

# **ADDIS ABABA UNIVERSITY**

## **SCHOOL OF COMMERCE**



### **THE PRACTICE OF TIME MANAGEMENT IN CONSTRUCTION PROJECTS: CASE STUDY OF BOLE-LEMI PHASE II AND KILINTO INDUSTRIAL PARK CONSTRUCTION PROJECTS**

A research submitted to Addis Ababa University, School of Commerce in partial fulfillment of the requirements for the Master of Arts in Project Management

by

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The Practice of Time Management in Construction Projects: Case Study of Bole-Lemi  
Phase II and Kilinto Industrial Park Construction Projects

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2018

## **Declaration**

I hereby declare that the study which is being presented in this research entitled “The Practice of Time Management in Construction Projects: Case Study of Bole-Lemi Phase II and Kilinto Industrial Park Construction Projects” is original work of my own. It had not been presented for a partial fulfillment for any educational qualification at this university or any other and in any projects by any means, and all the resources materials used for this research had been accordingly acknowledged.

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Yegetahun Agegnehu

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Date

## **Declaration**

I hereby declare that the study which is being presented in this research entitled “The Practice of Time Management in Construction Projects: Case Study of Bole-Lemi Phase II and Kilinto Industrial Park Construction Projects “is conducted by Yegetahun Agegnehu for the partial fulfillment of the requirements for the award of Master’s degree in Project Management. To the best of my knowledge it is original work carried out by him. It had not been presented for a partial fulfillment for any educational qualification at this university or any other and in any projects by any means.

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Seifu Mamo

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Date

## **Abstract**

Time is one of the major constraints in projects. However, delivering construction projects within envisioned time is becoming ever challenging. This study tries to put light on how this important constraint is managed with respect to project time management functions and contractual requirements. The study also investigated as how delay and extension of time is assessed and analyzed.

Taking two construction projects namely Bole-Lemi Phase II and Kilinto Industrial Park construction projects as cases, the research attempts to make an in-depth assessment of construction project time management practices. Construction time management process was developed consisting mainly of planning, scheduling and control of time and the associated tasks. The research methodology adopted a qualitative approach for data collection and analysis. All personnel from the contractors, consultant and employer taking part in the planning and monitoring of the project time have been interviewed. By interviewing the personnel, attending progress meetings and reviewing of the project documents and archives, the research explored the time management functions of the projects.

It was found that the time management practice substantially lacked the necessary diligences required from the contractors and the consultant. The work programmes were not being updated in accordance with the requirements of the contract. Estimation of progress was found to be an ad-hoc. The assessment and analysis of extension of time be re short of standard methods. Most of the methods, techniques and tools used for time management were not standardized. It is recommended that time management taken seriously and become specialization as core function of project management.

## **Dedication**

~ This research is dedicated to the memory of my mother, Sara Gebru, who was fervently fighting and struggling with terrible disease while I was undertaking and defending this research until she passed away on July 22, 2018. ~

**Sara Gebru (1952 – 2018)**

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## **List of acronyms and abbreviations**

CPM	Critical Path Method
DATs	Delay Analysis Techniques
DB	Dispute Board
DB	Design - Build
DBB	Design – Bid - Build
EOT	Extension of Time
FIDIC	Fédération Internationale des Ingénieurs-Conseils
IPDC	Industrial Parks Development Corporation
LADs	Liquidated and Ascertained Damages
LOB	Line of Balance
Ms Project	Microsoft Project
PERT	Program Evaluation and Review Technique
PMI	Project Management Institute
P3	Primavera Project Planner

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## **Chapter 1**

### **1. INTRODUCTION**

The construction industry has significant role in the economy of many countries. It contributes major part in the Gross Domestic Product (GDP) of considerable number of countries and for this reason, the industry is essential for the economic development of many countries. Ethiopia is not an exception. Rather the construction industry has been at the centre of major driver contributing for the economic development of Ethiopia. Owing to the fact that the nation needs many infrastructures and facilities, the significance of the construction industry will continue to be remarkably important in the future.

With ever-increasing number of construction projects and the huge demand of delivering the projects, the importance of having construction projects managed within the stipulated parameters/constraints are vital. One of the challenges the construction industry is facing is delivering projects within time which is one of the major constraints. Thus, effective time management for the construction project is important in curbing the risk of the delayed completion project.

Time is of huge importance in any project. The time for performance of a construction project is usually of the essence to the employer, contractor and other stakeholders involved in construction projects. Planning and scheduling are important in construction projects as they are the means of project time management. In construction projects whose contractual conditions are for instance Fédération Internationale des Ingénieurs-Conseils, abbreviated as FIDIC conditions, work programme is mandatory requirement. The party in the construction industry at the centre of the preparation of work programme is the contractor.

However, contractors usually don't prepare robust schedule and face lots of problem as the result. It is not unusual even to lose some rights and entitlements due to lack of good schedules.

In many construction projects work programme is merely Gant charts showing sequential activities and without the critical path established. Furthermore, they are not updated and hence don't reflect up-to-date situations of the project. So, working on obsolete work programme is not uncommon.

Delay in projects cause lots of problems in the parties to the contract and contractually the events that led to the delay need to be assessed so that the risks can be allocated accordingly for the contractual consequences of time and costs. It is almost impossible to determine and allocate as who caused delay without state-of-the-art schedule in place. This has made it crucial for contracting parties to analyze project delays for purposes of making right decisions on potential time and/or cost compensation claims. Many disputes have emanated from lack of appropriate and acceptable practice of delay analysis techniques.

There are lots of planning and scheduling techniques in the construction industry. The techniques and tools are under steady changes and progresses. Posed with such requirements and the recent developments of scheduling tools such as Microsoft Project (Ms Project) and Primavera, there is a tendency of using such scheduling tools in construction projects. The most customary software in use in construction projects in Ethiopia is Ms Project.

## **1.1 Background of the Study**

This study tries to capture the practice of an important constraint in construction projects namely time. In light of the tools and techniques for planning and scheduling, contractual

requirements and delay analysis, examining the case of Bole-Lemi Phase II and Kilinto Industrial Park construction projects, the study tries to assess as whether there are sufficiently detailed and elaborated schedules in place or not. Moreover, taking these projects into considerations, the study tries to make in-depth assessment of the practical situations of the projects with respect to the management of time.

## **1.2 Statement of the Problem**

Project time management is the allocation of the necessary time for the completion of a project, planning the project accordingly and then controlling the project followed by taking corrective measures whenever the project is facing delays. However, time overruns or delays occur in lots of construction projects. Additionally, the tools that are meant for the proper management of time in projects are not sufficient enough or don't exist at all in some instances. But many disputes among construction parties can be traced back to delays. In the first-place projects need to have realistic time allocated for their completions. Once the time is allocated, the necessary planning of time need to be done. The project time should then be controlled and monitored with all the necessary tools in place. Nevertheless, this is not the case in most of the construction projects and considerable number of projects face time related problems. Having observed many problems associated with the management of time in the construction industry in the past 15years of project management endeavour, the researcher was motivated to study the area and issues related with time management. Some issues and problems related to time management can be associated with the way construction projects are conceived and others with the way practitioners are managing time during implementation of construction projects. Poor management of project time can be attributed to lack of good practice of work programme, lack of

employing the necessary scheduling tools and lack of proper delay analysis in the midst of delays happening in the project.

One case related with the management of time of Bole-Lemi Phase II and Kilinto Industrial Park Construction Projects came to the attention of the researcher which troubled the parties and stakeholders in the decision making of extension of time. Assessment of the time management further revealed that the projects were not having full-bodied work programme without which granting the extension of time is difficult. Even though the contractors were having concrete incidents that caused the delays of the projects, they were not able to quantify and show their effect on the schedule and hence on the time allocated for the projects. Since then the researcher started asking “what was supposed to be done with regards to the time management of the projects?” and “which time management functions were not properly executed or not executed at all?”. The projects being executed by international contractor and consultant and financed by the world bank triggers more questions as how such problems happened as they are well-experienced in the management of huge projects. The researcher was then motivated to make an in-depth assessment of the situation which he believed will encourage others to give emphasis for the matter.

### **1.3 Research Question**

According to PMBOK guide (2013), project is a temporary endeavor undertaken to create a unique product, service, or result. The temporary nature of projects indicates that a project has a definite beginning and end. The end is reached when the project’s objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists. Therefore, one of the major

constraints that need to be managed is time. This is why one of the success parameter in any project is completion of the project within time.

Looking into the various time related requirements of construction projects, the level of seriousness required in the management of time is massive. Despite time management in construction projects is the core responsibility of the contractor, the Engineer and the Employer have also huge responsibilities. So now the question is: are all parties managing the time with such strictness level? The basic research questions as how time is managed construction projects, the research questions therefore revolve around such questions as: Is there standard method of project planning? Do parties in the contract and stakeholder employ the necessary time management tools? Drawn from the research questions here under are the specific objectives of this study.

#### **1.4 Research Objective**

The purpose of this master research work is to assess the practice of time management in the construction industry. It tries to investigate as how time is managed in construction projects with the frameworks of the contractual requirements, by putting light on two industrial park construction projects. The core objective is the study of practical time management processes required by the projects. The specific objectives are:

- Assessment of time planning in light of contractual requirements;
- Assessment of the practice of scheduling including the practice of developing work programme and studying the types of tools and techniques employed in the development of the work programmes;
- Investigating the application of project time management tools and techniques by the three major parties namely Contractors, Consultant and Employers; and

- Assessment of the practice of project time monitoring and control specifically,
  - As what tools and techniques are employed in controlling and monitoring project time;
  - How the progress of the projects estimated; and
  - As which delay analysis tools and techniques are used in construction projects.

### **1.5 Significance of the Study**

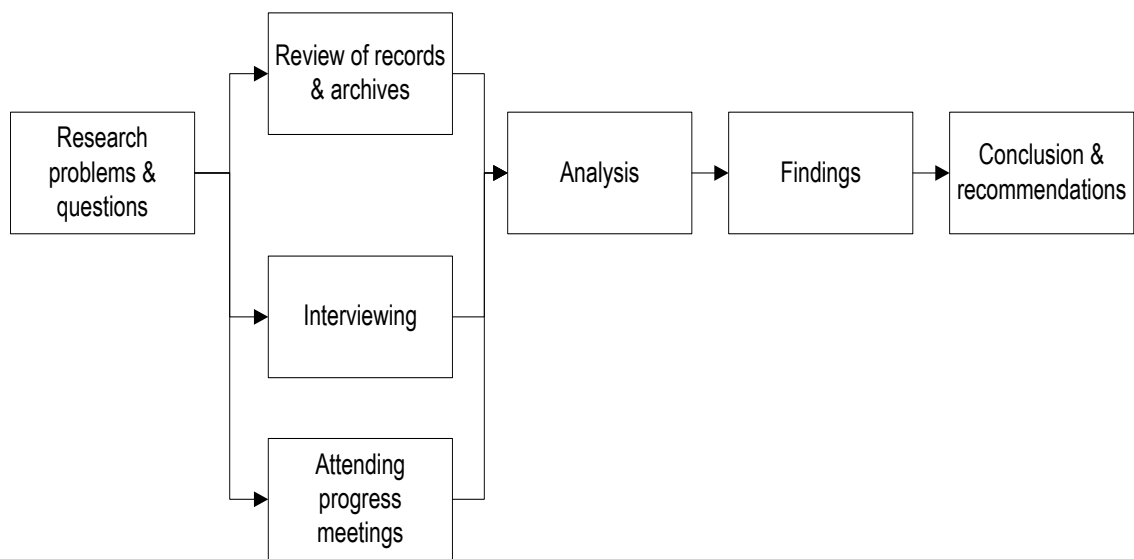
The propose and objectives of project control in construction industry are to make sure that construction projects will be finished within time and cost and reached the plan. Achieving to this aim is has become ever increasing difficult due to many factors amid the fact that projects are ever badly needed to be completed within time. It is very crucial, therefore that this matter be investigated and solutions suggested for improvements. Particularly in Ethiopia where many construction projects are in progress and many more to come, the significance of studies such as this one is very massive.

### **1.6 Limitation of the Study**

Due to the limitation in the time and scope of the study, the research only focused on two industrial park construction projects. This slightly puts limitation on extrapolating the finding to other construction projects. This is a major weakness of case studies. By giving the necessary depth for the study, the researcher has made the necessary effort to curb the limitations.

## 1.7 Outline of the Research

In the introduction is laid the introductory concepts of the research followed by literature reviews followed by the reviews of literature is in Chapter 2. Chapter 3 is dedicated to methodologies whereby the research design is explained, as how the research approach was selected and subsequent research processes are highlighted. Chapter 4 is dedicated to the results of the research. In chapter 5 discussions, conclusions and recommendations are made and presented. Figure 1 depicts the research process used for the study.



**Figure 1: Outline of the research process**

## **Chapter 2**

### **2. LITERATURE REVIEW**

#### **2.1 Introduction**

In this section of the study reviews of books, journals and internet was made. Reviews of related topics in the area of the study are presented here. In the following sections of the study, each of the time management functions are discussed in detail as they will be the building blocks of the time management endeavor.

Hoseini (2015) in his thesis titled Project Time Planning in Norwegian Construction Industry, studied the 'real word' experience of experts in Norwegian construction industry about project time planning and to find out how poor time planning lead to delay. The results of the study shown that more than 90% of the respondents agree that poor project time planning may lead to delay. Almost all of the respondents mentioned 'poor project management' as a reason of poor time planning. Besides, most of the respondents cited more experienced people as the most important enabler of time planning improvement.

Chin & Hamid (2015) examined the practice of time management on construction project of the Malaysian construction industry. Their study assessed the respondents' participation in the planning of construction works, investigated how progress records are kept to identify the process of monitoring the progress of work on the construction industry. From the study, they found that the project manager has the highest percentage in both drafting a planning method statement and project planning meetings. According to their study most of the respondents had their experience activity durations being calculated in whole or in part. They also found that the date constraints were used to onstraint the performance to

the dates given in the contract documents and float constraints were used to control critically. As for the progress reports, the majority prefer to keep the records on the paper but were immediately input into the database.

Solís-Carcaño, et al., (2015) conducted a study aimed at assessing the use of project time management processes and its relation with project schedule performance (i.e., timely completion). The study included the assessment of fourteen school construction projects executed by a public agency in the Yucatan Peninsula, Mexico. The projects were monitored during the construction phase in order to measure two different variables: the use of processes related to schedule planning and controlling processes and the project schedule performance. Finally they found that most of the projects that attained timely completion also made a greater use of the project time management processes.

## **2.2 Project Time Management**

Project Management Institute (2013) defines a project as “a temporary endeavor undertaken to create a unique product, service, or result”. The key words in this definition are temporary and unique. Any project must have a starting point and an ending point, and it must have a deliverable product, service, or result that is unique. The significance of time can easily be seen from the definition of project noting the fact that project has definite beginning and end. As the result of utilizing this limited project duration there need to be thorough planning and scheduling.

Projects have three main parameters; time, cost and quality which are interrelated to each other. The optimum combination of these three components will yield a successful project. As quality of the product increases the cost to produce same will be higher and likewise

when the project time increases the project cost increases. It is also the “time factor” in a project that determines the project cost.

Time is the essence of all construction contracts. In construction industry all projects are time bound; and time delays attract penalties while early completion can earn rewards as time is directly related to costs. It’s a general truth in that “Time is immortal and has no definite beginning and definite end”. On the other hand, when it comes to project, time would be bounded by the project start and end time; as project is a momentary effort to create a unique product. Time is an extremely important issue in construction. It is a primary objective for most clients of construction and a major criterion by which the success of a project is judged. Prolonged project durations can be costly and frustrating for clients. Timely completion is of great interest to contractors. If they finish late they will incur extra cost and may suffer liability for delay damages unless the time for completion is extended by excusable events (Hughes, et al., 2015).

According to Kerzner (2009) project management is designed to manage or control resources on a given activity, within time, cost, and performance. He further explains that time, cost, and performance are the constraints on the project. If the project is to be accomplished for an outside customer, then the project has a fourth constraint i.e., good customer relations. Kerzner (2009) additionally states that project personnel should keep in mind why the schedule was developed.

According to Kerzner (2009) there are also secondary objectives of scheduling:

- Studying alternatives;
- Developing an optimal schedule;
- Using resources effectively;

- Communicating;
- Refining the estimating criteria;
- Obtaining good project control; and
- Providing for easy revisions.

PMI (2013) describes a knowledge area as representing a complete set of concepts, terms, and activities that make up a professional field, project management field, or area of specialization. One of the knowledge areas accordingly is project time management which includes the processes required to manage the timely completion of the project. The project time management processes are according to PMI are:

- **Plan Schedule Management**—the process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule.
- **Define Activities**—the process of identifying and documenting the specific actions to be performed to produce the project deliverables.
- **Sequence Activities**—the process of identifying and documenting relationships among the project activities.
- **Estimate Activity Resources**—the process of estimating the type and quantities of material, human resources, equipment, or supplies required to perform each activity.
- **Estimate Activity Durations**—the process of estimating the number of work periods needed to complete individual activities with estimated resources.

- **Develop Schedule**—the process of analyzing activity sequences, durations, resource requirements, and schedule constraints to create the project schedule model.
- **Control Schedule**—the process of monitoring the status of project activities to update project progress and manage changes to the schedule baseline to achieve the plan.

Most of the time management processes are sorted out by PMI are applicable for the time management functions of construction projects depending on the project delivery methods. For instance, when the delivery is a design-build (DB), the whole processes may be required including defining the activities. The project under study in this research being a design-bid-build (DBB) project with all the construction activities sorted out clearly defined and specified processes such as “define activities” are not applicable. Time management processes for a DBB project are mainly planning, scheduling and controlling. Chin & Hamid (Chin & Hamid, 2015) examined the practice of time management on construction project. The study was conducted in the Malaysian construction industry. By focusing on the involvement of personnel in the time management and identifying the process of monitoring the progress of work on construction industry.

Aiming at assessing the use the practice of time management processes and its relation with project schedule performance (timely completion), Solís-Carcaño, et al. (2015) conducted a study in Mexico construction industry. They found that employing the time management processes have significant effect in relations on project performance, especially for completing the construction phase within the original schedule. This means

the implementation and application of project time management processes and tasks and delays have direct relationship.

Depending on the types of projects, there are various time management processes and tasks. After conducting and going through such processes, an effort has been made to develop appropriate time management processes. Taking into consideration that the projects under study are design-bid-build projects, there are no such tasks as activity definition. The main processes planning, scheduling and time control. The time management processes are depicted the figure 2. In each of the planning processes are defined the tasks and activities to be undertaken. Further to the flow diagram showing the time management processes, here under are described the tasks to be undertaken in each process.

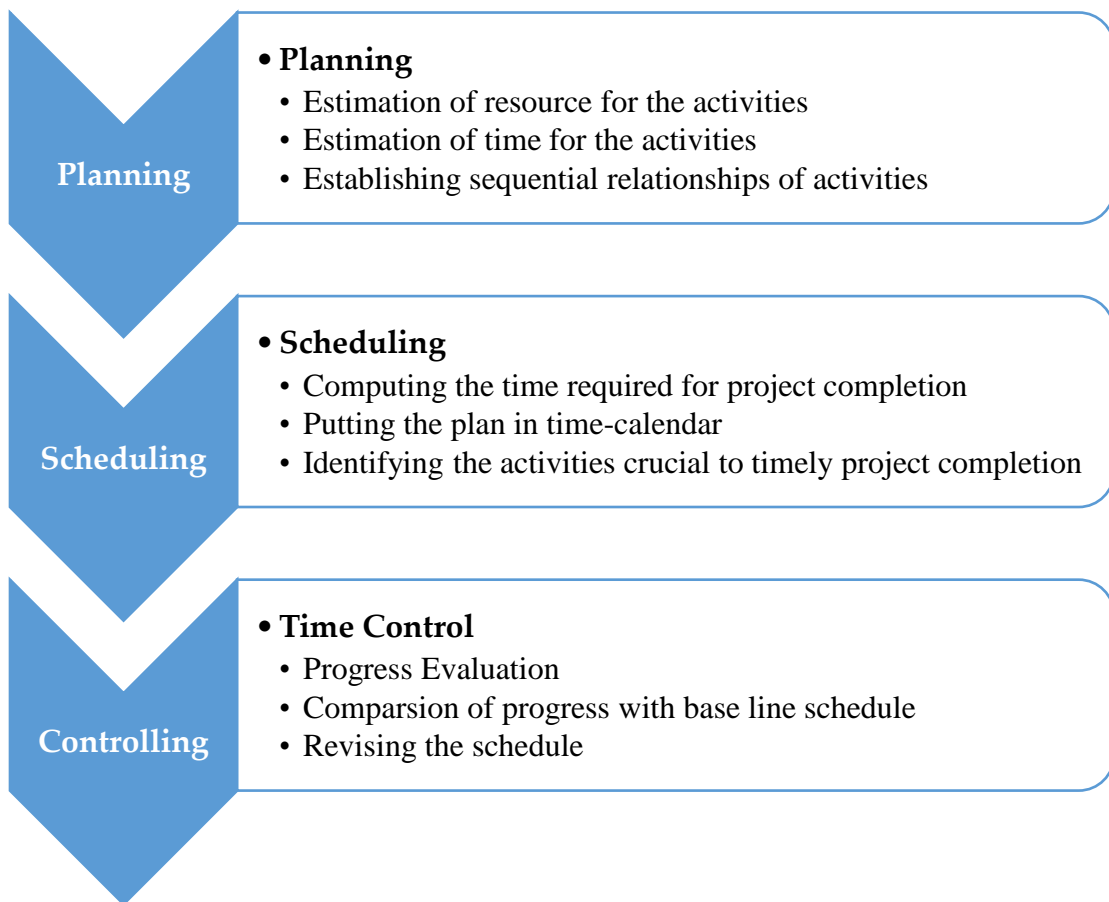
### **2.3 Planning**

Planning is an advance intellectual thinking of as to when and where work will be performed, how it is to be performed and by whom it is to be performed. Planning also essentially involves the choice of technology, the definition of work tasks, the estimation of the required resources and duration of individual tasks and the identification of any interactions among the different work tasks. Planning establishes what, how, where and in what order work will be performed, while scheduling sets forth who and when. Construction planning is the development of a feasible operational design for completing the work. The process involves the selection of work sequence and methods and provides information for the scheduling process. Planning is the determination of the methods of executing the tasks, estimating the resource required and time for the tasks to be undertaken for the realization of the project. Planning is the determination and communication of an intended course of action incorporating detailed methods showing time, place and the

resources required. It is easy to think of planning as the production of a time schedule but this is only one aspect of successful project planning.

There is always a need to consider planning in a wider context. Planning for a project must include not only consideration of time but also consideration of cost, quality, health and safety and other aspects such as design and production (Baldwin & Bordoli, 2014).

Scheduling is a time-based plan of action for coordinating various activities and resources to achieve specified objectives as set out during the planning stage. In other words, scheduling is putting the detailed planning on a calendar time scale.



**Figure 2: Construction project time management processes**

### **2.3.1 Estimation of resource**

Resources are materials, equipment, labor or anything needed to complete an activity. Most activities will require one or more resources; however, not all activities will require resources. Estimation of resource is the process of determining the resources required to execute an activity. Success on construction projects depends on the efficient utilization of limited and costly resources—labor, materials, and equipment. Contractors who minimize waste and re-handling materials, efficiently operate equipment, and maximize labor efficacy have a significant competitive advantage. A construction schedule that does not include resource allocations implies that the contractor has unlimited resources available and has the flexibility to apply all necessary resources to a project change without incurring added costs. However, a resource-loaded schedule illustrates the interdependencies between activities and resources. Moreover, a contractor's jobsite schedule tends to focus on resources rather than activities; therefore, their published master schedules should indicate this.

### **2.3.2 Estimation of time**

The duration of an activity is primarily a function of the quantity of work to be undertaken, the resources applied to it, the method used to carry out the work and the conditions under which the work is carried out. Activities consume time, the length of time they consume is called the duration. However, there are activities with zero duration which are known as milestones. There are two main factors that must be considered when determining durations, the time available and application of resources to maximize profits. Unfortunately, most projects today do not have the luxury of time. Therefore, activity durations have to be defined based on the available time as defined by the owner. The

second most influential factor for determining the duration of an activity is the contractor's profitability. Contractors assign durations and resources to an activity in order to maximize profit by performing the work efficiently. The overall goal is to apply a duration that will allow the work to be performed efficiently and result in a profit. Although these two factors heavily influence the determination of activity duration, there are other factors that may play a role: safety concerns, availability of materials, equipment, and tools, and special conditions and techniques. After closely considering the influencing factors, the durations must be determined.

In accordance with PMI (2013), there are four methods of activity time estimation. In expert judgment, guided by historical information, the expert can provide duration estimate information or recommended maximum activity durations from prior similar projects. Analogous estimating is a technique for estimating the duration or cost of an activity or a project using historical data from a similar activity or project. Parametric estimating is an estimating technique in which an algorithm is used to calculate cost or duration based on historical data and project parameters. The three-point estimation is a concept originated with the program evaluation and review technique (PERT) and uses three estimates to define an approximate range for an activity's duration : most likely ( $t_M$ ) estimate is based on the duration of the activity, given the resources likely to be assigned, their productivity, realistic expectations of availability for the activity, dependencies on other participants, and interruptions; in optimistic ( $t_O$ ) time estimate the duration is based on analysis of the best-case scenario for the activity and in pessimistic ( $t_P$ ) the activity duration is based on analysis of the worst-case scenario for the activity. Then the time for the activity is calculated using either triangular distribution or Beta distribution. According to triangular

distribution time estimate for an activity is  $t_E = \frac{(t_O + t_M + t_P)}{3}$  and according to Beta distribution  $t_E = \frac{(t_O + 4t_M + t_P)}{6}$ .

## 2.4 Scheduling and Scheduling Techniques

Scheduling determines the timing and specific sequence of tasks necessary to carry out the plan. The schedule is a result of the planning process and reflects the selected plan. Therefore, an inability to schedule stems from a reluctance or incapacity to plan.

Scheduling the construction process is essential not only so that projects can be completed profitably and on time, but also so that any delays can be evaluated in order to prove entitlement to time and cost compensation. As problems are encountered, the schedule helps project managers rearrange project tasks and resources so that they can meet the primary objectives of time, cost, and quality under limited resource and budget constraints. Although bar charts (Gantt charts) have been used as a simple scheduling method, network schedules that employ the critical path method (CPM) are now much more widely used. This is because of the fact that network analysis can show which activities are critical and which are not. Almost all project management software is therefore based on critical path analysis. There exist many planning and scheduling techniques from the simplest techniques such as to – do lists to complex ones like network analysis. The use of space diagram is another technique giving additional depth to the planning and scheduling processes. Baldwin & Bordoli explained (2014) that bar chart diagrams provide a two-dimensional ‘picture’ of the activities on a project and a schedule of when they will take place. As such they form one kind of chart. Planners show the relationship between construction activities by the use of other forms of diagrams. Space diagrams exist in a

variety of formats. Examples of space diagram time include chainage charts and multiple activity charts.

Nabil & Adnan (2005) in their research studied the use of time management tools and techniques in the construction industry. It can be stated that there is consensus between owners and contractors regarding the application of management tools that the most used time scheduling tool is the linked bar charts, while the least used tool is network scheduling (AoA/AoN). On the other hand, the results confirm that the work breakdown structure and resources allocation and levelling are not satisfactorily used. The results revealed that there are no significant differences in using time tools between owners and contractors. The findings show that using time tools is generally below a satisfactory level (Nabil & Adnan, 2005). The most widely used scheduling techniques are discussed in the following sections.

#### **2.4.1 Bar (Gantt) Charts**

Bar chart is a graphical representation of project activities that are shown in time scaled bar lines with no links shown between the bars (activities). The bar chart was originally developed by Henry L. Gantt, an American mechanical engineer, in 1917 and is alternatively called a Gantt chart. It quickly became popular—especially in the construction industry—because of its ability to graphically represent a project’s activities in a clear, simple, and time-scaled manner. Before a bar chart can be constructed for a project, the project must be broken into smaller, usually homogeneous components, each of which is called an activity or a task. None of the methods is a uniquely “correct” way to break down a project into activities, nor can we describe other ways as incorrect. However, the scheduler should take a balanced approach and break the project down into a reasonable

number of activities that are easily measured and controlled without being overly detailed (Mubarak, 2015).

Mubarak (2015) continues to explain that an activity, or a task, may be as large as laying the foundation of a building, as small as erecting the formwork of one footing, or anywhere in between. The duration of each activity must be estimated. Bars are then drawn to show each activity, the duration and the starting and ending points. As mentioned previously, links between activities are not usually shown. On a bar chart, the bar may not indicate continuous work from the start of the activity until its end. For example, the activity getting a building permit may be represented by a 2-month long bar. However, most of this time is a waiting period. Likewise, a concrete foundation summary activity may include several days of waiting for the concrete to cure. Non-continuous (dashed) bars are sometimes used to distinguish between real work (solid lines) and inactive periods (gaps between solid lines) Bar charts have become a vehicle for representing many pieces of a project's information.

Bar charts have gained wide acceptance and popularity, mainly because of their simplicity and ease of preparation and understanding. No “theory” or complicated calculations are involved. Anyone can understand them. They can be prepared anywhere with just a pencil and paper. So, although bar charts can carry—or be loaded with—other information, the user must be careful not to overload them and, thus, lose their main advantage: simplicity (Mubarak, 2015).

Unlike networks, bar charts are time-scaled; that is, the length of a bar representing a certain activity is proportional to the duration of that activity. Just by looking at the chart, you can get an idea of the duration of each activity and the entire project. Another

advantage of bar charts is that they particularly appeal to persons who do not have a technical background. For example, some clients and upper-level managers may better understand the plan for carrying out a construction project by looking at a bar chart than by looking at a schematic of a logic network (Mubarak, 2015).

A final advantage of bar charts is the ability to roll up or roll down a schedule, on the basis of either a specific activity code (e.g., area, phase, responsibility, or floor) or the project's work breakdown structure (WBS). For example, if the schedule on the detailed level (say level 5) has 2,130 activities, the bar chart can be rolled up to 342 activities (level 4) or to only 55 activities (level 3). This is a major reporting advantage, because you can show the schedule in detail to the technical teams but "roll it up" to a small number of major (summary) activities for executive management. Although this roll-up/roll-down feature exists in logic networks, it is much clearer and simpler in bar charts.

The main disadvantage of bar charts, Mubarak (2015) asserts, is their lack of logical representation (relationships). The reason can be a logical relationship, a resource constraint, or a subjective decision by the project manager. Although some software programmers try to depict logical relationships on bar charts, the result is not always clear. The logic lines get tangled, and unlike networks, bar charts do not allow the length of the bars to be subjectively changed or the bars to be moved around to make the chart look or read better.

Mubarak (2015) argued that another limitation, rather than a disadvantage, of bar charts is the size and complexity of projects. Bar charts may not be practical for projects with a large number of activities, unless used in two ways: showing a subset of the work activities to maintain the simplicity of the chart or showing summary/rolled up bars (each bar represents

a group of activities combined on the basis of a certain criterion, such as department, major component, or responsibility). This can be done during the early planning phase, when details are not available and when reporting the information to high-level management.

Given the fact that the projects under study are complex and with many tasks, it would not be applicable to use bar charts unless for breaking the master schedule for daily planning and monitoring.

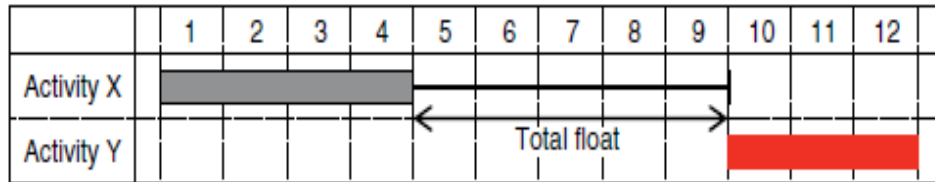
#### **2.4.2 The Critical Path Method (CPM) Floats**

The most widely used scheduling technique is the critical path method (CPM) for scheduling. This method calculates the minimum completion time for a project along with the possible start and finish times for the project activities. Computer programs and algorithms for critical path scheduling are widely available and can efficiently handle projects with thousands of activities. The critical path itself represents the set or sequence of activities which will take the longest time to complete. The duration of the critical path is the sum of the activities' durations along the path. Thus, the critical path can be defined as the longest possible path through the "network" of project activities. The duration of the critical path represents the minimum time required to complete a project. Any delays along the critical path would imply that additional time would be required to complete the project. There may be more than one critical path among all the project activities, so completion of the entire project could be delayed by delaying activities along any one of the critical paths. Formally, critical path scheduling assumes that a project has been divided into activities of fixed duration and well-defined predecessor relationships. A predecessor relationship implies that one activity must come before another in the schedule.

### 2.4.2.1 Floats

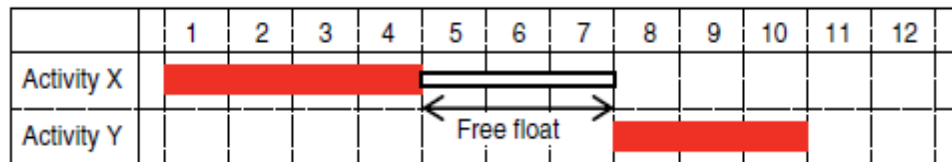
Central to the CPM method of scheduling is float which is the maximum amount of time an activity can be delayed from its early start without delaying the entire project or violating a schedule constraint. Mubarak (2015), from practical observation, deduced the following five points about float:

**Total float (TF)** is the most frequently used type of float. Total float is shown in the figure below.



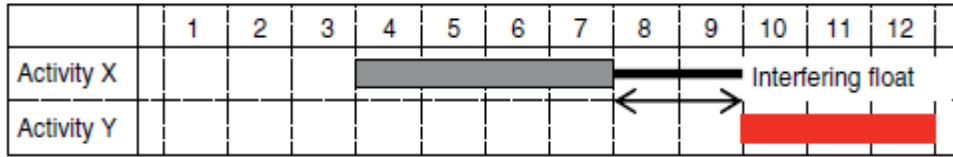
**Figure 3: Total float (Baldwin & Bordoli, 2014)**

**Free Float.** More valuable to the scheduler is free float. Within the free float period of total float, an activity can move without affecting the completion of the project and without affecting the timing of any other activity, as shown in the figure below. Utilising free float, the start of activity X can be delayed until the start of week 4 without affecting the start of activity Y.



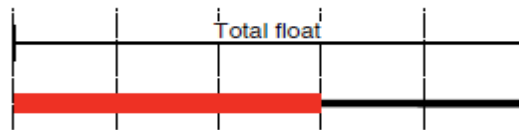
**Figure 4: Free float (Baldwin & Bordoli, 2014)**

**Interfering float** is the second component of total float and is the part that, if used, will not affect the completion date of the project but will affect the start and/or completion of following activities (see the figure below).



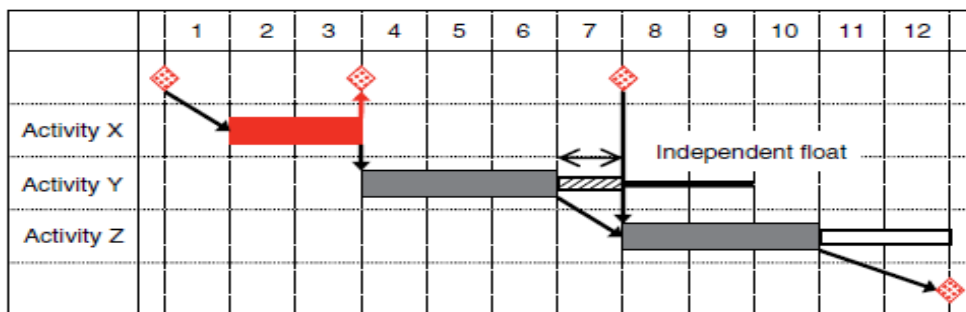
**Figure 5: Interfering float (Baldwin & Bordoli, 2014)**

Using the entire interfering float will have the same effect as using all the total float of an activity. This is shown in the figure below.



**Figure 6: Total float, free float and interfering float (Baldwin & Bordoli, 2014)**

**Independent float** is rarely quantified in current scheduling as its origins are in critical path networking using the activity-on-line technique. Independent float is less prevalent when earliest and latest activity dates are calculated using activity-on-node techniques, and the authors have not come across any present software that computes it (see the figure below).



**Figure 7: Independent float (Baldwin & Bordoli, 2014)**

In the conditions of contracts for the projects under study, the contract specifies CPM as the tools for the preparations of the work programme. With regards to the ownership of floats anyhow the author didn't find any statements.

### **2.4.3 Program Evaluation and Review Technique (PERT)**

The program evaluation and review technique (PERT) is about incorporating the uncertainty of the duration estimate in the overall network analysis. If each activity in the network is no longer deterministic (i.e., one value) but rather probabilistic, we can better estimate the uncertainty associated with achieving a given schedule (AIIUJA, et al., 1994).

The PERT method was first used in planning the development of the Polaris Weapon System (USA Navy, 19581), where schedules were continuously missed or considerably differed from the estimated ones. The concept was based on breaking the project down into individual components (activities), probabilistically estimating the times required to complete the work component and defining the precedence relations between them, performing a simple network analysis, and estimating the project completion time with an associated probability distribution.

In essence, the duration of each activity will be estimated using a three-time estimate reflecting the pessimistic, optimistic, and most likely values of the duration. Once this is accomplished the mean and variance for each activity time is estimated and used to find the mean and variance of the project completion time. Knowing these parameters will enable one to approximate the probability of completing the project in a particular time frame and to estimate other "risk assessment" Measures.

### **2.4.4 Milestone Date Programming Techniques**

Important deadlines in a project programme are highlighted by specific points in time called milestones. These are timeless activities usually at the beginning or end of a phase or stage and are used for monitoring purposes throughout the life of the project. Needless to say, they should be SMART, which is an acronym for Specific, Measurable, Achievable,

Realistic, Time bound. Often milestones are used to act as trigger points for progress payments or deadlines for receipt of vital information, permits, or equipment deliveries (Lester, 2014).

Besides that, milestone schedule is one of the most critical schedules that must be maintained and referred throughout the project's lifecycle. It is a summary level schedule where the project team leader can do a review and identify if any problems occur in the progress and make sure that no activity falls behind the schedule. Milestone schedule provides an estimated timeline for the project life including all project activities and interim steps needed to implement the project. Milestones are marked on bar charts or networks by a triangle or diamond and can be turned into a monitoring system in their own right when used in milestone slip charts, sometimes also known as trend charts (Lester, 2014).

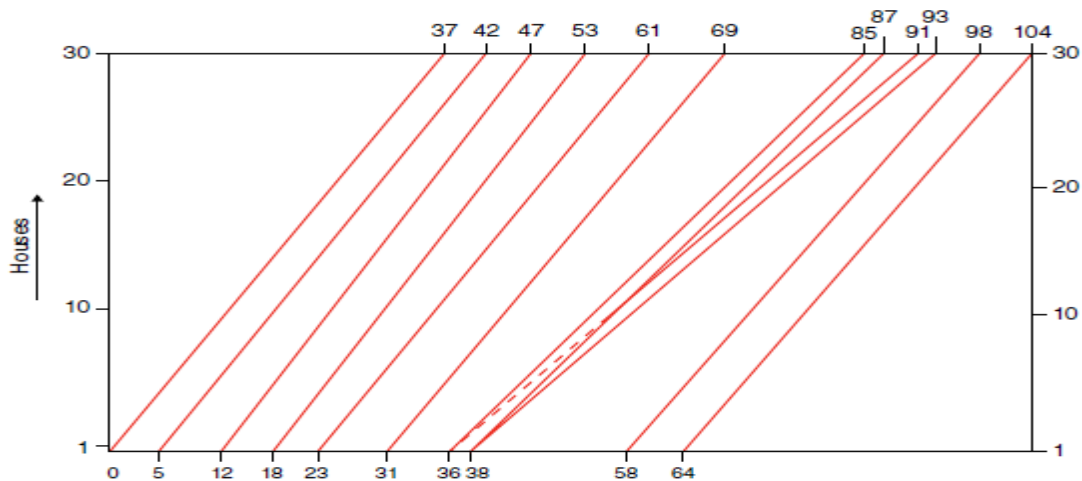
#### **2.4.5 Elementary Trend Analysis/Line of Balance Method (LOB)**

Network analysis is essentially a technique for planning one-off projects, whether this is a construction site, a manufacturing operation, a computer software development, or a move to a new premise. When the overall project consists of a number of identical or batch operations, each of which may be a subproject in its own right, it may be of advantage to use a technique called line of balance (LoB) (Lester, 2014).

Line-of-Balance (LOB) scheduling is a visual scheduling technique allowing the planner to explain the flow of the project explicitly. Some of the LOB scheduling advantages are that it clearly shows the amount of work taking place in a certain area at a specific time of the project; it has the ability to highlight and optimize the resources used by large number of repeated activities, executed in several zones or locations and it makes cost and time

optimization analysis easier because of all the information available for each activity in the project (Memon, et al., 2014).

Line of balance (LOB) is an established graphical technique for scheduling repetitive construction tasks. The LOB technique was developed for use in a manufacturing/engineering production environment and then adapted for use on repetitive construction projects. It is a graphical method that is less complex than traditional critical path methods. It can be used for monitoring and control purposes (Baldwin & Bordoli, 2014). The figure below the diagram shows that after construction commences it takes 64 working days (13 weeks) to complete the first unit. The contractor has agreed to hand over the units at the rate of four per week. Handover of the completed 30 units will take place after 104 days, at the end of 21 weeks (Baldwin & Bordoli, 2014).



**Figure 8: An LOB diagram for the completion of 30 houses (Baldwin & Bordoli, 2014)**

### **2.4.6 Precedence Network Diagram**

Precedence Network Diagram is quite similar with CPM, and it is also widely used in the construction industry. Precedence diagrams are also easier to draw and modify; additional activities can be inserted without changing node reference numbers. There is less risk of

making logical errors with precedence diagrams, since each activity is connected to others by a relationship (Memon, et al., 2014).

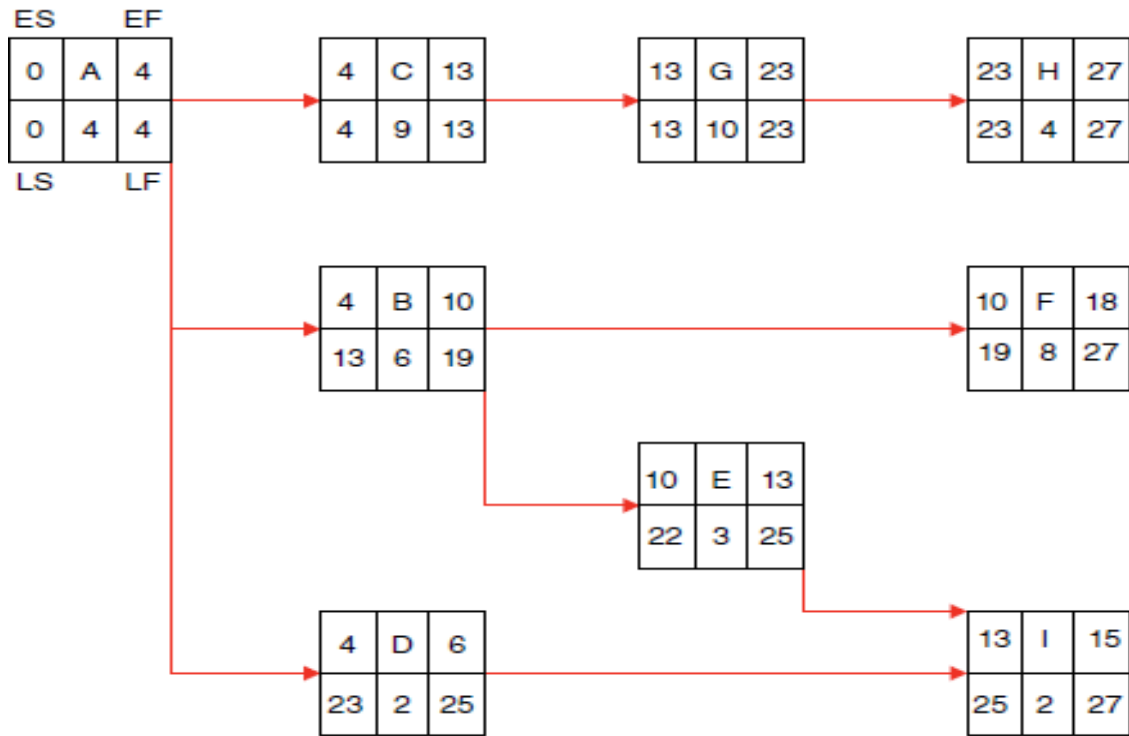


Figure 9: Precedence diagram (Baldwin & Bordoli, 2014)

## 2.4.7 Scheduling Software

Scheduling is becoming in an ever-increasing automation processes and dynamics. Substantial review of literature was made and some of the most come-on scheduling software are discussed in the next sections.

### 2.4.7.1 Microsoft Project

Microsoft project is a software designed to assist the project manager in developing a plan, assigning resources to tasks tracking progress, managing the budget and analyzing workloads. The program has many different versions where it allows the user to understand and control project schedules and finances, to communicate and present project

information, and to organize work and people to make sure that projects are completed on schedule. It also provides functionality for the user to create reports that communicate the status and progress of the project.

#### **2.4.7.2 Primavera Project Planner**

Primavera has been called one of the technology leaders in the project portfolio management. Primavera Project Planner (P3) can manage all kind of project whether large or short duration event critical project because it was designed to handle large-scale, intricate and multifaceted projects. This program is capable of organizing the resources (such as labour, material and equipment) needed by the company for managing complex and integrated projects. The main benefits of P3 include that it can handle the smaller to medium size of the project, produces various reports needed to document the project progress, and it can give real time comparison on where the project is at compared to the objectives in the business plan (Memon, et al., 2014).

#### **2.4.7.3 Asta Power Project**

This is a program developed for project planning. Asta Power Project is professional project management software where it is easy to use, and it helps to deliver the construction project in all types and size of organizations on time and within budget. Asta Power Project have same intuitive look and feel as a Microsoft office application. The activities are directly drawn onto the bar chart by using mouse or type in the spreadsheet. Asta Power Project is good planning software where it can produce professional looking project plans quickly and easily. So, it can help to win tenders and impress clients.

#### **2.4.7.4 Project Commander**

Project Commander is an extremely cost-effective planning tool written by experts in project management and enthusiastically endorsed by satisfied customers worldwide. It covers all aspects of project management from producing simple plans through to fully customizable professional output. This software is ideal for all those involved in project and resource planning, job scheduling or departmental. Besides that, Project Commander is one of the easiest software to use and also the most cost-effective planning solution. It has the capability to exchange information with Microsoft Project, Power Project and Primavera (Memon, et al., 2014).

#### **2.4.7.5 Microsoft Excel**

Microsoft Excel is one of the programs that provided by Microsoft. An Excel document is called a Workbook. A workbook always has at least one Worksheet. Worksheets are the grid where one can store and calculate data. Besides that, Microsoft Excel is a useful tool for scientific and statistical analysis with large data sets. Excel's statistical formulas and graphing help researchers to perform various types of analysis (Memon, et al., 2014).

### **2.5 Project Time Control and Contractual Aspects of Scheduling**

Time control is an input for revising the planning and programming processes and durations after a thorough and detailed comparison of actual job carried out for each specific activity (especially those at the critical path and with low floats) with that of the corresponding programmed durations. Therefore, it can be construed that the output of time control is the essence of time management.

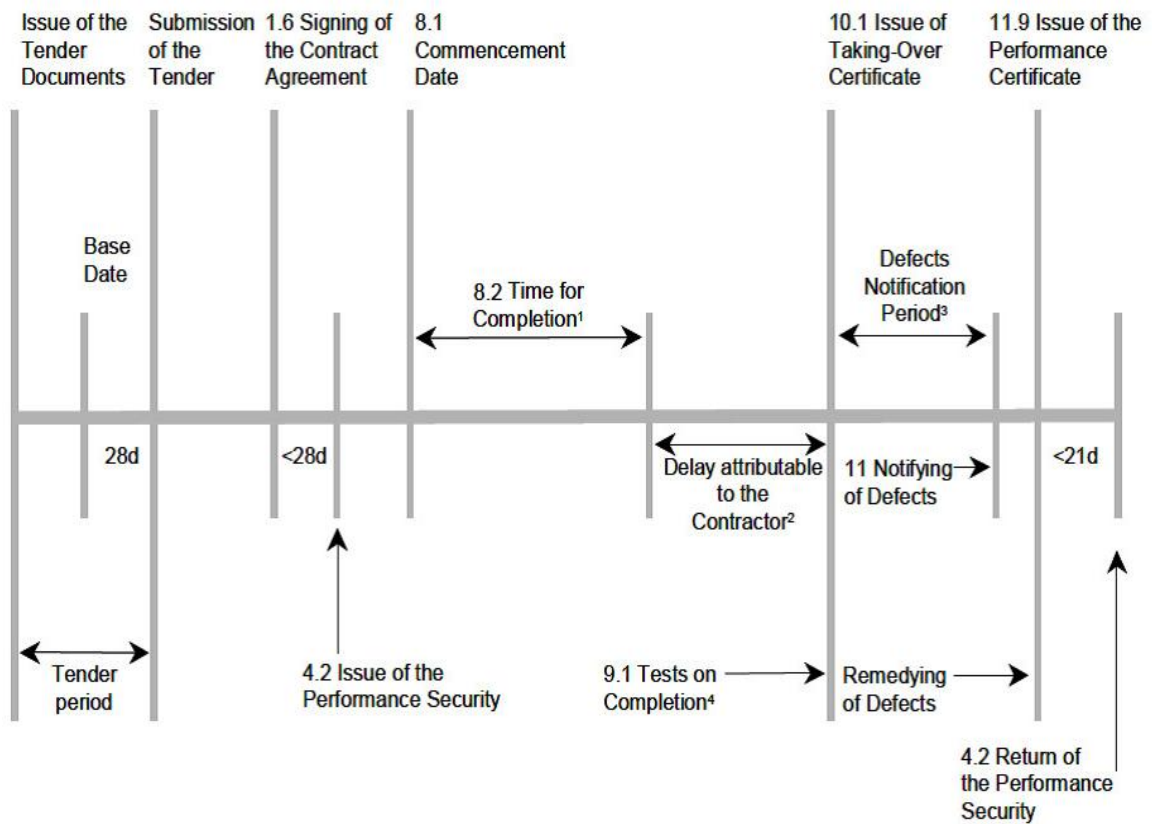
### **2.5.1 Time for Completion**

In construction contracts, the significance of time is vital. In FIDIC as well as other conditions of contract for construction works, the Contractor shall complete the works, within time for completion for the works. The contracts strictly specify the quantity of time representing time for completion, which may be extended according to the conditions in the contracts. In all FIDIC conditions of contracts, a Day is a defined term meaning a calendar day whilst the terms months and week are not defined and therefore open to discussion and varying interpretation by the Parties. Jaeger & Ho`k (2010) strongly recommend to state the relevant time for Completion in Days and not in “months” or “weeks”.

The FIDIC concept of Time for Completion is based on Clause 8 FIDIC Conditions. According to this concept the parties agree on a period of time for completion, which is usually indicated in the Appendix to Tender (Yellow Book, Red Book), in the Particular Conditions (Silver Book) or the Contract Data (Gold Book). Unless agreed otherwise, failure to comply with Time for Completion will usually lead to the entitlement of delay damages pursuant to Sub-Clause 8.7. However, if and when the Contractor is prevented from carrying out the works or if the Employer causes delay to the progress with effect to Time for Completion the Contractor is entitled to claim for extension of time (EOT) (Jaeger & Ho`k, 2010).

One of the underlying principles of all FIDIC forms of contract is the avoidance and reduction of the amount of change that occurs on construction projects. On the other hand, FIDIC recognises that change is inevitable, even though many changes can generally be avoided through good planning. Once having accepted that changes are inevitable a

management tool for time survey and time management is necessary. This is the reason why FIDIC requires the Contractor to provide a programme. The Programme is one of the most important tools for the Engineer and the parties to the contract during the whole course of the Works. As soon as the Programme is inconsistent with actual progress or with the Contractor's obligations the Contractor shall submit a revised Programme. Thus, the programme does not become accepted by the Employer, but it is nevertheless binding on the Contractor (Jaeger & Ho'k, 2010).



**Figure 10: Major time related events in FIDIC MDB Conditions of contract (FIDIC, 2010)**

The conditions of contract for the projects under this case studies, also known as the pink book, has the following major time events. When the Engineer issues the commencement

instruction in accordance with Clause 8.1 of the contract the contract commences and upon issuance of the taking over certificate the project will be completed. The events are shown in figure 15.

The programme has to show the Commencement date and the anticipated date for completion. If the Contractor encounters difficulties which result in delay or disruption then there are two possibilities. Either he encounters a difficulty which is at his risk, in which case he has to revise the programme and to show how he plans to recover the delay, or else he suffers delay from an event which is at the risk of the Employer. He is then entitled to claim for Time extension. Once Time extension has been granted, he shall submit a revised programme showing the new date for completion. In any case the Contractor shall submit a revised programme as soon as the Programme becomes inconsistent with actual progress or with the Contractor's obligations (Jaeger & Ho'k, 2010).

### **2.5.2 Work Programme**

This study focuses on the two industrial park construction projects whose conditions are FIDIC MDB 2010. Accordingly the details of the work programme are discussed. As indicated in Clause 8.3 of the FIDIC MDB conditions the Contractor shall submit a detailed time programme to the Engineer within 28 days after receiving the notice under Sub-Clause 8.1(Commencement of Works). The Contractor shall also submit a revised programme whenever the previous programme is inconsistent with actual progress or with the Contractor's obligations. Each programme shall include:

- a) the order in which the Contractor intends to carry out the Works, including the anticipated timing of each stage of design (if any), Contractor's

Documents, procurement, manufacture of Plant, delivery to Site, construction, erection and testing;

- b) each of these stages for work by each nominated Subcontractor (as defined in Clause 5 (Nominated Subcontractors));
- c) the sequence and timing of inspections and tests specified in the Contract; and
- d) a supporting report which includes:
  - i. a general description of the methods which the Contractor intends to adopt, and of the major stages, in the execution of the Works, and
  - ii. details showing the Contractor's reasonable estimate of the number of each class of Contractor's Personnel and of each type of Contractor's Equipment, required on the Site for each major stage.

Unless the Engineer, within 21 days after receiving a programme, gives notice to the Contractor stating the extent to which it does not comply with the Contract, the Contractor shall proceed in accordance with the programme, subject to his other obligations under the Contract. The Employer's Personnel shall be entitled to rely upon the programme when planning their activities.

In Particular Conditions (Part B) of the contract for the projects, it specifies as well that the type of work programme to be employed. In sub-clause 8.3 of Particular Conditions (Part B) it states that "Unless otherwise agreed, the program shall be generally based on the program submitted with the Bid and shall include Critical Path Method (CPM) analysis of various activities from commencement of work to completion. Further requirements of the work programme are also stated in detail.

### **2.5.3 Revision of Work Programme**

Most often after the preparation of work programmes, amid the execution of the projects are not going as originally planned, the schedules are not usually updated. This as the result means operating in an obsolete work schedules. When it becomes necessary to control the project in accordance with the schedule, it results in unrealistic situation which is not reflecting the actual situations. It is therefore necessary to diligently update the schedules. Updating work programme is a contractual requirement. If, at any time, the Engineer gives notice to the Contractor that a programme fails (to the extent stated) to comply with the Contract or to be consistent with actual progress and the Contractor's stated intentions, the Contractor shall submit a revised programme to the Engineer in accordance with Sub-Clause 8.3 (a).

Project schedules are, without a doubt, a useful tool for managing and controlling projects. However, this tool can be effective only if it is used properly. Colourful bar charts can be no more than decoration on the walls of the job trailer. They can also be a mere fulfilment of a bid or contract requirements. But if bar charts are well prepared and used seriously, consistently, and intelligently throughout the life cycle of the project, they can be an effective tool that informs the project management team of the project status at any point during the life of the project as well as a foundation for corrective action. The most important use of schedules is for project control: the scheduler compares actual performance with baseline performance and discerns any deviation. The project management team then deals with this deviation, analyses it, and suggests solutions to bring the schedule back on track, if possible (Mubarak, 2015).

Using critical path method (CPM) scheduling as an effective tool requires a serious commitment from upper management to adopt and use the schedule throughout the project. There is a difference in attitude between a contractor who uses the schedule because he or she is convinced that it is an effective and powerful tool for project management and a contractor who uses the schedule just because the owner requires it (Mubarak, 2015).

With respect to revision of the work programme, in sub-clause 8.3 of Particular Conditions (Part B) of the contract, it stated that the Contractor shall, when instructed by the Engineer, amend, correct or modify the Program of Works so as to take into consideration any delays and/or advances and modifications to designs or for other reasons considered necessary by the Engineer.

#### **2.5.4 Delays in Construction Projects**

Delays on the delivery of construction projects are seen as one of the most frequent problems in the construction industry. The aftermath of delays affects all people and organizations involved in the project. This is especially true for the owner's business since delaying the start-up of the project will impede obtaining the expected project revenue and will increase financial costs. In addition, the owner may face several other difficulties resulting from the commitments assumed based on the delivery date established in the contract. On the other hand, prolonging the project execution time usually results in contractors that have to deal with cost overruns due mostly to the following causes: extra expenses on management personnel, cost escalations of materials, increase of financial cost, paying contract penalties, and so forth. Moreover, given the usual competitive environment in the construction industry, contractors that fail to complete projects on time may get their reputation harmed and become impeded to obtain new contracts.

In developing countries delays during the construction of public assets, such as schools, could also result in social harms given the fact that this kind of infrastructure is usually urgently needed. Therefore, the sooner those projects are completed, the better for satisfying the social needs in those countries.

The duration of contract performance has a direct effect on the profitability of construction projects from the perspective of all stakeholders. For project owners, lost profits or benefits stem from being unable to make use of the project at the agreed date whilst to the contractor, extra cost will be incurred due to prolonged stay on site. Most standard forms of contract thus have provisions that anticipate delay brought about by the actions and/or inactions of the contractor, the owner or events outside the control of both parties. The contractor is often excused from the consequences and/or allowed compensation for any costs due to delays resulting from events or circumstances that are beyond its control. Contractual provisions also allow the owner to recover liquidated damages from the contractor for failure to deliver the project within the contract performance period. Liquidated damages clauses entitle the owner to recovery of a specified sum of money for each day or week of culpable delay. In both instances, a detailed schedule analysis is required to investigate the events that have actually caused the project to overrun. Over the years, owners and contractors have used various Delay Analysis Techniques (DATs) to achieve this. However, in the vast majority of cases, the parties are not able to settle delay claims amicably resulting in costly disputes after project completion (Braumah, 2013).

### **2.5.5 Extension of Time**

According to Gibson (Gibson, 2008), extension of time clauses should be drafted so as to include for all delays which may be the responsibility of the employer. Then, if the

employer, either personally or through his architect or professional team (consultant), hinders the contractor in a way which will delay the date for completion, the architect/engineer will have the power to fix a new completion date and thus preserve the employer's right to deduct liquidated damages. If the employer intends that liquidated damages are to be payable if the contractor fails to complete the works, then a date for completion must be stipulated in the contract. That is because there must be a definite date from which to calculate liquidated damages. There is an implied term in every contract that the employer will do all that is reasonably necessary to co-operate with the contractor and that he will not prevent him from performing.

In this respect, the employer also has a duty to ensure that the architect and other professional team members employed by him carry out their duties properly. Alongside the implied term of co-operation, there is an implied term that neither party, employer or contractor, will do anything to hinder or delay performance by the other.

### **2.5.6 Delay/Liquidated Damages**

Construction contracts usually have a time or date by which the contractor must complete the work. The importance of a prescribed time or date for completion is that it facilitates a claim by the employer for damages for delay by the contractor in finishing the work. If there is no prescribed time, the law implies a term that the contractor must complete within a reasonable time. Therefore, the existence of an agreed time is very important for the employer. On the other hand, contractors prefer a reasonable time. Linked to the problem of proving when the contractor is in breach for delay in achieving the date for completion is the problem of proving what damage was caused to the employer by the contractor's breach. To overcome this, most forms of contract have a provision for the parties to agree

upon a daily, weekly or monthly amount as damages for delay by the contractor. This amount is called liquidated (delay) and ascertained damages (LADs). The main purpose of LADs is to stipulate the employer's entitlement to damages for the contractor's breach of the obligation to complete by the agreed date. Even if the employer's actual damages exceed the LADs, the employer cannot recover more by way of damages. Similarly, if the employer's actual damages amount to less than the LADs, the employer can still recover LADs (Gibson, 2008).

### **2.5.7 Analysis of Construction Delays**

When delays happen in construction projects, there comes the need to appropriately manage it. First is identifying the delays, allocating them to the party responsible and then quantifying. Therefore the need of a standard method of evaluations is significant. As delays are major sources of disputes among contractors and employers, having an acceptable method of delay evaluations are crucial. Keane & Caletka (Keane & Caletka, 2008) describe the following types of delays.

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

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

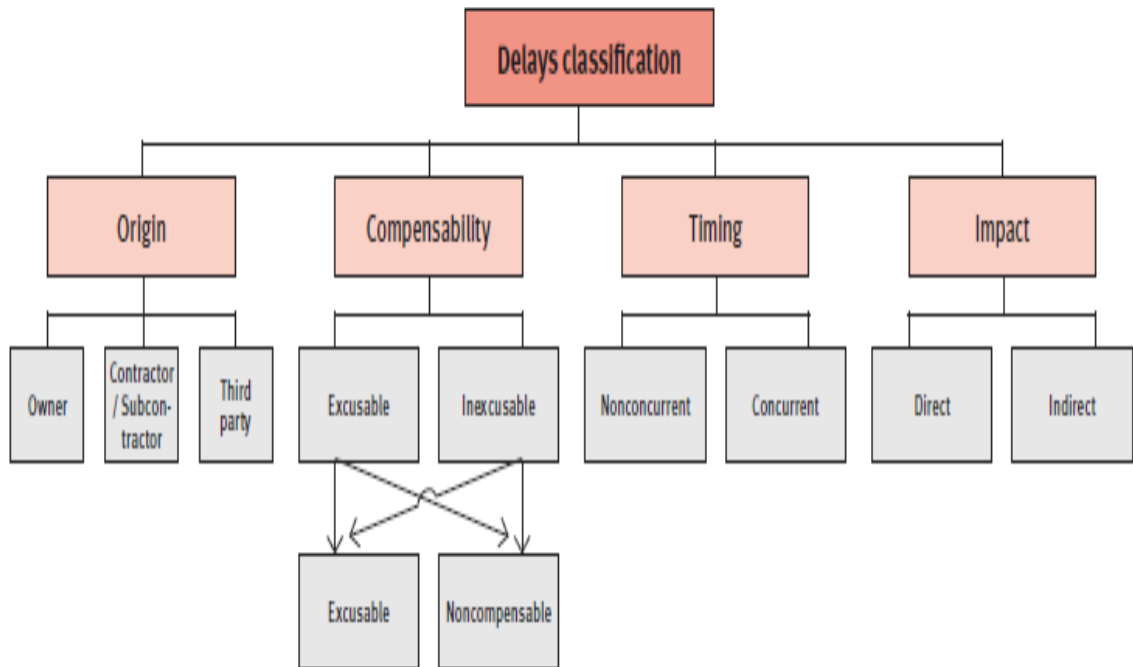
**Critical delay** is a delay to the progress of any activity on a critical path of a project which causes delay to the project completion.

**Excusable delay** excusable delay is a delay for which a contractor will have relief from damages (extension of time) and potential financial entitlement depending on contractual circumstances.

**Non-excusable delay** caused by contractor.

**Global delay claim (total time claim)** a claim for the total project over-run, calculated by comparing the actual completion date with the planned completion date, where there has been no discrete causal link established between the delay claimed and the individual employer risk events relied upon.

**Local delay** a delay to a group of isolated activities which are not on a critical path and which do not impact upon the planned completion date.



**Figure 11: Delay Classification (Keane & Caletka, 2008)**

Keane & Caletka (2008) states delay analysis techniques are known by many generic titles. Each method can be applied in several ways and the widely known methods of delay analysis are subject to frequent misuse. The application of the same technique by two opposing experts often produces varying and inconsistent conclusions. Keane & Caletka continue to describe the name applied to a technique is not as important as the application of that method. Braimah (2013) identified the following major delay analysis techniques.

- **Impacted As-Planned.** This method measures the impact of the delays on the contractor's as-planned CPM schedule. The various delays are formulated as activities and added to the as-planned network in a chronological order showing the effect of each delay at a time and demonstrating how the project is being delayed. The amount of delay equals the difference in completion dates between the schedules before and after the impacts. The technique can be used for analysis of delay during and after project completion.
- **Collapsed As-Built.** In principle, this method is a form of "but for" which does not use the as-planned as a baseline schedule, but rather uses the as-built schedule (and thus also referred to as "as-built but for" technique). It involves removing the delays of each party from the as-built network so that the resulting schedule will give the completion date of the project but for the delays of the other party.
- **As-Planned versus As-Built.** Under this method, all delaying events encountered on the project are depicted on the as-built schedule. The difference between the as-planned and as-built completion dates is the amount of time for which the claimant will request for compensation. The critical path is determined once in the as-planned and again in the as-built schedule. This technique and the net impact

technique utilising bar chart are similar in that they all show the net effect of all claimed delays.

- As-Planned But for.** This method entails injecting the as-planned schedules with all the delays of a particular party to form an adjusted schedule. The completion date of this adjusted as-planned schedule compared with the actual completion date gives the amount of delay for which the other party is responsible. A contractor using this method would identify and add all non-excusable delays to the as-planned schedule, whereas the owner would add all excusable delays. The advantage of this method is that it can be performed quickly because there is no need to consider actual progress of the work. This technique is applied to the sample project first for contractor's point of view and then for owner's point of view.

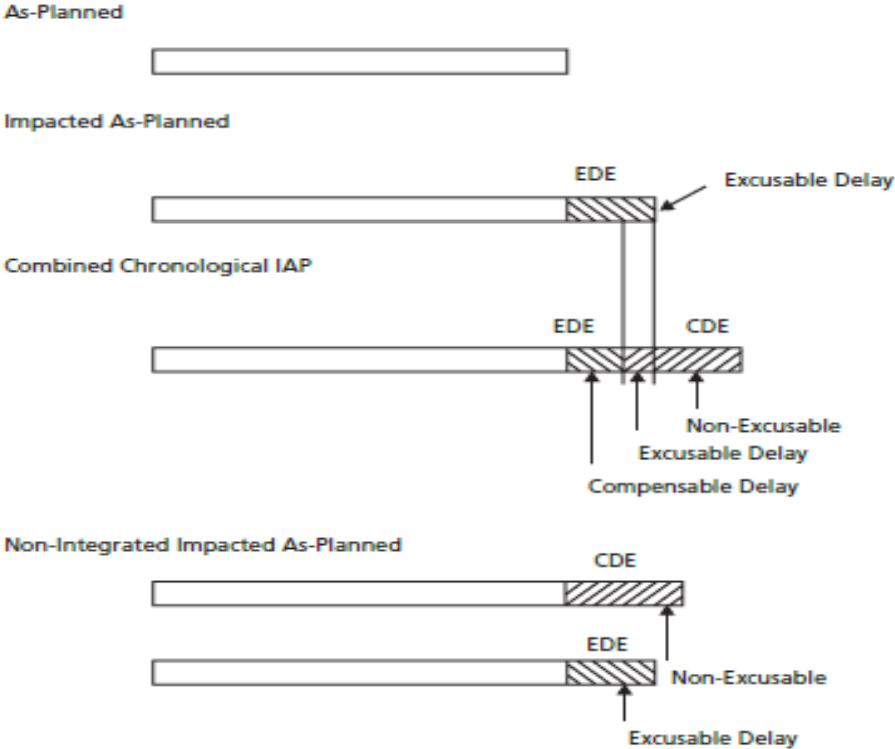


Figure 12: Programme comparisons for delay analysis (Keane & Caletka, 2008)

## Chapter 3

### 3. METHODOLOGY

There exist many research types, methodologies and methods of study. As a practitioner in the construction industry for the past many years it was good option for the researcher to undertake a case study of practical project management function, namely project time management. Furth more profound access to all the necessary archives of the projects made it possible to undertake an in-depth study of the projects. In selecting a subject for a research project, several factors are taken into considerations, among others such as topics of interest to the researcher, topics of current interest in practice, data required for the topic, sources of data for each topic, research limitations for the topic, available resource and time. Availability of enough published information in the projects and ability to conduct the study in the time has also been taken into considerations.

#### 3.1 Description of the Study Area

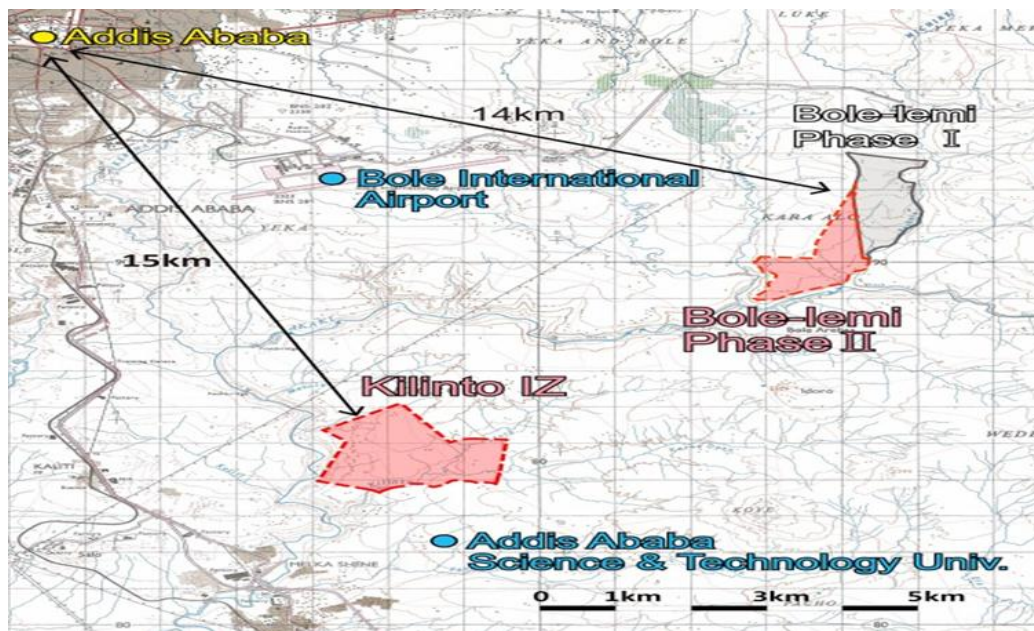
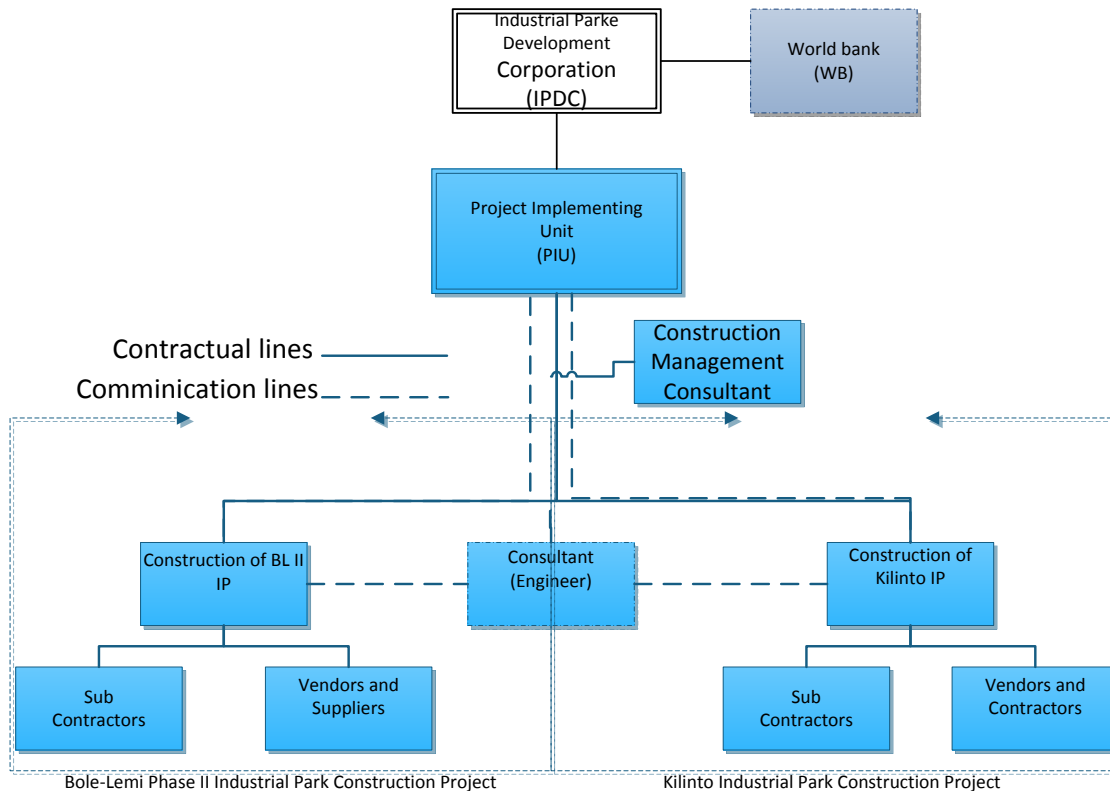


Figure 13: Location map of the case study projects

The Ethiopian Industrial Parks Development Corporation (IPDC) was established in 2014, as one of the public enterprises. Vested with the authority of industrial parks development, IPDC is recently undertaking construction of many industrial parks across the country. The focus of this study is to look into how time is managed in construction projects by taking two projects specifically Bole-Lemi Phase II and Kilinto Industrial park construction projects (figure 18) which are being undertaken by IPDC as employer. In the projects, IPDC is the employer (owner/client) who has procured contractors and consultant (Engineer) for designing and supervising of the industrial parks. The projects are design-bid-build (DBB) projects in which the employer develop the designs through consultant and procures the contractor for construction. Moreover, the projects have independent project team for their execution.



**Figure 14: Organization structures of the projects examined**

The two parks are financed by the World Bank through loan agreement with the government of Ethiopia. All the procurements were international tenders in accordance with the requirements of the World Bank. In the figure below is shown the organizational structures of the projects to scrutinized.

### **3.2 Kilinto Industrial Park**

Kilinto industrial park (see figure 20) involves development of an industrial park on a plot of 270 hectares.



**Figure 15: Kilinto Industrial Park**

It is located in the South of Addis Ababa, in Akaki Kaliti Sub City near Heineken Brewery. Being developed to be a Pharmaceutical Industrial Complex where the desired industrial (manufacturing) development is implemented in association with essential

business offices, commercial, customs, recreation and other infrastructure developments to make it a state of the art industrial park. Major infrastructures include roads, storm water drainages, Water supply, power and telecommunications with adequate parking lot, waste treatment plant and solid waste management facility. Kilinto industrial park is expected to be completed in 12 months of time with a budget of nearly 5.6 Billion Ethiopian Birr.

### **3.3 Bole - Lemi Phase II Industrial Park**

Bole - Lemi Phase II Industrial Park project (see figure 21) covers an area of 171.4 hectares, which is located in the south of capital of Ethiopia, Addis Ababa, 14km from south-east of heart of the city. Most of the area is farmland in between Kotobe and Beshale rivers.



**Figure 16: Bole – Lemi Phase II Industrial Park**

The park is, mainly intended for garment-leather and textile business type. The project mainly consists of development of facilities like ground levelling, road and pavement, sewerage, power, telecommunication, water supply and drainage, sewage treatment plant, solid waste disposal facilities, landscapes, fences, gate etc. as well as construction of auxiliary buildings including one administrative building, logistics warehouse and fire station.

### **3.4 Research Methodology**

Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. It is necessary for the researcher to know not only the research methods/techniques but also the methodology. Researchers also need to understand the assumptions underlying various techniques and they need to know the criteria by which they can decide that certain techniques and procedures will be applicable to certain problems and others will not (Kothari, 1990). Kothari (1990) continues to describe research methods as all those methods/techniques that are used for conducting of research. Research methods or techniques, thus, refer to the methods the researchers use in performing research operations. Since the object of research, particularly the applied research, is to arrive at a solution for a given problem, the available data and the unknown aspects of the problem have to be related to each other to make a solution possible.

According to Saunders, et al., (2009) choice of research strategy will be guided by the research questions and objectives, the extent of existing knowledge, the amount of time and other resources you have available, as well as the philosophical underpinnings of the researcher. In answering the research questions thus case study was selected as the research

strategy. The case study strategy will be of particular interest to when wishing to gain a rich understanding of the context of the research and the processes being enacted (Morris and Wood 1991). The case study strategy also has considerable ability to generate answers to the question ‘why?’ as well as the ‘what?’ and ‘how?’ questions, although ‘what?’ and ‘how?’ questions tend to be more the concern of the survey strategy. For this reason, the case study strategy is most often used in explanatory and exploratory research (Saunders, et al., 2009).

### **3.5 Research Design**

Research design is the general plan of how the study will be going in answering research questions. The basic research questions described in the first chapter of this study are generally related with the management of time in construction projects. The objectives were then drawn from these research questions. So, the research was then designed to in alignment with the getting the objectives achieved. The research employed case study research design.

Research design is the blueprint for fulfilling research objectives and answering research questions. In other words, it is a master plan specifying the methods and procedures for collecting and analysing the needed information. In addition, it must ensure that the information collected is appropriate for solving a problem. Therefore, the researcher must have a clear knowledge about the sources of information, the design technique such as survey or experiment, the sampling methodology and the schedule, as well as the cost involved (Adams, et al., 2007).

Case study method enables a researcher to closely examine the data within a specific context. In most cases, a case study method selects a small geographical area or a very

limited number of individuals as the subjects of study. Case studies, in their true essence, explore and investigate contemporary real-life phenomenon through detailed contextual analysis of a limited number of events or conditions, and their relationships (Zainal, 2007). The study tries to reckon the practical trends in the management of time in the two projects under considerations.

Case studies are often associated with a qualitative research design. They can use a wide range of data collection methods including systematic application of:

- observations by the researcher;
- interviews (often unstructured and semi-structured) with key informants;
- questionnaires;
- documents to enable public records of information; or
- attendance at meetings (Tharenou, et al., 2007).

In this study archival studies of the projects, semi-structured interviews and attending of weekly and biweekly progress meetings were the methods used to collect the data. Commonly, case studies employ interviews of key ‘actors’ in the subject of study; such interview data may be coupled with documentary data (such as in a study of a production process) (Richard & Anita, 2008). Accordingly, interviews were made with relevant personnel of the three parties (employer, contractor and consultant) namely project (counterpart) engineers, project and construction managers, resident engineers and other senior engineers.

The analysis performed for this study can be summarized as:

- Literature review of different books, master’s thesis, web sites of similar cases and sample project reports;

- Analysis of the records data of both projects;
- Attending progress meetings;
- Interviewing relevant personnel of Bole-Lemi Phase II and Kilinto Industrial park construction projects; and
- Finally, qualitative analysis of the data was done.

Other important consideration taken in this case study is triangulation. According to Saunders, et al. (2009) triangulation refers to the use of different data collection techniques within one study in order to ensure that the data are telling what is thought they are telling you. Specifically, in this study, to attain this purpose, data obtained from documents and records of the two projects were cross checked with data obtained from interviews and attendance of the progress meetings.

### **3.6 Population and Sample**

According to Johansson (2003) the case might be given and studied with an intrinsic interest in the case as such. The alternative to an intrinsic case study is a purposefully or analytically selected case. A case may be purposefully selected in virtue of being, for instance, information-rich, critical, revelatory, unique, or extreme. Industrial park projects are new to the construction sector in the country. Due to their complex nature and multidisciplinary nature they were an interest for the researcher. Compared to the completion time assigned for construction projects, the completion time for industrial park projects are very short ranging from 9months to 12months or 1year. This has also made an interest to study the phenomena of practicing time management in construction projects. The study focused on assessing the practice of time management in the case of Bole-Lemi

Phase II and Kilinto Industrial Park construction projects, which are recently being undertaken by Ethiopian Industrial Park Development Corporation.

The sampling technique found appropriate for the study was purposive or judgement sampling which according to Saunders, et al., (2009) is a sampling method that enable the researcher to use his judgement to select cases that will best enable to answer the research question(s) and to meet the research objectives. This form of sample is often used when working with very small samples such as in case study research and when you wish to select cases that are particularly informative (Saunders, et al., 2009)

All personnel directly or indirectly involved in the planning, controlling and monitoring of time for the projects were interviewed. In construction projects staffs usually directly working on time management activities such as planning, scheduling and time control are such staffs like project managers, resident engineers, contract and claim engineers of the consultant. Project managers of contractors are key in the preparation and follow up of time management in construction projects. Project engineers from the side of employers are the focal points in time management activities. Interviews were therefore conducted with these personnel.

### **3.7 Data Sources and Types**

The data collection techniques employed in researches may be various and are likely to be used in combination. They may include, for example, interviews, observation, documentary analysis and questionnaires. Data collection techniques and sources depend on the research strategy being employed. Yin (2009) stated that case study evidence can come from many sources. They are documentation, archival records, interviews, direct observation, participant- observation, and physical artefacts. Each source is associated with

an array of data or evidence. This is also supported by Saunders, et al., (2009) by explaining that case study strategy is likely to need to use and triangulate multiple sources of data.

The methods of data collections used for the study subsequently include interviewing, attending progress meetings and desk study of the two projects. The interviewees were selected based on their exposure to the planning, scheduling and controlling of the projects. Then to collect data, semi-structured interviews were employed in order to obtain most accurate answers based on the interviewees' opinion and experience. The methods of data collection used for this study is interviewing relevant personnel of the project along with study or archives and documentations of the projects. Documents and archives are employed as the major data source with data from interviews used to fill gaps identified from the documents and to triangulate the data gathered through document analysis.

### **3.8 Data Collection Procedures**

Secondary data have been obtained from literature review (including books, articles and reports) as well as the project reports and documents. Given the fact that the goal of this research is to explore and evaluate the practical management of time in construction for the two construction projects, the data collection methods used in this research is qualitative.

#### **3.8.1 Desk Study and Review of Documents**

Except for studies of preliterate societies, documentary information is likely to be relevant to every case study topic. This type of information can take many forms and should be the object of explicit data collection plans (Yin, 2009). Ad in-depth desk studies on the time management of the projects were used in this research which were then supported or

supplemented by responses and arguments found by interview. Apart from attending progress meetings and discussions, an in-depth review of the following documents was made.

- Monthly and biweekly progress reports;
- Service and works contracts;
- Relevant Correspondences;
- Work programmes; and
- Minutes of meetings.

### **3.8.2 Interviews**

Interview is one of the primary data collection methods which is flexible and adaptive way of investigating underlying motives of a subject in a way that self-administered questionnaires cannot. The interview undertaken for this study was based on semi structured style. This type of interview has a predetermined set of questions (generalized form of questionnaire) with a flexible order depending on what the interviewer perceives the subject matter by looking at the respondent capability and exposure or experience. One of the most important sources of case study information is the interview. Such an observation may be surprising because of the usual association between interviews and the survey method. However, interviews also are essential sources of case study information (Yin, 2009).

To determine the practice of time management semi-structured interviews were used. Questions were formulated in a way to determine how the practice of time management is happening and is used in practice and how familiar the actors in the project are with this

concept. Efforts have been made so that the questions will be aligned with the research questions.

In section 2.2 of this research, having made reviews of literatures and other related documents, time management framework for construction projects was outlined to be consisting of three phases of processes. The first step is the planning phase where mainly estimation of resources and time for the activities are done. This is then followed by putting the activities in light of the calendar or time allotted for the project. Finally, the progress of the project should be estimated and compared with the baseline schedule developed. The interview questions were thus devised based on this framework and the contractual requirements of the contract for the projects.

The interviewees were project managers, resident engineers, senior engineers from all the three parties precisely employer, consultant and contractors. These personnel have key direct or indirect role in the planning, scheduling, implementation, monitoring and controlling of the projects.

The other important matter related with time management is the roles of the parties involved in the projects. In construction projects, preparation of work programme and scheduling is the core duty of the contractor. Then according to the conditions of contract, the other parties can rely on the programme. The consultant will review the programme and suggests his opinion that to what extent the programme is applicable for the project. Then beside the internal duties of the contractor in monitoring and controlling of the project, monitoring and controlling is the core responsibilities of the consultant and the employer. The interview questions were therefore developed with this taken into considerations.

### **3.9 Ethical Consideration**

Prior to conducting a research project, the researcher needs to assess the research design to determine if it follows ethical procedures. The researcher must also obtain formal permission to conduct the study from the ethics body from his or her institution. Good research design follows good principles for ethics, and some important issues are outlined here for researchers to consider (Richard & Anita, 2008).

Selected from Tharenou, et al (2007) are relevant lists of issues that are considered by the researcher in order to conduct research that is ethically sound.

- The researcher should maintain his or her specialist knowledge and practice at an acceptable level of competence;
- Care should be exercised when seeking research participants/interviewees;
- The researcher should not exploit research participants (e.g., power, cost).
- The researcher should avoid conflicts of interest;
- The researcher should be particularly concerned when people are the research participants; and
- The researcher must always respect the personality, rights, wishes, beliefs, consent, and freedom of individual research participants.

All the necessary ethical cares indicated above as well as others were considered in undertaking the study. All interviews were made after getting consent from the interviewees. All the necessary approvals have been obtained from all institutions in undertaking the interviews and archival studies. The other important thing considered in the analysis of data were avoidance of bias. One test of this possible bias is the degree to

which the researcher is open to contrary findings (Yin, 2009). Every effort has been made to report the findings as they are without prejudice.

### **3.10 Analysis**

Firstly, the study used examination of documents and archives of the projects as its main source of data which was then supported by data obtained from interviews. Therefore, the records of the projects were assessed and studied followed by analysis of the interview data obtained. As case studies are normally best examined by qualitative data, therefore the analysis used in this study is qualitative.

## **Chapter 4**

### **4. RESULTS AND DISCUSSIONS**

#### **4.1 Introduction**

Thorough analysis of documents and archives of the two projects were made followed by interviewing of the relevant personnel of the contractors, the consultant and employer. The data obtained were then analysed. The results of the analysis of the data obtained for these endeavours are presented and discussed here under.

#### **4.2 Study of Archives, Documents and Project Records**

Major source of data for this study was the project documents of the case study projects under consideration, viz. Bole-Lemi Phase II and Kilinto Industrial park construction projects. Main project documents studied included work programmes, correspondences, minutes of meetings and progress reports. The results form reviews of these documents are presented here under with regards to the planning, scheduling and time control tasks of the projects.

##### **4.2.1 Planning**

The major source of data for the planning stage of time management was the work programme. Sub-Clause 8.3 of the contract requires the Contractor to submit a detailed programme to the Engineer within 28 days after receiving the notice of the commencement date. Accordingly, the contractors have produced work programmes. In reviewing the work programmes of the projects under study it was found that:

- Although the necessary resources such as personnel and equipment are indicated, as how these resources are estimated is not indicated. It is not clear as how the productivity of the resources was estimated;
- There were no records of the estimations of time for the activities. Thus, it is not clear as whether the time assigned for the tasks are optimum or not;
- Standard methods of resource and time estimations were not found. Thus, it is not clear as whether the time assigned for the tasks are optimum or not;
- Constraints such as rain and obstructions for instance are not shown in the schedule. There have been longstanding obstructions which prevented the contractors from undertaking some construction tasks as found from examination of the correspondences. However, they were not depicted in the work programme;
- The sequences of the various activities showing the order in which the contractor intends to carry out the works are indicated. However, the logics of such sequences are not shown or described;
- Industrial park development projects are multidisciplinary and complex in their nature which require procurement of many plants and equipment from abroad. Such tasks were not fully reflected and shown in details;
- In comparison with clarity, presentation and level of details, the work programme for Bole-Lemi Phase II construction project is found to be better.

#### **4.2.2 Scheduling**

The scheduling process determines the timing of work activities identified by the planning process and results in a project schedule. Scheduling represents sequencing and phasing of individual activities required to complete the work. The schedule is a management tool

used to predict project completion, and thereby ensure timely completion by adjusting resources applied to the work. With regards to this phase of project time management, summarised are hereunder are the major findings.

- The critical path method (CPM) is the scheduling tool used in the projects. Though the critical path for some work packages such as earthworks are indicated, the critical path for the whole projects were not identified;
- Bar /Gant charts are also employed. However, given the fact that the projects are huge and complex, the Gant charts should have been also shown for sub-tasks;
- Microsoft project is the software employed for the scheduling of the projects for the projects in combination with Microsoft Excel;
- The schedules are prepared based on the activities, which can be regarded as detail schedules. However other types of schedules for example master schedules and summary schedules were not made;
- The Engineer was not scrutinizing the work programme in light of the contractual requirements. For instance, there was no notification to the contractor of issues related to safety during night work, though the contractor is obliged to execute his works with due considerations of the safety of the personnel; and
- In the programme are not indicated such requirements as the time required by the Engineer for the approval of designs and drawings;

### **4.2.3 Time Control**

Activities consume time and resources; therefore, they must be assigned and measured. Assigning activities to responsible parties is vital because it significantly helps divide the project into manageable pieces, assigning them to the party best suited to perform the work.

In addition to determining what an activity is and how long it should take, the assignment tells who is responsible. In order to control the progress of the entire project, the progress of each activity must be measured and the assigned party held responsible for its sufficient progress. Commonly, activities are measured by quantities of materials installed, a percent complete based on a gut feeling or elapsed time. Measuring progress based on the quantities of materials installed, as compared to the planned quantities, is the most effective method, though it requires thorough tracking of installed materials. The other two methods are quick, but significantly less accurate.

In tracking and monitoring the progress of the projects, the responsibility of the Engineer is huge. Sub-clause 8.6 of the contract entitles the Engineer/consultant to instruct the contractor to submit proposals to revise his programme and to accelerate the work in order to achieve completion by the due date.

- Reviewing of the project records revealed that the Engineer was not executing his major duty of tracking the progress as well as initiating the revision of the work programme;
- Therefore the projects have been ongoing in the midst of obsolete work schedules which have become outdated due to the slow progress of the projects in comparison with the baseline schedules;
- Estimation of the progresses were merely based on crude percentage judgments which led to the fact that there lacked accurate estimation of progresses;
- S-curves were employed in the estimation of the progresses. However, both the plan as well as the accomplishments were not being revised and updated as the result of which realistic plans and progresses were not in place;

- There was no such refined method of extension of time analysis. One reason was the fact that there was no updated work programme. Additionally, analysis of extension of time lacked philosophical background to stick to one of the delay analysis techniques; and
- There have been lack of updating the work programme observed which have made the evaluation of delays as well as evaluations of extension of time.

### **4.3 Findings from Interviews**

The findings from interviewing of the personnel involved in the planning and management of time were very much aligned with the findings from the desk studies conducted on the archives and documents. The purpose of the interviews was mainly to fill the gaps from the studies of the documents.

Interviewees in this study have positions such as construction manager, department manager, contract manager, resident engineer and site managers. In the same manner by which the findings of the desk studies were presented, here under are the findings from the interviews which are uniquely and peculiarly identified by interviewing the project personnel.

#### **4.3.1 Planning**

Planning the initial stage in the preparation of work programme and time management. The blue print of the programme is laid at this stage the detail of which are realized through scheduling and time control. Taking planning as distinct phase of the preparation of work programme, the following major findings are discovered.

- Some interviewees reported that due to an extremely short completion time allotted for the project, there was not sufficient time for the planning aspects of the project. As the result the planning was not properly undertaken.

### **4.3.2 Scheduling**

According to the interviewees of the interview, the tool and technique used for scheduling are the critical path method (CPM) and Gant/bar charts. Microsoft Project is the most widely used tool for project scheduling in Ethiopia. Results from the interview also show that experts in the two projects use mostly Microsoft Project and Microsoft Excel as scheduling tools. As most of the interviewees explained this is related with user-friendliness which is the most ranked reason for using the specific tool for project planning. Generally, it was discovered that Microsoft Project is more user- friendly than Primavera.

### **4.3.3 Time Control**

The method of revising work programme is not evident from the project documents. However, from the interviewees it was found that revision of work programme was made based on site surveying data, request for inspections RFIs and joint measurement sheets which truly reflect the actual progress on site. As the interviewees explained, the challenge with updating progress and revisions on the schedule included among other difficulty in getting up-to-date data. Other findings based on the information form the interviewees are listed here under.

- Lack of capable planning experts was one of the challenges faced by the contractors. Though they are using various scheduling tools for other projects in

other countries, they were not able to get the expertise here. They were therefore obliged to rely on the exiting expertise.

- The other challenge mentioned that made the time control activities difficult was variations and design changes. Interviews have indicated that the quantities of activities shown in the tender documents have now substantially changed. This in turn varies and changes the volume of tasks to be undertaken lastly making the scheduling and updating of the schedules very frequent. This requires additional efforts and works in in making the schedules up-to-date.

## **Chapter 5**

### **5. CONCLUSIONS AND RECOMMENDATIONS**

As discussed in chapter 2 of this study, project time management conceived three distinct processes i.e., planning, scheduling and time control, the conclusions are therefore based on these processes. Generally, it can be stated that the time management of the projects studied didn't suffice for such huge, complex, multidisciplinary and international projects. More specifically it can be concluded as described in the following sections.

#### **5.1 Conclusions**

After undertaking an in-depth study of the documents, archives and records of the projects under study, the following major conclusions are drawn.

- The work programmes of the projects studied lacked planning efforts and details and didn't put the blue print of the projects. This shows that the contractors were not paying the necessary attention to this key processes and documents required for the management of time. The consultant was not either able to assert the preparation of robust work programme.
- As revealed from the discussions made with the project personnel, the major difficulty that put the contractors in trouble was an extremely short duration allotted for the completion of the projects. According to the interviews and meetings attended in the projects, they were originally envisioned for three years which were later on, during the tender stage, squeezed to only to one year. This has been an ambitious decision by the government. Considering the fact that there will be at least three months of rainy season, effective duration for the projects become only

nine months. In view of the fact that many construction projects which are by far smaller than the projects under study are given larger much longer completion time like 3 years, the completion time assigned for the projects is unrealistic and very difficult to implement on the ground. This as the result made the contractor to focus on physical accomplishment than giving attention to planning aspects such as work programme.

- The contractors and consultant also lacked creativity and adaptability of the existing methods work programme to the specific needs of the projects. For instance, rather than simply adopting the Gant chart linearly on the spread sheet, it would have been very much better to make it on the physical diagram /plan of the projects which would have given good sense of understanding and physically realizing the work programme.
- The available work programmes were not detailed enough to undertake comprehensive delay and extension of time analysis.

## **5.2 Recommendations**

- The predominant software adopted for scheduling in most construction projects in the country is Microsoft project. As many professionals and petitioners suggest, for complex projects such as the ones considered in this study, Primavera has many advantages. For instance the “Activity Steps” option, in Primavera P6 enables one to simplify the updating process of complex tasks. The other way round, activity steps break down a complex activity into smaller parts, while maintaining the simplicity of a Gantt chart. This can be done by inserting steps (phases) inside each activity. You can set the calculation of the Activity percent complete to be based

on the activity steps in order to have more realistic overview of the project's progress and thus more accurate progresses can be realized.

- Dispute may arise if the Contractors are discontent by the extension of time granted to the Engineer. For international projects such as the ones studied in this research such disputes are first referred to the dispute board (DB) and then to arbitration procedures which are expensive and time taking. Rather than getting into such complications it is better to establish state-of-the-art delay and extension of time assessment techniques.
- Project quality can also be affected due to construction delays since the construction team usually dedicates less time to quality control when the main concern is completing the project on time. When this is the case, workers are usually pushed to work overtime and to increase the production rate, which very often entails failures and reworks.
- Training and specialization in the areas of planning and project management need to be encouraged. For countries like Ethiopia destined and opting for many mega projects there is required immense capability to be developed. The area of planning and scheduling should be encouraged to be an area of major specializations. This can be done by incorporating rigorous planning courses in the areas of project management as well as capacity building by training.
- Planning should be started since the early development of projects. Time management of projects cannot be an exception. It is thus huge of importance that realistic time for projects set forth to avoid unrealistic schedules. This should be done from the conception stage of projects.

- More studies need to be undertaken in the areas of project management as an emerging new area of specialization. Professionals and academicians in the area need to be encouraged to undertake more and detail studies in the areas of project time management.

## **Appendix - Interview Questions**

### **a) Interview questions for the contractor's personnel**

#### ***I) Introduction***

Dear interviewee, the purpose of this interview is to collect data only for the research work entitled "The Practice of Time Management in Construction Projects - Case Study of Bole-Lemi Phase II and Kilinto Industrial Park Construction Projects." The focus of this study is to study as how time is managed in construction projects, taking Bole-Lemi Phase II and Kilinto Industrial Parks construction projects as cases.

As a professional with vast experience taking part in Bole-Lemi Phase II and/or Kilinto Industrial Parks construction projects, on behalf of the Contractor, I request you to kindly give you answers and opinions for the following questions. I assure you that this study is solely intended for academic purposes and confidentiality of your response is guaranteed.

#### ***II) General Information***

- 1) Name of interviewee (optional) \_\_\_\_\_
- 2) Roles of interviewees: \_\_\_\_\_
- 3) Relevant work experience (Years): \_\_\_\_\_
- 4) Educational qualification: \_\_\_\_\_

#### ***III) Planning***

- 5) Is there a standardized or formal documented process on how to manage time within the project?
- 6) Is there standard method of activity resource estimation?
- 7) Is there standard method of activity duration estimation?
- 8) Is there standard method of establishing sequential relationships of activities?

#### ***IV) Scheduling***

- 9) Is there standard time management techniques/methods (such as Bar chart, Critical Path Method (CPM), PERT, LOB or Other) in place for this project? If your answer is yes, could you list?

- 10) Do you use scheduling software (such as Microsoft project, Asta power project, Primavera, Project commander or others) in this project? If your answer is yes, could you mention which one?
- 11) Is there standard method of identifying time related contractual obligations and requirements in the project?
- 12) Do you prepare different levels of work programmes such as master work programme, summary and detail work programmes?
- 13) Do you prepare space diagram as part of the construction work programme?

**V) *Time Control***

- 14) Is there standard method of updating the construction work programme of this project?
- 15) How often is the construction work programme of the project updated?
- 16) How often should the construction work programme of the project updated according to the contractual requirements?
- 17) Do you use s-curve in the evaluation of project progress?
- 18) What is your method of progress evaluation? Does it reflect the actual progress of the project?
- 19) Do you have standard delay analysis techniques in proposing and claiming extension of time in this project?
- 20) Is there a procedure for the determination of concurrent delay and its effect on entitlement to extension of time?
- 21) Do you calculate and classify floats?
- 22) What tools/techniques do you use to expedite the project when you encounter delays?

**b) Interview questions for the Consultant/Engineer’s personnel**

***I) Introduction***

Dear interviewee, the purpose of this interview is to collect data only for the research work entitled “The Practice of Time Management in Construction Projects - Case Study of Bole-Lemi Phase II and Kilinto Industrial Park Construction Projects.” The focus of this study is to study as how time is managed in construction projects, taking Bole-Lemi Phase II and Kilinto Industrial Parks construction projects as cases.

As a professional with vast experience taking part in Bole-Lemi Phase II and/or Kilinto Industrial Parks construction projects, on behalf of the Engineer/Consultant, I request you to kindly give you answers and opinions for the following questions. I assure you that this study is solely intended for academic purposes and confidentiality of your response is guaranteed.

***II) General Information***

- 1) Name of interviewee (optional) \_\_\_\_\_
- 2) Roles of interviewees: \_\_\_\_\_
- 3) Relevant work experience (Years): \_\_\_\_\_
- 4) Educational qualification: \_\_\_\_\_

***III) Planning***

- 5) Is there a standardized or formal documented process on how to manage time within the project?
- 6) Is there standard method of reviewing activity resource estimation?
- 7) Is there standard method of activity reviewing duration estimation?
- 8) Is there standard method of reviewing sequential relationships of activities?

***IV) Scheduling***

- 9) Is there standard time management techniques/methods (such as Bar chart, Critical Path Method (CPM), PERT, LOB or Other) in place for this project? If your answer is yes, could you list?

- 10) Do you use scheduling software (such as Microsoft project, Asta power project, Primavera, Project commander or others) in this project? If your answer is yes, could you mention which one?
- 11) Is there standard method of identifying time related contractual obligations and requirements in the project?
- 12) Do you instruct/advise the contractor to prepare different levels of work programmes such as master work programme, summary and detail work programmes?
- 13) Do you instruct/advise the contractor prepare space diagram as part of the construction work programme?

**V) *Time Control***

- 14) Is there standard method of follow up of updating the construction work programme of this project?
- 15) How often is the construction work programme of the project updated?
- 16) How often should the construction work programme of the project updated according to the contractual requirements?
- 17) Do you use s-curve in the evaluation of project progress?
- 18) What is your method of progress evaluation? Does it reflect the actual progress of the project?
- 19) Do you have standard delay analysis techniques in reviewing extension of time in this project?
- 20) Is there a procedure for the determination of concurrent delay and its effect on entitlement to extension of time?
- 21) Do you calculate and classify floats?
- 22) What tools/techniques do you use to expedite the project when you encounter delays?

**c) Interview questions for the Employer’s personnel**

**I) Introduction**

Dear interviewee, the purpose of this interview is to collect data only for the research work entitled “The Practice of Time Management in Construction Projects - Case Study of Bole-Lemi Phase II and Kilinto Industrial Park Construction Projects.” The focus of this study is to study as how time is managed in construction projects, taking Bole-Lemi Phase II and Kilinto Industrial Parks construction projects as cases.

As a professional with vast experience taking part in Bole-Lemi Phase II and/or Kilinto Industrial Parks construction projects, on behalf of the Employer, I request you to kindly give you answers and opinions for the following questions. I assure you that this study is solely intended for academic purposes and confidentiality of your response is guaranteed.

**II) General Information**

- 1) Name of interviewee (optional) \_\_\_\_\_
- 2) Roles of interviewees: \_\_\_\_\_
- 3) Relevant work experience (Years): \_\_\_\_\_
- 4) Educational qualification: \_\_\_\_\_

**III) Planning**

- 5) Is there a standardized or formal documented process on how to manage time within the project?

**IV) Scheduling**

- 6) Is there standard time management techniques/methods (such as Bar chart, Critical Path Method (CPM), PERT, LOB or Other) in place for this project? If your answer is yes, could you list?
- 7) Do you use scheduling software (such as Microsoft project, Asta power project, Primavera, Project commander or others) in this project? If your answer is yes, could you mention which one?
- 8) Is there standard method of identifying time related contractual obligations and requirements in the project?

- 9) Do you instruct/advise the Engineer/Consultant to prepare different levels of work programmes such as master work programme, summary and detail work programmes?

**V) Time Control**

- 10) Is there standard method of follow up of updating the construction work programme of this project?
- 11) How often is the construction work programme of the project updated?
- 12) How often should the construction work programme of the project updated according to the contractual requirements?
- 13) Do you use s-curve in the evaluation of project progress?
- 14) What is your method of progress evaluation? Does it reflect the actual progress of the project?
- 15) Do you have standard delay analysis techniques in reviewing extension of time in this project?
- 16) Is there a procedure for the determination of concurrent delay and its effect on entitlement to extension of time?
- 17) Do you calculate and classify floats?
- 18) What tools/techniques do you use to expedite the project when you encounter delays?

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