KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,
KUMASI, GHANA

An Investigation into Scheduling Practices Deployed within the Ghanaian Construction Industry

by

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A Thesis submitted to the Department of Building Technology, College of Art and Built Environment
in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE
(Construction Management)

NOVEMBER 2015

DECLARATION

I hereby certify that all material contained within this report is my own work towards the award of MSc Construction Management and that, to the best of my knowledge, it contains no material previously published by another person, nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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Signature

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Supervisor Name

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Head of Department Name

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Signature

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Date

DEDICATION

This Dissertation is dedicated to my parents, Yaw Opoku-Amankwah and Mary Addai and to my siblings Andrew, Audrey, Benedicta and Hubert.

ACKNOWLEDGEMENTS

My appreciation goes to Almighty God, my supervisor Mr. James Danku and the entire lecturers of the Department of Building Technology for their supervision, constructive criticisms, useful suggestions, and encouragements. My thanks also go to Derek Abankwa and Stephen Akunyumu, post graduate students at the Department of Building Technology for their support and guidance. Thanks again go to Mr James Danku for his immense contributions in terms of guidance, suggestions and encouragements without which this work would not have materialized.

I am as well grateful to my parents for the words of encouragement and motivation.

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ABSTRACT

Schedules are prepared for construction projects to serve as control measures to ensure that cost and time objectives are achieved. Various techniques and tools have been developed over time to aid in developing construction project schedules. The aim of the research was to determine the impact of schedules on construction projects in Ghana. The research sought to identify the various scheduling techniques and tools used in the Ghanaian construction industry as well as identifying the factors that hinder the implementation of project schedules. Extensive literature review was done to determine the various scheduling tools and techniques. The research style used was the survey style and the approach adopted was quantitative. Non-probability sampling techniques namely purposive and snow ball were used in collecting data from an undefined population. Data collection instrument used was structured questionnaire. Questionnaires were administered to sixty (60) construction professionals in the Kumasi metropolis. With a response rate of 83.33%, data was analysed using descriptive data analysis such as the measure of central tendency and relative importance index (RII). The research identified Gantt chats, line of balance, queue scheduling and network diagrams, MS project, Excel and Prima Vera as the various scheduling techniques and tools used in the Ghanaian construction industry. Unavailability of funds, undefined project scope and project specific factors (e.g. ground conditions) with RII values of 0.7, 0.7 and 0.6 among others were ascertained to be factors that hinder the implementation of project schedules. The research as well established delay in project duration, resequencing of work and poor cost planning as impacts the use of scheduling techniques will have on a construction project. The research recommends that funds are made available on regular basis to ensure that schedules produced for construction projects are implemented accordingly.

Keywords: Scheduling, Construction, Project, Techniques.

CHAPTER ONE

GENERAL INTRODUCTION

1.1 BACKGROUND

Scheduling involves the application of the knowledge of mathematical, physical or engineering science to the implementation of creative work. It is practiced in the planning, progress and completion of design, analyses or implementation of building and several other projects (O'Brien and Plotnick, 2006.).

Construction projects are often an integration of various deliverables and activities which are coordinated to achieve specific objectives. A clear plan is therefore needed to ensure that the project is executed as required by the client. In most instances projects are not carried out by strictly adhering to defined timelines which results in either increase in project duration or cost (Ochieng, et al., 2013)

Essentially scheduling provides a distinctive path which indicates when and how the project deliverables will be achieved as presented in the scope of works and defined by the project team as well (Institute, 2007).

A reliable schedule helps to avoid certain factors that can hinder the progress of a project. Assigning durations and timelines to every activity on a project is a headache to most project/construction managers yet it becomes the challenge one is faced in projects. One must break project into manageable activities linked to increments of time that can be monitored and adjusted as the project schedule moves along (Weaver, 2006).

Several attempts have been done to develop the ability to provide sufficient timelines to various day to day activities and construction projects as well (Gronevelt and Mattila, 1999). Frederick Taylor in his bid to ensure increase in industrial production developed the first scientific time management technique in 1885. Henry Gantt improved this production scheduling technique

and was used in World War 1 around 1911. His scheduling technique is a graphical representation of activities versus time and is termed as the Gantt chart or Bar chart which remains widely used currently.

Around 1950s and 1960s the Critical Path Method (CPM) was developed alongside the development of computer software and hardware. CPM clearly defines the logical representation of activities, their durations and their interdependencies. CPM helps in calculating start dates, floats and finishing dates of various activities (Gronevelt and Mattila, 1999).

Program Evaluation Review Technique (PERT) was discovered in July 1958 in a publication captioned PERT, summary report, Phase 1 and was applied around October 1958 to the Fleet Ballistic Missile Program(Baldwin and Bodoli, 2014).

The various techniques employed in scheduling of most construction projects based on the above methods of analysis include the activity on arrow, Gantt or bar charts, the precedence diagrams and the line of balance.

Computerized tools for scheduling are widely used in recent times. These tools include MS Project, Microsoft excel and Primavera software.

1.2 PROBLEM STATEMENT

Construction projects have defined time frame for which the objectives are to be achieved. More often than not these durations are exceeded due to various reasons which include undefined scope, poor supervision, lack of communication between stakeholders and non-adherence to proper schedules or non-existent activity schedules (Jha and Iyer, 2006).

Scheduling techniques and tools have become necessary in modern day Ghanaian construction projects due to their enormous advantages yet their impacts have not been fully felt as schedulers may not have the needed experience to provide accurate timelines for the various

activities, unfamiliarity with the techniques and non-adherence to designed schedules among others. Even though schedules are prepared to facilitate the completion of construction projects in Ghana, most projects are completed beyond the designated durations provided per the project scope. These factors include client/consumer demands and delivery dates, unavailability of funds, availability of required resources etc. (Fugar and Agyarkwa-Baah, 2010).

It is therefore imperative to identify the best scheduling practices to adopt and to determine how these affect the performance of a construction project.

1.3 RESEARCH QUESTIONS

The following questions were formulated to serve as a guide in finding solutions to the objectives;

- What are the various scheduling tools and techniques contractors use in the Ghanaian construction industry?
- Does project scheduling have any factors hindering its implementation?
- How does the scheduling tools and techniques impact projects in Ghana?

1.4 AIM OF STUDY

The overarching aim of the research work is to determine the impact of project scheduling on construction projects in Ghana.

1.5 RESEARCH OBJECTIVES

The specific objectives translated from the research questions were as follows;

- To identify the various scheduling tools and techniques used in the Ghanaian construction industry.
- To determine the factors that hinder the implementation of project schedules.
- To determine the impact of the scheduling techniques on projects.

1.6 METHODOLOGY

Relevant literature related to the topic and its aim and objectives were reviewed and form the basis to the definition of problem at hand and how to bridge the gap in scheduling practices in Ghana.

The research style adopted was survey and the research approach adopted was quantitative. The sampling techniques adopted were purposive and snowball. The data sources were both primary and secondary with questionnaires being data collection tool. Secondary data were collected from journals, articles, books and other publications. Data were assessed and analyzed quantitatively using Statistical package for Social Sciences (SPSS) and Microsoft Excel. Mean score rankings and Relative Importance Index (RII) were employed for the study.

1.7 SCOPE OF STUDY

In spite of the topic generally considering Ghana, emphasis was placed on construction firms within the Kumasi metropolis, however, it is hoped that data gathered reflects on what pertains in Ghana in general. Kumasi is chosen because it is one of the largest metropolises in Ghana which records a lot of construction projects and firms. Kumasi is also preferred due to its proximity to the researcher; hence, data collection was done with less difficulty. This research only determined the type of scheduling tools and techniques used and rank them in terms of their popularity. The research also determined how well strict adherences to pre-determined schedules affect projects during construction phase.

1.8 LIMITATIONS

Compared to any other research this thesis has its own genuine limits and extents. The limits hopefully will serve as guidance for future research. The limitations included:

- Time was a constraint hence in-depth analyses of the issues raised were not fully dealt with.

- No published data was obtained on the perceived respondents of the research hence population was undefined and thus the research may not be wholly representative.
- Analysis of data was solely be based on data collected from questionnaires that were administered.
- Data collection was limited to selected construction firms and construction projects in the Kumasi metropolis.

1.9 STRUCTURE AND ORGANISATION OF THE THESIS

This thesis report shall be divided into five (5) chapters.

- **Chapter One** introduced the research conducted. The background of the study was discussed. This chapter also discussed the statement of problem, the research aim and objectives, scope of study and research questions.
- **Chapter Two** discussed the review of literature on project scheduling. The literature review was an account of related works published by researchers in the area of the study. The literature review also discovered scheduling tools and techniques used by contractors in the construction industries.
- **Chapter Three** described the research methodology. The process of the research, research design, research style, and research approach were discussed in this Chapter. The sample population, sample size, the sampling technique and the development of the questionnaire were described in Chapter three. The chapter explains methods that were used to analyze the data.
- **Chapter Four** provided descriptive analysis on the data collected. The appropriate relevant statistics used in analyzing and interpreting the collected data were discussed in this chapter.
- **Chapter Five** concluded the research conducted. Recommendations, findings and areas for future studies were well discussed in this final chapter.

1.10 SUMMARY OF CHAPTER

The chapter introduced the entire thesis. Chapter one presented the study background and the problem of the thesis. The aim and objectives were also presented. In order to address the specific objectives research questions were highlighted. The scope of the study and the structure or organization of the theses was further described.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Management has four main functions of which planning is a part. Planning in conjunction with organizing, leading and control have been determined to be the backbone of effective management (Robbins and Coulter, 2009). This chapter presents review of literature for this research. Relevant literatures pertaining to the scheduling of works in the construction industry were reviewed. The Concept of scheduling, types of schedule, planning process and activities, techniques and tools in construction projects are examined in this chapter.

2.2 LIFE CYCLE OF CONSTRUCTION PROJECTS

A project is a distinctive set of activities undertaken to generate a group of deliveries with clearly determined time, cost and quality constraints. The word project comes from the Latin word *Projectum*, which implies "something that comes before anything else happens" (Lewis, 2001). Attempting to manage a project without project management can be likened to attempting to play soccer in the absence of a clearly spelt out strategy and game plan. Project Management involves techniques, managerial processes and tools required in undertaking a project successfully. Meredith and Mantel (2009) asserts that, project management incorporates skills, tools and processes. Some specific characteristics of a Project;

- distinctive in nature
- Limited resources
- Risk Components
- Approved budget
- Beneficial change
- Defined timescale

For a project to be considered successful the following are the factors though not exhaustive; Stakeholder participation , input and involvement of executive management, Clear statement of requirements, Proper planning, targets that are achievable, Smaller Project milestones, Ownership, well defined scope of works, staff commitment and attitude (Pakseresht and Asgari, 2012).

The project life cycle is defined as the processes and stages through which a project is finally elaborated. Both complex and simple project go through similar life cycle though work packages, activities and methodologies may differ. Every project consists of four phases (Baker and Baker, 1992). These stages include the initiation phase, planning phase, the execution phase and the termination/closure phase.

2.2.1 Initiation phase

Every project begins with an intent or idea to fulfil a dream. During the initiation phase the rational or ideology of a project is clarified and finalised. It is usually during this stage that the client decides to start a project. It is imperative to map out a strategy and define the components of the project. An achievability study is then directed to research whether every alternative addresses the issue and a last prescribed arrangement is then advanced. A project is then undertaken to deliver the endorsed solution. During the initial phase also, a project manager is delegated who then recruits a project team and afterward move into the point by point planning stage (Baker and Baker, 1992).

2.2.2 Planning phase

During the planning stage, activities, tasks, dependencies and timeframes are outlined. There is also a listing of resource plans, material and plant resources. Monetary plans to identify the personnel to be used, equipment and plant and material expenses are determined. Quality plans are conducted to provide achievable targets, quality assurance and control measures. A Risk plan indicating various risks and their mitigating measures are documented in addition to

communication plans identifying the needed information to be relayed to stakeholders. Drawings and tender documents are completed. The implementing stage seeks to monitor the project, control and adjust so as not to go over budget, make sure the work is of good quality and done within specified time to meet the defined goals (Baker and Baker, 1992).

2.2.3 Execution phase

The execution phase includes executing the plans that were developed at the planning phase. At this phase changes are identified, potential risk events actually are realized, deliverable qualities are reviewed. At the instance when all deliverables have been undertaken and the consumer has accepted the final product the project is deemed fit for termination (Baker and Baker, 1992).

2.2.4 Termination phase

The success of a project is finally assessed at this phase. This is the termination phase or the transition phase as asserted by Baker and Baker (1992). The final project deliverable is then handed over to the client at this stage. Some major activities that go on during the closure phase are;

- Handing over project documentation
- Terminating supplier contracts
- Releasing project resources
- Communicating the project closure to all stakeholders

Project managers identify lessons learnt on a project for future projects.

2.3 CONSTRUCTION PLANNING PROCESS AND ACTIVITIES

Construction projects are expected to be completed on time, within the cost budgeted for the project and to expected quality and safety standards. These three items are the most common objectives of a construction project.

2.3.1 Construction planning definition

Planning forms the building blocks of control hence it would be pointless to create a plan provided there was no effort in controlling its implementation. Planning can also be the steps taken to set objectives, develop well defined strategies, and outline activities and schedules to achieve the objectives. Litman (2013) states that, planning means the steps taken to decide what to do and how to do it. Planning can occurs at many levels, starting from day-to-day decision making by individuals and families, to decisions of complex nature undertaken by government and corporate business groups. This is similar to the definition by UNDP (2009) stating that, planning is the procedure of setting objectives, creating techniques, laying out the execution plans and dispensing resources to accomplish those objectives. According to Dutton and Duncan (1987), planning is the process whereby we devise and maintain an executable plan to satisfy the business needs that the project was implemented to solve. Essentially planning also includes the innovative and mind boggling activity of determining what must be done, how, by when, by whom, and with what, i.e. doing the work in the brain as stated by Neale and Neale (1989). Another definition of planning was given by Hollins (1971) which stated that, it is the process by which executives assume and react to the probable impacts of events that may alter the activities and goals of their business. Planning is the cognizant determination of strategies, the constructing of choices in light of reason, actualities and considered evaluations. Laufer and Tucker, (2006), also agreed to the definition of Ackoff (1970) which stated planning as a decision-making procedure performed ahead of time of an activity which tries to plan an appreciated future and viable methods of achieving it. Planning is the creation of budgets, schedules, and other definite specification of the progressions to be taken after and the requirements to be complied with in project execution (Ballard and Howell, 1998). The Chartered Institute of Building provides a general definition of planning as “the process of analysis, formulating and organizing the intended actions for the carrying out of a project”.

2.3.2 Types of Construction Planning

There exist different types of planning strategies used in the construction industry to bridge the gap in experiences of previous projects and present and proposed actions that would yield favorable outcomes in coming years. The major types of planning used in the Industry are; strategic planning, Operational planning, Scheduling and Coordinative planning.

Strategic planning: Bryson and Alston (1996) as cited in Uher (2003) stipulates that, this process is undertaken by the client/owner's planners. These planners through their estimations determine exactly what project to pursue and the project duration including finish dates so as to meet owner's project objectives. Strategic planning provides the bedrock for construction teams to formulate the overall construction execution strategy within well-defined guidelines.

Operational planning: (Uher, 2003) states that, it is carried out by construction teams to generate detailed plans in achieving particular objectives. An example of an operational planning is the construction schedule. It differs from strategic plans in that it is a medium to short term with days, weeks or months as timing scales. Before an operational plan is developed the following are asked. They include:

- Is the strategic planning date achievable using the operational plan?
- Does the company have enough services and construction resources to achieve the project goals?
- Will present workload be affected by a new project?
- Where will we get the resources to deal with any overload?
- Are there any policies within the company that hinder the plan from attaining target dates?
- Are usually long delivery equipment or materials involved?

- Are the project concepts and design firmly established and ready to start the construction?
- Is the original contracting plan still valid?
- Will adopting fast-tracking scheduling approach be economically viable? (Uher, 2003).

Scheduling situates a detailed operational plan produced by strategic objectives on a time scale.

Through the process of coordinative planning policies are established, procedures, rules, tactics and strategies are connected together. Examples of a coordinative plan are quality management plan and risk management plan (Uher, 2003).

2.4 PROJECT PLANNING

To ensure project success an honest, thorough and logical planning ought to be done. Experience obtained from past projects gives basics for logical planning. The gap between current and past project is known to generate exceptional feature in a logical plan. Internal project delay factors, external delay factors, unusual client demands among others contribute to the gap in planning between current and past projects. To ensure that there are reduced negative effects when one prepares a master plan of a project and its subsequent scheduling these likely problems shall have to be tackled. It provides every segment of the plan a scrutiny individually based on inputs obtained from past experiences and from experts. Numerous planning tools and techniques have been developed to assist managers with planning. In Robbins and Coulter (2009), a comprehensive description of planning tools and techniques can be found. Some of those are reviewed below;

2.4.1 Environmental scanning

This is a systematic filtering of information from which a manager is able to determine and predict emerging trends. In some fields, such as information technology, where technological advances have become rapid managers are advised to constantly be on the alert for latest developments and trends that have the potential of maintaining or improving their

organisation's competitiveness. Competitor intelligence, global scanning and scenario-building have become the most widely used techniques (Uher, 2003).

2.4.2 Forecasting

This planning technique aids a manager in predicting future happenings. This involves predicting of future controllable and uncontrollable events and opportunities peculiar to an organisation's business dealings. It comprises of systematic and gradual assessment of future conditions, which include the economic climate, political and social issues, future demand for goods and services, population growth changes and others. Forecast are by their very nature always wrong. It is therefore the manager's task to continually revise and update the information upon which the forecasts and ultimately decisions are made (Robbins and Coulter, 2009).

2.4.3 Benchmarking

In benchmarking one compares practices between different units within the same company, or with other companies in the same industry, or setups in different industries (McGeorge and Palmer, 2002). The goal of any benchmarking process is to identify the best practice to help achieve superiority among competing firms. It has gained popularity in most industries and construction is no exception

2.4.5 Budgeting

Budgeting are plans made for assigning resources to particular activities that would be conducted by an organization in its endeavour to accomplish objectives. Budgets are formed for many different items or areas of activities.

2.4.6 Operational planning tools

Most managers use operational planning tools in their daily problem analysis and solution. This may consist of work scheduling through the usage of bar charts or the critical path method, resource allocating and levelling through the usage of linear programming, predicting

profitability through break-even analysis, and cost performance assessment by using earned value and risk assessment through the risk management concept (Uher, 2003).

2.5 DEFINITION OF CONSTRUCTION SCHEDULING

In construction projects, resources in the form of labour, materials and equipment are assigned to the various activities to be undertaken. These activities are to be completed within a designated time frame. Construction scheduling achieves this objective of assigning resources to activities and attaching clearly defined timelines to these activities.

In construction scheduling we apply knowledge and or personal judgment acquired from mathematical, physical and engineering sciences to the conception and the execution of creative works (O'Brien and Plotnick, 2006).

Scheduling of a construction project involves the steps taken to evaluate and quantify a program. It includes the determination of cost and duration of activities and the efficient usage of the allocation of resources (Uher, 2003). A schedule converts a project action plan into a timetable that is operational. Schedules form the basis of project monitoring and controlling activities together with other project plans and budget.

Construction projects lack continuity on a day to day basis and presents more project coordination problems and as such is imperative that proper schedules are provided to monitor and control the project (Meredith and Mantel, 2009).

2.6 IMPORTANCE OF SCHEDULING

Schedules represent the sequence and various phasing of the various activities required to complete a task. A schedule is a form of management tool used to predict project start and mainly completion thus ensuring early completion through the adjustment of resources delegated for the works.

Numerous benefits have been ascertained to be derived from proper scheduling and adherence to the schedules provided for a project

The list below as stated by Meredith and Mantel (2009) summarizes the benefits though not exhaustive.

- Scheduling provides a reliable framework used in planning' controlling and monitoring of a project.
- It helps in predicting the expected completion date of a project
- Some scheduling techniques helps in identifying the critical activities that, if delayed, will delay the entire project time of completion
- Scheduling predicts times which activities ought to start to ensure the project stays on the outlined timelines.
- It demonstrates the interdependence of all tasks, work elements and work packages
- It provides the roadmap in identifying which task ought to be coordinated to avoid conflicts of resources and timing

2.7 PREREQUISITE TO CONSTRUCTION SCHEDULING AND SCHEDULING MANAGEMENT

According to Taylor (2009), before a schedule can be effectively prepared a scheduler needs a work breakdown structure of a project into deliverables and work packages. He states that a WBS forms the foundation of project management technique for organization and definition the project scope. Earned value analysis serves are a monitoring and control tool in scheduling as it helps a project/construction manager determine the amount earned per an approved schedule.

2.7.1 Work Breakdown Structure

Lock (2004), ascertains that, the work breakdown structure (WBS) is a tool for breaking complex and large projects into smaller components or activities that can be managed by a designated manager. The structure looks like a 'family tree' with the overall project task sitting at the head of the tree, the next rank is that of the project deliverables and finally the work packages occupying the next work. The WBS can be broken down further into finer details including work activities.

According to Miller (2009), the actual date for developing the WBS is unknown and cannot be traced to anybody of knowledge as far as project management is concerned. It can be established from Miller (2009) that the WBS consists of three. These are

- The product breakdown structure (PBS)
- The activity breakdown structure (ABS)
- The organizational breakdown structure (OBS)

These three components can be represented diagrammatically. The PBS and ABS show the relationship between project deliverables and project activities.

The WBS is the first step in establishing a project schedule. The structure begins with the project's main objective and then sub dividing the objective into smaller components until all the project objectives are achieved (Naylor, 1995).

Rad (2002), stipulates that the WBS establishes a clear framework as a common reference for all specific tasks, project element within a construction project which ultimately enhances better project schedules and project estimates.

The WBS has been found to be of great relevance to any construction project. These include encouraging a well-structured and gradual planning procedure, reducing the probability of neglecting very important project elements, simplifying complex projects into smaller units

that are easily manageable and facilitating the integration of all project resources and ensuring utmost quality. Apart from providing a roadmap for scheduling, WBS does same for planning, monitoring and controlling all aspects of a project, such as the following as asserted by Rad (2002):

- Definition of work
- Estimation of cost
- Budgeting
- Estimation of timelines
- Scheduling Performance
- Productivity
- Allocation of resources
- Expenditures
- Changes to the project plan

2.7.2 Earned Value Analysis (Eva)

Earned value analysis is used in measuring the performance of a project within a period. It is a program management strategy or technique that predicts what will happen to a particular task or work based on the actual work progress over a specified duration. It gives a project/construction manager the opportunity to identify potential project risks and thus help managers to develop risk mitigation plans based on actual work progress, actual costs and work schedules (Nagrecha, 2002).

Jessop (2009) stipulates that EVA explores three basic characters:

- The value of work ought to have should been completed to date?
- How much value has been realized to date?
- Actual expenditure to date?

Through the comparison of the above parameters, an orderly evaluation of cost and schedule performance can be obtained. Earned value rather concentrates on how much has been accomplished till date of analysis instead of casually focusing on how much of project duration that has been taken to attain progress.

EVA integrates three critical aspects of project management: schedule or time management, scope management and cost management.

2.7.3 Key components of EVA

According to Anbari (2003) EVA uses the following parameters to determine and assess a projects performance:

- Planned Value (PV) - PV indicates the approved budget to be able to fully accomplish an activity, work package and any other thing related to the schedules provided. It can also be called the budget cost of work scheduled (BCWS)
- Budget at Completion (BAC) – it represent the total budget baseline for a particular project. It as well indicates the highest value of a PV.
- Actual Cost (AC) – Formerly termed actual cost of work performed (ACWP), indicates the actual amount of cost incurred at a specific period in the project life cycle.
- Earned Value (EV) – represents the cumulative value of the works completed in a particular period. EV was previously termed as budgeted cost of work performed (BCWP).

Beneath is a graphical representation indicating the relationship between the EVA parameters.

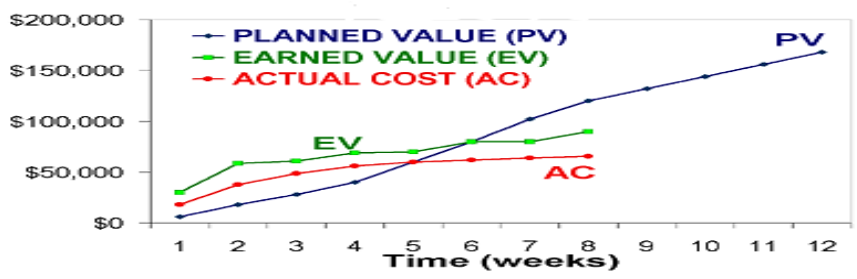


Figure 2.1 graphical representation of earned value parameters

2.8 SCHEDULING TECHNIQUES

2.8.1 BAR CHARTS

2.8.1.1 Gantt charts

Henry Gantt, an American industrial engineer developed the now famous Gantt chart over 100 years ago. It is a planning device which has gained prominence not only in the construction project but all other projects. Though officially known as the Gantt chart it is literally called a bar chart. Gantt charts are drawn to scale and show all important tasks in a project set out against a calendar (Lock, 2004).

Gantt Charts remain the most commonly and universally understood way of representing the relative time intervals of tasks set. When a task follows another immediately, the start of a following task bar is lined up with the finish of the preceding task bar.

These charts are not practical in the early stages of planning a project when durations are not known and precedence data changes occur frequently (Naylor, 1995).

Several advantages have been ascertained to be attributed to the use of Gantt charts. Though Gantt Charts may display lots of information, they are easily interpreted and understood. While Gantt Charts require frequent upgrading (as though not only limited to it), they can easily be maintained provided no changes have been effected to task requirements and or any major alterations of the schedules are not done. They provide a clear view of the current condition of a constructional project.

Gantt charts remain powerful communication devices to project management teams of senior levels though networks are usually of more help in the hands-on task of project management. Gantt charts are easy to construct as a network (Meredith and Mantel, 2009).

In spite of all the outlined advantages Gantt charts, do have serious flaws. Projects with complex and large set of activities, may be extremely difficult to track numerous activity paths of the project.

2.8.2 NETWORK ANALYSIS

A network schedule is an ordered and logical arrangement or sequence of activities that explains in graphical representation the technique that will be adopted to complete a project (Educators, 2013). A network diagram consists of two basic components, nodes, and links connecting the individual nodes. In construction management, there are two types of networks. These are the precedence diagram form of network and the activity on arrow form. Networks are used as scheduling techniques for effective management of construction projects. A network schedule presents the project manager with varying opportunities (Lock, 2004). It represents a mathematical model for showing the progress of construction activities over time. Network schedules provides a process to do "what-if" analysis, where the beneficiary of the network can alter one part of the process and observe the effect on the overall project (Jackson, 2010). Network scheduling has become extremely relevant in the settling of legal claims, simplifying the determination of progress payments, analysing cash-flows, and controlling costs. Most large construction projects require network schedules. Furthermore, the familiarity of the work plan gained while creating the network enhances the ability of the project team to control the actual project duration and cost effectively (Educators, 2013)

2.8.2.1 Precedence diagrams

Although the Critical Path Method (CPM) was initially used in analyzing the arrow diagramming scheduling technique, Professor John W. Fondahl (Stanford University) introduced in 1961 a new CPM representation using precedence diagrams. The rule of thumb was simple: instead of assigning activities to links, Professor Fondahl placed the activities on nodes. The links between the nodes represented the relationships between them. Initially this network diagramming was termed as "circle and connecting line", but later replaced with "precedence diagram" or "activity on the node" (Educators, 2013).

Although the arrow method and the precedence diagramming method adopt similar computational strategy, they remain fundamentally different in terms of network modelling.

The precedence diagram form of network is activity oriented. No events are present in the precedence method (Educators, 2013).

The focus of this type of networking is on activities. A square or a box graphically represents activities, though not only restricted to this shape as other shapes such as a circle or a hexagon can also be used. As a matter of fact the square representation has been accepted as a standard by the Australian Standard AS2443-1981 (Educators, 2013). Constructing a precedence network diagram is quite simple. Apparently because the precedence method is activity-oriented, linkages amongst various activities are easily formed through connecting activities together, and these connectors termed dependency lines. The flow of activities in such a schedule has been determined to move from left to right. To ensure easy interpretation of a precedence diagram schedule, there are suggestions that arrowheads are fixed to dependency lines to depict the direction of the workflow (Lock, 2004).

In precedence network dummy activities are not required in maintaining any logic, yet they can as well be created to identify a schedule's start and finish points (Uher, 2003).

2.8.2.2 Activity on an arrow (AOA)

Activities are represented with arrows while the beginning and the end of every activity (mostly termed as events) are represented by nodes. Arrow lengths connecting nodes have no bearing on the arrow diagram calculation and could be curved, bent or straight. Two activities depending on each other are represented on the diagram as two arrows having a single node.

Elbeltagi (2012) stipulates that, the under listed are some basic principles that ought to be noted and adhered to when constructing an activity on an arrow diagram network diagram:

- Each activity must have a unique $i - j$ numbers, where i (the number at the tail of the arrow) is smaller than j (the number at the head of the arrow).
- It is recommended to have a gap between numbers. This will allow for accommodation of missed activities.

- Avoid back arrows.

Dummy activities are introduced in the diagram when two or more arrows leave a particular node and arrive at another particular node. The dummy activity is identified as one with zero duration, consumes no resources, drawn as dashed lines.

According to Baldwin and Bordoli (2014) when constructing such a network the following conventions are accepted and used:

- Duration flows from left to right.
- Events are represented by numbers within a circle.
- The direction of flow of events is determined by the direction of an arrow head.
- Events are identified as Head Events or Tail Events.
- The numeric value of a head event is higher than that of a tail event.
- Arrow length has no significance likewise the orientation of the arrow
- Activity description ought to be written upon the straight part of the arrow.

2.8.2.3 Critical path methodology (CPM)

CPM remains the widely used time-scheduling analysis tool in the construction industry. CPM helps in determining the longest path through a network or schedule usually termed the critical path, float calculation, analyzing usage of resources, and accelerating a schedule at the minimum allowable cost (Mubarak, 2010).

The CPM enables a scheduler to compute the start and finish dates of every activity in a network schedule or precedence diagram. In doing so one can actually note a specific line of activities that shall not be slowed down at all without delaying the completion date of the entire project (Weaver, 2006).

The critical path is the term used in identifying the longest path connecting the various activities from the beginning to the finishing point of a schedule and the activities on this path are termed as the ‘critical activities’. In the CPM analysis some activities may be delayed if the need be

and such activities can be termed as non-critical. The amount of time needed in delaying such activities are known as 'float'. In essence, activities on the critical path have zero floats. This means of network analysis also provides the roadmap for very high detailed analyses of designated resources and aimed at attaining the most effective schedule shrinkage through the commitment to maintaining time and cost at optimum levels (Hildreth and Munoz, 2005).

A CPM schedule is developed in a graphical form either through the activity on arrow technique or the precedence diagram technique (Uher, 2003).

Mubarak (2010) has outlined the following as procedure used in preparing the critical path methodology schedule:

- *Determine the work activities*: Divide the project into smaller entities no matter how small or large the project is. These entities are termed as activities. No absolute procedure has been ascertained in breaking down a project into activities. Different schedulers will have different breakdown approach because of the non-existence of a defined rule.
- *Determine activities' durations*: with reference to the nature of construction project and experience of the scheduler, the techniques used in estimating activity duration may vary. Most activity durations may be calculated or determined as follows: Duration = Total quantity/Crew productivity
- *Determine logical relationships*: A scheduler needs to collect such information from a project manager and leaders and experienced personnel within a technical team. Determining a logical relationship ought to be the responsibility of the technical team. Logical relationships though are not be confused with constraints
- *Draw the logic network, and perform the CPM calculations*. Drawing such a relationship can be done with the use of computerized tools such as excel, primavera and MS project or can be done manually. This step provides the scheduler with the

calculated finish date of the project, the critical path, and the available float for all noncritical activities (Mubarak, 2010).

2.8.2.4 Program Evaluation Review Technique (PERT)

PERT is a network model that can be used to plan and control projects that have uncertainties attached. The main objective of this scheduling model is to keep track of the progress of a project and point out, at varying durations, the likelihood of finishing that project within time. Unlike CPM, this depends on sampling, PERT uses statistics, particularly the Central Limit Theorem, in calculating the probability of project outcomes (Miller, 2009).

PERT was developed in 1958, alongside the critical path method, by Malcomb and colleagues to assist the US Navy in developing of the Polaris ballistic missile system. At its inception it was conceived as a control technique in projects to ensure that the highly complex and strategically important Polaris project would be delivered on time. In the 1960s PERT remained the principal planning and control technique in the United States, especially on large military and aerospace projects including Titan I, Titan II, the Minuteman rocket systems and the Apollo space program (Uher, 2003).

2.8.2.5 Similarities and differences between CPM and PERT

Both CPM and PERT are used for planning, scheduling and controlling of projects. Aside both being developed apparently around the same time the step in creating both models are pretty much similar. These steps as asserted by Elbeltagi (2012) include:

- Create an activity list: this establishes the list of activities that need to be scheduled. They are activities within a project that need to be completed to ensure a successful completion of the entire project.
- Establish precedence relationships: this relationship establishes the activity flow with a project. The dependencies between activities are clearly established with this step.
- Assign estimated time for each activity

- Critical path identification
- Activity float calculation

In spite of the stated similarities these two models, Weaver (2006) indicates the following differences. These include:

- CPM uses activity oriented networks whilst PERT uses event oriented networks
- Duration of activities in CPM may be estimated with fair degree of accuracy whilst that of PERT of not that accurate and not definite as well
- Deterministic concept model is used in CPM. In PERT probabilistic model concept is used.
- CPM can control both time and cost when planning. PERT is basically a model for planning.
- Whereas CPM is used mostly in construction projects, PERT is mostly applied in research and development projects especially non-repetitive projects.

2.8.3 LINE OF BALANCE (LOB)

LOB is a simple graphical diagram that indicates position and period at which a particular working gang will be working on a particular assignment. It is a good scheduling technique for repetitive activities such as road and railway linear works. The technique can also be termed as called Time/Location Charts or Chainage Charts (Badukale and Sabihuddin, 2014).

Its first practical application was achieved by testing it on an industrial manufacturing and production control, where the objective was to achieve a production line rate of flow of finished products. This Technique was discovered by the Goodyear Company in the 1940's. By the early years of the 1950s, it had been developed for the control and programming of all projects whether repetitive or non-repetitive. Pai *et al*. (2013) indicates that the LOB has been applied

to various construction projects including resource scheduling, coordination of subcontractors, highway pavement construction and to other transportation projects.

In the construction circles, the LOB technique has been ascertained to produce the following advantages:

- Allowing project managers to identify lapses in the generated schedules and to draw conclusions as to continuing working as the project has been ran previously. They have been.
- The technique identifies various bottlenecks, allowing a project manager to particularly provide remedies on those areas responsible for slippage

LOB method ensures that a construction project with repetitive activities remain “in balance”. LOB in doing so ensures that the process produces at a rate that permits an equal flow of the items produced through a process and at a speed in agreement per objectives decided upon in a plan.

This method calculates the number of items that ought to pass through a particular operation and revealing figures with the number that actually did. According to Badukale and Sabihuddin, (2014) the main advantages of LOB schedule include its graphical presentation, easy interpretation of the schedule and the objectives of planning used in it.

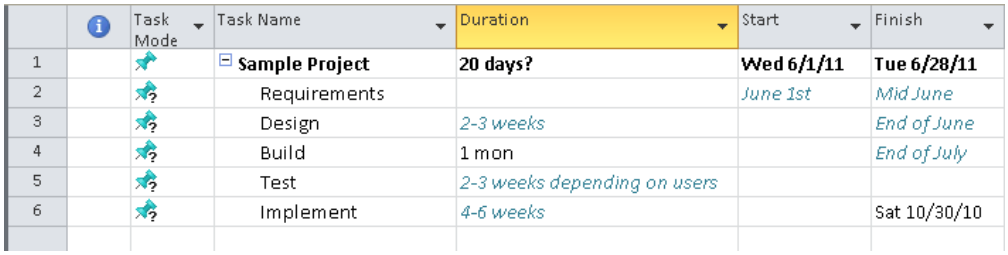
2.8.4 QUEUE SCHEDULING

Queue Scheduling is a more recent scheduling technique getting fast prominence among contracting and construction firms. It stands out to solely be the scheduling technique that identifies the relationship between the procedure of carrying out an activity and the cost to be involved in completion of such activity. Though similar to the line of balance, the Queue scheduling differs with some modifications made in 2004, to cater for varying amounts of repetitive activities at different segments or locations of the construction project (Rodriguez, 2015).

2.9 TOOLS FOR CONSTRUCTION SCHEDULES

Scheduling began with schedulers drawing bar charts manually to aid them track progress of their projects. In recent times, in the wake of technological advancement more sophisticated computerized software have been adopted in producing project schedules. These software have added tracking components so that a project manager can track various milestones and developments within the schedule. These software include Microsoft excel, Microsoft project and primavera.

Ms Project User-controlled scheduling enables a scheduler to generate project schedules with or without the help of the tool's scheduling engine. A scheduler can decide to enter task with or without durations, end dates and start dates.



	Task Mode	Task Name	Duration	Start	Finish
1		**Sample Project**	**20 days?**	**Wed 6/1/11**	**Tue 6/28/11**
2		Requirements		*June 1st*	*Mid June*
3		Design	*2-3 weeks*		*End of June*
4		Build	1 mon		*End of July*
5		Test	*2-3 weeks depending on users*		
6		Implement	*4-6 weeks*		Sat 10/30/10

Figure 2.2 Ms scheduling Sample

Manual scheduling mode gives the option to input text-based variables and document timing assumptions in the Start and Finish sections.

A scheduler has the option to use automatic mode of scheduling in Ms Project. Ms Project scheduling software produces Gantt charts and network diagram (Makar, 2011). The critical path of a project can be determined with this software.

Excel scheduling produces Bar charts that are not linked. It is used in scheduling of less complex projects.

Primavera gives control to today's project managers and schedulers. It is sophisticated software in scheduling more complex and multidisciplinary projects. It can be used to organize projects

of about 100,000 activities, and provides unlimited resources. It can be used to track the critical path of a project (Harris, 2008).

2.10 FACTORS THAT HINDER THE IMPLEMENTATION OF PROJECT SCHEDULES

The following factors have been ascertained to hinder the implementation of construction project schedules.

2.10.1 Owner's Incompetence

An unknowledgeable and incompetent owner will proceed with a project even with an unplanned and undefined scope of work. Such an owner will not employ a competent representative to look at his interest and may ask for changes to the project without proper planning (Authority, 2009).

2.10.2 Harsh Climatic Condition at Site

In a research conducted in India in relation to scheduling implementation failure factors a section of respondents had said they had in the past worked under harsh climatic conditions and could remember a number of cases where harsh conditions resulted in loss of considerable number of man-days. The research confirmed that harsh climatic conditions affects the efficiency and productivity of the work force in addition to causing difficulties in mobilizing the resources in time. In small projects work force inefficiency and unproductivity may not have a telling effect, however, when the project is on a large scale, time overrun will be a major concern (Jha and Iyer, 2006).

2.10.3 Project Specific Factor

Every project is unique and as such may require project team members to spend some period familiarizing themselves to the project. Variations in actual ground conditions compared with geotechnical report produced before tendering is an example of a project specific factor. The end result of the adjustment process may be drop in efficiency in the initial stages with the potential of negative effects on the schedule. In addition competition amongst tenderers might

cause the lowest bidder to submit a bid at a very low margin that may not encourage him enough to work to his best capabilities resulting in time overrun (Jha and Iyer, 2006).

2.10.4 Project Manager's Ignorance

Schedule overruns become a concern when the project manager is ignorant of planning tools and lack enough project management knowledge. This makes a project manager not able to recognize and monitor the critical activities that should be observed nearly and to be done for schedule completion. The project manager may not ask for timely help from management which may result in time overrun for the project. Clients and construction companies are advised not to compromise on the competence of a project manager since an uninformed and unknowledgeable manager can cause extreme harms to a project (Jha, 2014).

2.10.5 Indecisiveness of Project Participants

In the research conducted by Jha and Iyer (2006) it could be ascertained that indecisiveness in decision making has a negative effect on schedule performance as per the various projects mentioned by the respondents amid subsequent interviews they conducted. The research further confirmed that in one of the completed projects it covered it was found that due to indecisiveness in taking a decision in furniture layout the entire lighting and building management system work was held up which resulted in appreciable time loss.

2.10.6 Conflict among Project Participants

Conflicts among project team members is generally seen to dent team spirit and cohesion and can lead to division among the team which results in lack of cooperation between groups that are involved in conflicts. In Jha (2011), it could be concluded that conflicts amongst project team members derailed the smooth progress of work on some projects and caused delay in completion of all projects that required cooperation and coordination among the differing groups.

2.11 IMPACTS OF SCHEDULING TECHNIQUES ON PROJECTS

2 11.1 Delays

Wickwire *et al*., (2003) as cited in Arcuri *et al*., (2007) defines projects delay as an event that keeps the construction team from finishing the work within the contractually stipulated performance duration whilst Bartholomew (2002) considers delay as a slowing down of the work without ceasing it entirely, triggered by something other than a formal directive from the owner to stop work. In basic terms, a delay causes the loss of time. Delays on projects can be activated by any project team member without recognition to approved schedules. In most cases delays are caused by client's actions or inactions. Severe effects of delays on project include overhead and job site costs, equipment standby costs, wage escalation, and financing costs (Wickwire, et al., 2003).

2.11.2 Disruptions

Disruption can be termed as a happening that changes the contractor's pre-determined work procedure expected at the tendering stage resulting in increased cost, and/or time (Bramble et al., 1990). A contractor cannot perform as per the baseline schedule produced in the tendering process when disruption occurs hence no strict adherence to the schedules obtained by using the various techniques. Impacts associated with disruption in project schedules can include increase in labour costs due to inefficiency, the activation/deactivation of increased manpower, and additional equipment costs (Wickwire, et al., 2003).

2.11.3 Resequencing of work

Resequencing of the scope of work of a project is another effect of the non-usage of scheduling and scheduling techniques. This situation arises when a construction firm takes up a project that deviates from the original scope of work. Without proper recourse to approved schedules, the flow of various work could be interrupted.

2.11.4 Suspensions

A suspension of an activity of a project is a written instruction from the owner to put a stop to all work of a project, either because a contracting firm has not performed in accordance with contract documents and schedules provided during tendering, or at the owner's choice (Arcuri et al., 2007). As a result cost and time changes shall be effected for any suspension of work instructed by the client, provided the contracting firm cannot be proven to have been liable for the suspension of work. When clients flout approved schedules, according to Wickwire *et a*l., (2003) as cited in Arcuri *et al.*, (2007) a contracting firm in most cases is entitled to an adjustment of his profit margins.

2.11.5 Termination

Termination is a permanent pause of work of all or a parts of the contract. In contracts where time is very essential clauses are inserted to cater for termination. In most contracts the owner has the right to terminate the contract, while some contracts grant the contractor this right. In both instances when termination occurs there are compensations if the rational for termination are not cast in stone.

2.12 SUMMARY

The chapter has identified the various scheduling techniques that are widely used in the construction industry. These include the network diagrams which are analyzed with the CPM and PERT models. The other techniques are the Gantt charts, queue scheduling and the line of balance.

As a prerequisite to scheduling the chapter reviewed the WBS and EV analysis as part of procedures in achieving proper schedules.

Review of literature also identified various factors that hinder the implementation of project schedules and as well identified the impact that schedules do have on construction projects.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter explains the study approach the researcher used, discussion and rational of data collection methods employed. This chapter as well explains the design of the research methodology. The methodology used in investigating into project scheduling practices deployed within the Ghanaian Construction Industry were explained by the researcher. The researcher focused on factors that hinder the implementation of project schedules and the impacts of the scheduling techniques on projects in building and civil construction projects in Kumasi. Exploring of the research with particular recognition made to how the respondents were sampled and the processes adopted to gather the data are highlighted in this Chapter. It also describes the method of data assessment and analysis used in analysing the data. In addition the chapter explains how the sample size and population were determined. Areas considered in this chapter are:

- Research Design
- Strategy of research
- Research Population
- Sample
- Sampling Technique
- Measurement and Instrumentation of research
- Data collection procedure and
- Data Analysis procedures

3.2 PRELIMINARY INFORMATION GATHERING

This involved the surveying of structured questionnaires and the review of literature. The administration of questionnaires was the source of primary literature obtained. The secondary

literature was obtained mainly from peer – reviewed journals, articles, newsletters, text books and other departmental resources.

Questionnaire surveys are one of the highly regarded cost effective means to engage a large number of people in the process to ensure that appreciable results are attained per McQueen and Knussen's (2002) recommendation. The data collection instrument used was questionnaires. The fulcrum for developing the questionnaire were the objectives of the study. Data were gathered from the selected respondents within an undefined population. The analysis of the study was substantially based on this data.

The intent of the questionnaire survey was to obtain feedback from respondents on their opinions on the three objectives of the study by the researcher.

3.3 RESEARCH DESIGN

Research strategy is a plan used by a researcher to address research questions during the data collection process (Saunders et al., 2007). According to Naoum (1998), the strategy of research can be explained as the means through which questions are raised about research objectives. There exist two kinds of research strategies and they are; quantitative research and qualitative research (Naoum, 1998). Creswell (1994) gives a very concise definition of quantitative research. He states that it is a type of research that is `explaining phenomena by collecting numerical data that are analysed with the use of mathematical methods especially statistics. Quantitative research was the strategy adopted for this study. Fugar and Agyakwah-Baah (2010) stated that quantitative research includes the utilization of well-structured questionnaires where the response options have been predetermined and an extensive amount of respondents are included. It can also be defined as an enquiry process through the testing of a theory made up of variables with numerical values, and analysed using statistical methods. Its goal is to produce generalization that contributes on hypothesis that helps the researcher to predict, clarify and understand phenomenon. The researcher remained distant and independent

of what was being researched. Questions concerned with quantitative research are: How much? How often? To what extent? Collection of numerical data in order to explain, predict and or control phenomenon of interest are said to be characteristics of quantitative research. Data analysis is mainly statistical; the result of research is number or a set of numbers presented in graphs and tables or other forms of statistics (Abawi, 2008).

3.4 STRATEGY OF RESEARCH

Survey research was used in conducting this study. An in-depth review of literature was done to determine the various scheduling tools and techniques used in Ghana's construction industry. This review focused on materials including text books, internet search, journals and other relevant materials. A survey was then carried out on construction firms in the construction industry in Ghana particularly Kumasi to ensure that the research objectives were achieved. The study used the survey strategy in order to determine the factors that hinder the implementation of project schedules and the effects of scheduling on construction projects in Ghana.

3.5 RESEARCH POPULATION

Research population is all conceivable elements, subjects or observations relating to a particular phenomenon of interest to the researcher. The target population for this research comprised clients, schedulers, project managers, engineers, architects and contractors in Kumasi. The researcher targeted the above professional because from his experience such professionals are perceived to have theoretical and practical insight into construction project scheduling.

The population for this research is undefined though it focused mainly on the professionals within the construction industry as stated above. The population is undefined because the researcher could not identify published list of such professionals.

3.6 SAMPLE SIZE

The term “sample” is defined as a group of respondents selected from a larger population for survey purposes (Mugo, 2002). Polit and Hungler (1999) also define it as a process of selecting a part of the population to reflect the characteristics of the entire population. The difficulty of interviewing the whole population due to financial constraints, time and other factors make sampling a very important element in most research works. De Vaus (2001) ascertains that the process of sampling presents the opportunity to limit a study to a relatively small segment of the population. A sample thus becomes a representative selection of a population that is investigated into in acquiring statistical information of the whole.

Sample size determination is key to the success of every research work. Several factors account for determining a sample size. They include allowable sample error, size of population and the risk of choosing a bad sample (De Vaus, 2001). Letter “n” is mostly used to represent sample size and always known to be a positive figure. Large sized sample leads to increased precision in estimates of various properties of the population all things being equal. A non-probability sampling technique was employed to arrive at 50 respondents. For convenience purposes and the undefined nature of the population for the study a sample size of sixty (60) was used.

3.7 SAMPLING TECHNIQUE

Sampling of a population is the procedure of taking a subset of subjects that can represent the entity of the population. To warrant statistical analysis the sample must have sufficient size. Sampling is done on the grounds that it is essentially difficult to test each and every person in the populace. Sampling is likewise done to spare time and effort while conducting the research. The sorts of sampling methods available are: probability and non-probability sampling techniques. In probability sampling, each person in the populace have equivalent chance of being chosen as a subject for the research. Simple random sampling and Systematic sampling are some examples of probability sampling. A non-probability sampling is a sampling

technique where the samples are gathered in a process that does not give everyone in the populace equivalent possibilities of being chosen. Conversely with probability sampling, non-probability sampling techniques are usually selected on the premise of their availability or by the purposive individual judgment of the researcher. Non-probability sampling techniques are Quota sampling, Judgmental/Purposive sampling, Snowball sampling and Convenience sampling.

The sampling techniques adopted for this study are Purposive or Judgmental sampling and snow ball. Purposive sampling can be applied to research in a number of ways, for example, sampling informants with a particular type of knowledge or skill (Creswell, 1994; Patton, 2002). The procedure involves only intentionally handpicking respondents from a populace taking into account the researcher's knowledge and judgment.

Vogt (1999) as cited in Atkinson and Flint (2001) states that, snowball technique is used in finding research subjects. In this technique subject/respondent provides the researcher with the name of another respondent/subject who in turn provides the researcher with the name of another and so on.

Moreover, within the construction firms, the study purposively selected groups who were directly engaged in project scheduling processes and identified and selected: professional project/construction managers, schedulers/planners, engineers, architects, contractors. The study also adopted the snowball technique by asking for professionals within the Ghanaian construction industry who have characteristics similar to those stated above.

3.8 MEASUREMENT AND INSTRUMENTATION OF RESEARCH

The main instrument used to collect data from the respondents of the study was a survey questionnaire. A questionnaire is a group of written questions used to gather information from respondents and it is regarded as the most common tool for gathering data.

3.8.1 Description of the research questionnaire

This questionnaire forms part of this research project which studied into project scheduling practices deployed within the Ghanaian construction industry. Achieving survey success without a well-designed questionnaire is extremely difficult. In Maisha (2012), it is expressed that a questionnaire is a formalized arrangement of questions for acquiring data from respondents. It incorporates guidelines for its completion, response alternatives where appropriate and specific means for recording responses are needed. Based on the expected outcome, questions in a questionnaire could be open-ended or close-ended or a two's blend (Frazer and Lawley, 2000).

The questionnaire was developed in accordance to the objectives of the study, in relation to the comprehensive literature review conducted on the topic. The questionnaire was designed for professional project/construction managers, schedulers/planners, engineers, architects, contractors and any construction professional with in-depth knowledge of construction scheduling. It was made up of four (4) sections;

- Section A,
- Section B,
- Section C and
- Section D

Section A – Respondents background were acquired and were used to test if any of its variables had a significant influence on the rating of scheduling techniques in the construction industry.

Section B – Contained various scheduling techniques used in Ghanaian construction industry `which were obtained from literature. Some of the issues were the frequency of usage of the various techniques and tools and also the relevance of the tools and techniques in enhancing project duration and cost. Scales were put next to them.

Frequency of usage of the tools or techniques in your construction firm: The parameters were defined on a 5-point Likert scale as 1=very often, 2=often, 3=neutral, 4=sometimes, 5=never

The relevance of the tools or techniques in enhancing project duration and cost: The level was rated 1=very important, 2=important, 3=not sure, 4=fairly important, 5=not important

Section B also consisted of some close-ended questions such as;

- To what extent does your firm use the Scheduling Tools and Techniques during construction?
- How effective are the scheduling tools and techniques to Construction activities?
- How do you analyse your schedules?

The scheduling techniques and tools identified were

- Network diagrams (Precedence diagram, Activity on Arrow method)
- Bar Charts (Gantt chart)
- Queue scheduling
- Line of balance
- Microsoft Excel
- Microsoft Project
- Primavera

Section C – Respondents were asked the extent they would rate the factors hindering the implementation of project scheduling. Some of the various factors identified were;

- Harsh Climatic Condition at Site
- Frequent rework
- Undefined project scope
- Unavailability of funds

- Indecisiveness of Project Participants
- Disregard to approved schedules

Section D – This part of the questionnaire sought to seek the impact of the techniques and tools on a project. The following were some of the impact identified from relevant related literature;

- Delay in project duration
- Project termination
- Disruptions during construction activities
- Inadequate equipment supply plan
- Changes in scope of work and location

The research questions were generated by the researcher and were evaluated by some experts in academia and in construction firms. Subsequently, a pilot test of the questionnaire was conducted for six (6) participants keeping in mind the end goal in order to recognize and terminate potential ambiguity in the questionnaire.

3.9 DATA COLLECTION AND QUESTIONNAIRE ADMINISTRATION

Researchers are opened to different methods of administering questionnaires. Questionnaires can be administered through postal mail, telephone interviews, internet or self – administered (Shaughnessy and Zechmeister, 1997).

The questionnaires were self- administered by the researcher to professionals such as project managers, civil engineers, schedulers/planners, contractors. In some instances the questionnaires were retrieved on the spot. After the administration of the questionnaires the researcher used two and a half weeks to retrieve the answered questionnaires. Retrieving the answered questionnaires was a great problem for the researcher in the sense that the researcher had to go several times to these professionals to retrieve the answered questionnaires. In all sixty (60) questionnaires were administered and 50 of them representing 83.33% response rate were retrieved. The data collection methods or techniques has been an integral part of this

study**.** Patton (2002) explains that to achieve credible results and to strengthen ones study findings two or more data collection instruments would be ideal. Using above one data collection tool depicts a perfect picture of the research study area. In view of this, the researcher collected the desired data from two (2) different sources. This approach was utilized in the light that it uncovered issues that couldn't be brought up in utilizing one and only data collection instrument. The study made use of primary and secondary data sources in order to gather relevant information for the study. In such manner identified respondents to the study were taken out from a populace of individuals who are assumed to have required knowledge and enthusiasm in the area under study. Questionnaires were also sent electronically to places where the researcher was not able to actually go. The primary data gathered was evaluated by the researcher to guarantee most extreme precision, legibility, completeness and consistency which is typically known as sorting.

3.10 DATA PREPARATION AND STATISTICAL TOOL INTENDED FOR ANALYSIS

Questions one to four on the questionnaire formed the general information related to the respondents hence no scoring or ranking was done. The statistical tool used to run the analysis was descriptive statistics with frequencies. Relative Important Index (RII) was used to rank the identified factors in order to identify the most pressing issues in order of importance or significance.

3.11 DATA ANALYSIS PROCEDURES

The data gathered was edited, sorted, and coded. Statistical Package for Social Scientists (SPSS Version 17) and Microsoft Excel was used to examine the data. The premise for deviations from the basic patterns running through the responses was built up from the analysis using Mean Score ranking and standard deviation. The **Statistical Package for Social Sciences (SPSS**) was used to generate a database of responses and perform statistical analysis. The researchers analysed the data by these central tendencies on the responses from the survey;

standard deviation, mean score, frequencies and percentages hence frequency tables and bar charts were used to analyse the results. The study made use of the **Relative Importance Index (RII)** on the relevance of the tools or techniques in enhancing project duration and cost

RII = Sum of weights (W1 + W2 + W3 + …… +Wn) / A x N

Where W = weights given to each factor by the respondents and ranges from 1 to 5

Where '1' is not significant and '5' is highly significant

A = highest weight (i.e. 5 in this case), and

N = total number of respondents.

3.12 SUMMARY OF CHAPTER

The chapter revealed and discussed thoroughly the methodology used in answering the main research question. A quantitative research design was used and the research strategy was also discussed. The reliability of the questionnaire and sample procedure was discussed.

This chapter outlined the research design, the nature of the sample, the procedure used to collect the data, the description of the measuring instruments used and statistical techniques adopted for the study. The research instrument selected for this research was the questionnaire. A total number of sixty (60) questionnaires were administered in Kumasi. The population targeted in this study consisted of Project Team members which include project managers, civil engineers, schedulers/planners, contractors.

Statistical Package for Social Sciences (SPSS) was used to generate a database of responses and carry out statistical analysis. The researchers analysed the data by these analytical tools: Relative Importance Index and Mean score ranking. Chapter four will present the data analysis and interpretation of results.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

This chapter presents the results, analysis, discussions and findings of the data collected. Analyses of responses were done according to the research objectives. Field study was conducted in the Kumasi metropolis to determine the impact of project scheduling on construction projects. Tables and charts were used for the analysis. However, a sample of sixty (60) questionnaires were designed and administered to construction firms within the Kumasi metropolis. Out of the 60 questionnaires distributed to construction sites, 50 questionnaires representing 83.33% were retrieved.

The first section of the questionnaires entails the profiles of the respondents and the influence such attributes have on the research. The other part also deals with the detailed analysis of the specific objectives of the study in relation to project scheduling. The researcher thoroughly discussed the empirical analysis of the various scheduling tools and techniques, factors hindering the implementation of project schedules and the impact of the scheduling techniques on projects.

4.2 PRESENTATION AND DESCRIPTIVE ANALYSIS OF DATA (DEMOGRAPHIC)

The first section deals with the profile of respondents and the influence such attributes have on the research. The other part also details out the analysis of the specific objectives of the study in relation to project scheduling practices deployed within the Ghanaian construction industry.

4.2.1 Nature of Projects undertaken

The intent of this question is to identify the nature of projects the respondents' companies have undertaken within the Ghanaian construction industry. The nature of projects undertaken will ascertain which areas respondents' companies are well vested in. Therefore respondents were asked to indicate the nature of projects their companies have undertaken (see Figure 4.1). Four

(4) of the respondents indicated civil works and seventeen (17) indicated building projects. However, the remaining twenty nine (29) of the respondents which represents majority indicated they undertake both civil and building projects.

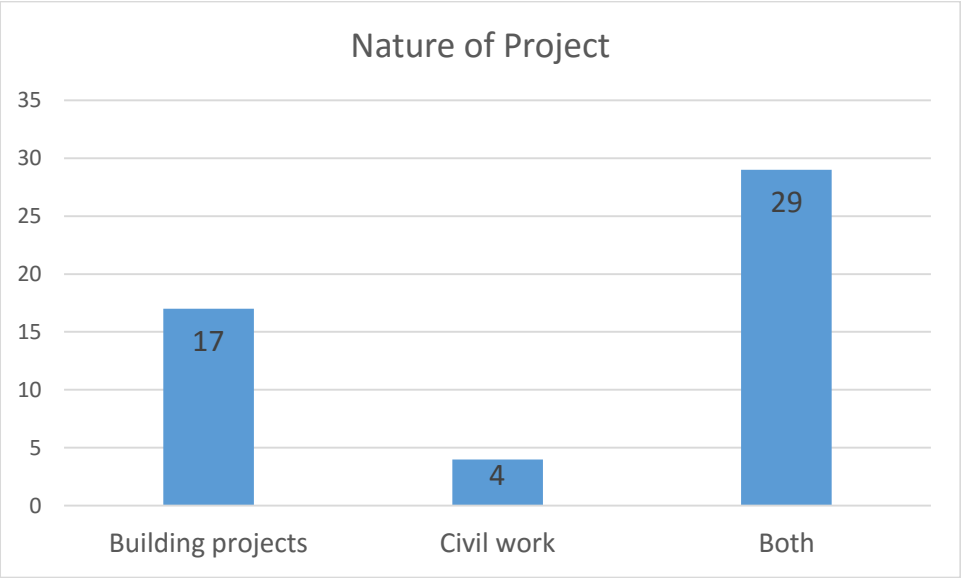


Figure 4.1: Nature of Projects undertaken

Source: Survey data, 2015

4.2.2 Highest level of education

The purpose of this question is to identify the highest level of education of respondents because the highest level of education of the respondent will affect the quality of responses that will be given. Figure 4.2 indicates the highest level of education of the respondents. Respondents were asked to indicate their highest level of education. 12% indicated they held Postgraduate certificates (MSc, MPhil, PhD), whilst the majority of the respondents constituting 72% indicated they also held University certificates (BSc). However, the remaining 16% of respondents had completed Polytechnics (HND). Ideally it is perceived that people of higher educational levels have better and clearer understanding of project scheduling hence the question.

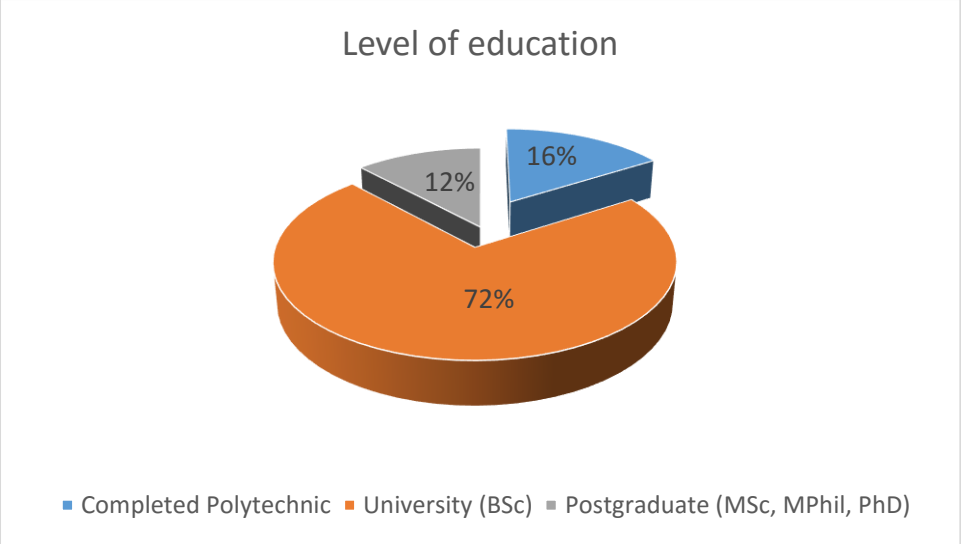


Figure 4.2: Level of education of respondents

Source: Survey data, 2015

4.2.3 Sector of Client

This question sought to find out the sector of clients respondents regularly undertook projects for. Respondents were therefore asked to indicate the sector of clients their firms frequently operated for. From figure 4.3, majority of the respondents constituting 28 respondents indicated they frequently operate in the private sector whilst the remaining 22 respondents indicate the public sector.

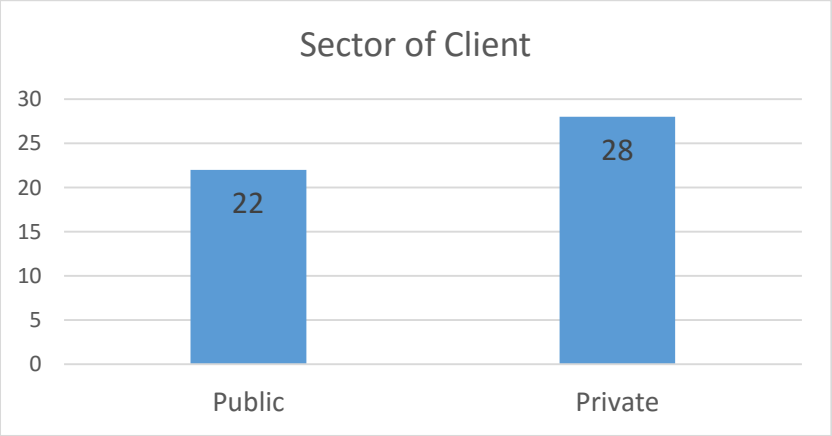


Figure 4.3: Sector of client

Source: Survey data, 2015

4.2.4 Role in Project

The intent of this question is to identify the various roles respondents play in undertaking projects. Figure 4.4 established the various roles respondents play in undertaking projects and it posits itself to the following interpretation; 12% of the respondents indicated that they were Contractors and 34% of the respondents were Project managers. However, majority of the respondents representing 54% indicated they were Engineers. The question was aimed at ascertaining if respondents had enough knowledge, needed background, required experience and understood the questions posted to them.

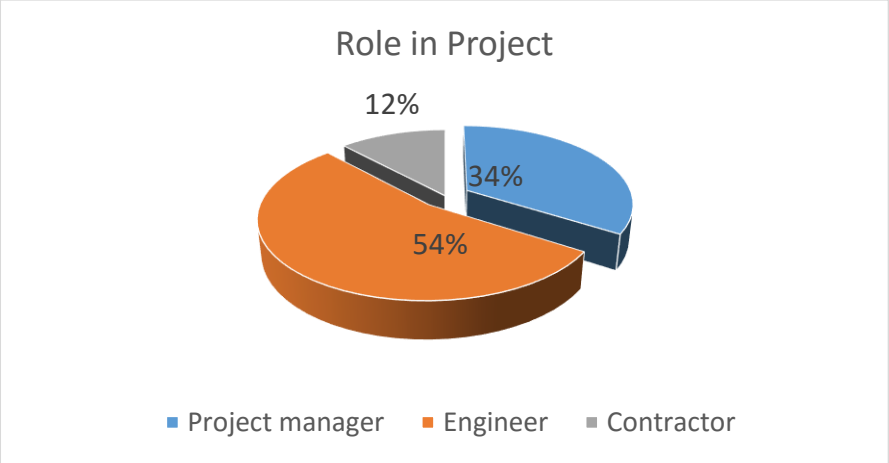


Figure 4.4: Role in Project

Source: Survey data, 2015

4.2.5 Years of Experience

The intention of this question is to identify the level of experience of the respondents in the construction industry because how long they have been in the construction industry will affect the quality of responses that will be given. Figure 4.5 indicates the number of years of the respondent in the construction industry. Respondents were asked to indicate how long they have existed in the construction industry. One (1) respondent indicated between 16-20 years, 7 respondents indicated above 20 years, ten (10) respondents existed between 11-15 years whilst the majority of the respondents constituting sixteen (16) respondents indicated they have

existed in the industry between 6-10 years. The remaining sixteen (16) respondents which also represent majority indicated 0-5 years.

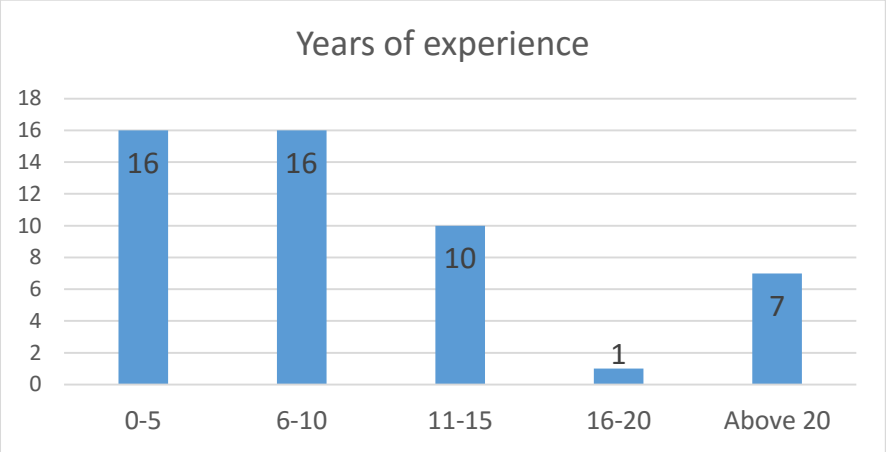


Figure 4.5: Years of experience of respondents

Source: Survey data, 2015

4.2.6 Professional Body Affiliation

Respondents were asked to indicate which professional bodies they were affiliated to in the construction industry. However, majority of respondents representing 60% indicated they were affiliated to GIOC whilst 12% indicated GHIS. The remaining 28% of respondents also indicated they were affiliated to CIOB.

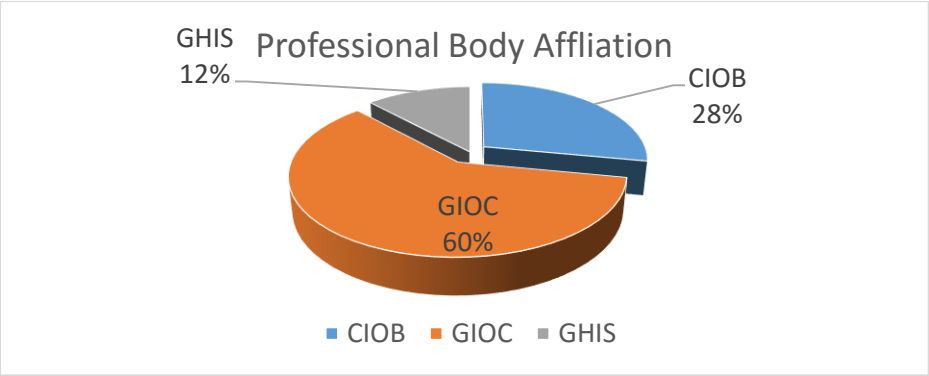


Figure 4.6: Professional Body of affiliation

Source: Survey data, 2015

4.2.7 Analysis of Schedules

The intent of this question is to identify the various forms of analysis respondents usually adopted in analysing schedules. Figure 4.7 established the various forms of analysis respondents adopted in analysing schedules and it posits itself to the following interpretation; majority of the respondents constituting forty five (45) respondents indicated they adopted the critical path method whilst the remaining five (5) respondents indicated PERT analysis.

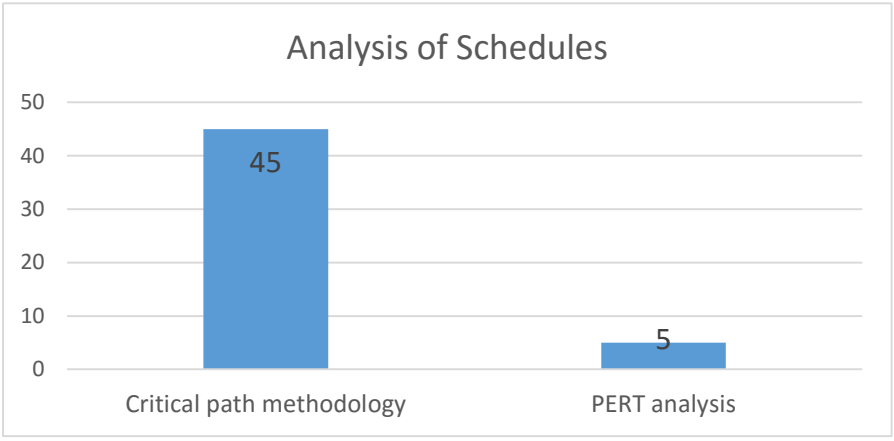


Figure 4.7: Professional Body of affiliation

Source: Survey data, 2015

4.2.8 Use of Scheduling Tools and Techniques

Respondents were asked to indicate how frequent they use analytical tools and techniques during construction works. Figure 4.8 indicates the frequency of use of scheduling tools and techniques by respondents. 2% of respondents indicated they have never used scheduling tools and techniques during construction, 24% indicated they sometimes use scheduling tools and techniques and 28% indicated often. However, the majority of respondents constituting 46% indicated that use scheduling tools and techniques very often.

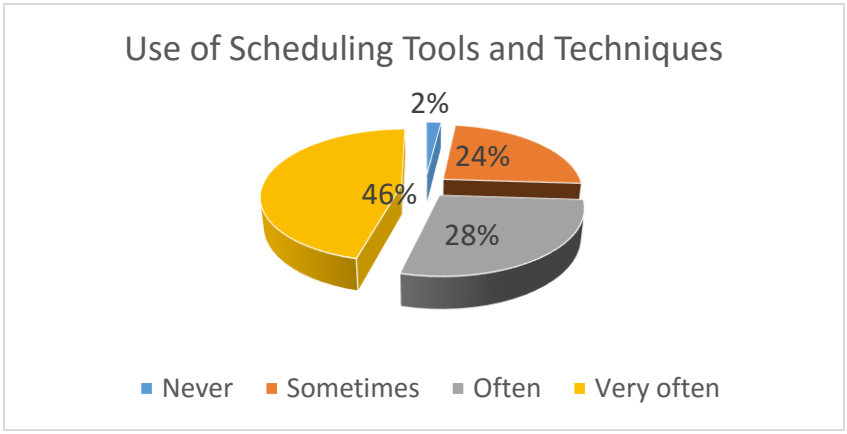


Figure 4.8: Use of Scheduling tools and techniques

Source: Survey data, 2015

4.2.9 Effectiveness of Scheduling Tools and Techniques

The intention of this question is to determine the effectiveness of scheduling tools and techniques to respondents. Respondents were therefore asked to indicate how effective scheduling tools and techniques were to construction activities. One (1) respondent indicated that scheduling tools and techniques were not effective at all, sixteen (16) respondents indicated they were moderately effective, ten (10) respondents indicated they were effective to construction activities whilst the majority of the respondents constituting twenty three (23) respondents indicated scheduling tools and techniques were very effective to construction activities.

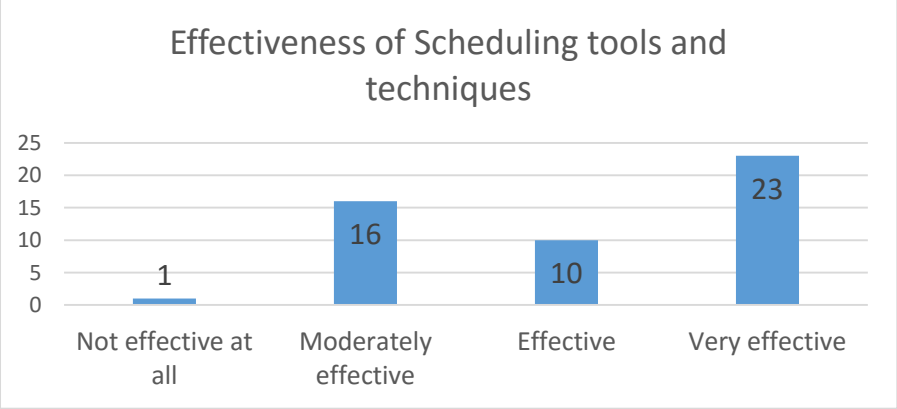


Figure 4.9: Effectiveness of Scheduling tools and techniques

Source: Survey data, 2015

4.2.10 Knowledge on Scheduling Tools and Techniques

Respondents were asked to indicate their knowledge, awareness and use of the scheduling tools and techniques in construction. Figure 10 indicates respondents' knowledge, awareness and use of the scheduling tools and techniques in construction. 12% of respondents indicated low knowledge, awareness and use of scheduling tools and techniques, 28% indicated very high knowledge, awareness and use whilst majority of respondents constituting 60% indicated high knowledge, awareness and use of schedule tools and techniques in construction.

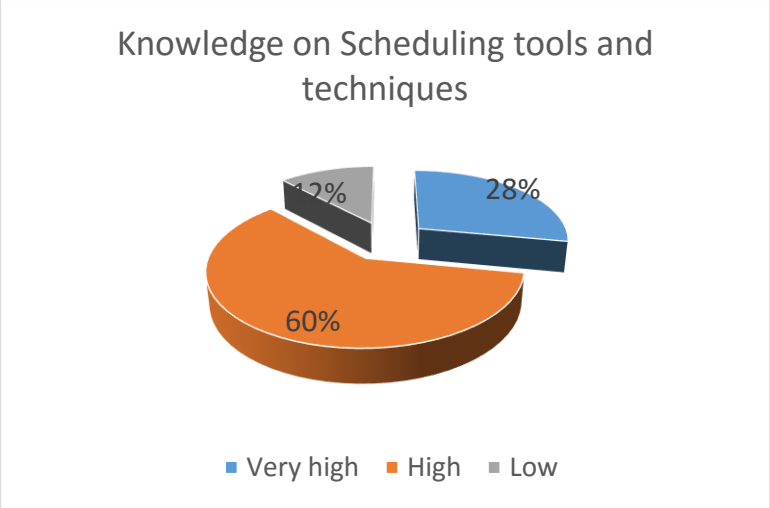


Figure 4.10: Knowledge on Scheduling tools and techniques

Source: Survey data, 2015

4.2.11 Effect of Non-usage of Scheduling Techniques and Tools

The intention of this question is to determine whether the lack of usage of project scheduling tools affect projects. Majority of respondents constituting forty two (42) respondents indicated yes, lack of usage of project scheduling tools affect projects whilst the remaining eight (8) respondents indicated no, lack of usage of scheduling tools do not affect projects. Respondents indicated that delay in project duration, poor cost planning and resequencing of work as some of the impacts or effects of non-usage of scheduling tools and techniques on construction projects in Ghana. The respective RII for these effects are 0.7, 0.7 and 0.6.

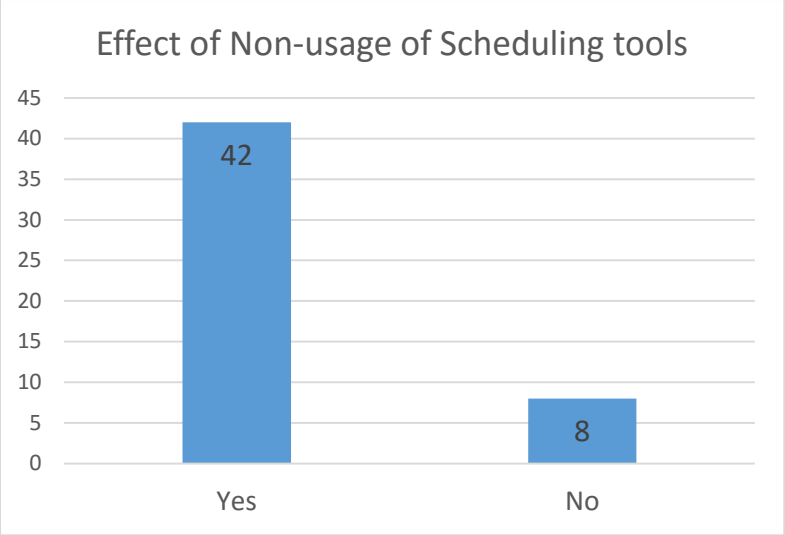


Figure 4.11: Effect of Non-usage of Scheduling tools

Source: Survey data, 2015

4.3 RELATIVE IMPORTANCE FOR THE VARIOUS SCHEDULING TOOLS AND TECHNIQUES USED IN THE GHANAIAN CONSTRUCTION INDUSTRY

This section of the questionnaire seek to provide respondents the opportunity to indicate on a five point Likert scale their frequency of usage and the relevance of the tools or techniques in enhancing project duration and cost.

4.3.1 Frequency of usage of the Tools and Techniques

From Table 4.1, respondents indicated Gantt chart is the frequently used technique, evident with an RII of 0.29 and a mean value of 1.46. This buttresses Robbins and Coulter (2009) assertion that Gantt chart is easy to use and usually adopted in the construction work processes. This is closely followed by Precedence diagram method with an RII of 0.51 and a mean value of 2.54, which is also very high indicating that construction personnel also prefer using the precedence diagram method. Activity on arrow method is third ranked technique with an RII value of 0.64 and a mean value of 3.18. However, Queue scheduling is the least ranked technique with an RII value of 0.70 and a mean value of 3.48.

Furthermore, respondents also indicated that MS Project is the frequently used tool, evident with an RII of 0.30 and a mean value of 1.68. This is closely followed by excel with an RII of

0.30 and a mean value of 1.72 and Primavera is ranked third with an RII value of 0.76 and a mean value of 3.78.

Table 4.1: Frequency of usage of the Tools and Techniques

	RATING									
TECHNIQUES	**1**	**2**	**3**	**4**	**5**	**Total**	**∑W**	**Mean**	**RII**	**Rank**
Gantt chart	34	11	4	0	1	50	73	1.46	0.29	1st
Precedence Diagram Method	14	19	1	8	8	50	127	2.54	0.51	2nd
Activity on Arrow (AoA) method	2	19	13	1	15	50	159	3.18	0.64	3rd
Line of Balance	4	8	14	11	13	50	171	3.42	0.68	4th
Queue Scheduling	2	9	19	3	17	50	174	3.48	0.68	5th
TOOLS										
MS Project	29	13	4	3	1	50	84	1.68	0.30	1st
Excel	35	2	9	0	4	50	86	1.72	0.30	2nd
Primavera	2	4	17	7	20	50	189	3.78	0.76	3rd

4.3.2 Relevance of Tools and Techniques

From Table 4.2, which represents the relevance of the tools and techniques in enhancing project duration and cost, Gantt chart is the most ranked technique with an RII and mean values of 0.26 and 1.32 respectively. This is an indication that Gantt chart is the most relevant technique according to respondents. Precedence Diagram is ranked 2nd with an RII and mean values of 0.38 and 1.90 respectively. This techniques is more versatile as compared to other network planning. Determination of Earliest Start, Earliest Finish, Latest Start and Latest Finish is similar to that of CPM except Precedence takes into consideration activity attributes. Even though ranked second by the respondents, this tool guides the managers in making critical decisions such as to deploy resources based on priority. It also assists the client in determining the duration for extension of time. Furthermore, activity on arrow method is ranked 3rd with an RII and mean values of 0.47 and 2.34. However, Queue Scheduling is the least ranked technique with an RII and mean values of 0.56 and 2.80. The research thus confirms Meredith

and Mantel (2009) assertion that the Gantt chart is very relevant as it provides a clear view of the current condition of a constructional project.

Respondents further indicated that MS Project is the most relevant tool evident with an RII value of 0.28 and a mean value of 1.42. This is closely followed by excel with an RII value of 0.36 and a mean value of 1.78. However, respondents ranked Primavera very low with an RII value and a mean score value of 0.54 and 2.72 respectively.

Table 4.2: Relevance of the Tools and Techniques

	RATING									
TECHNIQUES	**1**	**2**	**3**	**4**	**5**	**Total**	**∑W**	**Mean**	**RII**	**Rank**
Gantt chart	38	9	2	1	0	50	66	1.32	0.26	1st
Precedence Diagram Method	21	16	10	3	0	50	95	1.90	0.38	2nd
Activity on Arrow (AoA) method	14	10	23	2	1	50	117	2.34	0.47	3rd
Line of Balance	9	14	19	6	2	50	128	2.56	0.51	4th
Queue Scheduling	1	17	25	5	2	50	140	2.80	0.56	5th
TOOLS										
MS Project	32	15	3	0	0	50	71	1.42	0.28	1st
Excel	29	8	9	3	1	50	89	1.78	0.36	2nd
Primavera	9	20	4	10	7	50	136	2.72	0.54	3rd

4.4 RELATIVE IMPORTANCE FOR FACTORS THAT HINDER THE IMPLEMENTATION OF PROJECT SCHEDULES

From the response, contractors ranked unavailability of fund as the 1st factor that hinders the implementation of project schedules, evident with an RII value of 0.70 and a mean value of 3.44. Most construction firms hesitate to the using of project schedules because of lack of funds. It was closely followed by undefined project scope with an RII value of 0.70 and a mean value of 3.36. Project specific factor is ranked 3rd by respondent with an RII value of 0.60 and mean value of 3.10. This buttresses Laufer and Tucker, (2006) assertion that factors such as lack of funds, undefined scope and project specific issues prevent the smooth application of

schedules used in analyzing construction projects. Indecisiveness of project participants is ranked 4th with an RII value of 0.60 and a mean value of 2.82. Respondents also ranked disregard to approved schedules 5th with an RII of 0.60 and mean value 2.78. Frequent rework is ranked 6th with an RII of 0.60 and mean value of 2.76.

Furthermore, respondents ranked client interference and competence 8th with an RII value of 0.50 and mean value of 2.62. Respondents indicated that most clients interfered with their activities and therefore prevented them from smoothly implementing project schedules. It was followed by harsh climatic conditions at site with an RII value of 0.50 and 2.62. However, the least ranked factor that hinders the implementation of project schedules is project manager's ignorance with an RII value of 0.0.40 and a mean value of 2.12. It can therefore be deduced that project manager's ignorance does not really hinder the implementation of project schedules in construction. The responses buttress the observations made by Jha (2011) highlighting that project scheduling implementation becomes extremely difficult if certain factors such as client interference and frequent rework are present.

Table 4.3: Factors that hinder the implementation of project schedules

	RATING									
FACTORS	**1**	**2**	**3**	**4**	**5**	**Total**	**∑W**	**Mean**	**RII**	**Rank**
Unavailability of funds	9	2	12	12	15	50	172	3.44	0.7	1st
Undefined project scope	5	10	8	16	11	50	168	3.36	0.7	2nd
Project Specific Factor	6	8	13	21	2	50	155	3.10	0.6	3rd
Indecisiveness of project participants	6	19	6	16	3	50	141	2.82	0.6	4th
Disregard to approved schedules	15	8	11	5	11	50	139	2.78	0.6	5th
Frequent Rework	5	20	13	6	6	50	138	2.76	0.6	6th
Conflict among project participants	17	4	11	12	6	50	136	2.72	0.5	7th
Client interference and competence	7	7	23	10	3	50	131	2.62	0.5	8th
Harsh Climatic Conditions at site	8	17	15	6	4	50	131	2.62	0.5	9th
Unavailability of material resources	11	17	9	10	3	50	127	2.54	0.5	10th
Project Manager's ignorance	28	3	8	7	4	50	106	2.12	0.4	11th

4.5 RELATIVE IMPORTANCE FOR IMPACTS OF LACK OF USAGE OF PROJECT SCHEDULING TECHNIQUES ON A PROJECT

From Table 4.4, delay in project duration is the most ranked impact of lack of usage of project scheduling techniques on a project, evident with an RII of 0.70 and mean value of 3.54. Delays in project duration can result in increase in project cost hence the need to use scheduling techniques. This is closely followed by poor cost planning with an RII of 0.70 and a mean value of 3.54, which is also very high indicating that if project schedules are not used the overall cost of the project might increase unreasonably and can as well affect budgetary allocations. Inefficient and ineffective planning is third ranked impact with an RII value of 0.70 and mean value of 3.46. Resequencing of work is fourth ranked impact with RII value 0.60 and mean value of 3.14. Resequencing of work has the potential of increasing project duration and cost hence the need to use scheduling techniques.

However, it is closely followed by disruptions during construction activities with an RII of 0.60 and mean value of 3.04. Lack of usage of production schedules adversely affects the entire

project and disrupt the construction activities. Inadequate equipment supply plan is ranked seventh with an RII value of 0.60 and mean value of 2.94. It is followed by poor estimates with an RII value of 0.60 and mean value of 2.88. Estimates are very essential in the operation of a business entity. Poor estimates affect the entire construction project and reduces the overall outcome of the project. The ninth ranked impact is suspension of parts of project with an RII value of 0.50 and a mean value of 2.64. However, project termination is the least ranked impact of lack of usage of project scheduling techniques a project with an RII value of 0.50 and mean value of 2.36 indicating that projects cannot be completely terminated as a result of lack of usage of project scheduling techniques but rather projects could be adversely affected. The responses obtained buttresses Wickwire *et al.,* (2013) assertion that non-usage of scheduling has significant on project durations particularly delays, poor cost planning, inefficient planning generally and frequent work resequencing

Table 4.4: Impacts of lack of usage of project scheduling techniques on a project

	RATING									
IMPACTS	**1**	**2**	**3**	**4**	**5**	**Total**	**∑W**	**Mean**	**RII**	**Rank**
Delay in project duration	5	8	6	17	14	50	177	3.54	0.7	1st
Poor cost planning	4	8	2	19	17	50	177	3.54	0.7	2nd
Inefficient and ineffective planning	3	14	6	11	16	50	173	3.46	0.7	3rd
Resequencing of work	3	9	18	18	2	50	157	3.14	0.6	4th
Disruptions during construction activities	9	7	11	19	4	50	152	3.04	0.6	5th
Changes in scope of work and location	7	10	14	16	3	50	148	2.96	0.6	6th
Inadequate equipment supply plan	8	8	18	11	5	50	147	2.94	0.6	7th
Poor estimates	4	20	14	2	10	50	144	2.88	0.6	8th
Suspension of parts of project	10	15	9	15	1	50	132	2.64	0.5	9th
Project termination	18	12	9	6	5	50	118	2.36	0.5	10th

CHAPTER FIVE

SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

Discussions and recommendations are concluded in the chapter five. Findings and observations drawn from the data analysis in chapter four of the study are also concluded in reference to the objectives of the study. Research into construction planning tools and techniques in the construction industry has been on the increase to improve on performance of work which intends satisfy clients. This study has added up to work by researchers on the investigation into project scheduling practices deployed within the Ghanaian Construction Industry. Three basic objectives relative to the construction industry were discussed in this study. The objectives of the study were to identify the various scheduling tools and techniques used in the Ghanaian construction industry, to determine the factors that hinder the implementation of project schedules, and to determine the impact of the scheduling techniques on projects. From this study issues identified have been summarised which led to the conclusion and recommendation of the study.

A total of sixty (60) questionnaires were administered to a number of professionals in the Kumasi metropolis. Out of the sixty (60) administered questionnaires, fifty (50) were responded to by the professionals within this study category. The chapter follows the following structure: a summary of how the key objectives were addressed and discussions on the achievement of the research objectives were provided to highlight the contributions of the research. The chapter ends with recommendations for further research that can be conducted based on the conclusions and limitations of the study.

5.2 ACHIEVING THE RESEARCH OBJECTIVES

The aim of the research is to determine the impact scheduling has on construction projects in Ghana. In order to achieve the stated aim, three objectives were set in the same section.

Objective 1 was achieved mainly through literature review. Literature review and structured survey questionnaires were conducted to achieve Objective 2 and Objective 3.

To identify the various scheduling tools and techniques used in the Ghanaian construction industry

Objective One was achieved through related literature on the various scheduling tools and techniques used in the construction industry which was thoroughly and comprehensively reviewed in the beginning stages of the study through academic journals, articles, books and other publications. The construction project life cycle (initial phase, planning phase, execution phase, and termination phase), construction planning process and activities, types of construction planning, project planning tools and techniques and work breakdown structure were ascertained. The various scheduling tools identified were inculcated into the questionnaire to describe the relevance of the tools or techniques in enhancing project performance and also identify the frequency of usage of the tools and techniques in construction firms.

To determine the factors that hinder the implementation of project schedules

Subsequently, key factors hindering the implementation of project scheduling were identified from literature and respondents were asked to rank on the basis of it being very severe and not severe. From the eleven problems that were identified to be hindering the implementation of project scheduling the results indicates that Unavailability of funds was identified as the key problem to implementing project schedules even though undefined project scope, Project specific factor, Indecisiveness of project participants and Disregard to approved schedules were deemed relevant.

To determine the impact of the scheduling techniques on projects

Objective 3 was examined by use of a structured questionnaire. Ten (10) critical impact factors were indicated in the questionnaire. The impact factors were obtained from relevant literature

from previous studies. After the data analysis, it was observed that, delay in project duration, poor cost planning, inefficient and ineffective planning, resequencing of work, and disruptions during construction activities emerged as the top 5 critical impact factors of the lack of usage of project scheduling techniques on a construction project.

5.3 CONCLUSION

This research work was geared towards determining the impact scheduling has on construction projects in Ghana. In conclusion, the research findings seek to directly address the objectives of the study which are as follows: To identify the various scheduling tools and techniques used in the Ghanaian construction industry, to determine the factors that hinder the implementation of project schedules and to determine the impact of the scheduling techniques on projects

The study identifies that contractors are not able to implement project schedules due to the unavailability of funds. Undefined project scope is greatly affecting the implementation of project schedules. Change is not made without consequences, even from more awful to better. When changes are introduced prior, during or after construction work has been executed, the synergistic impacts of these changes can drastically influence project performance. Identifying and quantifying the cause and effect relationships between changes in order to mitigate or avoid their impact is vitally important to the construction industry. An undefined scope or change in project scope would always affect the initial programme drawn for the execution of the project. This factor certainly makes it difficult to implement a programme using the various construction scheduling tools and techniques.

5.4 RECOMMENDATIONS

With reference to the above conclusion and findings from the Chapter four, the following recommendations are proposed for review and improvement.

- Construction project clients should ensure availability of funds such that schedule milestones are achieved. Unavailability of funds have been identified as the main factor that affects the implementation of schedules as seen in table 4.3.
- The construction firm should make it a point to employ the services of a professional to undertake project scheduling activities. A professional with all the required expertise will ensure that schedules will cater for most inconveniences hence project completion is attained within time and allocated budget
- Project objectives should be well spelt out in order to prevent future changes in construction work as variations can affect project performance. This can be ascertained from the fact that undefined scope of a construction project is ranked second as a factor that hinders the implementation of schedules.
- Project designs and specifications must be clear to the various stakeholders of the project to prevent future complexities during the construction activities which hinders scheduled programs.
- The use of Primavera should be encouraged amongst construction firms. This tool was ranked 3rd under both Table 4.1 and Table 4.2 in terms of its relevance and frequency of usage. Primavera handles large-scale, highly sophisticated and multifaceted projects. It also organizes projects of up to 100,000 activities with unlimited resources and an unlimited number of target plans.

5.5 LIMITATIONS OF STUDY

All issues were not adequately exhausted due to the unavailability of time for the research. This was so because the study was an academic study. Data collection was limited to selected construction firms and construction projects in the Kumasi metropolis hence the study is still constrained all though lots of efforts have gone into its planning and execution. In addition the

undefined nature of the population has the potential of making this research not wholly representative.

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APPENDICES

QUESTIONNAIRE SURVEY

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

College of Art and Built Environment

Department of Building Technology

MSc. Construction Management

RESEARCH TOPIC: **AN INVESTIGATION INTO PROJECT SCHEDULING PRACTICES DEPLOYED WITHIN THE GHANAIAN CONSTRUCTION INDUSTRY**

Introduction

This questionnaire will be used by the researcher to solicit data aimed at investigating into project scheduling practices being used the Ghanaian Construction Industry. In essence this questionnaire will allow the researcher to quickly and realistically determine the factors that hinders the implementation of project schedules and also to determine the impact of the tools and techniques used on projects. Your objective response to this questionnaire is an invaluable aid to this research work. The research is strictly for academic purposes and information given will be kept confidential. Any question on this research, please contact:

Opoku-Amankwah Philip

Email: kojo_philip@ymail.com

Contact: 0249219368/0264219368

INSTRUCTIONS: You are please required to tick (√) the appropriate options.

(SECTION A) - RESPONDENT'S BACKGROUND

1. Nature of Project: a) Building projects ☐ b) Civil work ☐ c) Both ☐

2. Highest level of education:

a) Completed polytechnic ☐

b) University (BSc) ☐

c) Postgraduate (MSc, MPhil, PhD) ☐

3. Sector of client: a) Public ☐ b) Private ☐

4. Your role in the project

a) Project manager ☐ b) Engineer ☐

c) Contractor ☐ d) Architect ☐ e) Subcontractor ☐

f) Others (specify): …….

5. Years of experience in construction project

a) 0-5 ☐ b) 6-10 ☐ c) 11-15 ☐ d) 16-20 ☐ e) above 20 ☐

6. Professional body affiliated to

a) CIOB ☐ b) GIOC ☐ c) GHIS ☐ d) AGIA ☐ e) ACA ☐

f) Others (specify): …….

SECTION B – THE VARIOUS GENERAL SCHEDULING TOOLS AND TECHNIQUES USED IN THE GHANAIAN CONSTRUCTION INDUSTRY

7. The various scheduling techniques used in construction firms in Ghana are listed below. Please tick for each technique the option which in your view best describes the frequency of usage of the tools or techniques in your construction firm. The parameters are defined on a 5-point Likert scale as 1=very often, 2=often, 3=neutral, 4=sometimes, 5=never

Techniques	**1**	**2**	**3**	**4**	**5**
Network Diagrams					
Precedence Diagram Method					
Activity on Arrow (AoA) method					
Bar Charts					
Gantt chart					
Queue Scheduling					
Line of Balance					
If others, kindly specify					
Tools	**1**	**2**	**3**	**4**	**5**
Excel					
MS Project					
Primavera					

8. Please tick for each technique the option which in your view best describes the relevance of the tools or techniques in enhancing a construction project. The parameters are defined on a 5-point Likert scale as 1=very important, 2=important, 3=not sure, 4=fairly important, 5=not important

Techniques	**1**	**2**	**3**	**4**	**5**
Network Diagrams					
Precedence Diagram Method					
Activity on Arrow (AoA) method					
Bar Charts					
Gantt chart					
Queue Scheduling					
Line of Balance					
If others, kindly specify					
Tools	**1**	**2**	**3**	**4**	**5**
Excel					
Ms Project					
Primavera					

9. How do you analyze your schedules?

a) Critical path methodology [ ] b) PERT analysis [ ] c) others (specify please) [ ]

10. To what extent does your firm use the Scheduling Tools and Techniques during construction?

a) Never [ ] b) Sometimes [ ] c) Often [ ] d) Very often [ ]

11. How effective are the scheduling tools and techniques to Construction activities?

a) Not effective at all [ ] b) Moderately effective [ ] c) Effective [ ] d) Very effective [ ]

SECTION C - THE FACTORS THAT HINDER THE IMPLEMENTATION OF PROJECT SCHEDULES

12. To what extent would you rate the factors hindering the implementation of project scheduling? The parameters are defined on a 5-point Likert scale as 1=not severe, 2=less severe, 3=moderately severe, 4=severe, 5=very severe

Factors	**1**	**2**	**3**	**4**	**5**
Harsh Climatic Condition at Site					
Client interference and competence					
Frequent rework					
Undefined project scope					
Unavailability of funds					
Conflict among Project Participants					
Unavailability of material resources					
Indecisiveness of Project Participants					
Disregard to approved schedules					
Project Manager's Ignorance					
Project Specific Factor					
Others (please specify)					

SECTION D - THE IMPACT OF THE TECHNIQUES USED ON A PROJECT

13. How do you assess your knowledge, awareness and use of the scheduling tools and techniques?

a) Very high ☐ b) High ☐ c) Low ☐ d) Very Low ☐

14. Would the lack of usage of project scheduling techniques and tools affect project?

a) Yes ☐ b) No ☐

15. To what extent would you rate the following impacts of lack of usage of project scheduling techniques on a project? The parameters are defined on a 5-point Likert scale as 1=not severe, 2=less severe, 3=moderately severe, 4=severe, 5=very severe

Impacts	1	2	3	4	5
Delay in project duration					
Poor cost planning					
Inefficient and ineffective planning					
Disruptions during construction activities					
Project termination					
Suspension of parts of project					
Resequencing of Work					
Poor estimates					
Inadequate equipment supply plan					
Changes in scope of work and location					
Others (please specify)					

Thank you