Lack of legitimacy/In accuracy of submitted bid document	2	3	25	8	5	0.651	7	
									0.570
	Factors related to material								
1	Inadequate raw material	5	7	4	12	15	0.716	5	
2	Late material delivery	5	9	11	11	7	0.628	9	

3	Late procurement of items	7	5	14	12	5	0.614	12	
									0.653
	Factors related to labor productivity								
1	Lack of labor motivation	10	9	14	4	6	0.540	27	
2	Worker absenteeism	10	12	15	3	3	0.493	32	
3	Inadequate skilled man power	7	10	17	6	3	0.544	25	
									0.526
	Factors related to Managerial skill								
1	Lack of communication and coordination	10	12	11	7	3	0.512	29	
2	Lack of stakeholders mapping and engagement	7	6	16	9	5	0.595	15	
3	Lack of management commitment to project work	9	13	12	7	2	0.507	31	
4	Unavailability of supply chain management	6	6	14	12	5	0.619	10	
5	Slow decision making	11	7	12	8	5	0.549	24	
									0.556
	Factors related to technology and machinery								
1	Unavailability of machinery and equipment	9	8	14	7	5	0.558	22	
2	Lack of technological capability	6	8	15	11	3	0.586	17	
3	Technological obsolescence	11	9	15	3	5	0.516	28	
									0.553
	Factors related to Finance and Resource								
1	Difficulty of financing the Project	6	4	11	11	11	0.679	6	
2	Effect of Inflation	1	1	5	12	24	0.865	1	
3	Inadequate resource/ budget allocation	5	8	17	11	2	0.586	17	
4	Inadequate foreign currency	4	2	4	5	28	0.837	2	
5	Late payment	9	3	18	4	9	0.605	13	
									0.714
	Factors related to Governmental counterpart								
1	Existence of corruption	9	3	13	11	7	0.619	10	
2	Bureaucracy	3	3	3	18	16	0.791	3	

3	Unavailability of Infrastructure facility (interruption of electric power, lack of road facility)	3	8	5	12	15	0.730	4	
									0.713

4.4. Scales used to identify critical factors

32 delay causes in metal industry projects were identified and the ordinal Scale method is used to determine the criticality or severity of the factor from the relative importance indicated for criticality or severity.

Table 10: Ordinal Scale

Index value (Scale)	Severity (Criticality)
<20	Very low
20-40	Low
41-60	Medium
61-80	High
81-100	*Very High*

The relative importance index placed in high and very high place is taken as critical in this study accordingly the critical identified is indicated in table 11

Table 11: Critical factors of Delay

No	Factors	RII	Ranking
1	Effect of Inflation	0.865	1
2	Inadequate foreign currency	0.837	2
3	Bureaucracy	0.791	3
4	Unavailability of infrastructure facility (interruption of electric power, lack of road facility)	0.730	4
5	Inadequate raw material	0.716	5
6	Difficulty of financing the Project	0.679	6

7	Lack of legitimacy/In accuracy of submitted bid document	0.651	7
8	Unacceptable level of change orders by clients	0.637	8
9	Late material delivery	0.628	9
10	Existence of corruption	0.619	10
11	Unavailability of supply chain management	0.619	10
12	Late procurement of items	0.614	12

4.5. Critical factors identified based on RII value

1. Effect of Inflation /Escalation of Price
2. Inadequate foreign currency
3. Bureaucracy
4. Unavailability of infrastructure
5. Inadequate raw material
6. Difficulty of financing the Project
7. Lack of legitimacy/In accuracy of submitted bid document
8. Unacceptable level of change orders by clients
9. Late material delivery
10. Unavailability of supply chain management
11. Existence of corruption
12. Late procurement of items

Unlike other studies that examined construction projects in Ethiopia, this study finds inadequate cost control system by the owner and Lack of stakeholders mapping and engagement among 15 ranking order Factors compared to previous studies that examined the delay of construction projects in Ethiopia and in this Study the root causes of delay identified as effect Inflation, Shortage of foreign currency, Bureaucracy, Unavailability of infrastructure and Inadequate raw material by Pareto diagram.

4.6. Mean value of critical causes related to factors

4.6.1. Factors related to Finance and Resource

The finance and resource-related group account for .714 mean value that includes; the difficulty of financing the project, the effect of inflation, inadequate resource, inadequate foreign currency, and late payment. These factors contribute most to delay, in this group; Based on mean ranking of RII Factors, the effect of inflation ranks the highest. Hence, implementation of the project begins with the investment of our scarce resources into the particular implementing project and project highly affected by the factors of Finance and resources as the finance part is the blood system of the project without which the project could not be executed. Because the implementation consumes many resources.

4.6.2. Factors related to Governmental counterpart

The mean is .713 in this category that includes existence of corruption, Bureaucracy and unavailability of Infrastructure facility and the bureaucracy accounts the highest rank followed by the unavailability of infrastructure facility.

4.6.3. Factors related to project competency

The mean value is .570 In this set, lack of inaccuracy of submitted bid document representation accounts for the highest value. Hence, project execution needs necessary knowledge for the appropriate detail level of the project activities that will be done in the specified time which requires skill of executing the project in a particular time.

4.6.4. Factors related to material

The mean value is .653 in this category, inadequate raw material accounts for the highest, raw material is the key component of the manufacturing process unless projects acquire the necessary raw material, they could not produce the product that they intended to manufacture. The product is only realized when we integrate money, material, machinery, and people.

4.6.5. Factors related to managerial skill

The mean value is 0.556 In the managerial-related factors**,** the unavailability of supply chain management accounts for the highest rank in this category. The Weak management and institutional capacity are a reflection of a lack of skill and lack of adequate monitoring and evaluation system which results in implementation of delays and cost overruns.

4.6.6. Factors related to planning and scheduling

In the planning and scheduling category, the mean value is (0.588) that includes inaccurate cost estimation as well as the absence of a cost-controlling system accounts for the highest rank. In this category, the manager should plan in a way that meets the predetermined goal and predetermined procedures to carry out the projects, because the project has a start date and specific completion date with limited resources and budget available unless the project manager properly plans and control the cost. It is impossible to execute the project within allocated budget in specified time.

4.7. Root cause analysis

4.7.1. Fishbone Diagram

The fishbone diagram has been used to identify the factors that cause delays in projects in the metals industry, as it is a tool that systematically identifies all the possible causes of a given problem and presents them in a schematic representation of cause and effect. The possible causes are represented at different levels of detail in interconnected branches, with the level of detail increasing outward; an outer branch is a cause of the inner branch to which it is connected. The Ishikawa diagram (fishbone diagram) of the categories and factors causing delays in this study. There are six main categories of causes of delay identified in this research and under each category, there are many underlying reasons for the main causes of delay, which are indicated in fish bone diagram. For each main causes, there are sub causes that is considered as the root cause of delay in the metals industry projects. the main causes that related to critical causes include; managerial skill related, material related, governmental counterpart related, Scheduling and Planning related and project competency related which is indicated in the following diagram based on critical factor identified.

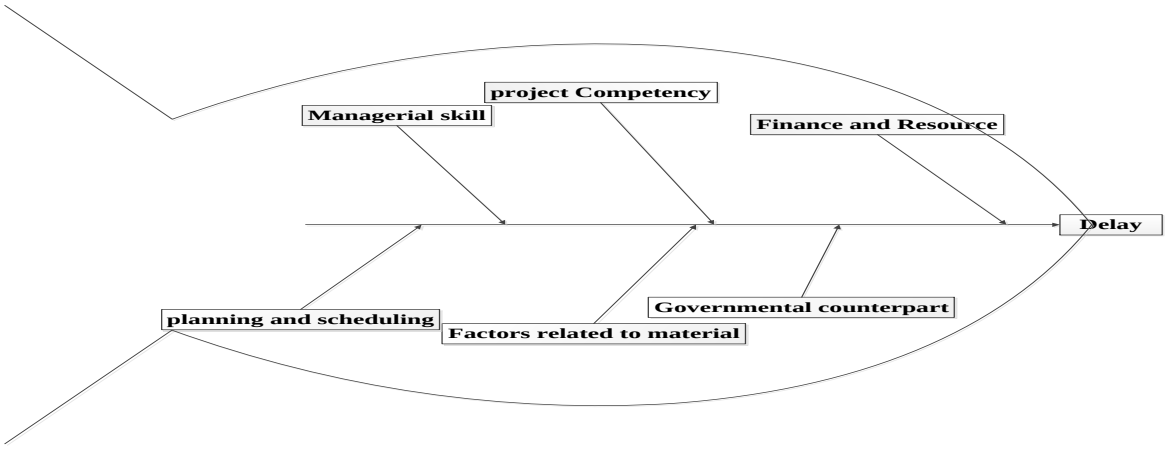


Figure 4: Fishbone diagram

Cause and Effect diagram of Metals industry projects delay

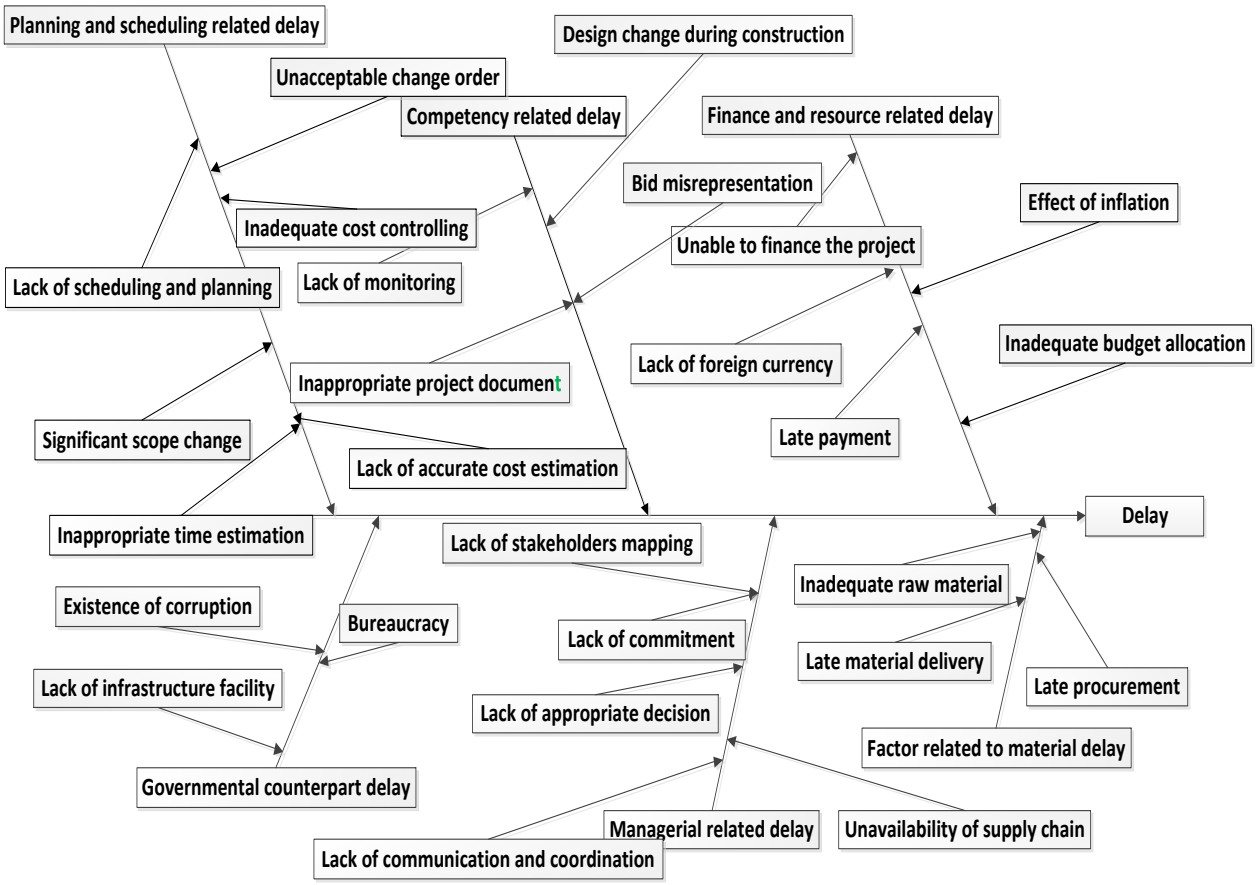


Figure 5: Root causes of project delay

4.7.2. Pareto principle

In the Pareto Principle, Pareto is a method to identifies the few things that matters most that in most cases, 80% of results come from only 20% of activities. Vital few which create the majority of delay in metals industry projects were identified using pareto diagram. the root causes of Metal industry project delay accordingly. Effects of inflation, shortage of foreign currency, bureaucracy, Unavailability of infrastructure facilities, and Inadequate raw materials are the root causes of metal industry project delays. The Pareto principle is also evidence for positive feedback loops and negative feedback loops. An increased effect amplifies the situation. In pareto distribution, those to start to have probably get more and the less get lesser.

The critical (20%) which accounts for the many (80%) of the problem that extracted from Pareto analysis that is shown Figure 6 are: -

- Effect of Inflation
- Shortage of Foreign Currency
- Bureaucracy
- Unavailability of infrastructure facility
- Inadequate raw material

These five contributed to 80% of the problem that is indicated in pareto Diagram. In addition to this group discussions were carried out to give a detailed definition of each root cause. The manufacturing technology and engineering industry Research and Development Center staff researcher demonstrated each root cause during the brainstorming session: -

Shortage of foreign currency: - mainly happened due to the export and import imbalance with the inability to substitute the importing material and not export as much as the import.

Effect of inflation: - The inflation is rising import prices due to falling exchange rate, with the inability to substitute the importing material.

Bureaucracy: - a lack of a proper working system that is not supported by technology results in bureaucracy and unclear working procedures.

Unavailability of infrastructure facility: - Infrastructure problems occurred due to road, Electric power Shortage, and Land acquisition. These factors negatively affect the metal industry project implementation duration.

Inadequate raw material: - Shortage of foreign currency and unable to substitute some parts of the imported goods domestically contribute to the delay of the metal industry projects

Table 12: RII Value for pareto Chart

No	Factors	RII
1	Effect of Inflation	0.865
2	Inadequate foreign currency	0.837
3	Bureaucracy	0.791
4	Unavailability of infrastructure facility	0.73
5	Inadequate raw material	0.716
6	Difficulty of financing the Project	0.679
7	Lack of legitimacy	0.651
8	Unacceptable level of change orders by clients	0.637
9	Late material delivery	0.628
10	Existence of corruption	0.619
11	Unavailability of supply chain management	0.619
13	Late procurement of items	0.614
14	Inadequate cost control system	0.605
15	Late payment	0.605
15	Lack of stakeholders mapping and engagement	0.595
16	Lack of accurate cost estimation	0.591
17	Lack of technological capability	0.586
18	Inadequate resource/ budget allocation	0.586
19	Inappropriate project documents	0.572
20	Lack of comprehensive and detailed project scheduling and planning	0.572
21	Significant scope change	0.567
22	Inappropriate estimation of activity time	0.558
23	Unavailability of machinery and equipment	0.558
24	Slow decision making	0.549
25	Lack of site management and supervision	0.544
26	Inadequate skilled man power	0.544

27	Lack of labor motivation	0.54
28	Technological obsolescence	0.516
29	Lack of communication and coordination	0.512
30	Design change	0.512
31	Lack of management commitment	0.507
32	Worker absenteeism	0.493

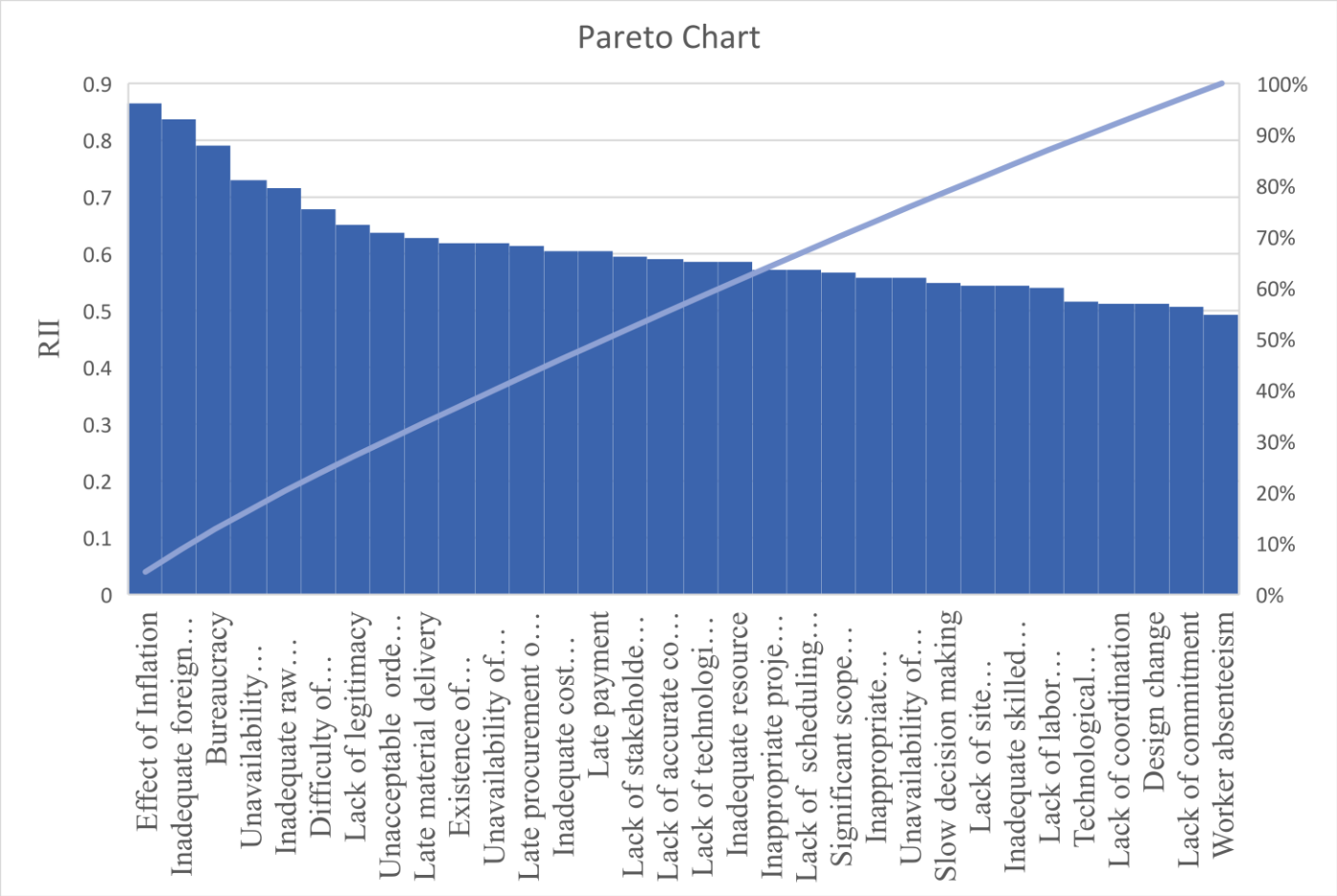


Figure 6: Pareto diagram

4.8. Feedback of the causes of metals industry project delay system

In this study, system dynamics Causal loop Diagram is used to indicate effect of major causes of delay variable interaction on project duration. By diagrammatical representing the relation among causes of delay variables. There are major identified causes of delay that their interaction affects metal industry projects progress. The model helps to build causal loop, show how they influence each other and influenced by system variable to understand how their interaction affect the overall delay of the project. Therefore, this study finds of delay factor interaction in metal industry projects. The causes exhibit interdependent interaction to overall system variable.

4.8.1. Causal Loop Diagrams of metal industry project delay

The causal variable demonstrates how Factors impact and influence each other, as well as the system variables they affect. The plus and minus signs in the arrow's head depict the mutual influences between the dependent and independent variables. If the arrow's head contains Plus signs, then the causes and the effect have direct relationship. Whereas, the negative sign in the arrow head indicates the inverse relationship between the causes and the effect variables. In this research qualitative relationship between the variables is represented by the causal loop of the factors that lead to project delays in the metal industry, with positive and negative signs in the arrow's head. The diagrams built based on interactions between the main reasons for project delays in the metal industry. The key variables mostly have an impact on productivity and the status of the project work. those key variables that interact with system variables are diagrammatical represented in the causal loop diagram with their relationship positive or negative sign. Accordingly in this study the critical factors are considered as key factors.

Critical Causes of Metals Industry Project delay: -

1. Effect of Inflation /Escalation of Price
2. Inadequate foreign currency
3. Bureaucracy
4. Unavailability of infrastructure
5. Inadequate raw material
6. Difficulty of financing the Project
7. Lack of legitimacy/In accuracy of submitted bid document
8. Unacceptable level of change orders by clients
9. Late material delivery
10. Unavailability of supply chain management
11. Existence of corruption
12. Late procurement of items

4.8.2. Causal Loop Diagram

Helps to capture structure of the system to understand dynamics of the system which rise from positive and negative feedback system.

4.8.3. Feedback loop of causes of project delay Interaction With projects system variables

The study includes generally important part of project phases: - Productivity, project Schedule, project progress, actual work performed, Labor force, project completion time and project rework are system variable as they are dominantly affecting project success according to Jhon D. Sterman (2000). the critical factors identified were integrated into the model as intervention factors Accordingly, the key intervention variables are the variables identified as critical metal industry project delay factors.

4.8.4. Performance gap and additional staff

When there exists the performance gap between the actual performance and the desired performance the project stakeholder implements additional human resource to depict the situation to balance the performance gap. In this case, the feedback loop is the balance loop since it contains two positive and one negative polarities

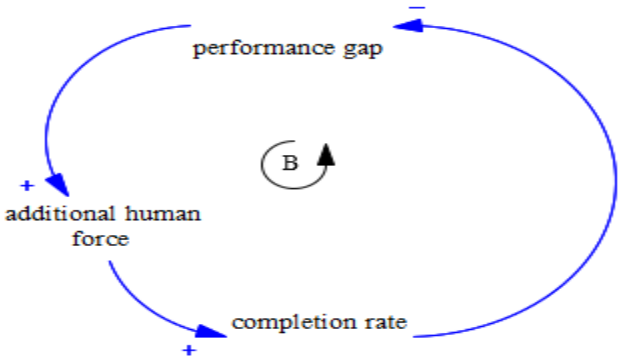


Figure 7: Balancing feedback loop

4.8.5. Reinforcing and Balancing

soon after the project's start. If the remaining time against performance time is not according to the initial plan. the project owner assessed their strategy and traced the remaining time to make sure the remaining time is adequate. met the project's actors' goals experienced the pressure of a busy schedule, and the management's implementation of overtime in a hurry brought respite and good performance. However, when there is a delay in time, the overtime work leads to weariness and inaccuracy, which in turn causes performances to suffer. Finally, the rework requires more time for identification and repair, which lowers productivity. The progress of the projects is therefore impacted by productivity. Since the starting circumstances are amplify

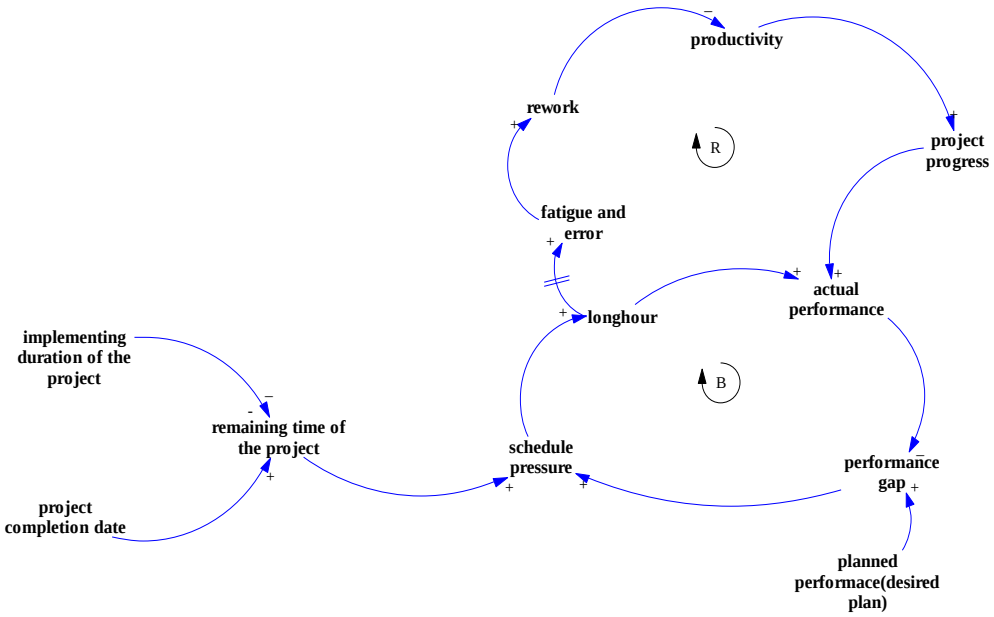


Figure 8: Balancing and Reinforcing loop

4.8.6. Causal loop of Major cause of Metal industry project delay

The causal loop diagram includes a key variable that interacts with system variables. The causal variable shows how they influence and influenced each other and with system variables. The plus and minus signs indicated in the head of an arrow show how the dependent and independent influence each other. If the head of the arrow is plus that means the independent and dependent variable is directly proportional. On the other hand, a negative sign indicates the change in independent variables is indirectly proportional to the dependent variable. In general, the causal factors affect the progress of the project by delaying the work to be done in their specified schedules. The Major cause of the delay of the metal industry projects mainly influence the progress of project tasks as well as productivity. Factors interaction is indicated in Figure 10.

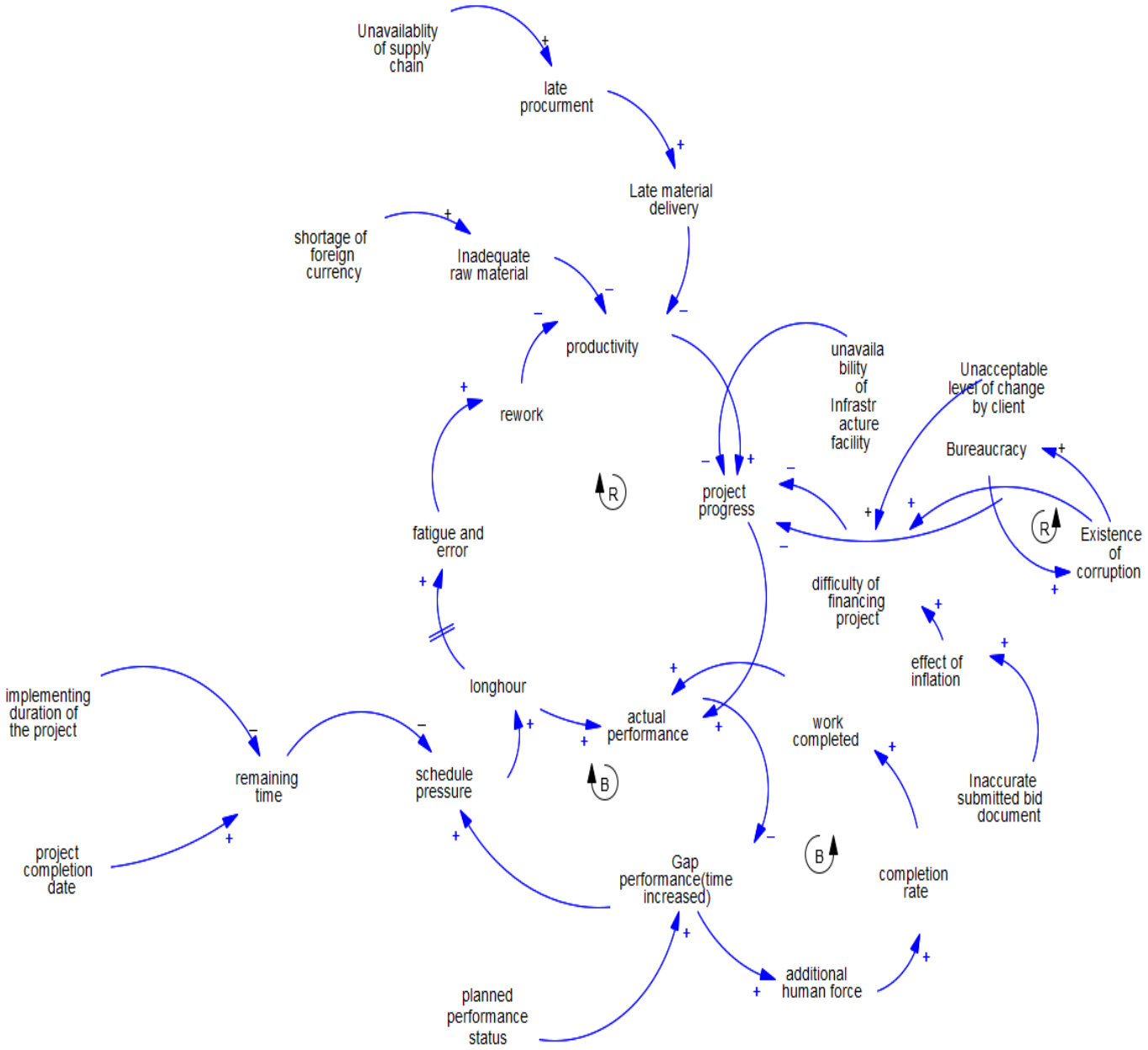


Figure 9: Interaction of causes of delay

4.9. Conceptual framework of project delay

A conceptual framework model is created based on the interactions for the key reasons discovered in this research and the fundamental causes found via Pareto diagram. If we can apply the mitigation strategy ahead of time, the metal industry project delay will be reduced. Hence, Successful project implementation is mostly influenced by the root cause and dynamic interaction of the principal cause of project delay.

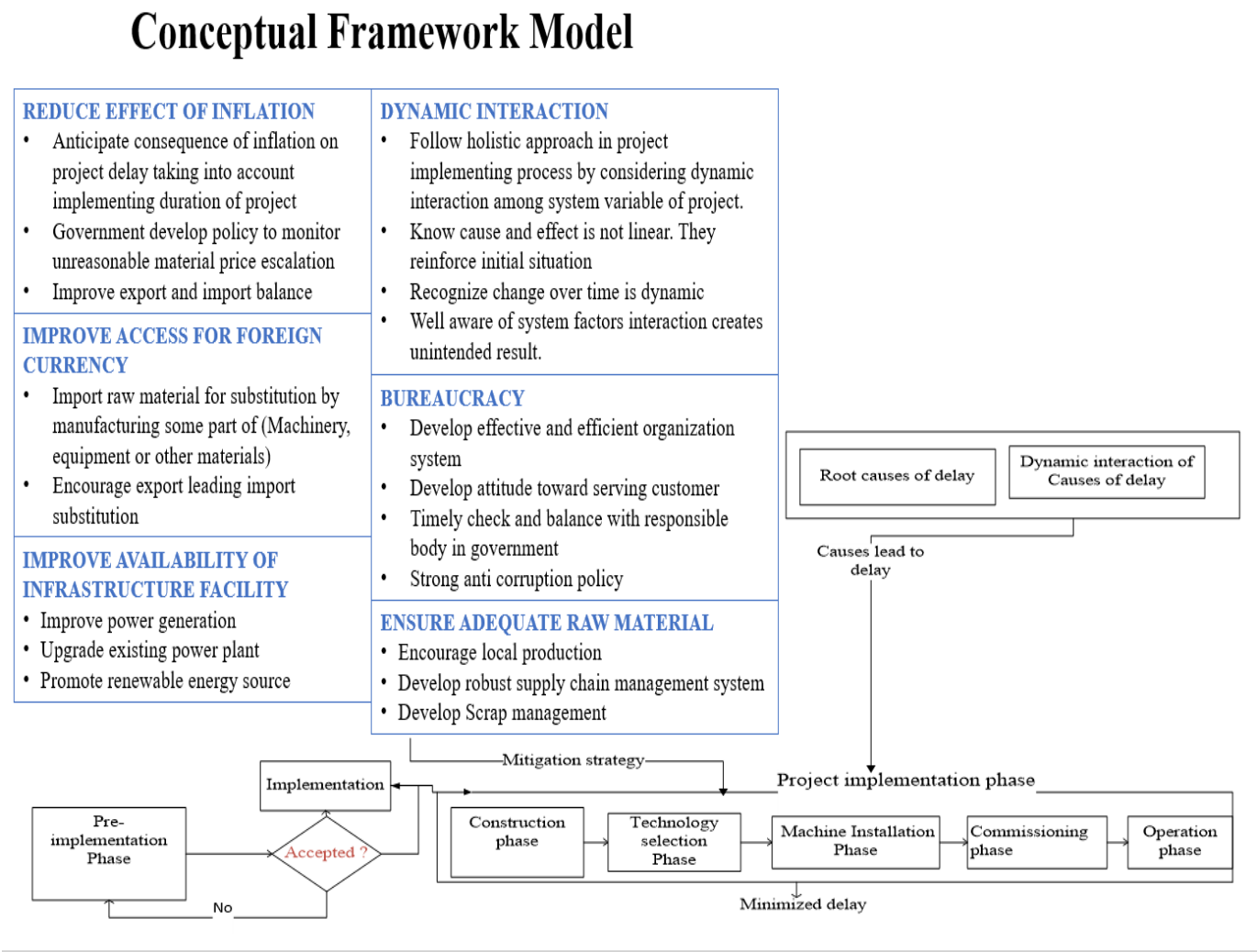


Figure 10:Conceptual Framework Model

4.10.Result and discussion

This study identified major causes of delay as

1. Effect of Inflation: effect of Inflation/Escalation of Price in Material, The Manufacturing industry primarily depends on raw materials to produce the desired products. The targeted projects admitted that the effect of Inflation has a significant impact on delay in that it creates problems in accessing the raw material and desired technology due to this the project owner considered as the first delaying factor of metal industry projects in the Manufacturing technology and engineering industry research and development center.
2. Inadequate foreign currency: Concerning dollarization which plays a very important role in the manufacturing industry starting from raw materials to manufacturing technologies are bought aboard the country and this requires exchange, there are two aspects here the first one is the foreign currency exchange rate and the other is availability of foreign currency. Currently, the manufacturing industry are struggling with both the availability and the exchange rate increment.

3. Bureaucracy: - In this study, many project activities were delayed due to office procedures and request delivery methods. Project activities that are delayed due to prolonged and time-consuming procedures and unclear project supporting systems which hinder them from progressing according to their time schedule.
4. Unavailability of infrastructure facility (interruption of electric power, lack of road facility) in this regard, frequent interruption of electric power, lack of timely distribution of transformer contributes to delay of projects, during field visit the researcher observed projects with the lack of transformer and manufacturing land acquisition problem.
5. Inadequate raw material: there are extreme problem that the project owner encounters due to lack of raw material for manufacturing industries. As some of project owners

mentioned if government could support, some parts can be manufactured to substitute the importing of raw materials.

6. Difficulty of financing the Project: This is including financial institutions and create specialized financing schemes tailored to the needs of industrial projects. Pursuing the project to integrate with bank that includes getting low-interest loans, providing guarantees for project financing and studying accurate project feasibility study. Good Collateral procedures, which urges the need to revise governmental policy for conducive environment for manufacturing industries to get access to the finance.
7. Lack of legitimacy/In accuracy of submitted bid document: While preparing the document Contractor some time misrepresent the data or underestimate for the lowest award purpose.
8. Unacceptable level of change orders by clients: - During construction frequent change order led to scope growth that forces the project implementation process to be extended.
9. Late material delivery: - This happens due to material shortage or price escalation procedures this is due to method and procedure internal in the project and implementing efficient inventory management systems.
10. Unavailability of supply chain management: - Industrial project stakeholders should focus on optimizing the supply chain that include establishing reliable relationships with suppliers and using technology-driven solutions to track and monitor material deliveries. Because regular communication and coordination among stakeholders will facilitate timely material procurement and reduce project delays by creating linkage among the project stakeholder and suppliers.
11. Existence of corruption: In project implementation process, some service provider organization individuals need handout for the service even though the government paid them for the service they provide and expect the responsible body to serve impartial without additional money requirement. This responsible body force the

project actors to give them additional resource by creating unnecessary bureaucracy and procedure by intentional making difficulty the requirement for specific service and provide the service after long period of time.

12. Late procurement of items: - Availability of materials at the right time and location facilitates the progress of the project by encompassing a wide range of activities that include purchasing equipment, materials, and services required for the implementation of the projects. From the major cause, five are identified as root causes of delay they are: -

- Effect of Inflation
- Shortage of Foreign Currency
- Bureaucracy
- Unavailability of infrastructure facility
- Inadequate raw material. If the project stakeholder focusses on those root cause 80% of the problem will be solved. Finally, the interaction of the causes and the root cause result in delay. However, if we implement the mitigation strategy proposed a heady of time delay of metal industry project will be minimized.

Chapter Five

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

The metal and engineering industry projects are an important component of Ethiopia's economic growth and development. The timely completion of these projects is therefore critical to the country's economic growth. The objective of the study was to investigate the causes of delay in metal projects and indicate the effect of their interaction on project delay by system dynamics. Accordingly, factors that have an impact on delays in metal and engineering projects were established from a total of 32 causes of project delay that were identified from the existing literature, and reports. These findings showed that the top 12 factors identified in this study were as follows: Impact of inflation, insufficient foreign exchange, bureaucracy, unavailability of an infrastructure facility (interruption of the power supply), insufficient raw material, difficulty in financing the project, presence of corruption, an unacceptable level of change orders by customers, Lack of legitimacy/In accuracy of submitted bid document, late delivery of material, Unavailability of supply chain management and Late procurement of items. In this study root causes Identified by Pareto analysis include: the effect of Inflation, Shortage of Foreign Currency, Bureaucracy, Unavailability of infrastructure facilities, and Inadequate raw materials.

5.2. Recommendation

Based on the findings of this study, the following are recommendations suggested by the author so as to reduce project delay.

- The factors related to finance and resource including financing the project, the effect of inflation, inadequate resource, inadequate foreign currency account for the major cause of project delay. The project contractors should forecast and handle the problem during and prior to the implementation of projects to address these issues by taking into account the implementation duration of the project and change overtime that creates dynamism.

- The government provides a lot of incentive to manufacturing industries. Yet, what undermines the effort of the government is that Corruption, Bureaucracy and Unavailability of infrastructure still remain as key causes of project delay. It is recommended that the government takes unwavering action in resolving these factors to minimize project delay in metals industry projects by implementing policy that address the mentioned problems.
- Management weakness and institutional capability are reflections of lack of skill and inadequate monitoring and evaluation system which result in implementation of delays and cost overruns. In order to overcome this the project owners as well as project managers should implement the conceptual frame work developed in this study.
- Owners of the project are responsible for interrupting the progress of the project without detailed and scheduled procedures. so, the client should be consulted before interrupting the project work.
- Furthermore, the Study is limited to exploring the causes of delay, the effect of their interaction and the change over time behavior of project delays in metal industry. It is therefore recommended for future researchers to quantify the identified factors responsible for the delay and evaluate the interaction of each factor numerically in metal industry projects.

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7. APPENDIX

7.1. Questionnaire

Addis Ababa University School of Mechanical and Industrial Post Graduate Studies Program Master of Science in Mechanical and Industrial Engineering (Industrial System Engineering-Stream)

Subject: Questionnaires on causes of delay in metal industry projects: A case of selected metal industry projects

Prepared by: **Andinet Haile**

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With the guidance of **Kassu Jilcha** (Associate professor) from AAIT-School of Mechanical and Industrial Engineering

E-mail: Jkassu@gmail.com

My name is Andinet Haile and I am an MSc Student at the Addis Ababa Institute of Technology (AAIT). I am conducting this study to fulfill part of the requirement for the Master of Science in Industrial Engineering. The aim of this questionnaire is to collect relevant data and information on the causes of project delays from stakeholders of metal industry projects. The study identifies the root cause of project delays and models projects in the metal industry. The result of this study will help project stakeholders gain a comprehensive understanding of the causes of project delays in the metal industry and subsequently implement mitigation strategies. Any data you provide for this research is confidential as the data are needed for academic purposes only. Finally, I would like to thank you in advance for your cooperation in providing valuable data for this study.

1. **Section one:** *Respondent Profile*

Please tick your response with this symbol (✓) for all empty boxes below

1.1. Current Occupation/Title

☐ Owner of the project ☐ Project manager/Project Engineer ☐ Staff Researcher

1.2. Respondent education level

☐ Diploma ☐ Degree ☐ Masters and above ☐ High school and below

1.3. Respondent's year of experience on this project and other related projects

☐ Less than one year ☐ 1-4 years ☐ 4 -8 years ☐ 8-12 years

☐ Greater than 12 years

2. **Section two:** *Project Profile*

2.1.Duration of the project in implementation

☐ Less than 1 year ☐ 1-2 years ☐ Between 2 & 5years ☐ 5 years & above

2.2. Is your project lagged behind implementation schedule?

☐ Yes ☐ No

2.2.1. If your answer is yes, for how long?

☐ Less than one year ☐ 1-4years ☐ 4- 8 years ☐ 8-12 years

☐ 12 years and above

3. **Section 3:** *Open-ended and Close-ended questions on causes of project delays*

3.1. Close ended questionnaire

3.1.1. Please tick your response with this symbol (✓) concerning your project, depending on the Likert scale rating, 1=very low, 2=low, 3=Medium,4=High,5=very High

No	DESCRIPTION	RATING NUMBERS				
		1	2	3	4	5
	Factors related to planning and scheduling					
1	Lack of comprehensive and detailed project scheduling and planning					
2	Unacceptable level of change orders by clients					
3	Significant scope change					
4	Inappropriate estimation of activity time					
5	Lack of accurate cost estimation					
6	Inadequate cost control system					
	Factors related to project Competency					
1	Lack of site management and supervision/lack of monitoring of project activity					
2	Inappropriate project documents/feasibility study					
3	Design change during construction					
4	Lack of legitimacy/In accuracy of submitted bid document					
	Factors related to material					
1	Inadequate raw material					
2	Late material delivery					
3	Late procurement of items					
	Factors related to labor productivity					
1	Lack of labor motivation					
2	Worker absenteeism					
3	Inadequate skilled man power					
	Factors related to Managerial skill					
1	Lack of communication and coordination skill					

No	DESCRIPTION	RATING NUMBERS				
		1	2	3	4	5
2	Lack of stakeholders mapping and engagement					
3	Lack of management commitment to project work					
4	Unavailability of supply chain management					
5	Slow decision making					
	Factors related to technology and machinery					
1	Unavailability of machinery and equipment					
2	Lack of technological capability					
3	Technological obsolescence					
	Factors related to Finance and Resource					
1	Difficulty of financing the Project					
2	Effect of Inflation					
3	Inadequate resource/ budget allocation					
4	Inadequate foreign currency					
5	Late payment					
	Factors related to Governmental counterpart					
1	Existence of corruption					
2	Bureaucracy					
3	Unavailability of Infrastructure facility (interruption of electric power, lack of road facility)					

3.1.2. Is/are there a reason/reasons for your project's delay that wasn't covered in the questionnaire? Yes ☐ No ☐

3.2. If your answer is yes, would mention them?

1._____-

2._____

3._____

7.2. Causes of project delays according to different researchers

Table 13: Causes of project delays according to different researchers

No	**Delay major Factories**	**Gebrehiwet & Luo (2017)**	**Koshe & Jha(2016**	**(Doloi et al., 2012)**	**Durdyev & Hosseini (2020)**	**Banobi & Jung, (2019)**	**(Mbala et al., 2019)**	**Adeboy et al(2021)**	**Kikwasi (2013)**	**Akogbe et al (2013)**	**Samarah & Bekr (2016)**	(Muhammad et al., 2016)	Industry minister report	**(Zidane & Andersen, 2018)**
1	Ineffective project planning and scheduling	X	X	X	X	X	X	X			X			X
2	Scope change			X		X								_
3	Financially difficulty		X	X	X	X		X		X				X
4	Poor Site Management	X			X		X				X			X
5	Corruption	X												
6	Slow in decision making													X
7	Bureaucracy													X
8	Poor communication and coordination			X	X	X		X						X
9	Low productivity of labor (shortage of labor, lack of labor, unskilled labor		X			X	X				X			
10	Availability of Infrastructure Facility					X								
11	Late design and design change	X					X		X		X			X
12	Inflation	X	X											
13	Slow delivery of material	X						X						

No	Delay major Factories	Gebrehiwet & Luo (2017)	Koshe & Jha(2016	(Doloi et al., 2012)	Durdyev & Hosseini (2020)	Banobi & Jung, (2019)	(Mbala et al., 2019)	Adeboy et al(2021)	Kikwasi (2013)	Akogbe et al (2013)	Samarah & Bekr (2016)	(Muhammad et al., 2016)	Industry minister report	(Zidane & Andersen, 2018)
14	Late in agreement of contract and reviewing completed work	X							x					
15	Late payment for completed work		X		X	X			X					
16	Late delivery of material		X			X	X							
17	Insufficient data collection and Survey		X											
18	Weather condition				X		X							
19	Material shortage				X		X							
20	Lack of commitment	-		X		X								X
21	Substandard contract			X										X
22	Slow quality inspection													X
23	Sponsor/client lack of commitment													X
24	Office issues													X
25	Poor quality material	X				X				X				

No	**Delay major Factories**	**Gebrehiwet & Luo (2017)**	**Koshe & Jha(2016**	**(Doloi et al., 2012)**	**Durdyev & Hosseini (2020)**	**Banobi & Jung, (2019)**	**(Mbala et al., 2019)**	**Adeboy et al(2021)**	**Kikwasi (2013)**	**Akogbe et al (2013)**	**Samarah & Bekr (2016)**	(Muhammad et al., 2016)	Industry minister report	**(Zidane & Andersen, 2018)**
26	Inadequate foreign currency												X	
27	Technological Capability									X				
28	Inadequate cost controlling system				X									
29	Lack of stakeholder mapping												X	
30	Unavailability of supply chain management											X		
31	Inappropriate estimation of activity time				x									
32	Technological obsolescence									X		X		X