ADDIS COLLEGE

SCHOOL OF POSTGRADUATE STUDIES

PROGRAM-CONSTRUCTION TECHNOLOGY & MANAGEMENT

TIME PREDICTION MODEL FOR BUILDING CONSTRUCTION PROJECTS USING MULTIPLE REGRESSION ANALYSIS: A CASE STUDY ON COMMERCIAL BANK OF ETHIOPIA'S BUILDING CONSTRUCTION PROJECTS

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March, 2024 G.C

Addis Ababa, Ethiopia

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By; Messay Delelegn

A Thesis submitted to Addis College, School of Postgraduate Studies, Department of Construction Technology and Management in Partial fulfillment of the requirement for the award of Masters of Science Degree in Construction Technology and Management

Advisor: Belachew Asteray (PhD)

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DECLARATION

I, Messay Delelegn Masresha, hereby declare that this thesis entitled "**Time Prediction Model for Building construction Projects Using Multiple Regression Analysis: A Case Study on Commercial Bank of Ethiopia's Building Construction Projects**" is the culmination of my own extensive work, critical thinking and intellectual growth with the guidance and assistance of my research advisor. I have duly acknowledged all the sources of information used in this study and I confirm that this Msc. thesis has not been previously submitted, in whole or in part, at this college or any other higher institution. It is being presented as a partial fulfillment of the requirements for the degree of Master of Science at Addis College.

Declared by: Messay Delelegn Masresha

Signature _____

Date _____

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

Belachew Asteray (Ph.D) _____ _____

Name of Principal Advisor Signature Date

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APPROVAL SHEET

This is to certify that the thesis entitled "**Time Prediction Model for Building construction Projects Using Multiple Regression Analysis: A Case Study on Commercial Bank of Ethiopia's Building Construction Projects**" has been carried out by Messay Delelegn under my supervision. I hereby certify that the recommendations and suggestions given by the board of examiners are appropriately incorporated into the final version of the thesis.

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Principal Advisor Signature Date

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LIST OF ABBERVIATION

B+G+M – Basement + Ground + Mezzanine

BCM - Building Construction Management

CBE – Commercial Bank of Ethiopia

CCD – Construction Contract Duration

CPM – Critical Path Method

CTD – Contract Time Duration

MRA – Multiple Regression Analysis

PDM – Precedence Diagramming Method

PERT – Program Evaluation and Review Technique

RII – Relative Importance Index

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ABSTRACT

This thesis presents a time prediction model for building construction projects utilizing multiple regression analysis, with a focus on the projects undertaken by the Commercial Bank of Ethiopia (CBE). The study addresses the need for accurate and reliable methods to forecast project durations, considering the unique challenges and characteristics of construction projects in Ethiopia. The research methodology involves both qualitative and quantitative approaches, incorporating structured questionnaires and statistical analyses. Primary data is collected from the professional staff of the CBE Building Construction Management Department, supplemented by secondary data from organizational publications and documents. Through a comprehensive literature review certain factors which affects significant factors from the data collected most potential factors which affects CTD has been identified. The significance of those factors on the determination of contract duration for each CBE projects were ranked based on their Relativity Importance Index value. And among the selected significant factors that are highly affecting each projects, four common factors were selected, Site location, Project size/scope, Labour availability, and Material availability. These potential factors have been used to develop the time prediction model for CBE projects. The findings highlight the significance factors such as project scope and material availability in influencing project durations. A developed time prediction model by using those significant factors is presented, utilizing multiple regression analysis to quantitatively assess the impact of various factors on project timelines. After the result the study suggested clients /CBE to use multiple regression analysis for the optimum project time/ duration prediction since proper selection of contract time allows for optimization of construction engineering costs and other resources. Finally, Recommendations for future research include external validation of the model, incorporation of advanced analytical techniques, and exploration of dynamic modelling approaches. Overall, this thesis contributes to enhancing project scheduling accuracy and improving the efficiency of building construction projects in Ethiopia.

Keywords: Contract Time Determination, significant factors, Relativity Importance Index value, and, Multiple regression analysis

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

The construction industry is critical to worldwide economic development, and building construction projects account for a significant portion of this sector. Timely completion of construction projects is critical for cost effectiveness, client satisfaction, and overall project success. However, precisely estimating the duration of projects remains challenging due to the complex relationship of factors impacting construction durations.

The Duration of a Construction Contract refers to the amount of time or period given for a construction project to finish all its tasks under normal working conditions and following standard work practices. It should be noted that this timeframe does not account for unforeseen events like force majeure or situations where work needs to be expedited. The specific start and end dates are typically agreed upon when the contract is initially established. (Pokhrel et al, 2021)

According to (Thornton, 1988) the duration of a contract refers to the agreed-upon timeframe for completing the terms of the agreement. In construction, the contract duration specifies the expected length of time for completing the project, including start and end dates and any intermediate milestones. The contract period encompasses the time from the contract's inception to its completion or from site possession to practical completion of the project.

The difficulty in accurately estimating the project's completion time comes mostly from the fact that the construction process is exceedingly fragmented and complex and dependent on a wide range of participants and activities. Because of the constantly rising demands of customers and the market, it has become even more complicated. (Shabir H. et al., N.D).

Traditional methods of project scheduling often rely on subjective assessments or simplistic models that may not adequately account for the diverse range of factors impacting construction project duration. As a result, there is a growing need for more sophisticated and data-driven approaches to time prediction in building construction projects

Accurately estimating the time required for a construction project can benefit everyone involved. It is important to make reasonable and precise estimates, as this allows for accurate cash flow forecasting for both the contractor and the client. Proper estimation of construction duration can also help with resource allocation, financial planning, profitability, and efficient use of capital within a set timeframe. Unfortunately, the determination of the contract period is often misunderstood by those creating the contract, and is based on individual perception rather than relevant data. Odabaşi (2009) noted that, in addition to a success criterion, the contractor's and the client's estimation of the project's time is crucial. The client can allocate the most effective amount of funds to the Project and can produce a financial, cash, and material flow plan in a predetermined amount of time. Realistic project length is significant since it always acts as a crucial benchmark for evaluating the effectiveness of a project's schedule and expense management.

CBE is one of the largest financial institution in Ethiopia. Among various division of the bank, Building Construction Management (BCM) is listed under facilities management, which are responsible for the construction of various buildings for different Branch, district and other purposes which are constructed in the various regional states of the country and its capital city Addis Ababa. CBE building construction projects under BCM department are chosen for the purpose of carrying out this research work. Currently there are completed, on-progress and on-bid buildings construction projects under the BCM department. For this research a total fifteen projects are addressed.

Most of Commercial Bank of Ethiopia's building construction projects have been assigned equivalent durations without considering the potential factors that could affect contract time determination and without a mathematical model that could integrate those potential factors. In light of these considerations, this study aims to develop a Time Prediction Model for Building Construction Projects using MRA. By systematically analyzing the time determinant factors of CBE construction projects, the study seeks to identify key predictors of project duration and construct a model that can reliably estimate the time required for future building construction endeavors.

Multiple Regression Analysis (MRA) offers a robust statistical technique for identifying and quantifying the relationships between multiple independent variables and a dependent variable, making it well-suited for modeling the factors affecting construction project duration. Thus, research tried to identify and assess the significant/determinate factors that should be considered in developing

a Time Prediction Model for accurately estimating project completion times of CBE construction projects and develop a Time Prediction Model for Building Construction Projects using MRA.

1.2 Statement of the problem

According to (El-Dash et al., 2019), the Realistic duration of projects is significant because it consistently acts as a key benchmark for evaluating the effectiveness of a project's time and expense. As a result, the project's estimated completion date is frequently unreliable and poses a serious risk while it is being built.

The construction industry often faces challenges in accurately predicting project completion times. Despite the significance of timely project delivery for efficient resource allocation and client satisfaction, existing methods for estimating project durations may lack precision and fail to account for the multitude of factors influencing construction timelines. This gap underscores the need for a comprehensive Time Prediction Model tailored specifically to building construction projects, utilizing advanced statistical techniques such as Multiple Regression Analysis.

Additionally, within the context of the commercial bank of Ethiopia, there is lack of scientific methods and scheduling techniques being used to determine the contract duration for CBE building construction projects. Even though, some major potential factors are considered while determining the contract duration, the magnitudes of the effects of those factors are primarily based on the personal judgment of the individuals involved in the procurement procedures rather than integrating the effects of the significant factors to the mathematical model. As a result, there is a lack of consistency in estimating the contract duration. Thus, the problem addressed by this thesis is the absence of a robust Time Prediction Model tailored to commercial bank building construction projects in Ethiopia, hindering effective project planning and management practices.

The precise estimation of the feasible project's duration in total is the key factor in reducing the chance of delays in construction. (Mohammed and Yousef, 2014) In general, it is essential to set realistic construction contract duration for CBE building projects based on the scope and complexity of the project. This will ensure that the project is completed safely, efficiently, and to a high standard.

Thus this study identifies and analyzes various significant factors influencing the determination of contract time in building construction projects and that should be considered in developing a Time Prediction Model for accurately estimating project completion times of CBE construction projects. And, it entails constructing a predictive model that utilizes multiple regression analysis to accurately forecast project completion times based on the identified significant factors.

1.3 Research Questions

The research will answer the following research questions: -

- What significant factors that should be considered in developing a Time Prediction Model for CBE building construction projects?
- How to develop a time prediction model for CBE building construction Projects?

1.4 Objectives

1.4.1 General Objective

The general objective of this study was to develop a Time Prediction Model for Building construction Projects Using Multiple Regression Analysis in case of Commercial Bank of Ethiopia's Building construction Projects.

1.4.2 Specific Objectives

The specific objectives of this study are:

- To assess the significance factors that should be considered in developing a Time Prediction Model for CBE building construction Projects
- To develop of a Time Prediction Model for CBE building construction projects by using Multiple Regression Analysis

1.5 Scope of the study

The study identify and analyze the significant factors influencing project duration in CBE building construction projects, Data pertaining to building construction projects undertaken by the commercial bank of Ethiopia was collected and analyzed. This will include project size, complexity, resource availability, weather conditions, geographical location, and other relevant variables.

Multiple Regression Analysis was employed to analyze the collected data and identify significant predictors of project completion times. The analysis involved determining the relationships between various independent variables and the dependent variable of project duration. Based on the results of the Multiple Regression Analysis, a Time Prediction Model was developed to forecast project completion times for commercial bank of Ethiopia building construction projects. The study concludes with recommendations for the application of the Time Prediction Model in project planning and management within the commercial bank of Ethiopia.

Overall, the scope of this thesis will provide a comprehensive analysis of the factors influencing project duration in CBE building construction projects closing in the development of a Time Prediction Model using Multiple Regression Analysis

The respondents selected for study are limited to professional employees from Building Construction Management Department that is involved in the contract administration and supervision of building construction projects of the Bank.

1.6 Significance of the Study

The case study approach focusing on Commercial Bank of Ethiopia's building construction projects provides a practical application of the time prediction model. The findings and recommendations from this study can be directly applied to similar projects within the organization or in other construction projects in Ethiopia. The development of a time prediction model for building construction projects using multiple regression analysis can provide valuable insights and tools for project managers in the construction industry.

By identifying and analyzing the key factors that influence project timelines, this study contributes to the body of knowledge on construction project management. The insights gained from the study can

help researchers, and practitioners, better understand and address challenges in the construction industry related to project delays and time overruns.

The recommendations addressed by this research will be useful specifically for CBE Procurement department which have direct relation in estimating the contract durations before their award and CBE-Building Construction Management (BCM) department which is responsible for supervising and administrating the construction projects.

The study's methodology and findings can serve as a valuable reference for future research on time prediction models and project management practices in the construction industry.

1.7. Limitation of the Study

- The study focused on the construction industry in Ethiopia and the case of CBE-BCM, which may not be representative of other industries or contexts.
- The results of the study may not be applicable to other construction companies or projects outside of the Ethiopian context.
- The study's findings and conclusions may be limited to the specific context of Commercial Bank of Ethiopia's building construction projects and may not be generalizable to other types of construction projects or industries.
- The study's scope is limited to the factors considered in the multiple regression analysis, and there may be other unexplored variables that could also impact project timelines.
- The study's recommendations may be specific to the context of Commercial Bank of Ethiopia and may require adaptation for application in other organizations or industries.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Construction Contract Duration (CCD)

Construction Contract Duration is the period of time that a construction project is expected to take, as stated in the construction contract. This covers the beginning and end dates of the project, as well as any interim milestones or deadlines. The contract period is a significant component in project planningand management, as it helps to create schedules for specific operations and allows for the allocation ofresources accordingly. It also provides a framework for monitoring and evaluating project progress, and for making adjustments as necessary to ensure that the project is finished on time and within budget.

According to (Florida department of transportation guidance, 2021) the maximum amount of time allotted in a construction contract for the completion of all work specified in the contract documents is known as the Contract duration. Regardless of the department's initial time estimate, the contract duration is determined when the contractor receives the bid blank. During ongoing construction projects, the issue of contract duration is commonly discussed. It typically arises when the contract specifies an excessive amount of or insufficient amount of time. Construction contracts involve numerous parties, therefore there is a chance that disagreements can occur if one or more of those parties feels confined by the amount of time given.

Gondy and Hildreth (2007), stated contract time is typically expressed as a specific number of days in the Invitation for Bids (for federal government projects) or the Public notice for Bids (for city, state and private projects). This approach is widely used to indicate the length of a lump sum contract.

2.1.2 Contract Time Determination (CTD)

The Contract Time Determination (CTD) is a method used to establish the duration of construction contracts and is included in bid documents. A crucial part of developing the CTD involves working closely with a skilled team consisting of designers, the project manager, and construction or maintenance staff. This collaboration ensures that all aspects related to the order of tasks, planning, and feasibility is thoroughly taken into account. (Texas Contract Time Determination Guidance, 2018)

CTD involves determining the duration of the construction project and the schedule for completion. This comprises determining a start and finish date for the project and establishing milestones and deadlines for various stages of the construction process. The time determination also takes into account elements such as weather conditions, availability of supplies and labor, and any potential delays or disruptions that may arise during the project. The contract will includeprovisions for penalties or incentives depending on meeting or missing deadlines, as well as provisionsfor change orders or extensions if necessary.

As per CTD Guidance, (2018) to guarantee that reasonable assumptions have been made and all items impacting construction length have been taken into account when generating the schedule, effective communication between design and construction subject matter experts is a crucial component of estimating contract time. Effective contract time estimating requires experience and engineering judgment. When anticipating the duration of future initiatives, looking back at previous results of comparable projects can also be helpful.

Contract Time Determination Guidance, (2018) outlined that the CTD schedule should be performed; In a way that allows the contractor sufficient time to complete the project, Is based upon at least one reasonable/constructible solution, Includes considerations to accelerated construction practices when applicable, Utilizes any valuable information that has been developed in the planning of the engineers' estimate (if applicable), Takes into account all known limitations of construction operations that the contractor will need to be made aware as part of the bid documents and finally Considers any unusual circumstances that impact the time related aspects of the construction.

CTD is predicting the length of time it will take to execute the project as out mentioned in the contract. This requires assessing different elements such as project scope availability of resources, project complexity and potential dangers. Accurate contract length estimation is vital or ensuring that projects are completed within the agreed-upon time schedule and budget.

A method for determining contract time must enable a designer to estimate a fair construction time even if he is unaware of the precise method or order in which the task will be completed, as well as the kind, size, or number of equipment that will be employed. (Contract Time Determination in Project Development, 2011).

It is the responsibility of the CTD developer to coordinate with area office staff, division staff, or other staff on any of these items they are not familiar with. While the CTD is typically finalized late in the design phase of the project, typically after the quantities have been completely tabulated, contract time should be considered throughout the plan development process. (Thornton, 1988)

According to (Gondy, and Hildreth, 2007). It is crucial to ensure that the contract time specified in bids is reasonable. Inadequate time can lead to higher bid prices, more time overruns, and contractor claims. It is necessary to take into account the workload of available contractors and provide them with the flexibility to schedule work efficiently. If the contract time is too short, it becomes challenging to maximize equipment and labor, which results in higher prices.

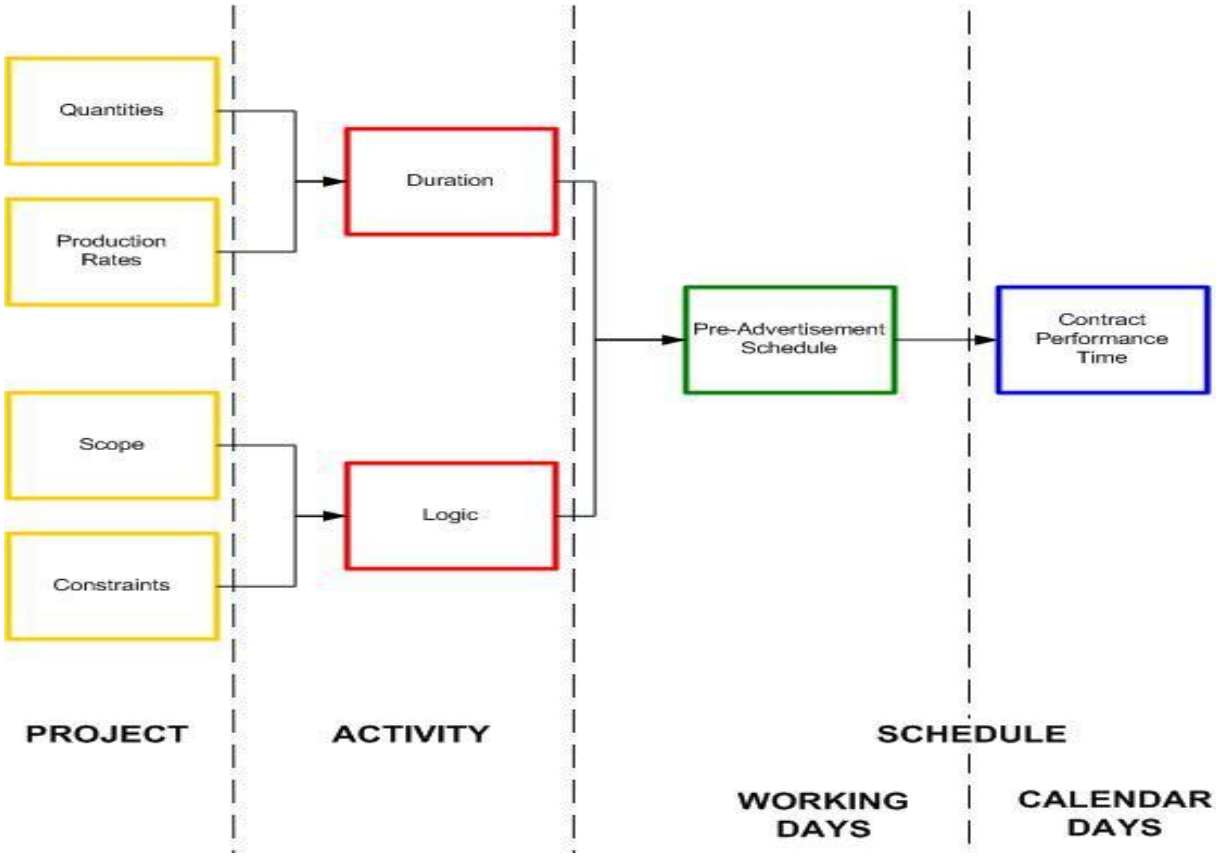


Figure 2.1 General Contract Time Determination Process flowchart (Gondy, and Hildreth, 2007).

2.1.2.1 Methods to determine Construction Contract Duration

Production Rates

The quantity produced or built within a specific amount of time is referred to as a production rate. When choosing an appropriate contract completion date, it is crucial to estimate actual production rates. Even for the same piece of work, production rates might vary significantly based on the scope of the project, the location (rural vs. urban), and other factors. For controlling items of work, production rate ranges based on project type (grading, structures, etc.), size, and location should be set in the State's written rules. (Florida department of transportation guidance, 2021)

According to Thornton, (1988) the measure of how much work is accomplished within a specific time frame is known as productivity rate. To determine the duration of a project, the total amount of work is divided by the productivity rate for that particular type of work. However, productivity rates alone are not sufficient in determining the project's duration. To establish the project's duration, productivity rates can be combined with a networking technique. It is important to note that the duration stated in a contract should account for other factors such as administrative requirements in addition to productivity rates.

As Gondy and Hildreth,(2007) states other sources of information may need to be considered in addition to productivity rates, and it is necessary to use sound engineering judgment and draw upon past experience with similar tasks in order to adjust these rates appropriately. Gondy and Hildreth, (2007) also "stated that before durations for individual work items computed, certain project specific information should be determined and some management decisions made. The relative urgency for the completion of a proposed project should be determined."

In order to calculate the time durations for each activity, it is necessary to gather specific information about the project and make certain engineering judgments. This includes determining the urgency of completing the project, analyzing the impact on traffic volumes and detours, reviewing the size and location of the project, considering the effects of staging, working double shifts, and the feasibility of night work, as well as taking into account any restrictions outlined in the traffic control plan regarding lane closures and other limitations. (Contract Time Determination Guidance, 2018)

Factors that can affect the production rate include the availability of resources, the skill level of workers, and the efficiency of equipment and tools. The production rate is a crucial factor in determining the duration of a construction project. Production rate should accurately estimate for each task or activity in order to determine how long it will take to complete the project. This information is essential for creating a realistic construction schedule and ensuring that the project is completed on time and within budget. In conclusion, the production rate is a significant aspect in determining the duration of a building project. The production rate for each task or activity should be carefully estimated and monitored throughout the project to ensure that it remains on schedule. Effective control of the production rate is vital for ensuring that the project is completed on schedule and within budget.

Expert Judgment

Expert judgment is another approach to estimating construction contract duration. This involves consulting with experienced professionals in the field, such as project managers, engineers, or contractors, to get their input on how long the project is likely to take. Expert judgment can be particularly useful when there is limited data available or when the project is highly complex or unique. According to (Thornton, 1988) this strategy entails taking advantage of the "expertise" of those familiar with the project. Design engineers and architects who have generated the design for the project are expected to apply their judgment and knowledge to decide the contract duration. Logically it makes sense that people most knowledgeable with the project should specify the contract duration. This assumption is based on the premise that most designers are informed about building and the methods currently being employed in the industry. However, Experience simply provides information about what has worked in the past. It does not notify the owner what is the optimum duration for his project or analyze the project for those components which could be changed to lower the duration.

2.1.2.2 Techniques to determine Construction Contract Duration

Project managers and planners used a variety of scheduling methods, from simple bar charts to complex networks. The Critical Path Method (CPM), Precedence Diagramming Method (PDM), and Program Evaluation and Review Technique (PERT) are three common scheduling methodologies. (Mohammed and Yousef, 2014)

Various techniques and models can be used to estimate construction contract duration, including the Critical Path Method (CPM), Estimated Cost Method, Program Evaluation and Review Technique (PERT), and Bar chart. Each approach has its strengths and weaknesses and may be more appropriate for certain types of projects or situations.

Critical Path Method (CPM):

Contract Time Determination Guidance, (2018) states A CPM schedule evaluates the critical tasks which take the greatest amount of time to complete and ultimately determine the duration to complete a project. A CPM schedule evaluates the critical tasks which take the greatest amount of time to complete and ultimately determine the duration to complete a project. CPM is a widely used model for estimating construction contract duration. It involves identifying all the tasks involved in the project, determining their dependencies, and estimating the time required to complete each task. The model then calculates the critical path, which is the longest sequence of tasksthat must be completed in order to finish the project on time.

Florida department of transportation guidance, (2021) explains that a CPM schedule shows which project tasks will cause the completion date to shift if they are not finished on time. Project completion times can be calculated by the evaluation of crucial tasks. This strategy is usually carried out through computer software due to the scale and complexity of most projects.

According to Thornton, (1988) CPM incorporates the logical connecting of activities into a network todemonstrate their construction sequencing and dependencies. And the other related networking strategies provide the ability to address many additional scheduling challenges. Many planners mix CPM with some other technique such as production rates or engineering judgment and experience to

establish the activity length. Once each activity duration is known, the total critical path can be established by either manually executing a forward and backward pass through the network, or utilizing a computer to execute those calculations.

According to (Mohammed and Yousef, 2014) the major and critical concern associated with the time scheduling process is the determination of activities durations. The more accurate the activity duration is the more efficient planning and scheduling will be. The traditional methods of Critical Path Method (CPM) activity duration estimation are based on a single value derived from the average productivity rates of all resources assigned to the activity.

According to Gondy and Hildreth (2007), the application of CPM includes the following methodology: Break a project down into individual tasks or procedures necessary for project completion. Each of these discrete actions or processes is called an activity. The completion of an action is called an event. Once all the actions necessary to execute a project have been outlined, the relationship of these activities to one another needs to be determined. When deciding the sequence of activities, various questions need to be posed such as: "What needs to be done before proceeding with this activity" or "what can be done concurrently?" Every action has a particular event to define its relationship with others with respect to completing a task a diagrammatic model of the project should be constructed displaying the correct sequence and linkage of activities and occurrences. Each activity is depicted as an arrow going to a node, which denotes the conclusion of an event or the passage of time. Real time can be specified to each operation based on output rates and other applicable criteria.

Cost Estimated Method (CEM)

The projected cost method is a regularly utilized strategy in construction contract time determination. This method entails determining the entire cost of the project and then dividing it by the estimated production rate to get the duration of the project. To apply this strategy, contractors need to precisely estimate the cost of all the resources required for the project, including materials, labor, equipment, andoverhead fees. They also need to assess any potential hazards or unforeseen occurrences that could affect the project timeframe.

Once the total cost has been established, contractors can divide it by the predicted production rate to determine the duration of the project. This calculation can help them design a realistic building timeline and guarantee that they have appropriate time and resources to complete the project on time and within budget. Events that effect the project duration, the actual duration of the project may differ from the estimated period.

In conclusion, the projected cost method is a good approach for determining the duration of a building project. Contractors need to precisely estimate the overall cost of the project and evaluate any potential hazards or unforeseen occurrences that could affect the project timeframe. By employing this strategy, they can build a realistic construction timetable and ensure that they have sufficient time and resources to execute the project on time and under budget.

Bar Chart

Gondy, and Hildreth, (2007) states The Bar Chart method can be used for projects that have only a few work components that are easy to comprehend and have clear linkages between them. The project should also have a well-defined scope of work and a modest level of uncertainty that is not likely to generate significant adjustments. A bar chart is a basic graphical tool for arranging activities. In the construction sector, a bar chart is used to design a scheduling form.

A bar chart is made up of a succession of activities, each having its own start date, duration, and finish date, which are then placed into the project time scale. The Bar Chart method is ideal for utilization

with projects that have a modest number of work components withwell-established links between them. The project's scope of work should also be adequately established.There may be a level of uncertainty that is unlikely to result in significant changes. Projects are represented graphically using bar charts or Gant charts. Graphical representations of projects with defined due dates and activities are called bar charts or Gantt charts. The length of each activity's scheduled duration is shown by bars or lines.

Bar charts have the virtue of being simple to construct, simple to interpret, and a valuable tool for calculating contract duration. One issue is that they do not explain how the different work phases are interconnected and dependent on one another. Bar charts are tough to interpret accurately when construction adjustments take occurred. Additionally, controlling things are displayed in the same way as minor items, making it tougher to distinguish which objects are in fact in control of the project's overall temporal progress

Program Evaluation and Review Technique (PERT):

PERT is another popular approach for estimating construction contract time. It entails breaking down the job into smaller, more manageable parts and estimating the time required to finish each activity. The algorithm then determines the projected length of the project based on these predictions, taking into consideration the uncertainty and variability of each activity.

PERT is best employed in projects where the activity time estimate cannot be forecasted precisely. In other words, it accounts for uncertainty. PERT in its pure form cannot be used for time/cost trade off analysis. PERT Network uses a probabilistic approach to estimating for each activity. To estimate for an activity, the following formula is used.

$$\boldsymbol{Epected\ time} = (\boldsymbol{optmistic} + \mathbf{4} * \boldsymbol{Most\ Likley} + \boldsymbol{pesmistic})/\mathbf{6}\ldots\ldots\ldots\textbf{Eqn. (2.1)}$$

Where, Optimistic = lower probability (Approximately 1%) that the activity will be complete

Most likely = the highest probability of completing the activity in this time
Pessimistic = the longest possible

2.2 Empirical Review

2.2.1 Factors Affecting contract time Determination

According to (Stoll, B.L, et al.,2006) on their research project, estimating project durations require knowledge of construction and an understanding of the uncertainties associated with a project. Some of the influencing factors includes; Geophysical (Weather, Location, Environmental) Construction Operations (Mobilization, Materials, Utility Relocation, Conflicting Operations, Night/Weekend Work) Project Characteristics (Project Type, Dominant Operations) Economic/Legal (Budget, Letting Time, Permits) Miscellaneous (Project Size, Operation Overlays, Project Urgency, Community Events)

Chan and kumaraswamy, (2002) outlined the various elements that should be taken into account when calculating contract duration and categorized them into four categories, including project scope, project complexity, project environment, management attributes, and others.
Contract Time Determination Guidance, (2018) states that the there are other constraints that should be considered when determining contract time which includes Definitions of working days, Effect of traffic control plan, Accelerated construction program, curing time/waiting period , seasonal limitations, conflicting operations, review time, and etc

According to (Thornton, 1988) factors which influence the duration of the contract can be divided into two groups, those which lengthen the contract (nearly all of the factors) and those which shorten the duration (very few). And are listed below, and as (Thornton, 1988) tries to explain those factors;

Project size (small, medium, large, super, and mega), While price volume is misleading in determining the size of the project, it can serve to illustrate the idea that a larger price volume. All contracts will often take longer. However, one has to consider the economy of scales of large projects which are not complicated in terms of the work required. These projects could be completed more

quickly than other less costly but more complicated in terms of materials, equipment, or processes used to produce the facility. Clearly, the point is that a larger dollar cost will serve only as a guide to roughly defining the contract duration.

Budget and resources: The budget and resources available for the project are considered when deciding the duration of a construction contract. This includes analyzing the availability of financing, equipment, and employees.

Site location: since CBE is currently building different branch and district projects at different regions of Ethiopia, the location of the building site can also affect the duration of a contract. If the site is in a remote or hard-to-access area, it may take longer to get materials and equipment to the site, which can delay the project.

Weather conditions: Weather circumstances can have a considerable impact on the duration of a building contract. Extreme weather such as heavy rain, snow, or high winds can delay operations and extend the project timeline.

Availability of labor and materials: The availability of skilled workers and materials can also affect the duration of a building contract. If there is a shortage of workers or materials, it may take longer to accomplish the project.

Client expectations: The expectations of stakeholders, including clients, investors, and regulatory authorities, should also be addressed when defining the duration of a construction contract. This includes understanding their expectations for project completion and any unique requirements they may have.

Legal and contractual considerations: Legal and contractual considerations should also be taken into account when determining the duration of a construction contract. This includes reviewing any relevant laws and regulations, as well as ensuring that all contractual obligations are met.

Types of contract while the vast majority of construction contracts are of the fixed price variety, the owner should be aware of the effects the contract type can have on delivery. The types of contracts

under consideration are fixed price, both lump sum and unit price, cost reimbursable with fixed fee, cost reimbursable with percent fee, Phased construction, and convertible contracts.

Local Conditions Along with the other aspects discussed previously, the owner has some choice over the consequences of local conditions. This component is supposed to examine the size, location and accessibility of the site, climate conditions, and administrative limits like zoning or environmental standards. While the owner can have some control over the selection of site, such other aspects as weather, zoning, and any other restrictions he may only be able to influence little. Weather can only be influenced by determining the time of year to start building. The influence of these circumstances cannot accurately be foreseen prior to start of the contract. Unfortunately, not every environmental requirement may be known before to construction. This can lead to a longer wait for the facility than expected.

Administrative Requirements; Administrative requirements are those factors contained in the contract which support the owner's ability to administer the contract successfully. Some of the present requirements are: submitting of proposed materials, engineering drawings, and equipment for approval, demolition plans, safety plans, quality management plans (if required), certificates of insurance, performance and payment bonds, administrative requirements set by the owner, security requirements such as citizenship and loyalty of workers, scheduling and planning requirements in the contract, and owner/user operational requirements.

Other factors Thornton, (1988) states other factors affecting estimation of construction contract duration includes material choice, type of construction, type of facility, type of project; types of construction

According to (Gondy& Hildreth, 2007) Factors that affect the determination of a construction contract includes, but not limited to; Curing time and waiting periods between successive paving courses or between concrete placement operations, as well as specified embankment settlement periods, Seasonal limitations for certain items when determining both the number of days the contractor will be able to work as well as production rates, Conflicting operations of adjacent projects, both public and private; Minimize annoyances in residential areas, Minimize traffic disruption and delay in high

traffic areas, Political sensitivity and public awareness, Coordination with adjoining projects to provide usable roadway sections to avoid conflicting operations, Inclement weather conditions, project location, permit application processes and submittal review time, material acquisition, utility relocation, Time of the year of the letting as well as duration of the project

According to (Odabaşi, 2009) the most significance factors affecting construction duration includes Cost, Cash flow, Productivity of on-site, Procurement Project related Factor, Technology and Methodology of Construction, Experience, Coordination, Weather Construction site and the degree of completeness of design project.

2.2.2 Duration Prediction Modeling for Construction Projects

In the construction industry, accurate prediction of project duration is crucial for effective project planning, resource allocation, and cost estimation. Overruns in project duration often lead to increased costs and potential disputes between stakeholders. Therefore, developing reliable time prediction models is essential for enhancing project management practices and achieving successful project outcomes. According to (Stoll,B.L,et al.,2006) Estimating project durations requires knowledge of construction and an understanding of the uncertainties associated with a project.

Historically, construction project duration estimation has relied on conventional methods such as expert judgment, historical data analysis, and deterministic scheduling techniques like Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). While these methods offer initial insights into project duration, they often lack the ability to account for the dynamic nature of construction projects and the multitude of factors influencing project timelines.

Emergence of Predictive Modeling Techniques

In recent years, there has been a shift towards the adoption of predictive modeling techniques to improve the accuracy of time predictions in construction projects. Multiple regression analysis has gained popularity as a statistical method for developing predictive models by identifying significant variables and their relationships with project duration.

The duration of construction project depends on many factors, such as: cost, location, site characteristics, procurement methods, area of construction, footprint of the building and its height, etc. (Odabaşi 2009) a critical aspect of developing a time prediction model using multiple regression analysis is the identification and selection of appropriate predictor variables. Previous research has identified various factors influencing construction project duration, including: Project characteristics such as size, complexity, scope, and type of construction. Environmental factors including weather conditions, geographical location, and regulatory requirements. Resource allocation and management variables such as labor availability, material procurement lead times, equipment utilization rates, and subcontractor performance. Project-specific constraints and uncertainties that may impact the project schedule.

Kumar and Reddy (2005) constructed a model using fuzzy logic. The significance of a project's unique qualities has been underlined by the writers as a means of improving duration estimates. By employing a fuzzy logic approach, Kumar and Reddy (2005) developed this model to achieve the goal of estimating the project parameters. This model takes into account both qualitative and quantitative elements for each activity. The relevant qualitative (linguistic) elements determining the time of each building activity were implemented once the project activities were analyzed.

Kumar and Reddy (2005) covert the nominal durations of activities to an appropriate range to apply the qualitative factors, for example:

- Weather conditions [Bad (B); Medium (M); Good (G)]
- Labor experience [High (H), Medium (M), Low (L)]
- The engineer's experience [Highly Experienced (HE), Moderately Experienced (ME)]

According to (Odabaşi 2009) tries to estimate project duration for educational building projects which were new built projects completed between 2004 and 2007 were obtained from the Department of Construction and Technical Works. Odabaşi (2009) use 10 parameters to predict the project durations

which includes Number of Block, Number of Floor, Total Height, Average Height of the Floors, Total Area ,Average Floor Area, Total Volume, Average Volume of Floors Façade Area, and Adjusted Detailed Cost Value.

Odabaşi (2009) first, use the BTC Model to verify whether such a relationship holds for the data pertaining to the case study projects by using Microsoft Excel 2003 for the regression analysis. The BCIS Model, which is based on data related to 1,500 case study buildings, was also considered for calculating project durations. The model was applied by using its own Building Construction Duration Calculator (BCDC).

Following this Odabaşi (2009), conduct SLR analyses with 10 parameters finally; multiple linear regression analyses were carried out taking into consideration the results of the simple linear regression analyses' results by using Microsoft Excel 2003.

According to (Odabaşi 2009) when parametric models are studied, it is seen that regression models are used widely used. Regression analysis is used to express a dependent variable (y) in terms of the independent variables x1, x2 …xn for investigating the functional relationship between a dependent variable and one or more independent variables. The equation representation is as follows:

$$Y=\alpha 0+\alpha 1X1 + \alpha 2\ X2 + ... + \alpha n\ Xn \quad \text{……Eqn. (2.2)}$$

Where,

Y=dependent variable

α0 =regression constant

α1, 2, 3…...10=partial regression coefficient of X 1, 2, 3….10

X1, 2, 3…..10 =independent variables

These regression models were selected on purpose in order to prove the applicability of regression analyses to predict construction duration.

El-Dash et al.,(2019) developed a prediction model by taking Estimated and actual durations, and budget values from existent construction projects in three countries: Egypt, Kuwait and KSA between (1998 and 2013). El-Dash et al.,(2019) developed Comprehensive statistical regression models using

real data from 13 large construction projects in Egypt, Kuwait and KSA. Thirteen distinct projects were investigated covering a diverse sample of large construction projects for both public and private sectors. The regression models delineate the relationship between activities estimated and actual durations to predict actual durations based on their pertinent estimated duration through conventional estimation techniques.

Shabir H. et al.,(N.D) Analyzes the relationships between projects time and costs using the BTC Model (Bromilow's Time-Cost).Time-cost models are used globally to predict the time factor of the construction project from its cost factor. (T = K*CB). The initial time-cost model was developed by Bromilow in 1974.

Cost and time data of 30 different projects were selected for the study from different organizations to make consensus between all three cases. the cost and time data of those 30 different projects were collected from National Engineering Services, Pakistan (NESPAK), the Works & Services Department and from the Hyderabad Development Package each.

Shabir H. et al., (N.D). Carried the linear regression analysis for the cost and time data all 30 projects that were selected from 3 organizations. Shabir H. et al.,(N.D). Then has tested the Model Validation (MAPE) to validate the generated model before its application in the field.

Construction duration estimation models that are based on statistical data are considered to be more representative of the true picture and, therefore, more reliable. For this reason the Multiple Linear Regression (MLR) Analysis was chosen for this study.

2.3 Identified theoretical gap of the reviewed articles

Although time prediction models are widely used in building construction projects, there is a potential dearth of research specifically examining the utilization of multiple regression analysis, particularly within the context of Ethiopia or comparable developing nations. From the literature examined, it appears that there is a restricted use of multiple regression analysis concerning the incorporation of significant factors that could influence a particular project as independent variables.

Existing literature might not adequately address the temporal dynamics and unique characteristics of building construction projects in Ethiopia, such as seasonal variations, workforce dynamics, or regulatory constraints. There may be an opportunity to explore how these factors impact the effectiveness of time prediction models.

CHAPTER THREE

3. MATERIALS AND METHODS

This chapter outlines the survey materials and the survey methodology used in the research. The methodology section also includes its own sub-sections that describe the study period, the research design and approach, the sampling design, the data sources and collection methods, the research instrument, the method of data collection, and the procedures for data analysis.

3.1 Sources of Data

This research employed a combination of primary and secondary data collection methods. Primary data was acquired through the distribution of a structured questionnaire to all members of the professional team involved in CBE-BCM projects within the CBE-BCM Department. Conversely, secondary data was sourced from various alternative outlets, including organizational publications, websites, and relevant documents.

Information regarding CBE building construction projects, encompassing project duration, scope, cost, and other pertinent project characteristics, from both ongoing and recently completed projects spanning the years 2008 to 2015, was procured from the CBE-BCM Department. A total of 15 projects were analyzed, as detailed information was exclusively available for those projects. Additional insights were gleaned through informal interviews

3.2 Study Period

The study period covers the whole time from the preparation of the first draft of the proposal to the final submission of the research report after data analysis. The overall study period covers about 8 months.

3.3 Research Design and Approach

The research employed a mixed-method approach, combining both qualitative and quantitative methods to gather comprehensive data on the factors influencing contract time determination.

Qualitative research involved in-depth interviews, observations, and field notes to capture nuanced insights into the project dynamics.

Quantitative research utilized a structured questionnaire to gather numerical data on the perceived significance of various factors affecting contract time determination.

3.4 Sampling Design

The group of people being studied was made up of 40 professional project team members from the Department of CBE-BCM who are involved in managing building construction projects. The census method was chosen because the population is small and easy to reach. Therefore, all 40 members of the project team (including project managers, senior civil engineers, associate engineers, junior engineers, managers, and directors) were included in the study. Questionnaires were handed out to all of the team members to collect data. In total, 40 questionnaires were distributed.

3.5 Research Instrument

A questionnaire served as the research tool, distributed among the professional staff of the CBE Building Construction Management Department. The questionnaire adopted a structured Likert-type format, requiring respondents to rate statements on a five-point Likert scale, ranging from 1 (Low) to 5 (Very High). The questionnaire was tailored to achieve the research objectives, which included assessing the importance of various factors influencing contract time determination for the projects under study and exploring the consequences of unrealistic estimations of contract durations on project performance.

3.6 Methods of Data Analysis

Qualitative Data Analysis: Qualitative data obtained from interviews and observations were analyzed thematically to identify recurring patterns and themes related to project time prediction.

Quantitative Data Analysis: The quantitative data collected through the structured questionnaire were analyzed using statistical techniques, including descriptive statistics and Multiple regression analysis was employed to identify significant predictors of project duration

3.6.1 Relative Importance Index

Relative importance index was used to determine the significance of the effects of the potential factors on contract time determination, the index was calculated by transforming the five-point rating scale into a relative index for each factor, based on the rankings given by the respondents. By comparing these rankings was able to assess the relative importance of each factor. A higher value of the relative importance index indicates that, the factor contributes a lot on determining contract duration of the project.

Relative Importance Index (RII) for each individual factor, using the following formula, as adopted by Kumaraswany and Chan (1997, 1998), Assaf et al (1995) & Iyer & Jha (2005);

Relative importance index (RII) = W ÷ (H x N) ……. Eqn. (3.1)

Where W is the total weight given to each factor by the respondents, which ranges from 1 to 5 and is calculated by summing the various weightings given to a factor by the entire respondent, H is the highest ranking available (i.e., 5 in this case) and N is the total number of respondents that have answered the question.

3.6.2 Model Development

A time prediction model for building construction projects was developed using multiple regression analysis. The model aimed to predict project duration based on a set of independent variables, including project characteristics, environmental factors, and external constraints. The model development process involved selecting appropriate predictor variables, testing for multi collinearity, and assessing the model's goodness-of-fit and predictive accuracy.

Based on the results of the Relative index value, factors having high influence on contract time determination used to conduct the MLR analysis. It is aimed to compare the predicted and actual durations of each projects using the most significant variables (without using unnecessary variables)

with adequate fit. In MLR, insignificant variable was eliminated with p-value (significance level) and R2 (coefficient of determination). P-value shows significance of the independent variables in the model. R2 determines how much of the variability of the dependent variable is explained by the independent variables.

Multiple Regression Analysis formula used

$$Y = \alpha 0 + \alpha 1X1 + \alpha 2X2 + \ldots + \alpha nXi \quad \text{Eqn. (3.2)}$$

Where, Y=dependent variable

α0=regression constant

α1, 2,3…. n=partial regression coefficient of X1, 2…. Xn

X1, 2, Xn =independent variables

3.7 Validity and Reliability

3.7.1 Validity

The accuracy of an instrument in measuring its intended purpose is referred to as validity. In this study, the content or validity of the data collection tool was ensured by seeking guidance from the research advisor.

3.7.2 Reliability

Reliability refers to the consistency or stability of a measuring instrument. (Jackson S. L., 2009) To measure the consistency of the Questionnaires, the reliability analysis was done using Cronbach's Alpha (α), the most common measure of scale reliability test. According to Hulin et al, 2001, it is generally accepted that a value between 0.6 and 0.7 indicates an acceptable level of reliability, and a value between 0.8 and larger, is a very good level. According to previous research, a value between 0.6 and 0.7 indicates an acceptable level of reliability, while a value between 0.8 and larger indicates a very good level. The alpha values for each variable in this study were all greater than 0.7, indicating that the instrument was considered acceptable in terms of reliability.

$$\alpha = \left(\frac{k}{k-1}\right)\left(\frac{s_y^2 - \sum s_i^2}{s_y^2}\right) \quad \text{..... Eqn. (3.3)}$$

Table 3.1 Factors affecting contract time determinations of CBE building construction Projects and their respective Cronbach's alpha coefficients

Part I Labels (Examining factors affecting contract time determinations of CBE building construction Projects)	**No. of item**	**Cronbach's alpha**
Gilgel-beles Branch Office Construction Project	15	.785
Mota Branch Office Construction Project	15	.806
Debre-Markos Branch Office Construction Project	15	.708
Bahirdar District Office Construction Project	15	.802
Butajira Branch Office Construction Project	15	.702
Jinka Branch Office Construction Project	15	.802
Gidayana Branch Office Construction Project	15	.750
Kake Branch Office Construction Project	15	.899
Hossana Branch Office Construction Project	15	.752
Hawassa District Office Construction Project	15	.705
Kombolcha Branch Office Construction Project	15	.806
Woldia Branch Office Construction Project	15	.708
Shire Endeslase Branch Office Construction Project	15	.809

As shown in the above, Table 3.1 displays the Cronbach's alpha coefficient, this measures the reliability of the variables used in the study. The alpha values for each variable are all greater than 0.7, indicating that the instrument was deemed acceptable.

3.8 Ethical consideration

In this study, the researcher made sure to adhere to ethical guidelines when developing and implementing their data collection methods and techniques. The questionnaire provided participants with an introductory letter that explained the purpose of the study and assured them that their responses would remain confidential and solely used for research purposes. By taking these steps, the researchers aimed to prevent any potential harm or ethical breaches during the research process.

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1 Introduction

The main objective of this chapter is to carefully examine and interpret the outcomes of the research. This includes analyzing various elements such as descriptive statistics, the RII value and predictions of the MLR analysis.

To summarize, out of the 40 questionnaires that were given to participants, 37 were filled out and returned, accounting for 92.5% of the total. Only 3 questionnaires were not returned, so due to this, the analysis was performed using the 37 completed questionnaires, resulting in a response rate of 92.5%.

4.2 Demographic Information of Respondents

The relevance of the respondents in completing the questionnaire on Assessment of potential factors affecting contract time determination in the case of the CBE building construction projects was evaluated by examining the background information of the participants, as indicated in table 4.1 below.

Table 4.1 Demographic Information of Respondents

Label		Count	Column N %
Educational level	Degree	20	54.1%
	Masters	17	45.9%
Experience in Building construction work (in years)	> 10 years	6	16.2%
	1 - 3 years	7	18.9%
	3 - 5 years	13	35.1%
	5 -10 years	11	29.7%
Experience in Commercial Bank of Ethiopia (in years)	> 10 years	3	8.1%
	1 - 3 years	9	24.3%

	3 - 5 years	9	24.3%
	5 -10 years	16	43.2%
Current position in CBE	Associate Engineer	13	35.1%
	civil engineer	1	2.7%
	Director	1	2.7%
	Junior Engineer	6	16.2%
	Manager	1	2.7%
	Project Manager	4	10.8%
	Senior Engineer (Civil Engineer /Quality Management Engineer)	11	29.7%

Following the demographic questions, the education level of the participants was assessed. The findings revealed that 17 respondents (45.9%) held a master's degree, while 20 respondents (54.1%) held a bachelor's degree.

When we come to the experience of respondents in building construction work, respondents who have 3 - 5 years and 5 - 10 years take 13(35.45%) and 11(29.7%) respectively, being the majority of the participants. Whereas, respondents with more than 10 years of experience take 6(16.2%), and the remaining 7(18.9%) respondents have 1- 3 years of experience. This implies that 80% of the respondents have more than 3 years of experience in building construction work. This indicates that the respondents have enough experience with construction projects and the evidence they provided can be trusted on.

The respondent's experience in the Commercial Bank of Ethiopia is the other demographic information requested. The results indicate that number of the participant respondents who had 1-3 years of work experience in CBE is 9(24.3%), and respondents who had 3-5 years of work experience in CBE represented 9(24.3%) of the respondents, and 16(43.2%) of the participants had 5-10 years of experience in

CBE. The remaining 3(8.1%) of the respondents in the study had more than 10 years of working experience of in CBE. This implies that 80% of the respondents have more than 3 years of experience in CBE which implies that the respondents are eligible for this research.

The last demographic item is the respondent's current position in CBE. The respondents' current job titles are categorized as Director, Manager, and Civil Engineer. Each taking 1(2.7%), Project Manager 4(10.8%), Junior Engineer 6(16.2%), Associate Engineer and Senior Engineer (Civil Engineer /Quality Management Engineer) take 11(35.1%) being the majority of the participants.

4.3 Descriptive Results and Analysis

4.3.1 Identifying factors affecting CTD of CBE building construction projects

This thesis aimed to offer valuable insights into the potential factors influencing the determination of contract time for building construction projects undertaken by the Commercial Bank of Ethiopia. The literature review highlighted a range of factors impacting contract time determination, with particular emphasis on those relevant to CBE building construction projects. These factors include project size and scope, project complexity, availability of materials, availability of equipment and labor, site location and accessibility, presence of underground water, seasonal weather conditions, project urgency, project quality, changes in local regulations, lengthy permit processes, contractor quality, and political or social unrest.

4.3.2 Significance Factors affecting CTD of CBE building construction Projects

Furthermore, a questionnaire survey was conducted to assess the magnitude of the above-listed potential factors affecting contract time determination from professionals involved in the Commercial Bank of Ethiopia's building construction projects.

The RII (Relative Importance Index Value) of factors that are considered by practitioners as the determinant of the construction contract period for each project show as:

Relative Importance index of potential factors affecting contract time determination of each CBE Building projects.

Table 4.2 (a) and (b), relative Importance index for potential factors affecting contract time determination of each CBE Building projects.

Factors which affects	**CBE construction projects**						
contract time duration	**GB**	**M**	**DM**	**BA**	**BU**	**J**	**G**
Project Size/Scope	0.35	0.40	0.50	0.79	0.46	0.39	0.35
Complexity of the Project	0.36	0.36	0.46	0.76	0.44	0.37	0.36
Material Availability	**0.85**	**0.84**	**0.82**	0.79	**0.82**	**0.83**	**0.80**
Equipment Availability	0.59	0.67	0.65	0.67	0.69	0.68	0.67
Labor Availability	**0.81**	**0.82**	0.74	0.77	0.73	0.74	0.79
Site Location	0.73	0.68	0.65	0.74	0.58	0.76	**0.80**
Site Accessibility	0.51	0.50	0.51	0.64	0.59	0.63	0.67
Occurrence of Underground Water	0.66	0.69	0.52	0.69	0.55	0.60	0.61
Heavy RF Season	0.46	0.44	0.53	0.60	0.66	0.68	0.65
Project Urgency	0.60	0.61	0.62	0.69	0.64	0.68	0.69
Quality of Project	0.66	0.66	0.61	0.69	0.62	0.62	0.63
Change in Local Low	0.62	0.61	0.64	0.59	0.53	0.53	0.52
LC Long Permit Process	0.59	0.60	0.61	0.67	0.69	0.68	0.69
Quality of the Contractor	0.67	0.67	0.63	0.69	0.64	0.65	0.65
Political/Social Unrest	0.64	0.68	0.68	0.53	0.53	0.54	0.69

(a)

Factors which affects	**CBE construction projects**							
contract time duration	**KA**	**HO**	**HA**	**KO**	**WO**	**SE**	**HU**	**MK**
Project Size/Scope	0.39	0.30	0.75	0.48	0.38	0.47	0.37	**0.84**
Complexity of the Project	0.36	0.30	0.73	0.46	0.36	0.45	0.35	**0.83**
Material Availability	**0.83**	**0.82**	0.72	**0.82**	0.77	**0.83**	**0.83**	0.75
Equipment Availability	0.66	0.65	0.56	0.60	0.59	0.69	0.62	0.55
Labor Availability	**0.80**	0.79	**0.80**	0.77	0.76	0.77	0.78	**0.80**
Site Location	0.75	0.63	0.68	0.70	**0.81**	**0.86**	**0.84**	**0.82**
Site Accessibility	0.62	0.64	0.67	0.61	0.64	0.62	0.61	0.67
Occurrence of Underground Water	0.46	0.51	0.69	0.68	0.53	0.52	0.50	0.51
Heavy RF Season	0.55	0.60	0.61	0.63	0.64	0.60	0.61	0.60
Project Urgency	0.60	0.65	0.69	0.65	0.67	0.65	0.63	0.69
Quality of Project	0.62	0.55	0.69	0.65	0.69	0.69	0.68	0.69
Change in Local Low	0.48	0.51	0.53	0.53	0.50	0.51	0.52	0.51
LC Long Permit Process	0.62	0.63	0.64	0.62	0.67	0.62	0.62	0.68
Quality of the Contractor	0.65	0.55	0.69	0.66	0.69	0.68	0.66	0.69
Political/Social Unrest	0.69	0.66	0.52	0.54	0.75	0.74	0.73	0.79

(b)

Whereas,

GB - Gilgel-beles Branch Office Construction Project (B+G+M+3)

M - Mota Branch Office Construction Project (B+G+M+3)

DM - Debre-Markos Branch Office Construction Project (B+G+M+5)

BA - Bahirdar District Office Construction Project (B+G+M+12)

BU - Butajira Branch Office Construction Project (B+G+M+5)

J - Jinka Branch Office Construction Project (B+G+M+3)

G - Gidayana Branch Office Construction Project (B+G+M+5)

KA – Kake Branch Office Construction Project (B+G+M+2)

HO – Hossana Branch Office Construction Project (B+G+M+2) (only finishing work)

HA – Hawassa District Office Construction Project (B+G+M+11)

KO – Kombolcha Branch Office Construction Project (B+G+M+5)

WO – Woldia Branch Office Construction Project (B+G+M+3)

SE – Shire Endeslase Branch Office Construction Project (B+G+M+5)

HU – Humera Branch Office Construction Project (B+G+M+3)

MK – Mekelle District Office Construction Project (B+G+M+17)

Through statistical analysis, several significant factors affecting project duration were identified, including project size/scope, complexity of the project, material availability, labor availability, site location, site accessibility, occurrence of underground water, heavy rainfall season, project urgency, quality of the project, changes in local laws, letter of credit (LC) permit process duration, contractor quality, and political/social unrest.

Based on the results obtained from the relative importance Index value as shown in the table 4.2 (a) and (b), the underlined results are the most significant potential factors that affects contract time determinations of the specified project. And Based on the rankings given by the respondents, as shown in the table 4.2 (a) and (b), the researcher found that Project size/scope, Material availability, Labor availability, and Site Location are the four most common significant factors that affect the determination of construction contract period in the case of CBE building construction projects that are conducted in the study. Whereas, Change in local law, and Occurrence of underground water remain the least common significant factors that affect the determination of construction contract period. Moreover, the study discussed the four most significant factors that need to be considered when planning the construction contract period in the case of CBE-Building Construction projects as follow.

- **Project size/scope**

Project scope includes the objectives, deliverables, and tasks necessary for its completion, whereas project size refers to the actual size and complexity of a construction project. The amount of time needed to successfully complete a project is largely influenced by the size and scope of the project. CBE building Project size has ranged from (B+G+M+2) to (2B+G+M+17) the higher the scope and project size, the higher the project duration should be.

- **Material Availability**

Material requirement and availability play a crucial role in contract time determination of construction projects. The timely availability of materials is essential for the smooth progress of construction activities and meeting project deadlines. The research found that some ways such as Material procurement, Material delivery, Material quality, Material storage and handling, Material availability, Material substitutions, affect the project durations of CBE building projects.

- **Labor Availability**

Labor availability can also have an impact on contract time determination through its impact on project productivity, in addition to project size/scope and material availability. The workforce's efficiency and availability have a direct bearing on how quickly construction projects are completed. For instance, a lack of experienced workers may result in cost overruns, timetable delays, and decreased productivity.

- **Site Location**

The site location of a construction project is very important in determining the project's contract time. The site's location and a number of other factors may significantly affect how quickly a building project moves along. This study looked at how site location influences how construction project timelines are determined, and one of the main ways that accessibility and transportation due to remote sites affect project timelines is through site location. The mobilization of resources and materials

can be significantly impacted by the site's accessibility and the local transportation system.

4.3.3 Multiple Regression Model Development

The multiple regression model developed for predicting project duration demonstrated a strong level of explanatory power, as evidenced by the high coefficient of determination (R^2). The model effectively captured the variance in project duration explained by the selected predictor variables.

The results highlighted the relative importance of each predictor variable in influencing project duration. The common significant Factors has been selected from the highest Relative Importance index, in order to perform the multiple regression analysis. Thus, multiple regression analysis is used to show the relationship between the independent variables and dependent variable (y)

Therefore In this case the dependent variable is y (actual project duration) and the independent variables are taken (Project Scope, Material availability, Site location, Labor availability) Since those selected variables has a qualitative measure, Quantitative measure was set to the potential factors by their level of effect. Which ranges from (0-0.25) low, (0.25-0.50) medium, (0.50-0.75) High and (0.75-1) very high. The Quantitative measure was set to those factors by Expertise who are participated on the Estimation of contract time duration for CBE building construction Projects. Since the P value for variables (site location and Labor availability was > 0.05) (i.e., if the P value of the independent variable is > 0.05 then, the independent variable has no significant effect on the dependent variable.) so that those variables were Excluded.

Therefore, only two variables that have a p value < 0.05 (Project scope and Material availability) were used to perform Multiple Regression Analysis.

Actual project duration used in the study:

Table 4.3 Actual Duration of CBE building construction

Project name	Duration (calendar days)
Butajira Branch Office construction project	450
Hawassa district office building project	900
Hossana branch office building project	365
Kake branch office building project	540
Jinka Branch office building project	450
Bahirdar District office building project	900
Mota Branch office building project	365
Gilgelbeles Branch office building project	540
Deberemarkos Branch office building project	540
Mekelle District office building project	900
Humeraa Branch office building project	540
Wodia branch office building project	540
Shire endesilase branch office building project	540
Gidayana brncj office construction project	450

Results of the Multiple Regression Analysis:

Table 4.4 Statistics of Multiple Regression

Regression Statistics	
Multiple R	0.878888593
R Square	0.772445159
Adjusted R Square	0.734519352
Standard Error	93.42135662
Observations	15

Table 4.5 Results of Multiple Regression Analyses for two significant factors, i.e., Project scope and Material availability

	Coefficients	*P-value*
Intercept	526.1891993	0.017662233
project scope	742.4732302	0.000187045
Material Availability	-602.4210282	0.027196732

As shown in the above P-values for both variables are <0.05 which indicates that the independent variables have significance impact on the dependent variable. And The R^2values is 0.77 which is close to 1, this means the dependent variable can be explained by the variance of the independent variables.

Residual output

Observation	*Predicted Project duration*	*Residuals*
1	387.4785514	62.52144857
2	872.1967621	27.80323795
3	401.4837716	-36.48377162
4	482.7337047	57.26629527
5	519.8573662	-69.85736624
6	839.9650996	60.03490038
7	475.7310946	-110.7310946
8	378.3653303	161.6346697
9	461.7258744	78.27412556
10	802.8414381	97.15856189
11	549.9784177	-9.978417651
12	566.0942489	-26.09424887
13	654.3467921	-114.3467921
14	587.1020792	-47.10207916
15	580.0994691	-130.0994691

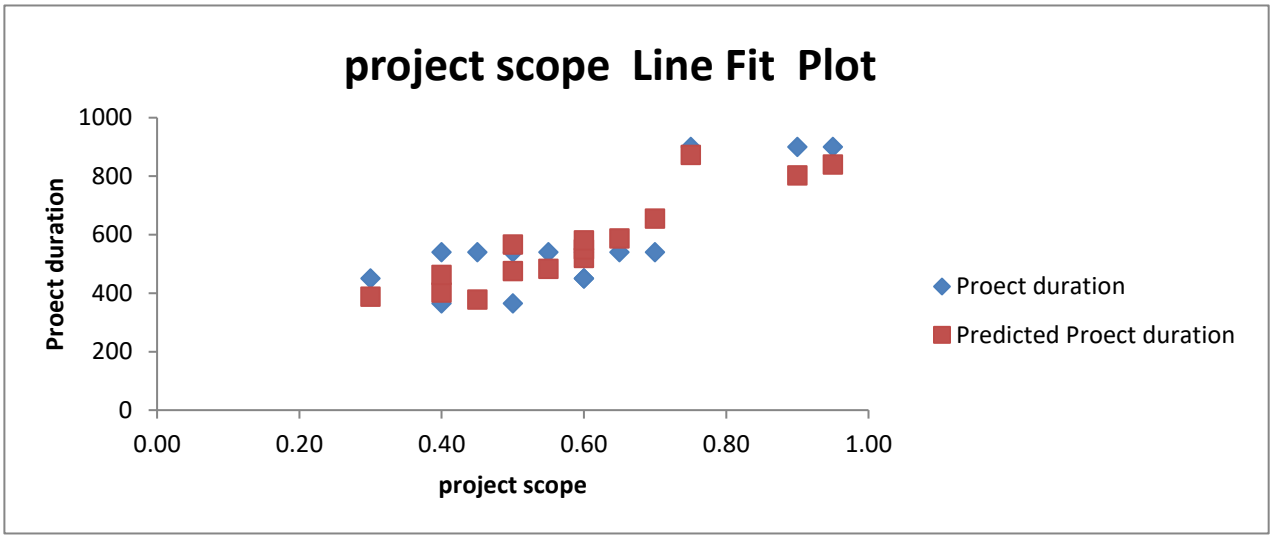


Figure 4.1 Graphical presentation of the impact of project scope on project duration

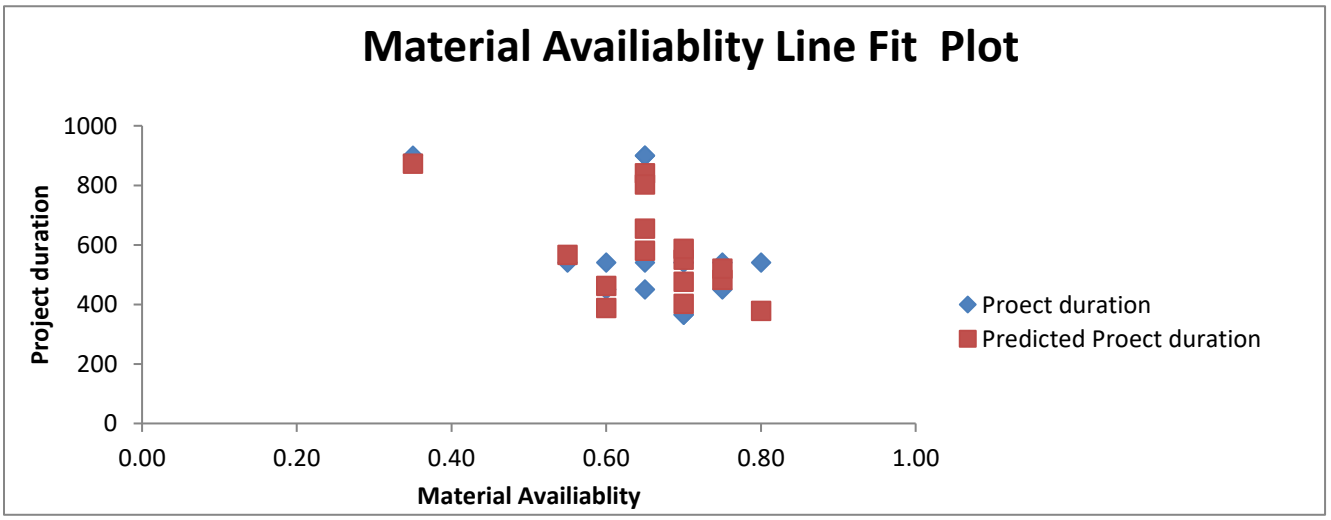


Figure 4.2 Graphical presentation of the impact of material availability on project duration

Developed Time prediction model

As it is expressed above, the P-values for both variables are <0.05, which indicates that the independent variables have a significant impact on the dependent variable.

And the R2 value is 0.77, which is close to 1, which means the dependent variable can be explained by the variance of the independent variables.

As depicted in Figure 4.1 above, there is a linear relatiom between the dependent variable (project duration) and the independent variable (project scope). Consequently, an increase in the project scope corresponds to an increase in project duration. Thus, the coefficient for project scope is positively attributed.

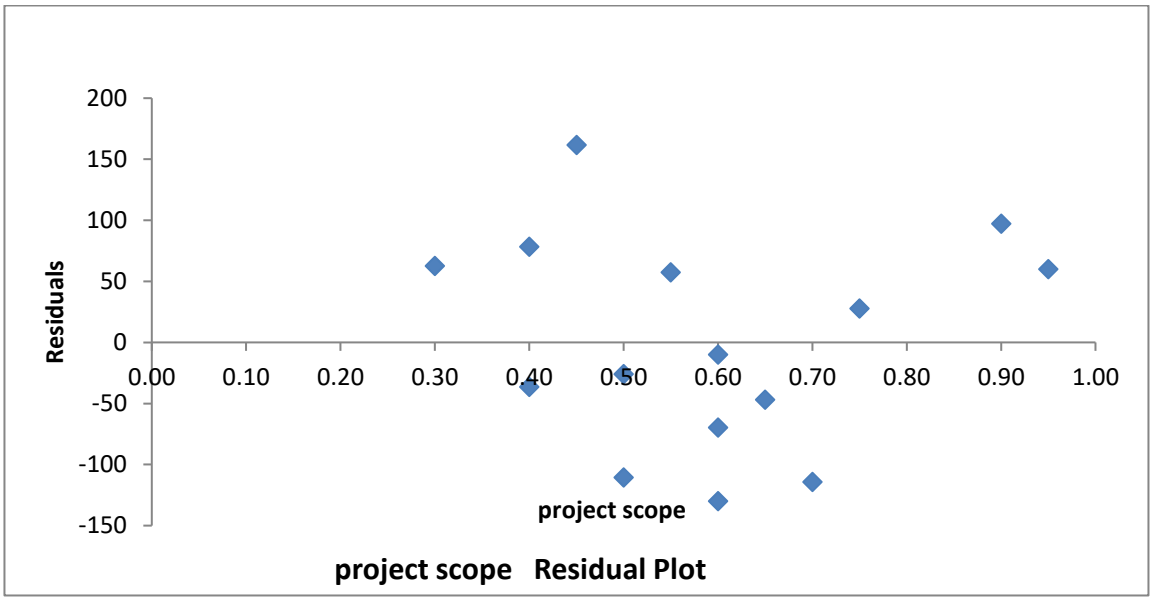
Contrarily, as illustrated in Figure 4.2, the relationship between the dependent variable (project duration) and the independent variable (material availability) is nonlinear. In cases where material availability at the project site is abundant, project duration tends to decrease. Conversely, when material availability is limited, project duration tends to increase. Therefore, the coefficient for material availability is negatively associated.

Therefore, the developed time prediction model is

$$\mathbf{Y} = 526.12 + 742.47\mathbf{X1} + 602.42\mathbf{X2} + \ldots + \boldsymbol{\alpha}\mathbf{nXi} \quad \textbf{Eqn. (3.4)}$$

Homoscedasticity: The spread or dispersion of the residuals should remain relatively constant across different predicted values. In other words, there should be no visible cone shape or fan shape in the plot. Homoscedasticity suggests that the variability of the residuals is consistent across the range of predicted values, which is desirable for a well-fitted model.

As showed below on figure 4.2 below, it appears that the spots are diffused and do not form a clear specific pattern, so it can be concluded that the regression model does not have a heteroscedasticity problem.



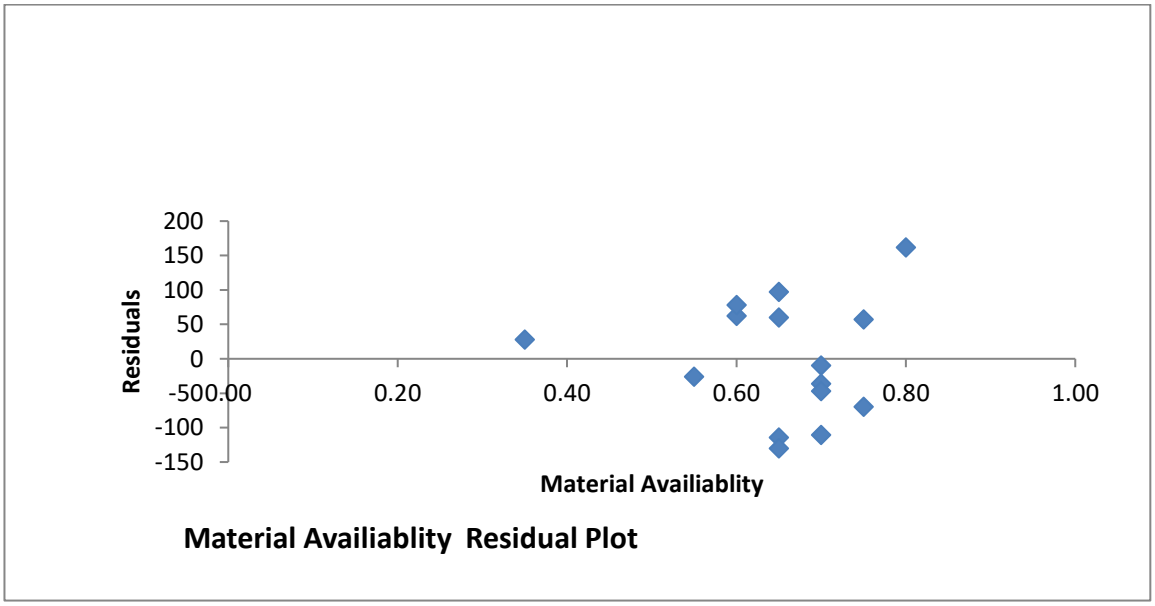


Figure 4.2 Project scope and Material availability residual plot.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, the development and application of a time prediction model for building construction projects using multiple regression analysis, as demonstrated in this thesis, offer significant insights and benefits for the construction industry, particularly within the context of the Commercial Bank of Ethiopia's building projects. Through comprehensive data collection, analysis, and model development, several key findings and conclusions emerge

- ✓ **Identification of Significant Factors**: Through the analysis, several significant factors affecting project durations were identified. These factors include project scope, material availability, labor availability, site characteristics, and external factors such as regulatory constraints and political/social unrest. Understanding and accounting for these factors are crucial for accurate time prediction and project planning. Moreover, the study revealed highly significant factors affecting CTD of individual projects according to their Relative importance index. (Project size/scope, material availability, labor availability, and site location) are Common highly significant factors that are investigated as highly affecting CTD of CBE building construction projects.

- ✓ **Model Effectiveness:** The multiple regression analysis-based time prediction model proved to be effective in estimating project durations for the Commercial Bank of Ethiopia's building construction projects. By incorporating various independent variables such as project scope, material availability, labor availability, and site characteristics, the model accurately predicted project timelines.

- ✓ **Practical Implications:** The findings of this study have practical implications for project managers, construction companies, and stakeholders involved in building construction projects. By utilizing the developed time prediction model, stakeholders can better plan and manage project timelines, allocate resources efficiently, and mitigate potential delays.

- ✓ **Enhanced Decision-Making**: The implementation of a robust time prediction model facilitates informed decision-making throughout the project lifecycle. Project managers can use the model outputs to identify critical paths, anticipate resource requirements, and proactively address potential delays, ultimately enhancing project efficiency and success.

Overall, the findings and insights presented in this thesis contribute to the body of knowledge in construction project management and provide valuable tools and methodologies for improving the accuracy and efficiency of time prediction in building construction projects.

5.2 Recommendation

The following points are recommended such as:

- ✓ **Adopt a Time Prediction Model:** use a time prediction model as a valuable tool for accurately forecasting the duration of building construction projects. Incorporate the model into the bank's project planning and management processes to improve scheduling, resource allocation, and overall project performance.

- ✓ **Integration with Project Management Systems:** Integrate the time prediction model into existing project management systems and workflows within the Commercial Bank of Ethiopia. Ensure seamless compatibility and interoperability with project management software platforms to streamline data exchange, analysis, and reporting processes.

- ✓ **Invest in Data Collection and Management:** Allocate resources to enhance data collection mechanisms and establish robust data management systems. Ensure that comprehensive project data, including project scope, material availability, labor availability, and site characteristics, are consistently collected and updated to support the time prediction model's accuracy and reliability.

- ✓ **Continuous Model Refinement**: Commit to ongoing refinement and calibration of the time prediction model based on real-time project data and feedback from construction projects. Regularly review and update the model's variables, coefficients, and algorithms to reflect changing project dynamics and industry trends accurately.

- ✓ **Capacity Building and Training:** Provide training programs and capacity-building initiatives for project managers and construction professionals on the use and interpretation of the time prediction model. Enhance stakeholders' understanding of the model's methodologies, assumptions, and implications to empower informed decision-making and effective project management.

- ✓ **Performance Monitoring and Evaluation:** Establish mechanisms for monitoring and evaluating the performance and effectiveness of the time prediction model in predicting project durations.

5.3 Future Research Directions:

While this thesis has made significant strides in developing a time prediction model for building construction projects, there remain opportunities for further research and refinement. Future studies could explore additional variables, refine the model methodology, validate the model across diverse project contexts, and assess its applicability in other industries and geographical regions.

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APPENDICES

Factors that affect Contract Time Determination (From the literature Reviewed)

Journals	Factors affecting contract time determination
Stoll, B. L, et.al. 2006	Geophysical (Weather, Location, Environmental), Construction Operations (Mobilization, Materials, Utility Relocation, Conflicting Operations, Night/Weekend Work), Project Characteristics (Project Type, Dominant Operations) Economic/Legal (Budget, Letting Time, Permits) Miscellaneous (Project Size, Operation Overlays, Project Urgency, Community Events)
Chan and Kumaraswamy (	Project Scope- (construction cost, gross floor area, number of storeys, building type, contract procurement systems, and variations. Project complexity - (client's attributes , site conditions/ site access problems, build ability of project design, quality of design co-ordination, quality management . Project environment – (physical, economic, socio-political, industrial relations. Management attributes – (client/design team management attributes, construction team management attributes, communication management for decision making, organizational structures and human resources management, productivity. Other factors
Chauhan, R.I, and Chiang, W.C. (1989)	Project Relations Factors – (Lack of project information and uncertainties of details, work plan, construction site problems, defining the project finish date, contract conditions. Environmental Related Factors – (Economic and commercial factors, socio-cultural factors, legal/political factors. Management Related Factors – (Leadership in management , communication and motivation sufficiency, flexibility in organization, insufficient and careless management systems , control systems, financial factors.

Ahuja, H.N., and Nandakumar, V. 1984	Factors that ultimately affects site productivity - (work space availability, attendance of operatives, learning curve, weather, labor relations, project complexity, foundation condition, effectiveness and supervision
Singh, .S. (1984)	Physical – (Forms of construction, size of project, number of story, and existence of basement. Managerial – (Contractual system, tendering procedure, management efficiency of the construction form, development of coordination between the various agencies
Sadashiv, M.C. (1979)	The height of a building (NoF) Project complexity (construction technique, major equipment needed, construction sequence) The number of major fishing works The location of building (whether or not restrictions of easements exist .Availability of services Supply of resources, Use of major equipment and productivity of site.
(Odabaşi, 2009)	Cost, Cash flow, Productivity of on-site, Procurement Project related Factor, Technology and Methodology of Construction, Experience, Coordination, Weather Construction site and the degree of completeness of design project.
(Gondy & Hildreth 2007)	Curing time and waiting periods between successive paving courses or betweenconcrete placement operations, as well as specified embankment settlement periods, Seasonal limitations for certain items when determining both thenumber of days the contractor will be able to work as well as production rates, Conflicting operations of adjacent projects, both public and private; Minimize annoyances in residential areas, Minimize traffic disruption and delay in high traffic areas, Political sensitivity and public awareness, Coordination withadjoining projects to provide usable roadway sections to avoid conflicting operations, Inclement weather conditions, project location, permit application processes and submittal review time,

	material acquisition, utility relocation, Time of the year of the letting as well as duration of the project.
Tornton (1988)	Project size (small, medium, large, super, and mega), type of construction, type of contract used, type of materials used, local conditions, administrative conditions of the contract, project delivery method

PROJECT DESCRIPTION AND STATUS

No	Project description	Floor height	Contract time		Total Duration Given	Total Time Extension Given	Completion date after Additional Time Given	Physical status to date (%) as of June 2023
			Initial date	Completion date				
1	Motta branch office project	B+G+M+3	May 21,2023	May 21,2024	365	8	May 29,2024	80.51%
2	Humera branch office building project	B+G+M+3	December 10,2019	June 01,2021	540	27	June 28,2021	9.77%
3	Woldia branch office building project	B+G+M+3	December 18,2019	June 10,2021	540	116	October 04, 2021	19.31%
4	Mekelle district office building project	2B+G+17	September 20,2018	March 07,2021	900	190	September 12,2021	17.01%
5	Kombolcha branch office project	B+G+M+5	January 30,2017	July 24,2018	540	54	September 17,2018	98.57%
6	Shire endaselassie branch office project	B+G+M+5	January 10,2017	July 04,2018	540	45	August 18,2018	95.11%
7	Gondar District office building	B+G+4	September 03,2012	August 24,2014	720	657	June 11,2016	100%
8	Gilgel beles branch office building project	B+G+M+3	December 20, 2019	June 12, 2021	540	426	August 12, 2022	39.40
9	Bahirdar district office building project	2B+G+12	April 9, 2018	September 25, 2020	900	885	February 28, 2023	27.70
10	Hawassa district office project		2B+1SB+G+11	April 20, 2018	October 5, 2020	900	388	October 28, 2021
11	Butajira branch office building project		B+G+M+4	May 16,2018	August 8, 2019	450	680	June 18,2021
12	Jinka branch office building project		B+G+M+3	November 05,2020	August 29, 2019	450	532	February 11, 2021

13	Hossaena office building project		B+G+2	November 05,2020	November 04,2021	365	192	May 15,2022
14	Gida Ayana branch office project		B+G+M +2	August 3, 2018	October 26, 2019	450	512	March 21, 2021
15	Kake branch office project		B+G+M +2	February 28, 2020	August 20, 2021	540	176	February 12, 2022