

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND
TECHNOLOGY, KUMASI, GHANA

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Assessing the Adequacy of Construction Planning and Scheduling Data Utilized By
Construction Firms in Ghana

By

Nana Adi Appiah (B.Tech Building Technology)

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

NOVEMBER 2016

CERTIFICATION

I hereby declare that this submission is my own work toward the award of Master of Science Degree in Construction Management and that, to the best of my knowledge it contains no material previous published by another person nor material which has been accepted for the award of any other degree of the University, except where duly acknowledged.

Nana Adi Appiah (PG 3553615)

.....
Signature

.....
Date

Certified by:

Dr. Emmanuel Adinyira
(Supervisor)

.....
Signature

.....
Date

Certified by:

Dr. T Adjei-Kumi
(Head of Department)

.....
Signature

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Date

ABSTRACT

The increasing need for residential apartments, educational facilities, health infrastructure and roads just to mention a few has over the years become the engine of a high growth rate

within the global construction industry. With the back drop of construction being a capital intensive venture, the need to ensure that cost is well managed and ultimately profit gained cannot be over emphasized. It is therefore important to have proper planning, scheduling, monitoring and controlling of construction projects throughout its entire period until project delivery. These principles are achievable by ensuring the preparation of comprehensive construction planning and scheduling data to be used as a yardstick for assessment of project in every aspect of time, cost and quality. The researcher, investigated and assessed the adequacy of data used for construction planning and scheduling among construction firms in Ghana. Data for the study was largely collected through a questionnaire survey and analysed using descriptive statistics. The research made bare the fact that construction firms in Ghana have made efforts at producing some form of planning and scheduling data to support their activities, however the majority are unable to develop the complete data that would allow them to have total control of every aspect of the construction process. Thus the most common representation of a construction plan and schedule by majority of the firms are just programme of works with time lines but no resource allocation for the purposes of cost and material monitoring and control. It was therefore the researcher's recommendation that that the real cost to the contractor for not having complete control over all aspect of cost, time and quality be investigated and made known in order to motivate them to ensure comprehensive planning and scheduling. Also construction firms and academia should get involved in monitoring and improving the skill and knowledge of personnel within the industry who have the duty of planning and scheduling construction works.

TABLE OF CONTENTS

CERTIFICATION	ii
ABSTRACT	iii

TABLE OF CONTENTS	iv
LIST OF TABLES	vii
LIST OF FIGURES.....	viii
ACKNOWLEDGEMENT.....	ix
DEDICATION	x
CHAPTER ONE	1
INTRODUCTION	1
1.1 BACKGROUND TO THE STUDY	1
1.2 PROBLEM STATEMENT	2
1.3 AIM AND OBJECTIVES	3
1.3.1 AIM OF STUDY	3
1.3.2 OBJECTIVES	3
1.4 JUSTIFICATION OF STUDY	3
1.5 SCOPE OF THE STUDY.....	5
1.6 METHODOLOGY FOR THE STUDY	6
1.7 GUIDE TO THE REPORT	7
CHAPTER TWO.....	9
LITERATURE REVIEW	9
2.1 INTRODUCTION.....	9
2.2 CONSTRUCTION PLANNING AND SCHEDULING	9
2.3 PLANNING AND SCHEDULING PROCESS.....	12
2.4 PLANNING AND SCHEDULING TECHNIQUES	13
2.4.1 BAR CHART (GANTT CHART)	13
2.4.2 NETWORK ANALYSIS (CRITICAL PATH METHOD)	15
2.4.3 LINE OF BALANCE METHOD	18
2.5 FACTORS THAT DETERMINE THE CHOICE OF PLANNING AND SCHEDULING TOOLS	19
CHAPTER THREE	20
RESEARCH METHODOLOGY.....	20
3.1 INTRODUCTION.....	20
3.2 RESEARCH QUESTIONS AND METHOD.....	20
3.2.1 RESEARCH QUESTION	20
3.2.2 RESEARCH METHOD	20
3.3 DETERMINATION OF THE SAMPLE SIZE	22
3.4 SAMPLING TECHNIQUE	22
3.5 DATA ANALYSIS	23

3.6	ANTICIPATED CHALLENGES	23
CHAPTER FOUR		24
RESULTS AND DISCUSSIONS		24
4.1	INTRODUCTION.....	24
4.2	DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS	24
4.2.1	CONSTRUCTION SECTOR IN WHICH RESPONDENT WORK.....	24
4.2.2	RESPONDENTS' QUALIFICATION	25
4.2.3	RESPONDENTS POSITION	26
4.2.4	YEARS OF EXPERIENCE IN CONSTRUCTION	26
4.2.5	NUMBER OF PROJECTS UNDERTAKEN BY THE RESPONDENT WITHIN THE LAST FIVE (5) YEARS	27
4.3	ANALYSIS OF RESEARCH OBJECTIVE ONE	28
4.3.1	PLANNING AND SCHEDULING AS A PROJECT REQUIREMENT	28
4.3.2	PLANNING AND SCHEDULING TOOL USED	28
4.3.3	SOFTWARE USED FOR PLANNING AND SCHEDULING	29
4.4	ANALYSIS OF RESEARCH OBJECTIVE TWO	30
4.4.1	DATA REQUIRED FOR COMPREHENSIVE CONSTRUCTION PLANNING AND SCHEDULING	30
4.5	ANALYSIS OF RESEARCH OBJECTIVE THREE	32
4.5.1	OBSTACLES IN EMPLOYING THE PLANNING AND SCHEDULING TOOL	32
4.5.2	BENEFITS OF EMPLOYING PLANNING AND SCHEDULING TOOLS	33
CHAPTER FIVE		35
CONCLUSION AND RECOMMENDATIONS		35
5.1	INTRODUCTION.....	35
5.2	REVIEW OF OBJECTIVES	35
5.2.1	OBJECTIVE ONE: IDENTIFY THE KIND OF PLANNING AND SCHEDULING TOOLS USED BY CONSTRUCTION FIRMS	35
5.2.2	OBJECTIVE TWO: IDENTIFY THE VARIOUS COMPONENTS CONSIDERED IN DEVELOPING A PLANNING AND SCHEDULING DATA	36
5.2.3	OBJECTIVE THREE: INVESTIGATE INTO THE POSSIBLE CHALLENGE(S) INVOLVED IN DEVELOPING A COMPREHENSIVE PLANNING AND SCHEDULING DATA	36
5.3	CONCLUSION	37
5.4	RECOMMENDATION	37
5.5	AREAS OF FURTHER STUDIES	39

REFERENCES	40
APPENDIX ONE.....	42

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LIST OF TABLES

Table 4. 1– Planning and scheduling as a project requirement	28
Table 4. 2– Planning and scheduling tools used	29
Table 4. 3 – Software used for planning and scheduling	30
Table 4.4 a – Source of data required for planning and scheduling	31
Table 4.4 b – Source of data required for planning and scheduling	31
Table 4. 5 – Existence of obstacles to comprehensive planning and scheduling; Survey Data (2016)	33
Table 4. 6 – Possible obstacles to comprehensive planning and scheduling	33
Table 4. 7 – Benefit of planning and scheduling; Survey Data (2016)	34



LIST OF FIGURES

Fig 2. 1- Basic bar chart (Gantt chart); Neale and Neale (1989)	14
Fig 2. 2- Linked bar chart of Gantt chart; Neale and Neale (1989)	15
Fig 2. 3- Activity on arrow network diagram; Harris and McCaffer (2002)	17
Fig 2. 4 - Activity on nodes network diagram (precedence diagram). Source: Harris and McCaffer (2002)	17
Fig 2. 5 - Line of balance diagram. Source: Harris and McCaffer (2002)	19
Fig. 4. 1 - Respondents based on construction sector; Survey Data (2016)	25
Fig. 4. 2 - Academic qualification of respondents; Survey Data (2016)	25
Fig. 4. 3– Official designation of respondents; Survey Data (2016)	26
Fig. 4. 4– Number of years of experience of respondents; Survey Data (2016).....	27
Fig. 4. 5– Number of projects executed within the last five years; Survey Data (2016)27	

ACKNOWLEDGEMENT

In a work of this nature, covering a span of many weeks of learning and working on the field, it is indeed very difficult if not impossible; to recollect all the sources of ideas used or acknowledge them where they are due. Any observed failure of such acknowledgement should not be seen as an instance of intellectual dishonesty. On the contrary, such ideas have become so completely absorbed that in my own thinking, they pass by unnoticed as mine.

I thank the Ever -Living -God, who by reason of His grace and might, granted me His divine enablement to complete this research work.

My profound gratitude goes also to staff of the Department of Building Technology, KNUST, Kumasi. Thank you for the training offered.

To my wife, Mrs Stellastina Appiah, I cannot thank you enough for the sacrifices you made just to see me succeed in my studies. God richly bless you.

Finally to all the members of MCM 2015/2016 – Tema Group, your encouragement and your support, I will always hold dear. Thank you Sarah, Edinam, Henry, Ernest and Peter. I truly appreciate these gifts shared.

DEDICATION

I dedicate this work first to the Almighty God by whose constant grace and protection I have come this far.

Finally to my father Mr Alfred B. Appiah and my mother Miss Elizabeth Moncar for all the investment they have made in my education.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The key to any meaningful profit making in any construction company is to have successful execution of construction projects. This success is achievable by the application of the principle of planning and scheduling, which is seen as one of the most important responsibilities of every construction project management team, (Hancher, 2003). That is to say, the success of construction projects is determined largely by the extent to which the project is executed with specific attention to how it is planned and scheduled. Three key project characteristics that cannot be over emphasized within the principles of construction planning and scheduling are time, cost and quality. Thus a successful project is defined as one that is completed on time, within budget and with all features as originally specified. Just as proper planning is vital to the success of an event in any facet of life, so is planning and scheduling within the construction industry and this is done at every stage in the construction process from the client, the designers and the contractors. Although similar in concept and goals, each of these three have peculiar data requirements for their construction or project plan. In total agreement with the authors, Harris and McCaffer (2002), the contractor's organization, for example is one of the three parties in the construction process that has historically put the greatest effort into the planning process because the results of a well-planned, carefully monitored and controlled contract reflects directly in the profitability of the contract and the company. Whereas this requirement may be true for the contractor's organization, it may not be the focus of the client or the designer.

Construction planning and scheduling, therefore involves the determination of appropriate construction sequence and methodology with the right allocation of resources over a specified time frame. The data presented when all these factors are analyzed and put together

is called the Construction Project Plan. Utilizing this data will involve both monitoring and possible rescheduling of activities all throughout the construction process until completion. The time required for completion of a project depends on the number of activities required, the durations of individual activities and the dependencies between activities. There is also the determination of the critical path of the project. The critical path is defined as the list of linked activities within the project schedule to which any change in their timelines or resources or both will have great impact on the entire project. Any delay on an activity within the critical path will delay the project and vice versa. The quality of the data also is dependent on the right allocation of resources with respect to cost, quantity and specification. Also clarity and proper layout and presentation of all activities describe the quality of the data.

In general, the adequacy and quality of construction planning and scheduling data is determined by the provision of a good roadmap that everyone in the construction team can follow, a realistic project time line, well detailed resource requirement, valid cost estimate and advanced identification of activity slippage.

1.2 PROBLEM STATEMENT

In Ghana, depending on which class of construction one belongs to and the nature of contract procurement, construction planning and scheduling data would be prepared at the inception of a project, usually as a tender requirement. Financial institutions also do request for the construction planning and scheduling data from construction firms as a prerequisite for loan approval or project financing. The data presented in all cases, varies in diverse degrees of adequacies.

A general observation of constructions projects has shown that most construction firms are unable to integrate the various components of a construction planning and scheduling data and this has resulted in firms exceeding construction timelines and resource usage.

Consequently overall construction cost are exceeded and usually are unknown at the end of projects. Construction to a large extent is a capital intensive venture, therefore to achieve targeted profit, it is important to ensure that a proper construction and scheduling data is generated and monitored all through to completion.

It is against this back drop that this research seeks to assess the details of data being considered for the purposes of construction planning and scheduling by various construction firms in Ghana.

1.3 AIM AND OBJECTIVES

1.3.1 AIM OF STUDY

The aim of this research is to assess the adequacy of data used by construction firms in Ghana in the preparation of their construction plans and schedules.

1.3.2 OBJECTIVES

In achieving the above aim, the specific objectives are to:

1. Identify the kind of planning and scheduling tools used by construction firms
2. Identify the various components considered in developing a planning and scheduling data
3. Investigate into the possible challenge(s) involved in developing a comprehensive planning and scheduling data

1.4 JUSTIFICATION OF STUDY

Contrary to the general perception within the construction industry, planning and scheduling are two separate activities. Planning aims at ensuring all work required to complete a project is achieved in the correct order, in the right place, at the right time, by the right people and equipment, to the right quality, and in the most economical, safe and environmentally

acceptable manner (Zanen and Hartmann, 2010) . Scheduling on the other hand, as further explained by Zanen & Hartmann (2010) aims at producing a logically acceptable sequence of construction activities. These two functions, if well prepared with all required data, results in a construction plan that will be realistic in all aspects of time, cost and quality.

Over the years, most construction firms have become very concerned over the failure of construction planning and scheduling in achieving its goals despite the allocation of considerable resources. This concern can most likely be attributed to poor or deficient planning techniques.

Unfortunately, most Ghanaian construction firms have fallen victims to the poor or defective planning techniques. A lot more have just represented a schedule of works as a construction plan and this has resulted in huge losses due to high overheads and direct construction costs. According to the 2015 CHAOS report released by the Standish Group; www.infoq.com/articles/standish-chaos-2015, (2016), out of 50,000 projects studied worldwide, 29% were successful, 52% were challenged and 19% were failed. This is interpreted as a fact that 71% of the projects were unsuccessful. The Chaos definition of an unsuccessful project is one that is either

- a challenged project, which implies completed, implemented, over budget, over time and with fewer features or
- An impaired project which implies cancelled at some point during the development cycle.

Ensuring a successful project, as indicated earlier, will then require a well-structured construction plan which will be well monitored and achieved with respect to time, cost and quality. There is therefore the need for some analysis of the prevailing challenges preventing the possible use of adequate data for planning and scheduling and putting forward proposed solutions to help construction firms in Ghana increase the success rate of construction.

Research in this area over the years have been very few and mostly focused on either planning techniques or various scheduling tool.

This research will seek to improve information on what constitutes an adequate construction and scheduling data and to suggest practical ways of improving construction success rate of construction firms in Ghana.

1.5 SCOPE OF THE STUDY

The construction industry is made up of three main divisions, namely clients, consultants and contractors. This research focuses on construction firms that are into offering consultancy services only, construction service only or both services. Within these service categories, the research will concentrate on D1/K1 construction firm which are firms with the highest construction qualification as awarded by the ministry of Water Resources Works and Housing in Ghana.

With the current increase in infrastructural development in Ghana, these are the firms handling multistory infrastructure and large civil structures like the sea water desalination plants, thermal power plants, multipurpose high rise buildings, hydropower projects and numerous shopping malls across the country. These project involve huge project costs and require careful and critical planning and scheduling if they are to succeed.

Consultants in this case will include architectural firms, structural engineering firms and project management firms involved in private construction projects as well as government awarded projects.

Data regarding the numbers and details of contractors and consultants within the D1/K1 category within this study will be obtained from the Ghana Institute of Architects, Ghana Institution of Engineers, Ministry of Water Resources Works and Housing, Registrar's General Departments, and the Ghana Association of Building and Road Contractors. Along the lines of this research objectives, the focus on this target group will be on the planning

techniques available to the building sector and the details of their usage as well as their benefits.

1.6 METHODOLOGY FOR THE STUDY

The methodology applied for the realization of the objectives of this research include:

- The comprehensive review of literature related to the research from textbooks, article, published research works, journals and the internet. This provided the opportunity for a broad understanding of the research objective and also deeper insight into the data requirement for planning and scheduling within the construction sector.
- Administering of designed questionnaires to various construction firm. Both openended and closed-ended questions were employed. The nature of questions were focused on receiving information relevant to the objectives of this research and ultimately addressed the aim. Respondents were asked to answer the asked questions in their own words whenever clarification of certain issues needed to be addressed.
- Visiting of selected offices of professionals within the construction sector for interviews relating to their data inputs in planning and scheduling of their construction projects. This afforded the researcher the opportunity to see at first hand, evidence of the planning and scheduling details and application within the selected firms.

1.7 GUIDE TO THE REPORT

This research is categorized into five main chapters as listed and described below.

- a) Chapter one is the Introduction.**

This chapter provides a brief insight by way of introduction of the research area of interest identified or problem identified with regards to the adequacy of data for planning and scheduling by construction firms and the methodology being used for the study. It also states the aims, objectives, scope and the relevance of the study.

b) Chapter Two, Literature Review,

This chapter deals with a look into the whole concept of planning and scheduling as found in various literature including text books, journals, internet and similar researches. It further presents some techniques for planning and scheduling as options available for use within the construction sector.

c) Chapter Three outlines the Method of Research.

This provides the details and contents of questionnaire, including the method used for distribution. It also clarifies all other methods used to collect data as well as the form of data analysis applied and finally method of determining the sample size for contractors and consultants in the industry is also provided.

d) Chapter Four is the Presentation of Data

In this chapter, data obtained from all previously stated method are statistically analyzed and presented in various formats including tabular forms, histograms and other related charts. It further explains the data presented in the various tables and charts and compares the findings with the literature

e) Chapter Five is the Conclusion and Recommendation

Once data has been gathered and analyzed, the import is presented as conclusion.

For the purpose of making the research work more useful, recommendations are made in this chapter which is meant to either improve or solve the main problem identified at the beginning of the research

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

For a country like Ghana which enjoys a 9.8% contribution to its Gross Domestic Product from the construction sector as stated by the Ghana Statistical Service (GSS) (2014), the construction industry's plays an important role in national development and its survival is vital to the county. According the 2014 statistical report of the Ghana Statistical Service, the sector has enjoyed a high growth rate of about 11.2% since the year 2008. That is to say, every effort to ensure that construction firms make adequate profit and untimely contribute more the nation cannot be over emphasized.

This literature assesses the adequacy of data that construction firms in Ghana utilize with respect to planning and scheduling of their works. This is aimed at helping to ultimately improve performance in terms of profits. The principles, requirements, tools and techniques needed to produce a comprehensive plan and schedule are considered in this chapter.

2.2 CONSTRUCTION PLANNING AND SCHEDULING

Construction planning and scheduling can be cited as the engine of the whole construction process, without which the success of a project cannot be feasible. In the view of Hendrickson (1998), construction planning is seen as the fundamental and challenging activity in the management and execution of construction projects. This lays bare, the processes and technology options required for the construction works, definition and identification of various work tasks, the interactions between the work tasks and all required resource estimations.

The definition of planning in relation to construction as defined by various authors underscore the very important role of planning in the attainment of project goals. These include but not limited to

- “Planning is processes of devising and maintaining a workable scheme to accomplish the business need that the project was undertaken to address” (Duncan, 2003 – PMBOK)
- “Planning is the creative and demanding mental activity of working out what has to be done, how, by when, by whom, and with what, i.e. doing the job in the mind” (Neale and Neale, 1989)
- “Planning is the systematic identification of program and project tasks, task schedules, and resources required for task accomplishment” (construction planning for engineers, p5);
- “Planning is the process by which executives anticipate the probable effects of events that may change the activities and objectives of their business. Planning is the conscious determination of courses of action, the basing of decisions on purpose, facts and considered estimates” (Hollins, 1971)

Again, Hendrickson (1998) states that “A good construction plan is the basis for developing the budget and the schedule for work”

The production of a construction plan is in itself a very challenging task, which involves the generation of all required activities, analyzing the possible implications of each activity and deciding among various means of performing activities.

Scheduling similar to planning refers to the method of producing a logically acceptable sequence of construction activities, usually as generated at the planning stage. (Zanen & Hartmann 2010). It is a means of communicating what work needs to be performed, which resources of the organization will perform the work or task and the timeframes needed for the work or task to be performed. The construction schedule should reveal all of the tasks associated with delivering the project on time. This communicates the complete effort, in terms of cost and resources, necessary to project delivery. Thus the distinguishing factor

between planning and scheduling is primarily figuring out the ‘when’ to carry out an action, in the case of scheduling, while planning is more concerned with the ‘what’ action is be carried out (Dean and Kambhampati, 1996)

Planning and scheduling goes beyond just the physical representation of activities needed to undertake and complete a project. It embodies the elements or resource allocations with regard to cost of materials, plant and labour allocation as well as monitoring and control of all these resources. As elaborated by Harris and McCaffer (2002), the cost control element are

- a) Measurement of work progress
- b) Calculation of budget allowances for that progress
- c) Comparing budget allowances with actual cost
- d) Take corrective action where necessary.

Harris and McCaffer (2002) further explain that monitoring, with respect to planned or scheduled activities is defined as the act of checking actual progress and resource usage against planned progress and resource usage. Thus where a planner is equipped with the appropriate tool to update activities in the course of the project, the updating of activities may be by

- a) Changing start date
- b) Changing duration
- c) Changing end dates
- d) Changing resource requirement

Control of planned and scheduled activities has to do with ensuring that the project stays on schedule, where there is any alteration which has the tendency of affecting future outcomes. It involves the rescheduling and reordering of activities and altering of resources to change

duration of activities. This is achieved by information regarding the rate of work progress and the current resource usage for updates. (Harris and McCaffer, 2002)

2.3 PLANNING AND SCHEDULING PROCESS

Planning and scheduling process of construction works is a continuous one that begins from the moment a decision for investment is made and runs until the project delivery. This process can be distinguished into three main levels as identified by Dvir, Raz and Shenhar (2003):

- a. The end-user level, where the planning focuses mainly on the functional characteristics of the project end product;
- b. The technical level, which focuses on the technical specifications of the project deliverables that are needed to support the functional requirements
- c. The project management level, which focuses on planning the activities and processes that need to be performed to ensure that the technical work proceeds effectively.

Dvir, Raz and Shenhar (2003) further explains that these three levels of planning can otherwise be regarded respectively as project conception planning, project design planning and construction planning. These levels (conception, design and construction) are the project delivery stages. A very important aspect of planning any construction project is the production of an appropriate construction project schedule which places all the tasks of the project in a logical and sequential order. Depending on the type of project tasks, variations in the sequence of tasks are possible. A basic construction schedule will contain the start and end dates of each task, their respective duration, their relations and dependency on other tasks and the types of dependency between various tasks. The schedules may also include some additional information such as float between one task and the other (Zanen & Hartmann 2010).

2.4 PLANNING AND SCHEDULING TECHNIQUES

There are a number of techniques used in the presentation of construction plans, with each having its unique way of providing necessary information and understanding, vital to the attainment of project goals. All these techniques however, make use of similar data such as time lines and cost/material resources. Some of these techniques include, the Bar Chart or Gantt chart, the Network Analysis and the Line of Balance, just to name a few.

2.4.1 BAR CHART (GANTT CHART)

The bar chart, also referred to as the Gantt chart is about the most widely used tool in the presentation of construction plan and it is very easy to understand. Most of the other more sophisticated techniques, when used, eventually end up being presented in a bar chart for simple understanding.

The bar chart was developed in the early 1990 by Henry L. Gantt as the first formalized presentation of project planning (Zanen & Hartmann, 2010). The Bar Chart was the first scientific attempt at present working schedule against time. As shown in **Fig. 2.1**, the graphical representation of the bar chart provides a time scale in days/weeks/months/years along the horizontal axis and a list of activities on the vertical axis. The time required for each activity is represented by a horizontal line (bar), with the length of the line indicating the duration of each activity. The position of the bars are determined by the start and finish times of corresponding activities.

An update of the basic bar chart has led to the development of the Linked Bar Chart (**Fig. 2.2**), which has consequently led to the resurgence in the use of the Bar Chart mainly with the development of project management software such as:

- C S Project Professional by Crest Software
- Hornet Windmill by Claremont Controls
- Microsoft Project by Microsoft Corporation

- Power Project Professional by Asta Development
- Project Commander by Construct.it USA

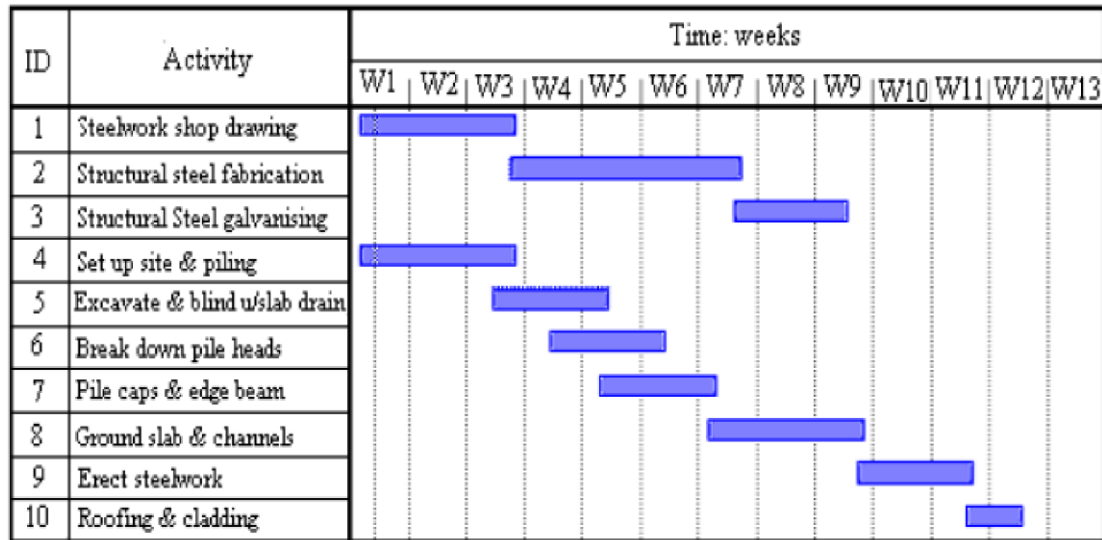


Fig 2. 1- Basic bar chart (Gantt chart); Neale and Neale (1989)

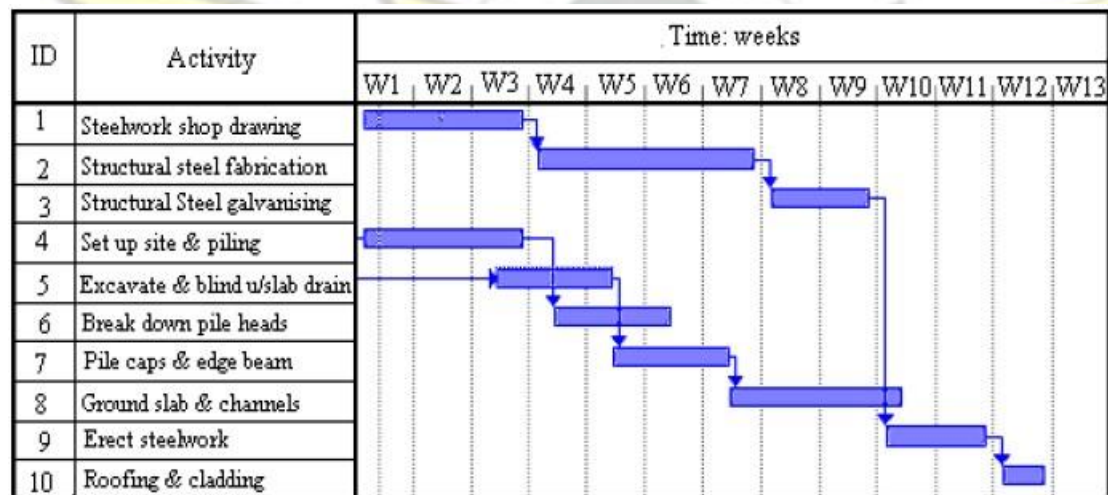


Fig 2. 2- Linked bar chart of Gantt chart; Neale and Neale (1989)

The linked Bar Chart uses arrow-head lines to indicate construction logic and relationship between various activities in terms of interdependencies. Thus changes made to preceding activities have effect on the current activities. The linked Bar Chart can be used in the identification of all critical activities within the construction process to help for better planning.

2.4.2 NETWORK ANALYSIS (CRITICAL PATH METHOD)

The quest to finding a technique that will overcome the limitations of the Bar Chart in the 1950s, resulted in the development of the Critical Path Method (CPM) which is a network analysis system. This was started by El Dupont in 1956 and further developed by Mauchley, Kelley Jr. and Walker in the early parts of 1957. The initial applications developed were only suitable for large complex projects and required the assistance of mainframe computers to analyze the data. However, the introduction of the personal computers around the middle of 1983, brought about the resurgence of the Critical Path Method and development of user friendly project planning software with basis of this technique, including □ Micro Planner Expert by Micro planning International

- Plantrac by Computerline Ltd.
- Primavera by Forgerack Ltd.
- Superproject by Computer Associates

The Critical Path Method is suitable and effective when used for complicated projects, especially those with external constraints and complex interrelationships (Neale and Neale, 1989). With advantages of being able to process the planning data by holding the data in computer files, the system provides a comprehensive method for project planning, scheduling and controlling. It also shows the relationship between various activities and scheduling of costs and resources.

The Critical Path Method is a technique which is based on the establishment of logical relationships between construction operations and their execution sequence. It allows for the determination of estimated project duration and also provides for distinguishing between activities whose execution times are crucial for earliest completion of the project and those that may not cause delay in overall project duration, should they be delayed for some specific time; non-crucial activities. The non-crucial activities provide an objective means of scheduling project activities to make the best use of the available resources.

The graphical representation of the network analysis can be done in two main forms,

1. The activity on arrows as shown in **Fig.2.3** In this system of network the activities are represented as arrows joined together by ‘events’ usually depicted as circles, in a logical manner so as to satisfy three main questions

- Which activities must be completed before another starts?
- Which activities can not start until an earlier one is completed?
- Which activities can take place at the same time as another and has no logical relationship?

2. The Activity on nodes, also referred to as precedence network diagram as shown in **Fig.2.4**. Similar to the activity on arrow, the precedence diagram follows the same logical procedure except that here the activities are represented as nodes or boxes linked together by arrows which defines the relationship of one activity to the other. In practice, the precedence diagram is far widely due to its flexibility and it reflects more easily, the way activities occur.

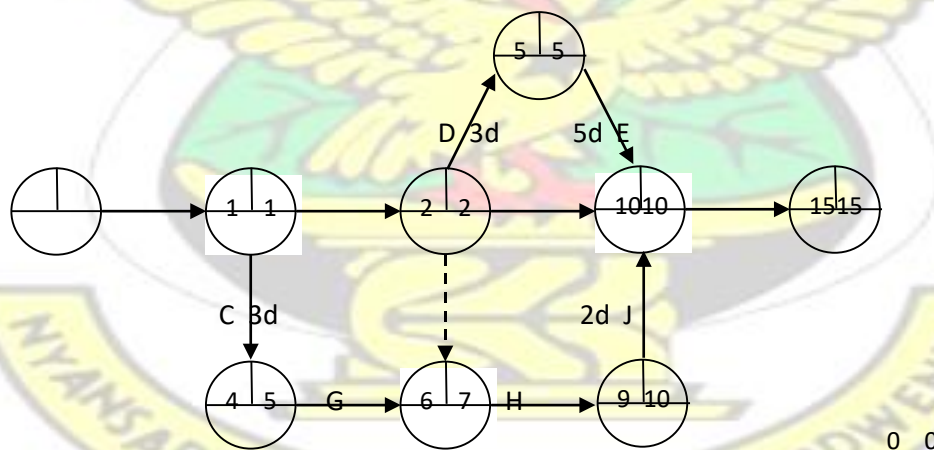


Fig 2. 3- Activity on arrow network diagram; Harris and McCaffer (2002)

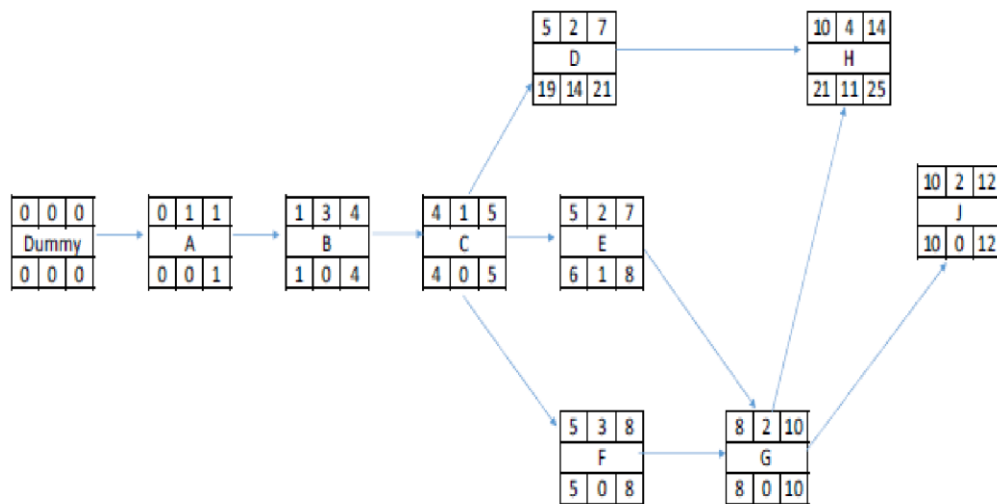


Fig 2. 4 - Activity on nodes network diagram (precedence diagram). Source: Harris and McCaffer (2002)

2.4.3 LINE OF BALANCE METHOD

Line of balance is a planning techniques used for repetitive works and it is represented graphically as a series of inclined lines which represent the rate of working between repetitive operations in a construction sequence. The basis of the technique is to find the required resources for each stage or operation so that the following stages are not interfered with and the target output can be achieved (Harris and McCaffer, 2002). As further explained by Neale and Neale (1989), this technique is used for the analysis of labour and plant resources and this ensures a study progression of resources from one item to the other in an orderly manner. It allows the completion works on all items with no delay or waiting for preceding works to complete. The main aim of this technique is to keep all resources in a balanced manner with each productively following the other with a clear work path.

This scheduling technique originated in the early 1940's by the Goodyear Company and was developed in the early 1950's by the U.S. Navy for the programming and controlling of both repetitive and non-repetitive projects. The primary concepts of Line of Balance has been applied in the construction sector as a planning and scheduling method.

The graphical representation of this technique comprises a series of inclined lines which denote working rate between repetitive operations in a construction sequence. It is the most appropriate planning technique for a repetitive work such as Dwelling units and Villas, High-rise building, pipeline, highways, railway and tunnels. It may however, be adapted for non-repetitive projects as well.

Unlike a Bar Chart, for example, which shows activity duration, the Line of Balance Chart shows the required work rate needed to be performed in order to stay on schedule. The relationship between successive processes is defined by the space between the lines.

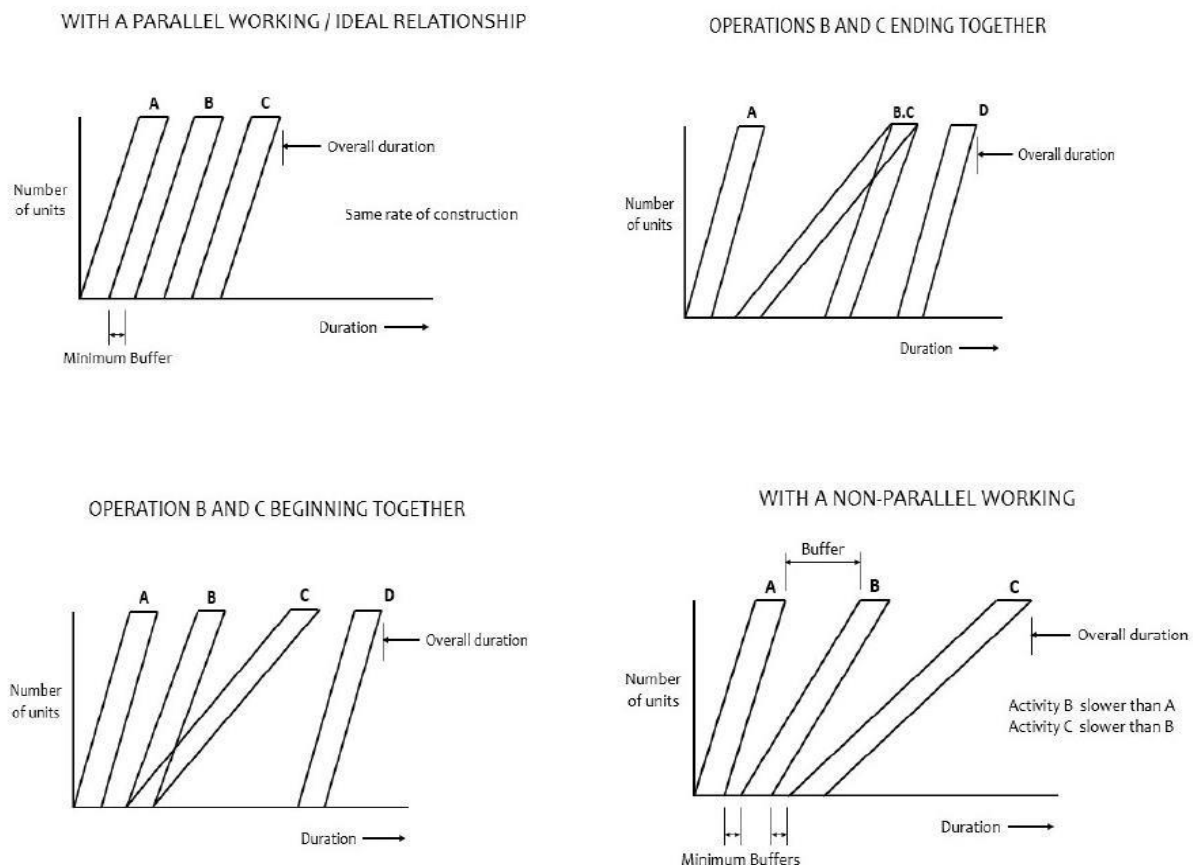


Fig 2. 5 - Line of balance diagram. Source: Harris and McCaffer (2002)

2.5 FACTORS THAT DETERMINE THE CHOICE OF PLANNING AND SCHEDULING TOOLS

Complexity of a project, personnel availability and labour quality, simplicity of planning and scheduling technique, project size, project duration and ultimately the client's

requirements are the major factors that influences the choice of planning and scheduling techniques required for a construction project; (Nyamekye et al. 2013)

Additional factors as further listed by Cooke and William (2004) had to do with the personal preferences of the project contractor. These include, location of project, quality requirement of project, technique popularity, technique efficiency, knowledge, availability and flexibility of technique and cost of technique software

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The main concern of this study was to find out the adequacy of data used in construction planning and scheduling of works by construction firms in Ghana. To this end, objectives were clearly defined and were addressed by the use of various methods and techniques.

As a first step towards satisfying the objectives of this research, preliminary interview via telephone with professionals within construction industry was conducted. The professionals were classified into three main groups consisting of consultants, contractors and those offering both services. For the purposes of this research work consultants were defined as architectural firms, structural engineering firms and project management firms involved in private construction projects as well as government awarded projects. These consultants included both private individual consulting firms and consultants working in the government agencies.

3.2 RESEARCH QUESTIONS AND METHOD

3.2.1 RESEARCH QUESTION

The fundamental issue that the study sought to investigate and find possible answers to, was to first identify the data used by construction firms in Ghana for the purposes of construction planning and scheduling, and analyze the adequacy of such data.

3.2.2 RESEARCH METHOD

The method applied in achieving the research objectives include the following:

a. Structured Questionnaire

The objectives of this research work was addressed principally through structured questionnaire administration to professionals as stated earlier. Separate sets of questionnaires were designed and respectively administered to contractors and consultants. The content of these questionnaires were the same. Administering of questionnaires was by personal submission and through the internet.

In the questionnaire, respondents were asked to indicate the education level acquired, agency they work for, their designation and years of experience in current position and number of projects worked on or handled within the past five years of operations. This was to assess the level of experience and qualifications of professionals in the industry. Similarly, questions such as ‘which planning technique(s) are you most familiar with?’, ‘how often do you use or recommend for use the planning technique specified?’, ‘how would you rate your knowledge in the technique(s) stated?’ and ‘how would you define construction planning and scheduling?’ were put forward. The objective for these types of questions were to help determine the frequency of use of each technique and the depth of knowledge of the concept of planning and scheduling.

There were statistical analysis of all response and the results were presented in tabular forms and charts.

b. Interviews

There were structured questions for interview of professional who for some reason did not have the time to fill out questionnaires. These interviews were conducted either by direct contact in their respective offices or via telephone. The content of the interview questions were the same as those distributed.

3.3 DETERMINATION OF THE SAMPLE SIZE

In order to have a fair number of questionnaire to be distributed to respondents, the Kish formula (Kish, 1965) was applied. The Kish's formula reads;

$$n = nl / [1 + (nl/N)] \dots\dots\dots (\text{equ. 3.1})$$

Where; n = sample size

N = population size

$$nl = s^2 / v^2$$

s = the maximum standard deviation in the population element
(i.e. total error of 5% at a confidence level of 95%)

v = the standard error of sampling distribution = 0.05

$s^2 = P(1-P) = (0.5) (1-0.5) = 0.25$; (P being proportion of population elements belonging to a defined class)

$$nl = 0.25 / (0.05)^2 = 100$$

By the application of Kish's formulae, a sample size of 56 was obtained out of a population (N) of 125. It is estimated that, the outcome of this study, would provide a fair representation of the adequacy of construction planning and scheduling date utilized by construction firms in Ghana.

3.4 SAMPLING TECHNIQUE

The convenience sampling technique was used in the collection of data. This is a statistical method of drawing representative data by selecting respondents due their ease of access or availability. This method which the researcher employed was due to very limited time available to be able to reach all members within the sample size. Thus the need for easy access and quick response was the driving force for this decision

3.5 DATA ANALYSIS

Data was mainly collected via the internet by the application of Google-forms which automatically presents response in statistical charts. There was also the option of downloading the data of respondents in Excel which allowed the researcher to analyze data with other tools. The researcher again entered responses collected in hard copies into the Google-forms page to update the respondent data and allow Google-forms to regenerate the data analysis.

3.6 ANTICIPATED CHALLENGES

As has been common with human nature, divulging of information is very sensitive and if not properly handled could lead to unfortunate outcomes. The uncertainty of what the information provided will be used for, who is requesting for the information and why the need for the that information are some of the reasons why the researcher found some level of apathy in the course of trying to gather data.

Other reasons, however tangible, why people will refuse to provide any information was the arguments that most research works are only used for academic purposes and offer no help to industry, hence they would refuse to be of any assistance.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

This section comprises of the statistical and graphical representation of data gathered from respondents of questionnaires. Using descriptive statistics, the data was critically analyzed with particular reference to the objectives of this study. The data as below, is first presented just as was provided by forty (40) respondents, representing forty firms spread across the construction industry in Ghana. Finally the data is analyzed with respect to each of the three research objectives.

4.2 DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

In the quest to ensure the credibility of results presented, the research questionnaire was developed to establish the true professional identity of respondents by requesting for information regarding their place of work, which sector within the construction industry they belonged, their academic qualifications, their official position in their respective firms, the numbers of years of work experience and the average number of construction projects they have been involved in within the last five (5) years.

4.2.1 CONSTRUCTION SECTOR IN WHICH RESPONDENT WORK

Fig. 4.1 is a representation of respondents based on which sector of construction they belong. This indicates that five percent (5%) of respondents work in the road sector while thirty percent (30%) are within the Real Estate sector. Those involved in general construction works represents another thirty percent (30%) and the highest of thirty-five percent (35%) refers to respondents working in the construction consultancy firms.

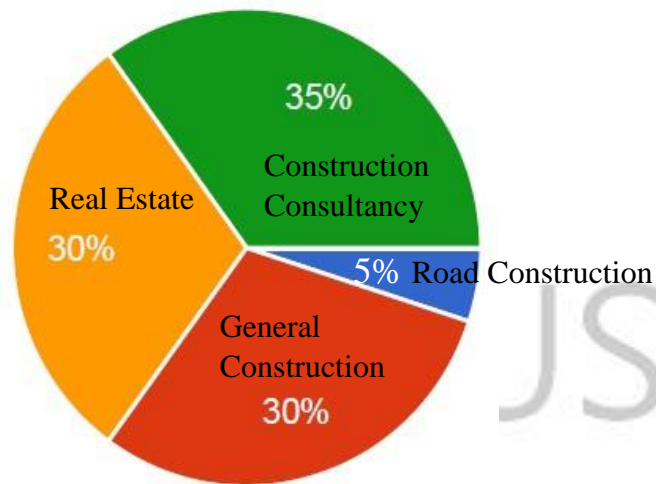


Fig. 4. 1 - Respondents based on construction sector; Survey Data (2016)

4.2.2 RESPONDENTS' QUALIFICATION

The academic qualification distribution as shown in **Fig. 4.2** indicates that none of the respondents had a PhD, five percent (5%) had Higher National Diploma (HND) whilst those with a Bachelor of Science (BSc) qualification make up seventy percent (70%). Master of Science (MSc) qualified respondents were ten percent (10%). Other qualifications are made up respondents with Post Graduate Diploma (PG. Dip) and Mater of Business Administration (MBA) and these represented fifteen percent (15%) of respondents

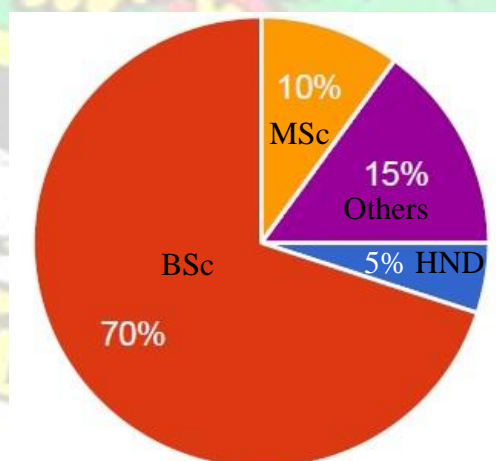


Fig. 4. 2 - Academic qualification of respondents; Survey Data (2016)

4.2.3 RESPONDENTS POSITION

In **Fig. 4.3** as shown below, the positions of Director/Deputy director, Contracts Manager, Project Planner and Supervisors each had five percent (5%) of respondents holding those positions. Project Managers were made up of twenty-five (25%) respondents with the majority of respondents being Quantity Surveyors; making up forty percent (40%). The remaining fifteen (15%) percent were made up of respondents within the 'other' category and they had the title Construction Engineers.

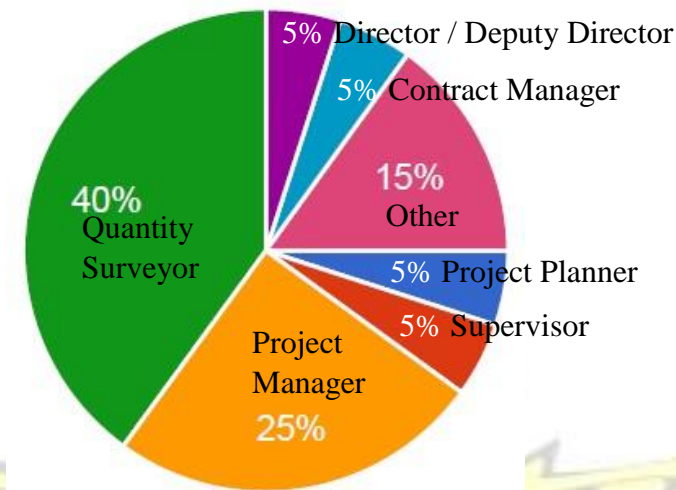


Fig. 4. 3– Official designation of respondents; Survey Data (2016)

4.2.4 YEARS OF EXPERIENCE IN CONSTRUCTION

The ranges of experience in years of respondents are as shown in **Fig. 4.4** below. The data provides that forty-five percent (45%) of respondents have worked in the construction industry for periods between one (1) and five (5) years. Thirty percent (30%) have been involved in construction works for between six (6) to ten (10) years, whilst the remaining respondents of twenty-five percent (25%) have construction experience of over ten (10) years.

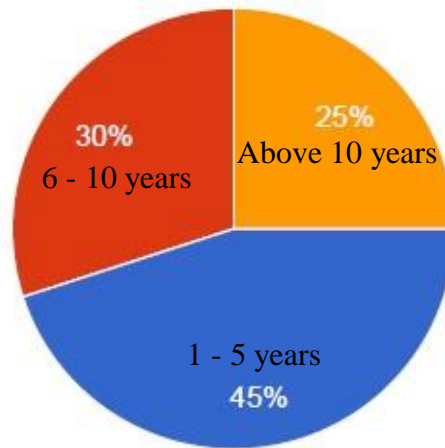


Fig. 4. 4– Number of years of experience of respondents; Survey Data (2016)

4.2.5 NUMBER OF PROJECTS UNDERTAKEN BY THE RESPONDENT WITHIN THE LAST FIVE (5) YEARS

Fig. 4.5 below represents the percentage of respondents and their respective number of projects undertaken within the last five (5) years. Thirty-five percent (35%) have undertaken less than five (5) projects whilst, forty-five percent (45%) have undertaken between five (5) and ten (10) construction projects within the same period. Respondents belonging to firms that have undertaken project between eleven (11) and twenty (20) represents fifteen percent (15%), with five percent (5%) representing firms with more than twenty (20) project execution within the last five years.

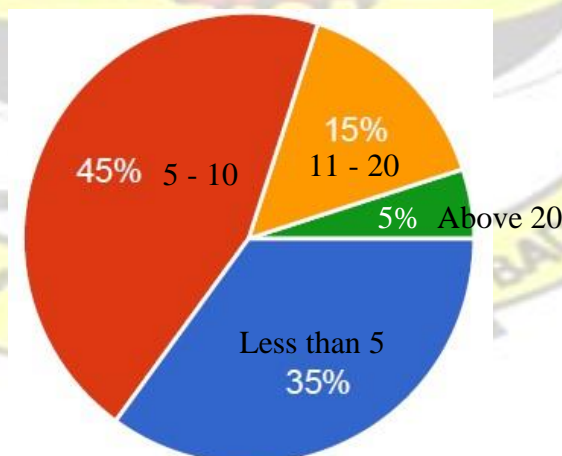


Fig. 4. 5– Number of projects executed within the last five years; Survey Data (2016)

4.3 ANALYSIS OF RESEARCH OBJECTIVE ONE

4.3.1 PLANNING AND SCHEDULING AS A PROJECT REQUIREMENT

Out of a total of forty (40) respondents, thirty eight (38), responded to the questions of whether or not planning and scheduling was a part of their project requirement; as indicated in **Table 4.1** below. The distribution indicates that thirty-six (36) of these respondents representing ninety-five percent (95%) said ‘yes’ to the question at hand while the two (2) remaining respondents, representing five percent (5%) responded ‘No’. This implies that that a total of ninety percent (90%) of the total number of respondents are well aware of the requirement of planning and scheduling as a part of project execution.

Table 4. 1– Planning and scheduling as a project requirement

Is construction planning and scheduling a part of your company's requirements for project execution?	Frequency	Percentage
YES	36	95%
NO	2	5%
TOTAL	38	100%

Source: Survey Data (2016)

4.3.2 PLANNING AND SCHEDULING TOOL USED

The presentation as shown in **Table 4.2** describes the types of scheduling tools being used by the firms of respondents. Thirty-two (32) responses representing eight-four percent (84%) indicates extent to which the Bar/Gantt Chart is been used, whereas four (4) responses representing eleven percent (11%) indicates use of the Network Analysis. Two (2) responses representing five percent (5%) indicates the use Line of Balance. The distribution as per the data collected indicates that all respondents use at least one of the scheduling tools, however the most commonly used tool is the Bar/Gantt chart. A zero percent (0%) response to the request for the application of any other planning and scheduling tool indicated that the Bar Chart, Network Analysis and the line of balance are the only tools currently being used by construction firms of respondents.

Table 4. 2– Planning and scheduling tools used

Which of the following planning and scheduling tools do you normally apply on your projects	Frequency	Percentage
Bar / Gantt Chart	32	84%
Network Analysis	4	11%
Line of Balance	2	5%
Others	0	0%

Source: Survey Data (2016)

4.3.3 SOFTWARE USED FOR PLANNING AND SCHEDULING

The usage of computer software in the planning and scheduling process indicates a seventynine percent (79%) usage of the MS Project and forty-two percent (42%) usage of MS Excel. **Table 4.3** gives the statistics of the distribution and further shows that none of the respondents use any other software for planning or scheduling of their works. The response also indicates that all the firms represented use either MS Project or MS Excel or both in the preparation of their project plans and schedules. The most commonly used software, however, is the MS Project. The use of these two software corroborates the eighty four percent (84%) usage of the Bar chart/ Gantt chart in **Table 4.2** above.

Table 4. 3 – Software used for planning and scheduling

Which of the following software do you apply?	Frequency	Percentage
MS Project	30	79%
MS Excel	16	42%
Primavera	0	0.0%
Other	0	0.0%

Source: Survey Data (2016)

4.4 ANALYSIS OF RESEARCH OBJECTIVE TWO

4.4.1 DATA REQUIRED FOR COMPREHENSIVE CONSTRUCTION PLANNING AND SCHEDULING

Table 4.4a shows the extent to which respondents use data from various construction documents in the planning and scheduling process. These show a sixty percent (60%) inclusion of the method statement for planning and scheduling. It further shows a thirty-five percent (35%) each, for the application of both human resource and material resource data. The usage of data form the bill of quantities in the planning process stands at fifty percent (50%) while the use of schedule of works shows fifty-five percent (55%) application. Analysis of response further shows in **Table 4.4b** that thirty percent (30%) representing the majority of firms use only a single data source for planning and schedule with only fifteen percent (15%) using all five (5) sources of data for the purpose of planning and scheduling. A total of thirty percent (30%) also use between two (2) and four (4) data sources, while the reaming twenty-five percent (25%) of the total population sampled did not indicate the use of any of the sources of data for planning and scheduling. This is interpreted as eighty-five percent (85%) of the population sampled do not use all the sources of data for the preparation

of construction plans and schedules. The effect of this is that proper monitoring of all resources employed during construction will be very difficult is not impossible. For example, using only a method statement and schedule of works to plan without the allocation of resources, both cost and material, may results in oversights or poor tracking of cost. This could lead to overspending in both direct costs and overheads and ultimately affect a project negatively.

Table 4.4 a – Source of data required for planning and scheduling

Which of the under-listed data do you consider in your planning and scheduling	Frequency	Percentage
Method Statement	24	60%
Material Resource	14	35%
Human Resource	14	35%
Bill of Quantities	20	50%
Schedule of works	22	55%

Source: Survey Data (2016)

Table 4.4 b – Source of data required for planning and scheduling

Which of the under-listed data do you consider in your planning and scheduling	Frequency	Percentage
All five data sources	6	15%
Four data sources	4	10%
Three data sources	6	15%
Two data sources	2	5%
One data source	12	30%

Source: Survey Data (2016)

4.5 ANALYSIS OF RESEARCH OBJECTIVE THREE

4.5.1 OBSTACLES IN EMPLOYING THE PLANNING AND SCHEDULING TOOL

Table 4.5 shows that thirty-two (32) respondents representing eighty percent (80%) claims they have some obstacles that prevent them from comprehensively preparing their construction plan and schedules. On the other hand, eight (8) respondents representing

twenty percent (20%) have no problems in preparing their construction plans and schedules. Of the thirty-two (32) respondent who have some obstacles, **Table 4.6** shows the description of the obstacles and the extent to which these have contributed to their inability to prepare comprehensive construction plans and schedules. Each of the respondents in this category had at least one obstacles. Fifty (50%) identified ‘No or incomplete Bill of Quantities’ as an obstacle, while thirty-one percent (31%) claimed ‘no or incomplete material schedule’ was an obstacle. Another obstacle with a twenty-five percent (25%) response rate was ‘no or incomplete method statement’, and finally sixty-nine (69%) was blamed on the inability of respondents to allocate resources to programme of works. If the respondents are a fair representation of the class of construction firms in Ghana, then it will be fair to imply that up to eighty percent (80%) of the highest class of construction firms in Ghana are unable to apply a complete integration of all data required for a comprehensive construction plan and schedule. The implication is that exact project cost during and after construction project will be nearly impossible to determine.

Table 4. 5 – Existence of obstacles to comprehensive planning and scheduling; Survey Data (2016)

Are there any obstacles that prevent you from comprehensively planning and scheduling your construction projects?	Frequency	Percentage
YES	32	80%
NO	8	20%

TOTAL	40	100%
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Source: Survey Data (2016)

Table 4. 6 – Possible obstacles to comprehensive planning and scheduling

Which of the following would you say is/are the obstacles?	Frequency	Percentage
No / Incomplete Bill of Quantities	16	50%
No / Incomplete Material Schedule	10	31%
No / Incomplete Method Statement	8	25%
Inability to allocate resources to programme of works	22	69%
Others	0	0%

Source: Survey Data (2016)

It is worth noting, however, that fifty-five (55%) of the total population sampled are unable to allocate resources to their programme of works.

4.5.2 BENEFITS OF EMPLOYING PLANNING AND SCHEDULING TOOLS

Table 4.7 shows the extent to which planning and scheduling has been beneficial to respondents. With every respondent having at least one reason, the data shows that benefit of cost control and proper monitoring of budget accounts for thirty-two (32%) percent of all benefits. The ability to properly monitor progress of work accounts for sixty-eight (68%). The quick response by team leaders and supervisors due to clarity of task definition and resources also accounted for thirty-two (32%) percent of the benefits. This make evident the fact that the majority of the represented firms are more focused on the monitoring of time lines than budget and cost control. It is worth noting that completing a project within the planned time line does not necessarily define profit or loss. Thus, if sixty-eight (68%) of

response are focused on better control of construction planned time then the implication is that the majority of construction firms are not reaping the full benefit of a comprehensive construction plan and may be losing out on making any meaningful profits.

Table 4. 7 – Benefit of planning and scheduling; Survey Data (2016)

How helpful would you say planning and scheduling has been to your firm?	Frequency	Percentage
It has helped in managing the construction budget by allowing control of cost allocation and variations	12	32%
It has allowed for better control of construction planned time and proper monitoring of work progress	26	68%
It clearly defines all tasks with respect to details and required resources which has allowed for quick response from supervisors and team leaders in performing their duties	12	32%

Source: Survey Data (2016)

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter provides the researcher the opportunity to present a summary of findings as per the analysis provided in earlier chapters and also gives conclusions on the findings. Recommendations are then provided regarding the subject matter of “Assessing the adequacy of construction planning and scheduling data utilized by construction firms in Ghana”.

5.2 REVIEW OF OBJECTIVES

5.2.1 OBJECTIVE ONE: IDENTIFY THE KIND OF PLANNING AND SCHEDULING TOOLS USED BY CONSTRUCTION FIRMS

The researcher's first objective was to find out which type of tools were in use by construction firms in Ghana for the purposes of planning and scheduling of their construction projects. The analyzed data received from respondents indicates overwhelmingly that the Bar/Gantt Charts is the most widely used tool. Though the network analysis and the line of balance was also mentioned, their use within the industry were significantly low. It was then no surprise that the more popular of the two software in use turned out to be the Microsoft Project and the other was Microsoft Excel. Both of these provides ease of drafting and presenting plans and schedules in the form of Bar/Gantt charts and depending on the depth of information intended to be accessible, the most appropriate is opted for.

5.2.2 OBJECTIVE TWO: IDENTIFY THE VARIOUS COMPONENTS CONSIDERED IN DEVELOPING A PLANNING AND SCHEDULING DATA

Among the list of data sources required for comprehensively planning and scheduling construction projects, the researcher had a second objective of finding out what the construction firms in Ghana look out for when planning and scheduling their works. Among the sample population examined, the researcher found that the majority of the firms, up to seventy-five percent (75%) used only a fraction of the required data. Thus, a combination of data from the bill of quantities, method statement, available materials and work personnel, and the schedule of works were considered by only fifteen percent (15%) of the firms. The results imply that the planning and scheduling data produced by majority of firms do not provide total information regarding budgets and cost, timelines and required resources. The possibility of tracking every aspect of the construction process could become a very tall order and may result in unforeseen losses in both time and cost.

5.2.3 OBJECTIVE THREE: INVESTIGATE INTO THE POSSIBLE CHALLENGE(S) INVOLVED IN DEVELOPING A COMPREHENSIVE PLANNING AND SCHEDULING DATA

The researcher's third objective was based on the doubt of most firms not being able to produce comprehensive construction plans and schedules hence an investigation into possible challenges that may have given rise to this. As was evident in the researcher's second objective, which showed a seventy-five percent (75%) usage of less data than required, the researcher found out that the main reason for this was the inability of persons responsible for planning and scheduling to allocate resources to their schedule of works. Other reason which was also quite high among the other reasons was the use of incomplete bill of quantities.

Another revealing fact was the response to the question of how helpful planning and scheduling has been to the firms, which had sixty-eight percent (68%) praise for better control of time and monitoring of work progress. Interestingly, the issue of budgetary control and resource allocation received only thirty-two percent (32%) each. This in the researcher's opinion gives an idea of what most firms consider as planning and scheduling.

5.3 CONCLUSION

In the opinion of the researcher, construction firms in Ghana generally are very much aware of the requirement of a comprehensive construction plan and schedule. However the majority of firms have accepted working with the data required separately mainly because of their inability to combine them all into one document. This situation may be the reason why most firms the researcher has visited cannot declare exactly what was spent on a project and what profit had been made. Additional cost to a company due to exceeded time lines, or price adjustment, or improper resource allocation will be very difficult to identify if there is no plan or schedule being used to track progress of work in all aspects and not just

duration. The whole purpose of this research was an assessment of how adequate data within construction plans and schedules are among construction firms in Ghana. In view of the findings, it is the researcher's conclusion that the data presented as construction plan and schedule is largely inadequate and construction firms may not reap the full benefit of a comprehensive plan data.

5.4 RECOMMENDATION

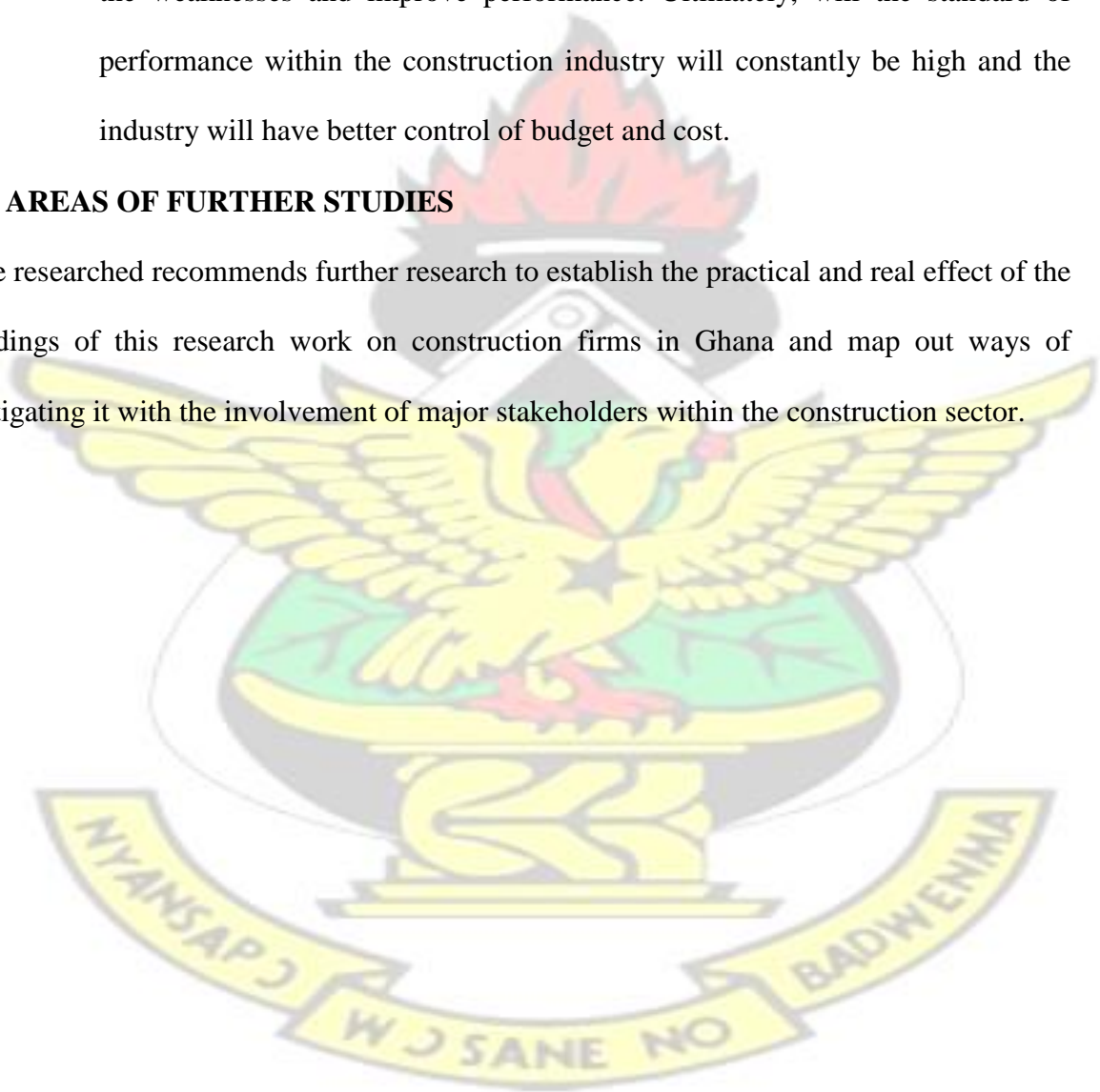
The researcher recommends that:

1. Personnel responsible for planning and scheduling of construction works should be provided the opportunity to update their skills and knowledge especially in the area of resource allocation. That is to say, construction firms should identify and choose one specific tool that best suits their interest and train their designated personnel in the use and application of that tool and ensure that the trained personnel actually produced the required results of a comprehensive plan and schedule on every project. This will also mean an improved collaboration between Quantity surveyors, Planners, Project Managers, Procurement personnel and most importantly the company's financial accountants.
2. The construction industry should get more interested in producing comprehensive planning and scheduling data as a means of having full control of every aspect of the construction process in one go.
3. Construction and engineering oriented educational institutions should critically examine the performance of their products within the construction industry and decide on the best way to address some of these deficiencies revealed on the practical field of work. This can be achieved by, having some form of affiliation with the various construction unions and organized bodies like the Ghana

Institution of Surveyors, Ghana institute of Construction and the Ghana institute of Engineers, whose members will be periodically required to take some 'Performance Test' in their specific areas of operation as a means of maintaining their status within the organization. In this way, the strengths and weaknesses of personnel within the construction industry would be evident and this would present academia, the opportunity to design appropriate programmes to mitigate the weaknesses and improve performance. Ultimately, will the standard of performance within the construction industry will constantly be high and the industry will have better control of budget and cost.

5.5 AREAS OF FURTHER STUDIES

The researched recommends further research to establish the practical and real effect of the findings of this research work on construction firms in Ghana and map out ways of mitigating it with the involvement of major stakeholders within the construction sector.



REFERENCES

- Al-Nasseri, H. and Aulin, R. (2015). “Assessing Understanding of Planning and Scheduling Theory and Practice on Construction Projects”, *Engineering Management Journal*
- Anon (2013). “A review of methods and algorithms for optimizing construction scheduling”, *Journal of the Operational Research Society*, pp. 1091–1105.
- Arditi, D., Tokdemir, O. B., and Suh, K. (2002). “Challenges in Line-of-Balance Scheduling”, *Journal of Construction Engineering and Management*.
- Barrie, D.S. and Paulson, B. (2014). “An investigation into risk factors and preventive measures in building construction projects in Abuja FCT, Nigeria”, *International journal of science and research publications*, Vol. 4, No. 1, pp. 1-6.
- Cooke, B. And Williams, P. (2004). *Construction Planning, Programming & Control*, 2nd. Edition, Blackwell Publishing.
- Dean, T. and Kambhampati, S. (1996). “Planning and Scheduling”, *The CRC handbook of computer science and engineering*, pp.14–636.
- Duncan (2004). *Project Management Body of Knowledge*, 3rd Edition.
- Elbeltagi, E. (2009). *Construction Project Management*, Thesis for structural Engineering Department, Mansoura University.
- Ghana Statistical Service (2014). *Gross Domestic Product*. Available At: <http://www.statsghana.gov.gh/docfiles/glsreportpdf> (Accessed: July 18, 2016)
- Halpin, D.W. and Riggs, L.S. (1992). *Planning and Analysis of Construction Operations*, John Wiley and Sons publications.
- Hancher, D.E. (2003). *Construction Planning and Scheduling*, CRC press: USA
- Harris, F. and Mccaffer, R. (2002). *Modern Construction Management*, 5th Edition, Blackwell Publishing: UK.

- Harris, R.B. and Ioannou, P.G. (1998). "Scheduling Projects with Repeating Activities"; *Journal of Construction Engineering Management*
- Idoro, G.I. (2012). "Influence of Project Plans on The Outcome Of Construction Projects", *Journal of construction in developing countries*, vol. 17, No. 2, pp. 81-103.
- Lines, B., Sullivan, K., Hurtado, K. and Savicky, J. (2015). "Planning In Construction: Longitudinal Study of Pre-Contract Planning Model Demonstrates Reduction in Project Cost and Schedule Growth", *International Journal of Construction Education and Research*.
- Kish, L. (1965). *Survey Sampling*. New York; John Wiley & Sons Inc.
- Neale, R.H. And Neale D.E. (1989). *Engineering Management: Construction Planning*, Thomas Telford Ltd: UK.
- Nyamekye, C.A. (2013). *Extent of Utilisation of the Linear Programme Planning Technique for Scheduling Road Construction Works in Ghana*, Thesis for the Department of Building Technology, Kwame Nkrumah University Of Science And Technology Kumasi.
- Oberlender, G. D. (2000). *Project Management for Engineering and Construction*, 2nd. Edition, Mcgraw-Hill Companies.
- Sousa, R. D., Monteiro, J.M.F, and Heineck, F.L.F.M. (2014). "Line Of Balance – Is It a Synthesis of Lean Production Principles as Applied to Site Programming of Works", *Proceedings IGLC-22, June, Oslo, Norway*, pp.703–714.
- Standish Group (2016). *The Chaos report*. Available at www.infoq.com/articles/standishchaos-2015 (Accessed: July 14, 2016)
- Zanen, P. and Hartmann, T. (2010). "The Application of Construction Project Management Tools an Overview of Tools for Managing and Controlling Construction", *Working Paper No. 3, pp. 1-14*.

APPENDIX ONE

FORMAT OF QUESTIONNAIRE

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI, GHANA

MSC CONSTRUCTION MANAGEMENT - RESEARCH QUESTIONNAIRE

Nana Adi Appiah

Assessing the adequacy of construction planning and scheduling data utilized by construction firms in Ghana

1. **What is the Name of your firm (please ignore if you want to remain private)**

2. **Indicate which of the under listed construction sectors you work in (Mark only one oval.)**

- ☐ Road Construction
☐ Real Estate
☐ General Construction
☐ Construction
☐ Consultancy

Other:

3. **Please state your current education level (Mark only one oval).**

- ☐ HND
☐ BSc
☐ MSc
☐ PhD
☐ Other:

4. **What is your current designation or position in your firm (Mark only one oval).**

Director / Deputy Director

Contracts Manager

Project Manager

☐ Quantity Surveyor

☐ Project Planner

☐ Supervisor

☐ Other:

☐

☐

☐

5. **How many years of experience do you have in the construction industry** (*Mark only one oval.*)

☐ 1 - 5 years

☐ 6 - 10 years

☐ Above 10 years

6. **Please state the number of construction projects you have been involved in within the last five (5) years** (*Mark only one oval.*)

☐ Less than 5

☐ 6 - 10

☐ 11 - 20

☐ Above 20

7. **Is construction planning and scheduling a part of your company's requirements for project execution?** (*Mark only one oval.*)

☐ Yes

☐ No

8. **"A successful project is defined as one that is completed on time, within budget and with all features as originally specified" Do you agree with this definition?** (*Mark only one oval.*)

☐ Yes

☐ No

9. **If your answer to question (7) above is 'YES', which of the under-listed data do you consider in your planning and scheduling** (*Check all that apply.*)

Method Statement

Material Resource

Human Resource

- ☐ Bill of Quantities
- ☐ Schedule of works
- ☐

☐ 10. Which of the following planning and scheduling tools do you normally apply on your projects (Check all that apply).

- ☐ Bar / Gantt Chart
- ☐ Network Analysis
- ☐ Line of Balance
- ☐ Other
- ☐

11. What is the reason behind your choice in question (10) above

12. Do you apply the use of any software in the preparation of your construction plan and schedule? (Mark only one oval).

- Yes ☐
- No ☐

13. If your answer to question (12) is 'YES', which of the following software do you apply? (Check all that apply).

- ☐ MS Project
- ☐ MS Excel
- ☐ Primavera
- ☐ Other: _____

14. How would you grade yourself with respect to your knowledge and application of the scheduling tool(s) selected in question (10) Mark only one oval.

- ☐ Average
- ☐ Good
- ☐ Very good
- ☐ Excellent

15. Which of the following scheduling tools would you recommend for use in your field of work (Mark only one oval).

- ☐ Line of Balance
- ☐ Network Analysis
- ☐ Bar/Gantt chart
- ☐ Other:

16. How helpful would you say planning and scheduling has been to your firm?

Check all that apply.

- ☐ It has helped in managing the construction budget by allowing control of cost allocation and variations
- ☐ It has allowed for better control of construction planned time and proper monitoring of work progress
- ☐ It clearly defines all tasks with respect to details and required resources which has allowed for quick response from construction team
- ☐ Other:

17. Are there any obstacles that prevent you from comprehensively planning and scheduling your construction projects? (Mark only one oval).

- ☐ Yes
- ☐ No

18. If your answer to question (17) is 'YES' which of the following would you say is/are the obstacles?

(Check all that apply).

- ☐ No / Incomplete Bill of Quantities
- ☐ No / Incomplete Material Schedule
- ☐ No / Incomplete Method Statement
- ☐ Inability to allocate resources to programme of works Others
- ☐