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COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

ASSESSING THE EFFECTS OF SCHEDULE DELAY ANALYSIS IN CONSTRUCTION PROJECTS: A CASE STUDY IN ASHANTI, BRONG-AHAFO AND EASTERN REGIONS OF GHANA

PAUL ASABRE PINAMANG

AUGUST, 2016

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PAUL ASABRE PINAMANG

(8111760024)

A Dissertation in the Department of Construction and Wood Technology Education, Faculty of Technical Education Submitted to School of Graduate Studies, University of Education Winneba in Partial Fulfilment of the Requirement for the Award of the Degree of Master of Philosophy in Construction Technology

AUGUST, 2016

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DECLARATION

STUDENT'S DECLARATION

I declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and acknowledged is entirely my own original work and it has not been submitted either in part or whole for another degree elsewhere.

Signature: ……………….......................   Date……………………...............

PAUL ASABRE PINAMANG

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis as laid down by the University of Education, Winneba.

Signature:…………………....................   Date:………..................................

DR. JOSHUA AMPOFO

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ACKNOWLEDGEMENT

I wish to express my sincere thanks to the Almighty God for seeing me through this study successfully. My gratitude also goes to my supervisor Dr. Joshua Ampofo for his support throughout the study. I am grateful to all friends who spent time to provide me the needed information especially Mr Timothy Adu Gyamfi. Without their responses, I could not have been able to achieve the objectives of this study, I say a big “Thank You” to them all. In addition, I am indebted to Dr Humphrey Danso and all the lecturers at Department of Construction and Wood Technology Education, at the College of Technology Education, University of Education Winneba, for the valuable training I have gained.

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DEDICATION

This thesis is dedicated to my family

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ABSTRACT

Completing projects on time is an indicator of efficiency, but the construction process is subject to many variables and unpredictable factors. In analyzing delays, the common used methodologies include time impact and as-planned expanded. The purpose of the study was to assess the effects of scheduling delay analysis in construction projects a case study in Ashanti, Brong-Ahafo and Eastern Regions of Ghana. The research design adopted for this study was descriptive cross-sectional case study and exploratory design using quantitative method. A purposive sampling method was used to select 80 respondents. Opinions of employees were solicited using a structured questionnaire and interview. The data was analysed using Statistical Package for Social Sciences (SPSS) version 20.Results from the study showed that the major objectives of scheduling in construction projects in the construction industries include “to expose and adjust conflicts between trades or subcontractors” and to “resolve delay claims”. The major causes of construction delays include construction mistakes, followed by poor supervision, poor coordination on site, changes in specifications, contract modification and, as well as delayed payments. The results from this study also indicated that a relationship exist between time analysis and project scheduling. It was revealed that project scheduling was explained by 67.0% (R^2= 0.67) of the variance in time analysis. It was also revealed that construction delays explained the bulk of the variance in as-planned projects (beta= .943, t=17.544, p<.001).The results indicate that there was significant correlation between delays and project planning. In conclusion, the study revealed that scheduling in construction projects is important in finishing projects on time within budgets and ensure customer satisfaction. Again it may be concluded that time impact analysis has an impact on project scheduling and Construction mistakes were the major causes of construction delays. From the study, it is recommended that project should be finalised with all details before tendering the work. Clients should allocate sufficient time and adequate finances for the design of the projects.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the study

The construction process can be divided into three important phases, i.e. project conception, project design and project construction. Usually, the vast majority of project delays occur during the 'construction' phase, where many unforeseen factors are always involved (Kumaraswamy & Chan, 1997). In construction, delays and disruptions are among the challenges faced in the course of executing construction projects. Delay could be defined as the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for the delivery of a project (Assaf, 2006). It is a project slipping over its planned schedule and this is a common problem in construction projects (Assaf, 2006). To the client, delay means loss of revenue through non availability of production facilities and rentable space or a dependence on present facilities. In some cases, delay causes higher overhead costs to the contractor because of longer work period, higher material costs through inflation, and due to delay labour cost increases. Completing projects on time is an indicator of efficiency, but the construction process is subject to many variables and unpredictable factors, which result from many sources. The sources are the performance of parties, resources availability, environmental conditions, involvement of other parties, and contractual relations, and the completion of a project within the specified time is rare (Assaf, 2006).

Cost and schedule overruns occur due to a wide range of factors. If project costs or schedules exceed their planned targets, client satisfaction would be compromised. The funding profile no longer matches the budget requirement and further slippage in the

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schedule could result (Kaliba, Muya, &Mumba, 2009). According to Ahmed, Azher, Castillo,and Kappagantula, (2002), delays on construction projects are a universal phenomenon and road construction projects are no exception. Delays are usually accompanied by cost overruns. These have a debilitating effect on contractors and consultants in terms of growth in adversarial relationships, mistrust, litigation, arbitration, cash-flow problems, and a general feeling of trepidation towards other stakeholders (Ahmed et al., 2002). This problem is not unique to developed countries and is being experienced in most of the developing economies.

When projects are delayed, they are either extended or accelerated and therefore, incur additional cost. The normal practices usually allow a percentage of the project cost as a contingency allowance in the contract price and this allowance is usually based on judgment (Akinsola, 1996). Although the contract parties agree upon the extra time and cost associated with delay, in many cases there are problems between the owner and contractor as to whether the contractor is entitled to claim the extra cost. Such situations result in questioning facts, causal factors and contract interpretations (Alkass, Mazerolle, & Harris, 1994). Therefore, delays in construction projects cause dissatisfaction to all parties involved and the main role of the project manager is to make sure that projects are completed within the budgeted time and cost. Several studies (Akinsola, 1996; Alkass et al., 1996; Long, Ogunlana, Quang, & Lam, 2004) have been undertaken on factors causing delays and cost overruns, and affecting quality, safety and productivity, etc. and specific problems in special types of projects. These studies usually focus on specific aspects of project performance. Practitioners need to develop the capacity to foresee potential problems likely to confront their

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current and future projects. Identification of the common problems experienced on past projects in their construction business environment is a good option (Long et al., 2004).

In analyzing schedule delays, the commonly used methodologies include global impact, net impact, adjusted as-built CPM, as-planned expanded, but-for, snapshot, time impact, windows, isolated delay type techniques and isolated collapsed but-for delay analysis methodologies (Yang & Yin, 2009). In general, by using the as planned or as-built schedules as baseline schedules, available methodologies calculate schedule impacts of delayed events according to the differences between the baseline schedules and some entitled impacted schedules that are derived from delayed events. Furthermore, most available methodologies are processes-based approaches, which are executed by schedule analysts manually. In other words, if project schedules are complex, the processes for completing required delay analyses are tedious and time-consuming. Most of the methodologies mentioned above are not computerized. That is, the schedule delay analysts should complete their works manually although their available schedules are generated by professional scheduling systems or project management systems.

1.2 Statement of the Problem

Construction schedule delays in a project can cause major problems for contractors and clients, resulting in costly disputes and other controversial issues. Schedule delays commonly occur in construction projects and often result in delay claims. However, there is no well recognized and acceptable claim resolution approach for solving construction schedule delays. Several studies have proposed different schedule delay analysis methodologies for performing delay analysis systematically; this study seeks to

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assess the effects of schedule delays on construction projects. The methodologies commonly used include global impact, net impact, adjusted as-built CPM, as-planned expanded, but-for, snapshot, time impact, windows, isolated delay type techniques and isolated collapsed but-for delay analysis methodologies (Ng, Skitmore, Deng, &Nadeem, 2004; Mohan & Al-Gahtani, 2006; Yang & Yin, 2009). Though all these methods of schedule delay analysis have their pros and cons, impact analysis methods have been shown in literature to be very effective (Mohan & Al-Gahtani, 2006). This project analyzes schedule delay analysis in construction projects using a case study of time impact analysis method.

1.3 Purpose of the study

The purpose of the study is to assess the effects of schedule delay analysis in construction projects in Ghana.

1.4 Objectives of the study

Based on the purpose of the study, objectives of the study are:

1. To determine the importance of scheduling in construction projects
2. To determine the major causes of construction delays
3. To assess the effectiveness of time impact analysis of project scheduling
4. To measure the impacts of construction delays on an as-planned project

1.5 Research Hypotheses

The following hypotheses were used for the study:

Ho: There is no significant effect of construction delays on as-planned projects.

Ha: There is a significant effect of construction delays on as-planned projects.

Ho: There is no significant effect of time impact analysis on project scheduling.

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Ha: There is a significant effect of time impact analysis on project scheduling.

1.6 Significance of the Study

Realistic construction time has become increasingly important because it often serves as a crucial benchmark for assessing the performance of a project and the efficiency of the contractor (Kumaraswamy & Chan, 2002). This study intends to push the boundaries on knowledge about the effects of construction schedule delay in the Ghanaian construction industry. This study would serve to benefit all stakeholders in the construction industry.

1.7 Organization of the Study

The study is organized with six (6) chapters. Chapter one looks at the background of the study, the statement of the problem, the purpose of the study, research hypothesis/questions, and the significance of the study, delimitations, and organizations of the study. Chapter two deals with review of related literature on the topic under discussion. Chapter three is on the methodologies and instruments for data collection. Chapter four will deal results of the study. Chapter five is discussion of the study. Chapter six is made up of the summary, conclusion, suggestions and recommendations for further studies.

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CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter of the study presents a review of related literatures, which provide critical points of knowledge that has to do with the research topic. This chapter includes a conceptual/theoretical framework and empirical evidence, which is relevant and appropriate to explain the key variables, constructs, and variables adopted to guide the study. This chapter contains findings of the review of secondary sources of data relating to the research topic. Information for the literature review was obtained from relevant articles, textbooks, journals, speeches, web sites and other important sources of information. This chapter also contains the works that have been done by other researchers, which were considered relevant for the subject of study.

2.2 Construction Project Planning

Throughout history, the concept of project planning in construction projects has been successfully undertaken across generations. According to Lawrence (2000), a project has been defined as having a beginning and an end (the life) and the project can be divided up into several stages. A project could be viewed as a system, which is dynamic and ever changing from one stage to another in a life cycle, from an idea or a concept through to feasibility studies, execution, and finally completion. Project involves larger capital investments, and embraces several disciplines, widely dispersed project participants, stringent quality standard, and tighter schedules coupled with high-speed developments in Information and Communication Technology (ICT).These factors have influenced project planning to take a new turn. The concept first emerged

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in the early 50s on large defence projects. Gradually, smaller organisations took to adapting the idea and currently the smallest construction firms are known to operate project planning in some way. According to Reiss (1995), the concept pertains tackling new ground, avoiding problems, managing a group of people and trying to achieve very clear objectives quickly and efficiently.

Planning is a complex process that can take many forms. There are different kinds of planning and different ways of planning. According to Shapiro (2001), planning is the systematic process of establishing a need and then working out the best way to meet the need, within a strategic framework that enables you to identify priorities and determines your operational principles. Arikan and Dikmen (2004) give the definition of 'planning' as "Trying to anticipate what will happen and devising ways of achieving the set of objectives and targets"; and point out that in planning concepts there are always objectives to be reached in future. Planning means thinking about the future so that you can do something about it now. The combination of a good strategic framework and a good action plan guides organisations in prioritising and making decisions, provides a clear understanding of what you need to do in order to achieve your development goals, and provides a coherent guide for day-to-day implementation (Shapiro, 2001). Arıkan and Dikmen (2004) describe planning as "a process during which efforts and decisions are made to achieve the goals at the desired time in the desired way". They further line up the main objectives of a construction project as follows:

1. To complete the construction within the specified time (duration)
2. To complete it within the budget, (with a profit)
3. To complete it in compliance with technical and administrative specifications

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Project planning has been also defined as "the process of selecting the one method and order of work to be used on a project from among all the various methods and sequences in which it could be done" (Callahan Quackenbush, &Rowings, 1992). Construction project planning is a method of determining "what" is going to be done, "how" things are going to be done, "who" will be doing activities and "how much" activities will cost. Callahan et al. (1992) also notes that this process supplies detailed information used for time estimation and schedule; besides a baseline for project control. Mubarak (2005) states that project planning works for several functions such as cost estimating, scheduling, project control, safety management, etc.

According to Arıkan and Dikmen (2004), the main purpose of planning is to provide the primary duties of the manager, namely, direction and control. The second objective of planning is to organize all the relationships and information systems among the many parties involved in the construction project. The authors further describe the third function of planning as enabling project control and forecasting. Smith (2002) emphasizes the importance of careful and continuous project planning in the success of a realization of a project; and also notes that the activities of designers, producers, suppliers, workers and contractors, and their resources must be coordinated and integrated with the objectives of contractor. Oberlender (2000) agrees with Smith that planning coordinates all works of the construction to reach a completed quality project. The author determines the basic benefit of project planning and scheduling as an effective tool of preventing some of the problems like delays in work, cost overrun or decline in productivity and principally puts in order the desired results of project planning and scheduling as indicated below:

1. Finish the project on time.

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2. Continuous (uninterrupted) flow of work (no delays).
3. Reduced amount of rework (least amount of changes).
4. Minimize confusion and misunderstandings.
5. Increased knowledge of status of project by everyone.
6. Meaningful and timely reports to management.
7. You run the project instead of the project running you.
8. Knowledge of scheduled times of key parts of the project.
9. Knowledge of distribution of costs of the project.
10. Accountability of people, defined responsibility/ authority.
11. Clear understanding of who does what, when, and how much.
12. Integration of all work to ensure a quality project for the owner.

In this sense, planning does not cover scheduling, which addresses the "when", but once planning is complete scheduling can be done (Fig. 2.1)

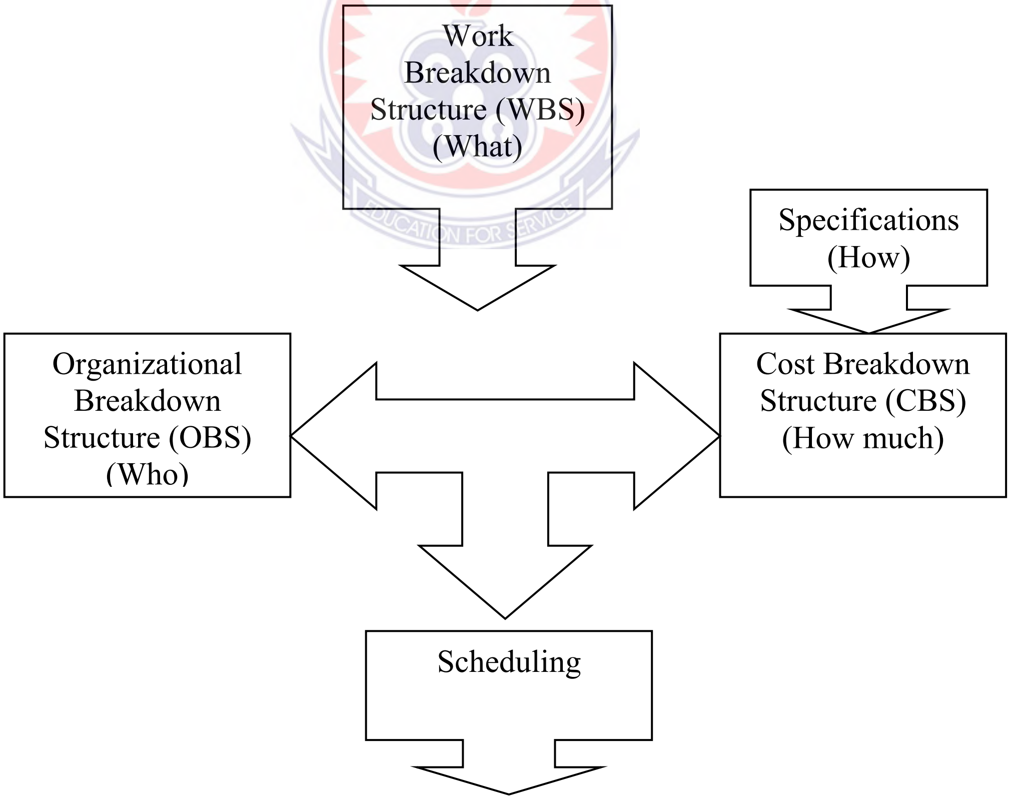

Figure 2.1: General Framework for the Planning Process

Source: Adapted from De Marco (2011)

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2.2.1 Work Breakdown Structure (WBS) – "What"

Work breakdown structure is the process of dividing the project task into smaller manageable components for planning purpose. A complex project is made manageable by first breaking it down into individual component in a hierarchical structure, known as the work breakdown structure (WBS). The WBS is the structure which defined task, facilitating resource allocation, assignment of responsibilities and measurement and control the project. The WBS is widely used by the project managers as a tool in the planning activity for the construction project (Newitt, 2005).

When projects are simple, consisting of few defined activities, it might be possible for a single person to grasp the total construction effort with little difficulty. Unfortunately, most projects for which formal plans are prepared tend to be defined with dozens of even hundreds or thousands of activities: the larger the project, the greater the number of activities and higher the levels of detail managers have to handle (De Marco, 2011). When a project plan consists of numerous activities, it is often advisable to organize the activities in some way to allow communication of plan information to others and to maintain an understanding of the various aspects of the project, while there are many ways that a plan can be organised, one common practice is the Work Breakdown Structure (WBS).

The Work Breakdown Structure (WBS) is a key planning tool used to define a project in terms of its deliverables, while providing a method for breaking down those deliverables into meaningful work efforts. The WBS enables project managers to clearly describe the hierarchical nature of work to be performed. The WBS also establishes a foundation for other elements of the formal project plan. Project managers

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regularly are challenged to clearly describe desired project outcomes to all involved, while they also capture the order and sequence of the work necessary to produce those outcomes. Once it is complete, the WBS becomes an essential building block and reference point for other project plan components (Newitt, 2005).

The WBS is a convenient method for decomposing the project complexity in a rational manner into work packages and elementary activities. Some firms prefer to use a standard means of identifying work packages common to all similar projects. These work packages are then coded so that both costs and the schedule can be controlled. A common numerical accounting system is then applied to the activities, so that the coding indicates factors such as the type of material involved or the physical location within the project. Commonly there are three main types of WBS, namely, the Contract WBS, Standard WBS, and project WBS.

A contract WBS is agreed between owner and contractor. This is a decomposition of the scope of work into the main elements that will be used for progress measurement, control and payment of the contract price (Hinze, 2004).

2.2.2 Organizational Breakdown Structure – "Who"

Once what needs to be done is defined, it is necessary that all human resources required to perform the project are identified. Depending on the portions of work scope, the project may need engineering skills, procurement capabilities, construction labour, management staff etc. The organization breakdown structure is a practical method to decompose the pool of human resources needed to execute all of the tasks into different competence areas and then into project roles, independently of the number of individuals that will be assigned the specified role. The OBS is prepared with the idea

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that each task in the WBS must be assigned to a role or committee of roles. In other words, roles are allocated to detailed tasks with a specified number of resources and related estimated work load required to perform the task. In summary, the planning process thus far, we have created the WBS and have now incorporated a responsible committee or person to each element of the WBS. In essence, from activities developed in the WBS we have allocated resources through the OBS (Meredith & Mantel, 2006).

2.2.3 Cost Breakdown Structure – "How much"

After know what is going to be accomplished through WBS and who is going to perform activities through the OBS, owners and contractors want to know how much things will cost. Determining the cost is done through the Cost Breakdown Structure (CBS). A CBS includes all direct full cost of labour, material, as well as the so-called project overhead, which is still a direct cost required to execute the project. The CBS is a system for dividing a project into hardware elements and sub elements, functions and sub functions and cost accounts, typically labour, materials, and other direct costs. In addition, it represents the economic breakdown of the projects into budgets per work package. This will allow the project manager to track project progress and expenditure according to planning breakdown of activities and responsibilities. Project overhead embraces the cost of construction equipment (usually under the terms of average amortization of construction assets), project management, design services, permits, and insurance fees (Meredith & Mantel, 2006).

2.3 Project Scheduling

The terms of project planning and scheduling are often mistakenly thought of as synonymous. However, as Mubarak (2005) indicates scheduling concentrates on the

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timing and sequence of operations in the project planning effort. Therefore, while project planning covers the issues of what is going to be done?, where?, how? and when?, the term of project scheduling covers only the issue of when?. Trauner, Manginelli, Lowe, Nagata, and Furniss, (2009) agree with Mubarak and define project schedule as "a written or graphical representation of the Contractor's plan for completing a construction project that emphasizes the elements of time and sequence". According to the Trauner, et al. (2009), the project schedule should display all the construction tasks from the beginning of the project through completion, the time periods for each tasks, and the sequence of these tasks in a logical order. Oxley and Poskitt (1996) define project scheduling as "the process of determining the actual time periods during which the activities are planned to take place: that is, start and finish dates for each activity". In order to determine the construction activities and their time periods, project planning should have been done before project scheduling. Oberlender (2000) claims that a successful project planning is more difficult to organize than scheduling. If the activities are identified in project planning, then scheduling the project will become relatively easy.

2.3.1 The Objectives of Project Scheduling

After a successful planning process, the schedule of the project is prepared. There are major objectives that are expected from good project scheduling. According to Mubarak (2005) there are eight important objectives of scheduling as noted below:

1. To calculate the project completion date.
2. To calculate the start or end of a specific activity.
3. To expose and adjust conflicts between trades or subcontractors.
4. To predict and calculate the cash flow.

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5. To evaluate the effect of changes.
6. To improve work efficiency.
7. To resolve delay claims.
8. To serve as an effective project control tool.

A project schedule is viewed as a valuable project control tool for Project Managers to successfully conduct construction projects (Trauner et al., 2009). Trauneret al. (2009) further explain the basic purposes of a project schedule as effectively depicting the construction plan to the project participants, permitting management to control and measure the progression of the work, and finally accommodating the participants with information for timely decisions.

Callahan et al. (1992) claim that the probabilities of on-time, on-budget and dispute-free completion may be increased by means of a schedule and the purpose of the schedules is specified by the individual using the schedule. The authors further explain that the purpose of predicting project completion for contractors is that they can arrange crew sizes, shifts or equipment to speed or slow progress. While, for architects or engineers the purpose is to determine how long design and construction will take for completion of the project. The authors add that subcontractors use the information of specific activities' start and finish times to predict when they are needed at the site. Also, the activity completion dates are used by owners in order to decide when to deliver owner-furnished equipment and to coordinate partial occupancy. Another purpose of scheduling for contractors is to reveal and resolve conflicts between firms or subcontractors. Both for contractors and owners schedules are used to plan cash flow.

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Callahan et al. (1992) also indicate that schedules are used for measuring delay and time extensions. If the schedules are regularly updated including work sequences, unanticipated delays, actual activity completion dates and change orders, then the owner and contractor can measure the effect of additional works and unanticipated delays, thus avoiding disputes. The causes and different types of schedule delays are given in the following paragraphs.

2.4 Delays

The successful execution of construction projects and keeping them within estimated cost and prescribed schedules depend on a methodology that requires sound engineering judgment (Hancher& Rowing, 1981). To the dislike of owners, contractors and consultants, however many projects experience extensive delays and thereby exceed initial time and cost estimates. Delay is a major problem in construction industry. In construction, the word “delay’’ refers to something happening at a later time than planned, expected, specified in a contract or beyond the date that the parties agreed upon for the delivery of a project (Pickavance, 2005).

Delay can affect any activity of work in a schedule and results in many problems between parties. Lo,Fung, and Tung(2006) define delay as the slowing down of work without stopping construction entirely and that can lead to time overrun either beyond the contract date or beyond the date that the parties have agreed upon for the delivery of the project. Trauner et al. (2009) defines that construction delays make something happen later than expected, to cause something to be performed later than planned, or to not act timely.According to Al-Khalil and Al-Ghafly (1999), delays can adversely influence project stakeholders, such as clients, contractors, and designers. To the client,

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delay perceives loss of revenue due to lack of rentable space or lack of production facilities. On the other hand, delay can be meant to the contractor as higher overhead costs, higher material and labour costs because the project takes longer than it was planned.

Mohamad(2010) defines delay as an act or event that extends the time to complete or perform an act under the contract. Also, Assaf and Al-Hejji(2006), states that delay is the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project. It is basically a project slipping over its planned schedule and is considered as common problem in construction projects worldwide. Assaf and Al-Hejji (2006) further illustrate that, to the owner, delay means loss of revenue through lack of production facilities and rent-able space or a dependence on present facilities. In some cases, to the contractor, delay means higher overhead costs because of longer work period, higher material costs through inflation, and due to labour cost increases.

Syed, Ahmed, Mauricio, and Pragnya (2002) classify delays into non-excusable delays, excusable non-compensable delays, excusable compensable delays and concurrent delays. Non-excusable delays are delays, which the contractor either causes or assumes the risk for. Excusable non-compensable delays are delays caused by factors that are not foreseeable, beyond the contractor's reasonable control and not attributable to the contractor's fault or negligence. Compensable excusable delays are compensable delays, are excusable delays, suspensions, or interruptions to all or part of the work caused by an act or failure to act by the owner resulting from owner's breach of an

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obligation, stated or implied, in the contract. Concurrent delays occur when both owner and the contractor are responsible for the delay.

Theodore (2009) classifies delays into two, those caused by the client and those caused by the contractor. Delays caused by the client such as late submission of drawings and specifications, frequent change orders, and incorrect site information generates claims from both the main contractors and sub-contractors which many times entail lengthy court battles with huge financial repercussions (Theodore, 2009). Delays caused by contractors can generally be attributed to poor managerial skills. Lack of planning and a poor understanding of accounting and financial principles have led to many a contractor's downfall (Theodore, 2009).

Factors which cause delay in the construction projects also have some effects on the overall project (Finke, 1999). When there is delay in construction projects, they are either expedited or the scheduled time for the completion of project, is extended. The result is cost overrun in both the cases. Main reason of cost overrun in the construction projects are the delays in the delivery of materials to the project sites in the developing countries (Manavazhi & Adhikari, 2002). Other major factors which are responsible for time overrun in the construction projects are revision and approving of design documents, delay in getting approval for major changes during the project, delay in sub-contractor work and the conflicts in sub-contractor schedule work and the conflicts in sub-contractor schedule in project execution (Wei, 2010).

Low communication between the project parties, changes made by the owners, contractor's inadequacy during work and poor planning are the main causes of cost

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overrun (Haseeb, Xinhai, Bibi, Maloof, &Dyian, 2011). During the construction projects there are some factors which cause disputes among the project parties. Recently, there have surfaced studies on the methods for analysis, quantification and accountability for delays, as well as on the deployment of measures to control causes of delay in the design and construction stages (Rahsid, ulHaq, &Aslam, 2013)

2.5 Disruptions

Disruptions are events that disturb the construction programmed. Interferences with the flow of work in the project are common disruptions (Howick,Ackermann, Terry, 2009). Howicket al (2009) point out that many disruptions to complex projects are planned for at the bid stage because they may be expected to unfold during the project. For example, some level of rework is usually expected, even when everything goes well, because there will always be 'normal' errors and mistakes made by both the contractor and client (Howicket al, 2009).

2.6 Construction Schedule Delays

There are a number of definitions for delay. In the construction management context, the simplest definition of a delay is made by Mubarak (2005) as "an event or a condition that results in finishing the project later than stipulated in the contract." Callahan et al. (1992) define delay in construction claims as "the time during which some part of the construction project has been extended or not executed owing to an unexpected event". In another study, Trauneret al. (2009) describe delay as "to make something happen later than expected or to not act timely". It is usual for delays to occur on construction projects. Callahan et al. (1992) claim that schedules have an important role in construction delays; since the effects of delays on the project

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completion date can be displayed and future delays can be anticipated by rescheduling the project through the computer.

2.6.1 Causes of Construction Delays

As Abd El-Razek, Bassioni, and Mobarak, (2008) studied several articles on examining the causes of construction delays in many ways; some studies determined the main causes of delay in different countries, while some of them investigated the delay analysis methods in different types of construction. Assaf, Al-Khalil, and Al-Hazmi, (1995) studied the main causes of delay in large building projects in Saudi Arabia and their relative importance. In the study undertaken by Assaf, et al. (1995), the largest number of causes of delay (56 causes) was listed and the respondents were asked to point out their degree of importance. The authors grouped the delay factors into nine major groups: financing, materials, contractual relationships, project changes, government relations, manpower, scheduling and control, equipment, and environmental factors. The financing group of delay factors was selected as the most significant delay factor by all parties and that environment group was selected as least significant. In another observation, Odeh and Battaineh (2002) carried out a study to determine the most significant causes of construction delays with traditional type of contracts with regard to contractors and consultants. According to the results of the study, owner interference, inadequate contractor experience, financing and payments, labour productivity, slow decision making, improper planning, and subcontractors are among the top ten most significant causes of delays.

Wahdan, Farid, and Abu Yousef(2013) carried out a study to assess the reasons for project delay or stalled from project management view in most Arabian countries.

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Based on the opinions provided by the respondents, specialists, associations and institutes involved in the construction sector, as well as prior studies conducted by previous researches, the researchers prepared a comprehensive file on preventative measures and recommendations, guided by strict criteria, which helped clarify the problems for the causes of construction projects delay. Their ranking method for the collected data captured ten major causes for project delay. The major ten causes, according to Wahdan et al. (2013) ranking from the highest to the lowest are as follows:

1. Inadequate details and inadequate design.
2. Difficulties in obtaining licenses and permits from authorities.
3. Deficient planning, activity, material, labour and equipment management.
4. Shortage of skilled labourers.
5. Delays in preparation of technical documentation by project designers while construction is in progress.
6. Neglect of critical activities.
7. Frequent change of orders during construction.
8. Deficient coordination among participants.
9. Low productivity.
10. Difficulty and delay in the drafting and submission of requests for institutional opinions and authorizations.

Another study was by Kaliba et al. (2009) which aimed to determine the causes and effects of cost escalation and schedule delays in road construction projects in Zambia. The authors compile the main causes of delays in road construction projects which are determined according to their survey, as in the following: delayed payments, financial processes and difficulties on the part of contractors and clients, contract modification,

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economic problems, materials procurement, changes in drawings, staffing problems, equipment unavailability, poor supervision, construction mistakes, poor coordination on site, changes in specifications and labour disputes and strikes. In another research, Frimpong, Oluwoye, and Crawford(2003) carried out a study to determine and assess the relative importance of causes of delays and cost overruns in Ghana groundwater construction projects. The research showed that monthly payment difficulties from agencies, poor contractor management, material procurement, poor technical performances, and escalation of material prices were the main causes in the study. In another research, Ahmed et al. (2010) conducted a study on the major causes of delays in construction projects in the Florida Construction Industry through a survey.

Mezher andTawil (1998) carried out a research in to find out the Causes of delays in the construction industry in Lebanon. A total of 64 causes of delays were identified through research in which client, contractor and consultant were undertaken the study. All three parties generally agreed on the ranking of the major categories of delay factors. Owners had more concerns with regard to financial issues, while contractors ranked contractual relationships highest, and finally, consultants firms ranked project management highest. These causes were categorized in 10 main groups: materials, manpower, equipment, financing, changes, government relations, project management, site conditions, environment and contractual relationships.

According to the authors, there are two groups of causes for delays in construction projects: external and internal causes. Internal causes of delays cover the causes, which come from four parties involved in that project. These parties are the owner, designers, contractors, and consultants. Other delays, which do not come from these four parties,

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are based on external causes for example from the government, material suppliers, or weather. Some of the possible causes of delays are as follows: Possessive decision-making mechanism, Highly bureaucratic organization, Insufficient data collection and survey before design, Site's topography is changed after design, Lack of coordination at design phase, Inadequate review, Improper inspection approach, Different attitude between the consultant and contractors, Financial difficulties, Inexperienced personnel, Insufficient number of staffs, Deficiency in project coordination, Spend some time to find sub-contractors company who is appropriate for each task. Often changing Sub-contractors Company Inadequate, and old equipment, Lack of high-technology equipment.

Arditi,Akanand Gurdamar, (1985) examined a large number of public projects in Turkey in order to determine and grade the level of importance of the causes of construction delays in such projects. According to the results of their research, the most important reasons of these delays and their average weights were as follows: Shortage of some resources like qualified manpower, technical personnel, construction materials and equipment (31%), Financial difficulties of contractors and public agencies (21%), Organizational deficiencies of public agencies and contracting companies such as bureaucratic obstacles and slow decision-making mechanism in public organizations (19%), Delays in design work, large quantities of extra work, frequent change orders (The total average weight of these three reasons is 14%). Average weight of the four reasons of construction delays mentioned above is 85%. The remaining 15% was related to other minor reasons of delays.

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Odabaşı (2009) investigated factors affecting construction durations and models for estimating construction durations. The author selected from the literature and listed the most significant ones under eleven headings as: cost, cash flow, productivity on site, material procurement, project related factors, technology and methodology of construction, experience, coordination, weather, construction site, and the degree of completeness of design project. In the study of Faridi and El-Sayegh (2006), significant factors causing construction delays in the United Arab Emirates (UAE) were analyzed. This research has determined the top ten most significant causes of construction delays as shown in the table 2.1 below.

Table 2.1: Ten most significant causes of delays in the UAE construction industry

Causes of delay	Rank	RII (Relative Importance Index)
Preparation and approval of drawings	1	2.495
Inadequate early planning of the project	2	2.429
Slowness of the owner's decision-making process	3	2.398
Shortage of manpower	4	2.348
Poor supervision and poor site management	5	2.337
Productivity of manpower	6	2.297
Skill of manpower	7	2.281
Non-availability of materials on time	8	2.280
Obtaining permit/ approval from the municipality/ different government authorities	9	2.275
Financing by contractor during construction	10	2.261

Source: Faridi and El-Sayegh (2006)

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Ogunlana and Promkuntong(1996) studied the delays in building project in Thailand, as an example of developing economies. They concluded that the problems of the construction industry in developing economies can be nested in three layers: (1) problem of shortages or inadequacies in industry infrastructure, mainly supply of resources; (2) problems caused by clients and consultants, and (3) problems caused by incompetence of contractors. Kumaraswamy and Chan (1998) surveyed the causes of construction delays in Hong Kong as seen by clients, contractors and consultants, and examined the factors affecting productivity. The survey revealed differences in perceptions of the relative significance of factors between the three groups, indicative of their experiences, possible prejudices and lack of effective communication. Mansfield, Ugwu, and Doran (1994) studied the causes of delay and cost overrun in construction projects in Nigeria. The results showed that the most important factors are financing and payment for completed works, poor contract management, changes in site conditions, shortage of material, and improper planning.

In another observation, Baldwin, Manthei, Rothbart, and Harris (1971) conducted the study to determine the causes of construction delays in the United States. The authors examined the causes of delays under seventeen categories as: weather, labour supply, material shortage, equipment failure, finances, manufactured items, construction mistakes, design changes, foundation conditions, permits, shop drawings, sample approvals, building codes, subcontractors, contracts, jurisdictional disputes, and inspections. The study of Lo et al. (2006) covering the issue of construction delays in Hong Kong civil engineering projects was conducted on mainly compiling the perceptions of civil construction practitioners on how important are the causes of delay.

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Lo, et al. (2006), therefore, summarized previous studies some of which are also stated above, on causes of delay in construction, as in the Table 2.2.

Table 2.2: Summary of previous studies on causes of delay

Researchers	Country	Major causes of delay
Arditi *et al.* (1985)	Turkey	1. shortages of resources 2. financial difficulties faced by public agencies and contractors 3. organizational deficiencies 4. delays in design work 5. frequent change orders/ design 6. considerable additional work
Baldwin (1971)	U.S.	1. inclement weather 2. shortages of labour supply 3. subcontracting system
Okpala and Aniekwu (1988)	Nigeria	1. shortages of materials 2. failure to pay for completed works 3. poor contract management
Dlakwa and Culpin (1990)	Nigeria	1. delays in payment by agencies to contractors 2. fluctuations in materials, labour and plant costs
Mansfield *et al.* (1994)	Nigeria	1. improper financial and payment arrangements 2. poor contract management 3. shortages of materials 4. inaccurate cost estimates 5. fluctuations in cost

Source: Lo et al., (2006)

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Table 2.3: Continued

Researchers	Country	Major causes of delay
Semple *et al.* (1994)	Canada	1. increases in the scope of works 2. inclement weather 3. restricted access
Assaf *et al.* (1995)	Saudi Arabia	1. slow preparation and approval of shop drawing 2. delays in payments to contractor 3. changes of design/design error 4. shortages of labour supply 5. poor workmanship
Ogunlana *et al.*(1996)	Thailand	1. shortages of materials 2. changes of design 3. liaison problems among the contracting parties
Chan and Kumaraswamy (1996)	Hong Kong	1. unforeseen ground conditions 2. poor site management and supervision 3. slow decision making by project teams 4. client-initiated variations
Al-Khall and Al-Ghafly (1999)	Saudi Arabia	1. cash flow problems/ financial difficulties 2. difficulties in obtaining permits 3. "lowest bid wins" system
Al-Momani (2000)	Jordan	1. poor design 2. change orders/ design 3. inclement weather 4. unforeseen site conditions 5. late delivery

Source: Lo et al., (2006)

According to Hinze (1993), the causes of construction delays are numerous, including strikes, adverse weather conditions, late decisions by the owner, unforeseen changes affecting construction duration and so on. He asserts that delays affect unfavourably all the contracting parties, for example; owners get their buildings later than planned, contractors are affected adversely due to increased construction costs. The causes of

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construction delays are classified by the author into three groups according to their origination as follows: Delays caused by the contractor or the contractor's agents; Delays caused by the owner or the owner's agents.

In another study, Trauneret al. (2009) exemplify the causes of delays to a project caused by the owner such as; a change in the design, an error or omission in the contract documents, a differing site condition, failure to make approvals on time, failure to respond to requested information required to progress the work, or even stop work orders. Delays caused by force majeure or acts of God in another field observation, Mubarak (2005) groups the causes of construction delays in six categories regardless of who is at fault; as listed below:

1. Differing Site Conditions
2. Design Errors or Omissions
3. Changes in Owner's Requirements
4. Unusually Adverse Weather
5. Miscellaneous Factors
6. Force Majeure

2.6.2 Types of Construction Delays

General types of construction delays should be clearly examined before schedule delay analysis begins. Schedule construction delays are categorized in many ways. According to Trauneret al. (2009), there are four main groups of construction delays:

- Critical or noncritical
- Excusable or non-excusable
- Compensable or non-compensable

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- Concurrent or non-concurrent

The diagram displayed in Figure 2.2 presents a general overview of how the construction delays can be categorized. Firstly, if the delay is critical or noncritical and concurrent or non-concurrent should be determined in the process of analyzing delay effects on the project. All construction delays are either excusable or non-excusable as shown in the figure. Then, excusable delays are classified into compensable or non-compensable delays. This figure presents only one interpretation, since excusability and compensability of delays can change according to the contract.

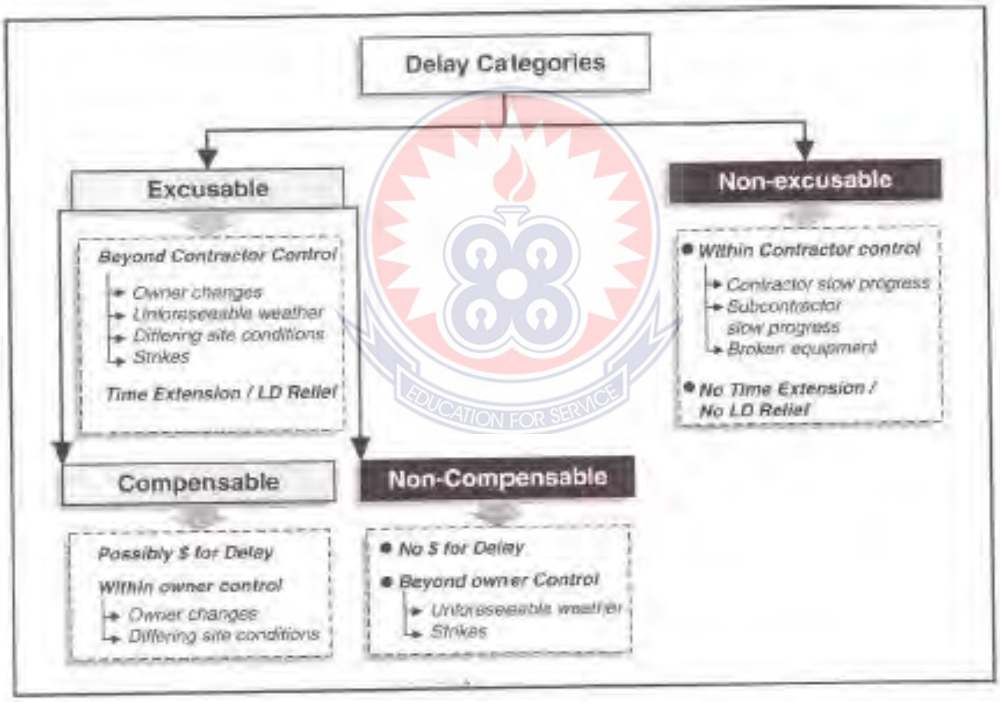

Figure 2.2: Delay Categories

Source: Trauneret al. (2009)

In the study of Yang, Yang, and Kao(2010) delay classification is given in a different manner, but similar to the concept of Trauneret al. In another study, Kartam (1999) classified project delays into three main groups in terms of their origin, timing and

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compensability. Delays classified by their origin: Owner Caused Delays (OCD), Contractor Caused Delays (CCD) and Third Party Caused Delays (TPCD). Delays classified by their timing: These are Concurrent Delays (CD) and Non-Concurrent Delays (NCD). Delays classified by their compensability: These are Excusable Delays (ED) which are also classified in itself as Excusable Compensable Delays (ECD) and Excusable Non-Compensable Delays (ENCD), and Non-Excusable Delays (NED).

2.6.2.1 Critical versus Noncritical Delays

While several authors (Mubarak, 2005; Kelleher, 2005; Levy, 2006) categorize delays into three groups as Excusable and Non-excusable, Compensable and Non-compensable and Concurrent and Non-concurrent; certain authors (Trauneret al., 2009; Callahan et al., 1992) add one more category to these three groups which is Critical and Noncritical delays. Theodore (2009) writes that delays that affect the project completion time or date are considered as critical delays. Delays that do not affect the project completion time or date are noncritical delays. If certain activities are delayed in the construction project life cycle, the project completion date will be delayed. Determining which activities truly control the project completion date depends on the following: the project itself, the contractor's plan and schedule (particularly the critical path), the requirement of the contract for sequence and phasing and the physical constraint of the project, i.e. how to build the job from a practical perspective (Theodore, 2009).

According to Trauneret al., (2009) and Callahan et al., (1992), the primary focus in any study of delays in a project is to see if the delay affects the progress of the entire project or the project completion date. The authors' further state that delays which result in

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extended project completion are considered critical delays, and delays that do not affect the project completion date are known as noncritical delays. Trauneret al. (2009) further claim that the issue of critical delays emerges from the Critical Path Method (CPM) scheduling. All projects have a critical path and if these critical activities on the path are delayed than the completion date of the project will be extended. The criteria determining the project completion date are as follows (Trauneret al., 2009):

1. The project itself
2. The contractor's plan and schedule (particularly the critical path)
3. The requirements of the contract for sequence and phasing
4. The physical constraints of the project—how to build the job from a practical perspective.

2.6.2.2 Excusable versus Non-excusable Delays

Construction delays are basically either excusable or non-excusable. Behboudi(2009) States that excusable delays are caused owners actions or responsibilities, hence, the contractor is entitled to extension of time. Whereas, non-excusable delays are caused by the contractors actions or responsibilities and the client is compensated. However, Theodore (2009) studies that all delays are either excusable or non-excusable. An excusable delay is a delay that is due to an unforeseeable event beyond the contractor's or the subcontractor's control. Non-excusable delays are events that are within the contractor's control or that are foreseeable. Non-excusable delays include: Late performance of sub-contractors, Untimely performance by suppliers and Faulty workmanship by the contractor or sub-contractors (Theodore, 2009).

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Callahan et al. (1992) and Trauneret al. (2009) claim that whether a delay is excusable or non-excusable depends on the clauses in the contract. The authors note that standard construction contracts specify types of delay that will allow the contractor to an extension of time. For instance, in some contracts, unexpected or unusual weather conditions are not considered as excusable and so these contracts do not allow for any time extensions. According to Trauneret al. (2009) an excusable delay, in general, is owing to an unforeseeable event beyond the contractor's or the subcontractor's control. The authors further explain that delays resulting from the following issues are known as excusable: General labour strikes, Fires, Floods, Acts of God, Owner-directed changes, Errors and omissions in the plans and specifications, Differing site conditions or concealed conditions, usually severe weather, Intervention by outside agencies, Lack of action by government bodies, such as building inspection.

In another study, Levy (2006) adds two more excusable delays to the above list as: Illness or death of one or more of the contractors, Transportation delays over which the contractor has no control. Moreover, Kelleher (2005) supplies the above list with two more delays as: Epidemics, Quarantine restrictions. Mubarak (2005) defines non-excusable delays as "delays that are either caused by the contractor or not caused by the contractor but should have been foreseen by the contractor". He also points out that a non-excusable delay does not entitle the contractor to either a time extension or monetary compensation. A project-specific labour strike caused by the contractor's unwillingness to meet with labour representatives or by unfair labour practices. In another observation, Mubarak (2005) adds other examples to the above list as: Contractor cash-flow problems, Accidents on the site caused by the contractor's negligence or lack of preparations, late delivery of the contractor's furnished materials

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and equipment. As stated in the excusable delays, again, the contract is the determinant whether or not a delay is considered non-excusable. Therefore, Trauneret al. (2009) warn contractors that before signing the contract it should be clearly understood which delays are defined as excusable and which as non-excusable.

2.6.2.3 Compensable versus Non-compensable Delays

In some studies, Callahan et al. (1992), Kartam (1999) and Mubarak (2005) claim that an excusable delay can be classified as "excusable compensable" and "excusable non-compensable". As Mubarak (2005) states compensable delays are caused by the owner or the designer (engineer or architect). The contractor is typically entitled to a time extension or recovery of the costs related with the delay, or both. Factors that are specified in the contract resulting in delays such as differing site conditions, changes in the work, access to the site are some examples of compensable delays. According to Trauneret al. (2009) only excusable delays may be compensable. The authors further explain non-compensable delays as those which despite being excusable do not entitle the contractor to any compensation. Many authors such as Barrie and Paulson (1992) and Mubarak (2005), point out that excusable non compensable delays are normally beyond the control of either owner or contractor such as unusual weather conditions, natural disasters, wars, national crises, floods, fires or labour strikes. They add that usually the contractor is entitled to a time extension, but not additional compensation. Trauneret al. (2009) emphasize that if a delay is compensable or non compensable basically depends on the issues of the contract. The contract determines the types of delays in detail and for which delay the contractor is entitled to time extension or monetary compensation.

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2.6.2.4 Concurrent Delays

Rider and Long (2013) defines concurrent delays as two or more parallel and independent delays to the critical path of a project. Concurrent delays can be on the same critical path or on a parallel critical path. Mubarak (2005) states that a concurrent delay includes a combination of two or more independent causes of delay occurring within the same time frame. According to the author, a concurrent delay often includes an excusable delay and a non-excusable delay. Another definition made by Callahan et al. (1992) is that "more than one delay contributed to the project delay, not that the delays necessarily occurred at the same time". Although this type of delays seems like a simple issue, still there is no clear definition of concurrent delays. According to Trauneret al. (2009) concurrent delays are simply defined as "separate delays to the critical path that occur at the same time". Levy (2006) names this type of delays as overlapping delays. Nguyen (2007) also points out that simultaneous delays, commingled delays, and intertwined delays are other names used for concurrent delays.

Levy (2006) further indicates that concurrent delays may be generated by the contractor or by the owner, but if it happens that both parties are responsible, and these delays overlap then neither party can be able to retrieve damages. Figure 2.3 shows the possible critical delay interactions among three parties: owner (O), contractor (C) and third party (N). The Venn diagram representation and the use of set theory to show concurrent delays are proposed as new concepts by the study of Mbabazi,Hegazy, and Saccomanno, (2005) and they are very useful in apportioning delays. The diagram presents all types of critical delay combinations. Based on these critical delay types, time and cost compensation can be determined accurately for each of the seven segments in the Venn diagram.

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The diagram covers three intersecting sets of (O), (C) and (N). Using uppercase letters is to emphasize that all delays are critical delays. For example, OC'N' represents a one-party delay meaning only owner caused delay but not contractor or third-party caused delay. Similarly, OCN' is an example of a two-party concurrent delay that is the owner and the contractor caused delays but not third party caused delay. Using set theorems, the right side is just a mathematical representation by seven variables a, b, c, d, e, f, and g of the values on the left side shown by each segment.

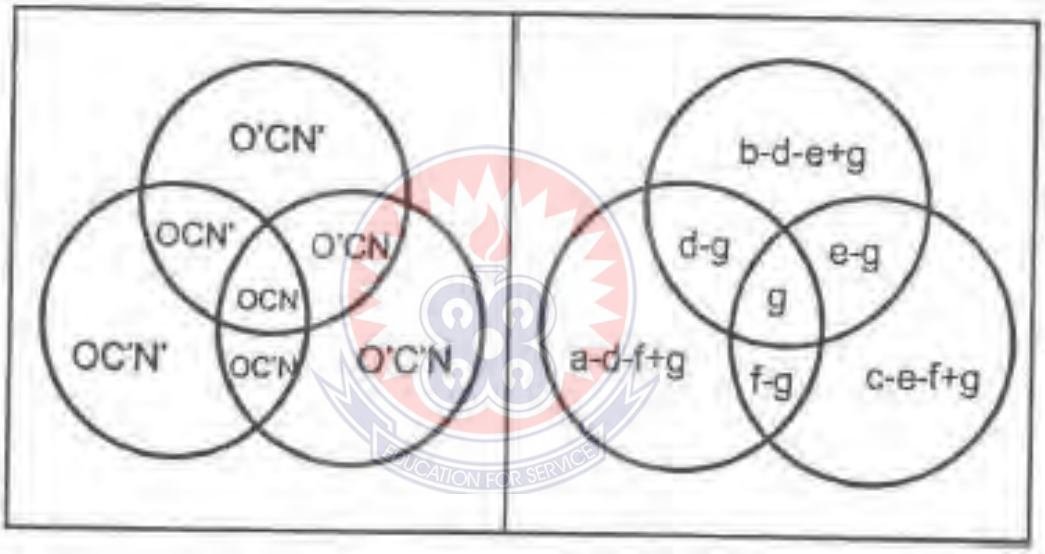

Figure 2.3: Concurrent delay representation

(Source: Mbanazi et al., 2005)

Table 2.3 concludes the different perspectives on concurrent delays from previous studies. Concurrent delay analysis brings about many issues, since both owners and contractors view concurrent delays as a strong defence tool against each other. For example, owners use them to preserve their interest in order to get liquidated damages, however contractors use them to neutralize their inexcusable delays and avoid damage entitlement. Courts, practitioners, researchers are generally inconsistent in the subjects

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of definition and apportionment of concurrent delays. All kinds of practitioners, especially contractors, contract administrators, andclaims consultants have divergent opinions on concurrent delays (Nguyen, 2007). As shown in the Table 2.3, general views regard concurrent delays as being similar to excusable delays. That means contractors are entitled only time extension.

Table 2.4: Divergent and inconsistent perspectives on concurrent delays

No	Literature	Concurrent Delays		
		Excusable& Inexcusable	Excusable& Compensable	Compensable & Inexcusable
1	Ponce de Leon (1987)	Excusable	Compensable	Excusable
2	Reams (1989); Battikha and Alkass (1994)	Excusable	Excusable	Not Available
3	Arditi and Robinson (1995); Al-Saggaf (1998)	Inexcusable	Excusable	Not Available
4	Rubin (1983); Galloway and Nielsen (1990); Wiezel (1992); Alkass *et al.* (1995); Schumacher (1995); Galloway *et al.* (1997); Kartam (1999); Stumpf (2000); Reynolds and Revay (2001); Niesse (2004)	Excusable	Excusable	Excusable
5	Construction (1993); Baram (2000); Construction (2002)	Inexcusable	Excusable	Inexcusable
6	Kraiem and Diekmann (1987); James (1991); Kutil and Ness (1997); Finke (1999); Ness (2000); Bubshait and Cunningham (2004)	Excusable	Excusable	Excusable or Apportioning
7	Hughes and Ulwelling (1992); Wickwire *et al.* (2003)	Excusable	Excusable	Apportioning

Source: Nguyen (2007)

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2.6.3 Schedule Delay Analysis

From a scheduling standpoint, the goal of every project is to be delivered on time and within budget, with desired functionality and acceptable quality level. In an ideal world, projects follow early starts and early finishes, float is not consumed, deadlines are met, the contractor never files claims for time extension, and the owner never assesses liquidated damages. In the study of Ndekugri, Braimah, and Gameson, (2008), Delay Analysis (DA) is defined as "the task of investigating the events that led to project delay for the purpose of determining the financial responsibilities of the contracting parties arising from the delay". The author's further point out that the techniques which have been developed for analyzing construction delays until today are referred to as "Delay Analysis Methodologies" (DAM).

2.6.3.1 Tools to Quantify Delay Impacts

Schedule analysis is used in order to identify delays and to measure the net impacts of delays on a project. Basic tools which are used in the schedule analysis are known as bar chart schedules and critical path method schedules.

a) Bar Charts

Callahan et al. (1992) defines bar charts as "a collection of activities listed in a vertical column with time represented on a horizontal scale". Bar charts show duration, start and finish times of project activities in chronological order. Henry L. Gantt developed bar charts during World War I. This tool is widely preferred since it is simple, easy to prepare and has an easily understandable format. However, bar charts have many limitations. Wickwire, Driscoll, Hurlbut, and Hillman (2003) give a detailed list of disadvantages of this tool:

- Size limits a bar chart in what it can graphically present

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- Bar charts do not show the interrelationships or interdependencies of one bar to another
- Bar charts do not show the available float or contingency time, nor can they show the delay impact of one bar on another
- Bar charts are not capable of accurately distributing or controlling manpower and project costs. Adding more detail to the bar chart makes it harder to read, understand, and maintain. Consequently, bar charts cannot show the logical relationships among activities. When there are continuous relationships between many activities, a bar chart becomes difficult to prepare schedule correctly (Callahan et al. 1992).

b) Critical Path Method

The E.I. Du Pont de Nemours Company in conjunction with UNIVAC Applications Research Centre of Remington Rand developed the Critical Path Methods between the years of 1956 and 1958. In 1961, CPM technique was first used in construction projects. However, this tool was not used widely in the late 1960s (Callahan et al., 1992). In project management, the Critical Path Method (CPM) is a planning, scheduling and controlling tool and using this tool properly facilitates the completion of projects timely. Wickwireet al. (2003) describe CPM as “a graphic representation of the planned sequence of activities that shows the interrelationships and interdependencies of the elements composing a project.” At first, CPM was introduced as a planning tool; however, later additional function of CPM appeared as proving delay claims. This function is the result of the ability of CPM as showing the picture of the project and changes.

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2.6.3.2 Schedule Delay Analysis Techniques

As Nguyen and Ibbs (2008) stated, there is a variety of schedule delay analysis techniques in construction industry. Many articles have researched these common techniques and some of them also have proposed new methodologies to the construction industry. The different methods of schedule delay analysis will be mentioned as some other techniques in the following part. However, in this part common current methods of schedule delay analysis will have been explained in detail. In the study of Nguyen (2007), the term reliability defines the result of a forensic schedule analysis that correctly presents and shows the facts. In the research of Arditi and Pattanakitchamroon (2008), a chronological analysis was built up to see the ratios of the usage of common schedule delay methods. This diagram includes the years of 1989 up to 2005. From the diagram it is understood that time impact analysis method is most preferred since it has become easier due to developed computer technologies; on the other hand impact as-planned analysis method has not become popular currently because this method is not accepted in courts as reliable any more.

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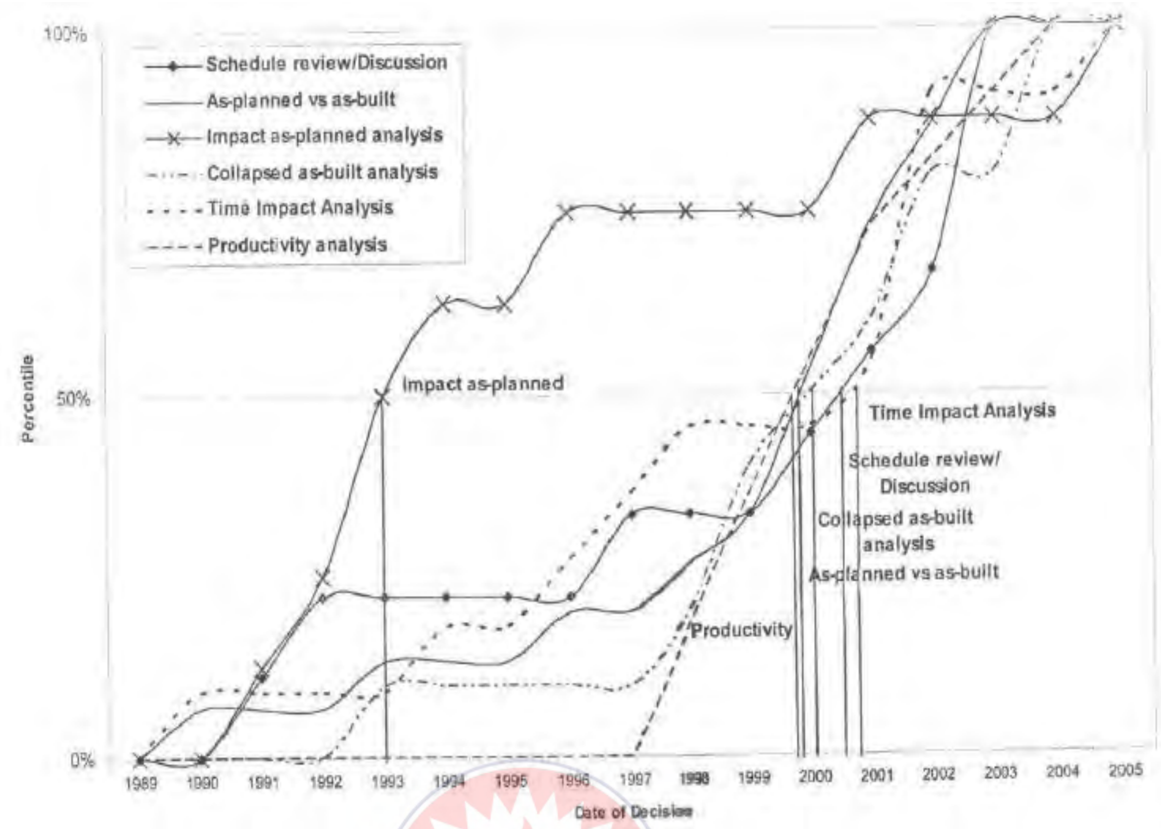

Figure 2.4: Chronological Analysis of Schedule Analysis Techniques

Source: Arditi and Pattanakitchamroon (2008)

Following methodologies are the most commented upon in literature; they are also given in detail in the following pages. As-planned versus as-built, Impacted as-planned, Collapsed as-built, Window analysis, and Time impact analysis.

a) As-planned versus as-built (Total time) method

Basically, the main concept is that the as-planned versus the as-built method compares two schedules, which is why it is also called "the total time method or net impact method". In this method the assumption is that one party (contractor) causes no delays and other party (owner) causes all delays. In this manner, the method displays the net impact of all claimed delays on project's finish date (Nguyen, 2007). Figure 2.5

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illustrates the as-planned versus as-built method where the as-planned schedule takes 10 days and as-built schedule takes 15 days. The difference between the two is 5 days which is total amount of delays recoverable. In other words, the difference between the two is regarded as delay to which a contractor is entitled to an extension of time as a means of an excusable delay activity.

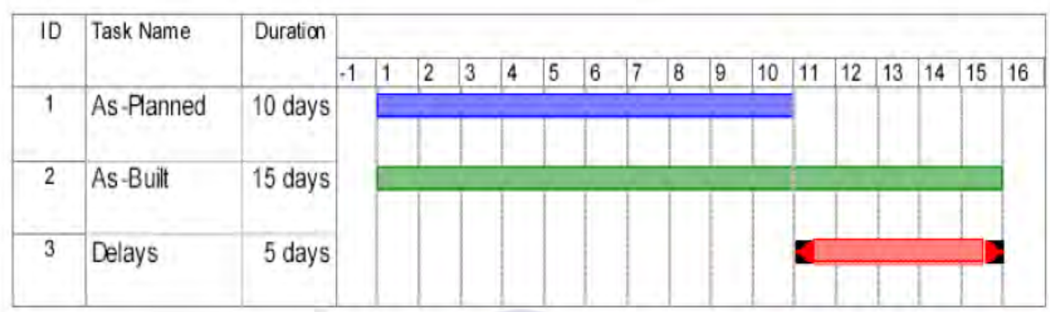

Figure 2.5: Diagram of As-Planned versus As-Built Method

Source: Nguyen (2007)

According to Ndekugriet al. (2008), the main advantage of this method is that it is inexpensive, simple and easy to use or understand, on the other hand its disadvantages are failure to consider changes in the critical path and incapability of managing complex construction delays.

2.6.3.3 Developing as As-Build Schedule

As new schedules of record are updated and modified, they are forming the basis of what will be referred to as the *as-built* schedule – a final documentation of actual starts and finishes of activities, any delays, change orders, extra work, weather, and other factors that affected project completion. As-built activities should correspond to those of the baseline schedule, although it may be necessary to account for changes in

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activities and logic. The as-built is an accurate historical representation of the actual sequence of construction and how it was completed. Project timing, sequence, and logic are developed through daily recording of various information, coming from an array of sources (Figure 2.6). Further, developing a list of problems, disputes, changes, and delay causing events, along with accompanying dates, can be arranged in chronological order and then plotted on the as-built in order to visualize the delaying events in the context of project history (Bramble, D'Onofrio, & Stetson 1990). Changes and delays are incorporated into the as built through addition or alteration of appropriate activities.

Sources

- Bid documents
- Contract documents
- Computer-based multimedia sound, still, or video files
- Cost and schedule data
- Daily reports
- Correspondence
- Meeting minutes
- Updated project schedules and progress reports
- Payment applications or certificates
- Testing records and reports submittal logs
- Expediting and receiving documents
- Concrete placement tickets
- Change order data

Information

- Actual start and finish dates for each activity
- Delays
- Actual project logic
- Change orders
- Extra work
- Weather data
- Labour job hours and head counts by craft
- Equipment hours and types
- Schedule of values information
- Material quantities installed
- Significant material or equipment received
- Earned costs
- Payment to date
- Significant milestones reached

Figure 2.6: Source of Information used to Develop As-Built Schedule

Source: Knoke & Jentzen (1996)

The idea behind gathering all the information is to be able to recreate the job on paper, ideally in its entirety, so that future disputes can more effectively be resolved.

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However, the sources and information listed above are not always available for analysis. Contemporaneous documentation may not exist, may contain errors, or may omit important information. The importance of accurate contemporaneous documentation that records the facts is that it gives credibility to the history of the project (Knoke & Jentzen, 1996). When disputes arise, courts look for detailed information gathered *throughout* the project, and not manufactured at project completion, most favouring an as-built record of construction that utilizes contemporaneous updates.

While the as-built schedule records all changes, it does not apportion responsibility or assign liability for delays (Clough et al. 2000). After reviewing what goes into an as-planned (baseline) schedule, updated schedules of record, and an as-built, the following sections will discuss the sources and causes of schedule impacts, as well as how they are classified. Accurate schedule documentation in the as-built should include detailed records of all events that could have potentially impacted the schedule and project completion.

b) Impacted as-planned (What-if) method

The other names of this method are "what-if" or "adjusted-baseline" method. According to Trauneret al. (2009), in this method the analyst specifies the as planned schedule, and inserts into this schedule the changes which caused project delays. These changes are the only determined delays recorded during construction process which may have affected the project duration. The period between the completion date presented on the as-planned programme and the one on the impacted as-planned programme is regarded as delay to which a contractor is entitled to an extension of time

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as a means of an excusable delay activity. Trauneret al. (2009) point out the major weaknesses of this method as follows: firstly the impacted schedule does not show the project activities as they occurred, secondly the decision of placing which changes or impacts into the schedule is greatly subjective, and finally, and also most significantly, it does not reflect the dynamic nature of construction project and the critical path. The authors also add that some analysts like this approach because of being simple and clean, however, this method is greatly inaccurate. According to the authors by using the first schedule, this method freezes the critical path at the beginning of the project, thus the real changes in the critical path will not be identified. Nonetheless, Nguyen (2007) claims that the what-if method is more reliable than the total time method since this method distinguishes between the types of delays.

c) Collapsed as-built (But-for) method

Another method of analysis is the collapsed as-built method, also called "the subtractive as-built or but-for method". In this method, the analyst studies all contemporaneous project documentation and prepares a detailed as-built schedule instead of an as-planned schedule as mentioned in the what-if method. The analyst subtracts or removes activities which affected the project from the as-built schedule (Trauneret al. 2009). The authors point out that if subtracting activities from the as-built schedule has an impact on the new schedule's end date, then the difference in time between the as-built and the collapsed as-built end dates is thought to be the delay caused by the subtracted or removed activities. In the study of Trauneret al. (2009) two different variations of this method are explained such as "unit subtractive as-built and gross subtractive as-built" methods.

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Finally, according to the authors, this method has many serious problems and their three primary weaknesses are explained as follows:

1. "It requires the analyst to construct a CPM network diagram based on as built information.
2. It is extremely subjective and highly amenable to manipulation.
3. With very little effort, the analyst can create an as-built schedule that supports a predisposed conclusion."

d) Window analysis (Contemporaneous period analysis) method

Window analysis method is also called the contemporaneous period analysis and snapshot method. In contrast to previous methods which analyze construction delays by taking into consideration the whole project, window analysis method analyzes delays within certain time periods individually (Nguyen, 2007). This technique is based on CPM scheduling. In this method, the basic concept is that the total project duration of CPM schedule is divided into digestible time periods or windows (e.g., monthly) and the delays that occurred in each windows of time are analyzed successively by focusing on the critical paths (Hegazy& Zhang, 2005). The authors indicate that the selection of boundaries of window sizes is specified with major project milestones, significant modifications in the critical path, occurrence of major delay events and dates for the issue of schedule revisions. These factors identify the number of windows and boundaries of these windows for the entire project. The study of Kaoa and Yangb (2009) compares windows-based delay analysis methods to determine their advantages and limitations. The differences in terms of the perspectives of use prerequisite, functional capability, analytical process and accuracy of analysis results are reviewed in

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terms of a simulated case. Windows-based delay analysis methods are grouped in the study of Kaoa and Yangb as follows:

1. Windows analysis
2. Modified windows analysis
3. Delay analysis method using delay section
4. Daily windows delay analysis

In the research of Hegazy and Zhang (2005, p506), the major drawbacks of traditional windows analysis are summarized below: "First drawback: While the as-built is the key to accurate delay analysis, it is widely recognized that it is manually done after the fact (after the project ends) and not as the events evolve, due to the difficulty in site-data recording. Accordingly, the as built schedule may be subjected to errors and omissions that hinder accurate delay analysis. Second drawback: With the window span being in the form of weeks or months, the focus is on the critical path(s) that exists at the end of the window time. Thus, the technique does not consider the fluctuation that occurs in the critical path(s) as events evolve on site. Third drawback: As a consequence of the above point, the technique loses sensitivity to the time at which the owner/contractor cause project delays within the window. Also, it loses sensitivity to the events of speeding or slowdowns within the window. Fourth drawback: The delay representation of existing software systems makes the application and automation of the windows technique a difficult task." On the other hand, the authors evaluate the above drawbacks as the desired objectives of their proposed method which is called "the daily windows delay analysis". According to the authors, the proposed method views the fluctuation day-by-day in critical path and so reaches correct and repeatable results to allocate project delays between the parties involved. The authors claim that this proposed

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method is a simple and practical alternative with its automated and computerized nature compared to a traditional window analysis which demands extensive effort.

In another study of Hegazy and Menesi (2008), the authors proposed a different variation of delay analysis called “delay analysis under multiple baseline updates”. This model which is based on a daily window size considers multiple baseline updates in order to accurately apportion delays and accelerations among project parties. Opposite to Hegazy and Zhang (2005), Ndekugri et al. (2008) argue that the main strength of window analysis method is its capacity to take care of the dynamic nature of critical path scheduling. According to the authors, this method is used successively for each of the windows to specify the impacts of all other delays on project completion. Nguyen (2007) also claims that many researchers, experts, courts as well as boards generally approve window analysis method as the most suitable choice.

e) Time impact analysis (Modified as-built) method

Nguyen (2007) indicates that the time impact analysis method (TIA) is one of the most reliable techniques presently. Alkass et al. (1996) state that this method is a variation of the window analysis technique, also in this method, the analyst focuses on a specific delay or delay activity, whereas in the window analysis the analyst focuses on time periods (also known as window or snapshot). This method analyzes the impacts of delays chronologically, starting with the first delay, by incorporating each delay (sometimes using a fragnet- or subnet-works) into an updated CPM schedule. The analyst determines the amount of project delay resulted from each of the delaying activity successively by calculating the difference between the project completion date of the schedule after the addition of each delay and that prior to the addition (Ndekugri et al. 2008).

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Alkasset al. (1996) notes that this method is incapable of analyzing potential concurrent delays. The effect of concurrent delays is not immediately dealt with in this method since delaying events are analyzed separately. According to Ndekugri et al. (2008), another drawback of the method is that it is time consuming and costly to operate, especially in situations with many delaying activities. Despite some of the above mentioned drawbacks, the Society of Construction Law (2002) recommends this method. Time Impact Analysis is the most appropriate method for specifying the amount of time extension that the contractor should have been given at the time that an excusable risk appeared. However, in order to apply this method successfully, the daily records and diaries should be noted very meticulously and accurately. Otherwise, the analysis will not give correct results.

2.6.4 Other Techniques of Schedule Delay Analysis

The study of Nguyen, et al. (2008) presented a new schedule delay analysis technique named as "FLORA which could control the dynamics of float, logic, and resource allocation in the analyses". The authors further indicate that this method examines both the direct impact of delay and also its secondary effect. On the other hand, Alkasset al. (1996) conducted a study to discuss different delay analysis techniques which are currently being used in the construction industry. The authors also presented a new delay analysis method called the Isolated Delay Type (IDT). According to the authors, this new technique can be used as a standalone module for delay analysis or can be integrated within a computer system for delay analysis and construction claims preparation called "Computerized Delay Claims Analysis (CDCA)". In another field observation, Kim et al. (2005) made a study of delay analysis methods and introduced a

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new method called the "delay analysis method using delay section" (DAMUDS) in order to eliminate inadequate accounting of concurrent delay and time-shortened activities.

In the research of Oliveros and Fayek (2005), the fuzzy logic model which combines daily site reporting of activity progress and delays with a schedule updating and forecasting system for project monitoring and control is introduced. Another research of Lee, Ryu, Yu, and Kim (2005) proposed a method for analyzing construction schedule delay in terms of lost productivity. They emphasize the necessity of a logical method for analyzing delays occurred by lost productivity in order to measure the delay time correctly. In the study of Shi,Cheung, and Arditi, (2001), a different method which is not established on critical path analyses is proposed for computing activity delays. The authors define this technique as "Construction Delay Computation Method" and add that this method may be combined with any delay analysis system in order to advance the process of delay analysis.

Kartam (1999) has presented a generic methodology for analyzing and resolving delay claims which has been developed and successfully used by the author. The developed methodology has brought into question of while several techniques for analyzing delay claims there are, how much adequate these techniques. In conclusion, there are many schedule analysis techniques: some of them are really simple to understand and apply, while some are perhaps more difficult and more complicated to analyze delay activities. Some of them are old, while some of them are quite recent. Even so, each of the technique has its own advantages and disadvantages. In analyzing the delay activities of the schedule, the analysis method should be selected according to the appropriateness

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of the technique. However, determinants in selection of the technique depend on the availability of possible as-built information such as: project daily reports and diaries, meeting minutes, pay requests/estimates, inspection reports by the designer or owner, official correspondences, memos in the files, construction photographs taken at the site, and etc. The skill level of the analyst, relevant contract clauses, the nature of the schedule delays and the available time are the other determinants for choosing a delay analysis method.

2.6.5 Float and Criticality in Project Schedules

Trauneret al. (2009) points out that the term "float" appeared when the Critical Path Method was introduced. The authors describe float as "the amount of time an activity can be delayed before it begins to delay the project". If the available float of an activity is used up, then the activity will be critical that means any other delay on the activity may extend the project duration. Callahan et al. (1992) note that float is measured by detracting the early finish time from the late finish time or detracting the early start time from the late start time. The early start and finish times mean the earliest time that an activity can start or finish depending on the activity durations in the project schedule and logical relationships between the activities. According to the authors, the float is a measure of schedule flexibility and an indicator of the ability of a given activity to have its performance time extended without affecting the project duration. Float and criticality of an activity have an important relationship in the Critical Path Method. When float of the activity equals to zero, the activity is on the critical path; and activities which are on the critical path are called critical activities. Any kind of project has at least one critical path in its schedule. The concept that while some activities are critical (their total float is zero) some other activities have float is very useful in

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appropriately analyzing the impacts of delaying events as a management tool in project schedules.

2.6 Risks in Construction Projects and Delays

Management of construction projects involves a great deal of managing risks. Managing risks involves: planning, identifying, analyzing, developing risk handling strategies, monitoring and control. Project team members particularly clients, consultants and contractors should eliminate/mitigate delays when playing their respective roles. Cohen and Palmer (2004) identify sources of construction risks to include changes in project scope and requirements; design errors and omissions; inadequately defined roles and responsibilities; insufficient skilled staff; force majeure; and new technology. Baloi and Price (2003) categorize construction risks as technical, social, construction, economic, legal, financial, natural, commercial, logistics, and political.

Similarly, Mills (2001) lists three most important risks to include: weather, productivity of labor and plant and quality of material. Other researchers such as Finnerty (1996), and Miller and Lessard (2001) have categorized same risks in addition to demand, supply, regulatory, operational, completion and sovereign. Time related risks identified by Zou,Zhang, and Wang, (2006) that are have influence on project delivery are: tight project schedule, design variations, excessive approval procedures in administrative government departments, variations by the client, incomplete approval and other documents, unsuitable construction program planning and inadequate program scheduling. Aiyetan, Smallwood, and Shakantu, (2008) point out that the three most significant factors that adversely impact construction project delivery time performance

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are: quality of management during construction; quality of management during design, and design coordination.

2.7 Effects of Delays and Disruptions

Effects of delays are the consequences that will occur when the causes of delays are not identified and worked on effectively. A study by Aibinu and Jagboro, (2002) reveals six effects of delay on project delivery in Nigerian construction industry which are: time overrun, cost overrun, dispute, arbitration, total abandonment and litigation. Sambasivan and Soon (2007) disclose the same effects of delay in Malaysian construction industry. Haseebet al. (2011) identify effects of delays in Pakistan construction industry as clash, claims, total desertion and slowing down the growth of the construction sector. Ramabodu and Verster (2010) identify critical factors that cause cost overruns in construction projects as changes in scope of work on site, incomplete design at the time of tender, contractual claims (extension of time with cost), lack of cost planning and monitoring of funds, delays in costing variations and additional works. These critical factors in turn are the delay factors. Chileshe and Berko (2010) indicate that causes cost overrun in Ghanaian road construction sector are delay in monthly payments to contractors; variations; inflation, and schedule slippage. Again, these explain the causes of delays and the effect of cost overrun.

The study of Pourrostam and Ismail (2011) identified and ranks the effects of construction delays as follows; time overrun; cost overrun; dispute; arbitration; litigation; and total abandonment of projects. Kikwasi(2012) identified 14 effects of delays in Tanzania and ranked them as follows; time overrun, cost overrun, negative social impact, idling resources, disputes, arbitration, delaying by the client to return the

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loans, poor quality of work due to hurrying the projects, delaying in getting profit by clients, bankruptcy, litigation, create stress on contractors, total abandonment and acceleration losses.

Further, the study of Sunjka and Jacob (2013) identified the effects of delays and tabulated them as follows; Time overrun: When the stipulated completion time is pushed forward, the project is said to have experienced time overrun; Budget overrun: When a project is completed at a cost higher than what was budgeted, it is said to experience a budget overrun; Poor quality completed project: inferior workmanship and/or inferior quality materials, can lead to issues of project quality; Bad Public Relations: When projects are delayed, contractors, consultants and clients could put their public reputations at risk; Litigation: Disputes can lead to court cases for resolution especially when large penalties are at stake; Arbitration: The project will have extra cost and time related to the engagement of professional arbitrators; Disputes and claims: Disputes and claims arise from the losses incurred through delays by either party in the contract; and Total abandonment: Delays in project execution could lead to total abandonment if issues leading to the delays are not resolved timeously.

2.8 Selection of Delay Analysis Methodology

The analysis method should be selected according to the appropriateness of the technique. Determinants in selection of the delay analysis technique depend on the available data on the as-built project such as: daily reports and diaries, minutes of the meetings, requests for payments, inspection reports by the designer or owner, official correspondence between the parties, office memos on record, photographs taken at the site, the level of skill of the analyst, relevant contract clauses, the nature of the schedule

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delays, etc, as stated in the previous paragraph. The analysis methods can be classified in many different categories, but classification of methods according to working process is more useful in selection of the methodology. Impacted As-planned (IAP) and Time Impact Analysis (TIA) methods which are based on adding impacts into the as-planned schedules are used both in forward looking and retrospective analysis applications.

On the other hand, Collapsed as-built method based on subtracting impacts from the as-built schedules can be used only in retrospective analysis applications. Again, in the windows analysis method as-built schedule is needed, and the as-built schedule may be applied to errors and omissions that obstruct accurate delay analysis. Also, the method of As-planned versus as-built which is based on comparison of an as planned and as-built schedule analytically is used only in retrospective analysis applications. Therefore, TIA and IAP methods remain since forward looking analysis application will be conducted in this study. In this stage, the decision of selecting TIA or IAP method will be determined. TIA method is more reliable and more acceptable than IAP method. As it is understood from the research of Arditi and Pattanakitchamroon (2008), TIA method is most preferred presently because it has become easier due to developed computer technologies; however IAP analysis method has not become popular currently because this method is not accepted in courts as reliable any more. The Society of Construction Law Delay and Disruption Protocol recommend TIA method at the same time. Therefore, TIA seems to be one of the best techniques for applying in this study.

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CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents an overview of the methodology. It draws the systematic approach of gathering information to understand a phenomenon and to generalize the facts obtained. Research methodology identifies the techniques and methods used in the data collection and analysis. The survey material includes the case study of completion construction works of an office complex at Asokwa in Kumasi. This chapter discusses the research design, the population, sample and sampling technique, instrumentation, data collection procedure and methods of data analysis.

3.2 Research Design

According to Akubia (2011), research design provides a description of what a researcher is writing on. The study adopted an exploratory, quantitative approach using a descriptive survey design to analyze the construction delays in the work-schedule of the case-study construction project in order to determine the delays and apportion the responsibility of such delays amongst all parties. A descriptive cross-sectional case study concerns the gathering of data to find answers to a research question or test hypothesis. Descriptive survey designs are used in preliminary and exploratory studies (Peter, 1981) to allow the researcher to gather information, summarize, present and interpret for the purpose of clarification. The study followed a case study survey design using quantitative model. Quantitative research is the systematic scientific investigation of quantitative properties and phenomena and their relationships. The objective of quantitative research is to develop and use mathematical models, theories and/or hypotheses pertaining to natural phenomena. The objective of using the quantitative

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model was to develop and employ mathematical models, theories and hypotheses pertaining to natural phenomena. Again, the quantitative model enabled the researcher to measure or compare association by using inferential statistics such as independence sample t-test and simple linear regression.

The descriptive survey was also useful in defining a population with an equal chance of participation in the study. Few problems occurred when using this study design. First of all, temporary associations between causes and effects were unclear. Again, since the size of the sample was small, generalization of the results could result in incorrectly representation of the entire construction companies in Ghana. Nonetheless, the researcher opted to use this design because its advantages surpass its disadvantages.

3.3 Population of the Study

According to Sekaran (1981), population of research study is any group of items that has characteristics in common that are of interest to the researcher. All items or objects within a certain population usually have a common, binding characteristic or trait. Usually, the description of the population and the common binding characteristic of its members are the same. The study population comprised of 15 construction companiestargeted from Ashanti Region, Brong-Ahafo Region and Eastern Region with some of the companies having speciality in construction work. Ten (10)employees each from the fifteen (15) construction companies were targeted totalling one hundred and fifty (150).

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3.4 Sample and Sampling Technique

Purposive sampling was used to select eighty (80) employees represented 53% of the population from fifteen construction companies. Purposive sampling method is chosen because the selected participant has expertise knowledge of the study and fits the purpose of the study (Durrheim & Painter, 2006). In Ashanti region seven construction companies were used with five (5) employees from each of the seven companies, totalling 35 respondents in Ashanti region. In Brong-Ahafo region five (5) construction companies were used with five (5) employees from each of the five companies, totalling 25 respondents whiles in Eastern region three (3) construction companies were used with six, eight, and six employees from the three companies respectively, totalling 20 respondents. However, according to De Looff (1996), a sample size of more than 10% of the population is enough for a credible empirical study. Purposive selection was done to enable the research to target employees who held important positions and were seen to be knowledgeable in their areas of expertise.

Table 3.1 List of Sampled Companies and their specialities

Companies And their	Population	Sample	Sample Technique	Data Collection Procedure
Building contractors	102	50	Purposive	Questionnaire/Interviews
Electrical contractors	14	10	Purposive	Questionnaire/Interviews
Other contractors	21	20	Purposive	Questionnaire/Interviews

Source: Researcher's Construct (2016)

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3.5 Instrument for data collection

The instruments for data collection used for the study were questionnaire and interview. The self-completion questionnaire was deemed most appropriate for the study.

Questionnaire

Questionnaires are easy to administer, friendly to complete and fast to score and therefore take relatively very little time of researchers and respondents. Additionally, review of literature on studies related to construction schedule delays (e.g., Assaf and Al-Hejji, 2006;Lo et al. 2006;Trauner et al.2009) made the most use of researcher designed questionnaires for data collection of self-completion questionnaire of two sections. The section A consist five items on respondents' background. Section B comprises 35Likert-type items on understanding project schedules. The questionnaire as shown in the Appendix A elicited demographic data, and data on understanding project schedules with aspects such as objectives of project schedule in construction, the importance of scheduling in construction projects, the effect of lack of scheduling in construction projects, major causes of construction delays, delay analysis technique and impact of the delay technique in construction projects. The five-point scale was used for the study. The five-point scales were: strongly disagree (5), disagree (4), uncertain (3), agree (2), and strongly agree (1).

Interview

Interview is face to face meeting between an interviewer and interviewee in an attempt to collect data for descriptive studies; this is according to Marshall 1997.An interview which is structured is the type of interview that all things to be found out are planned before the interview takes place. The other type which is the non-structured interviews

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is not planned ahead of time. Questions are developed during the course of the interview. The researcher decided to go for structured interview to find out of the respondents understanding in project scheduling. The interview guides were given to all the80 employees representing 53% from fifteen construction companies in Ashanti, Brong Ahafo and Eastern Regions.

The interview guides were designed in two sections, section A and B. The section A comprises five question on the respondents' background and section B consist of nine (9) items on understanding project schedules. See appendix B for interview guide.

3.6 Administration of the Instrument

The questionnaires for respondents were distributed and collected personally. Thirty-five (35) employees in Ashanti region (representing 43.75% response rate) returned their questionnaires. Twenty-five (25) questionnaires (representing 31.25% response rate) were distributed and collected personally in Brong–Ahafo region. Twenty (20) employees in Eastern region (representing 25% response rate) returned their questionnaires. In all, a total of 80 questionnaires administered were returned. This represented an overall response rate of 100%.

3.7 Data Analysis

After the data was collected it was organized and analyzed. Computer programmes called Statistical Package for Social Sciences (SPSS) and Microsoft Excel were used. The data was analyzed by both descriptive and inferential statistics using the Statistical Package for Social Sciences (SPSS) version 21. A relationship between variables and assumed cause-effect relationships was tested using appropriate statistical tools in SPSS. The study used the Pearson correlation, multiple regression, and analysis of

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variance to test the hypothesis formulated in chapter one. A probability value (p-value) of less than 0.05 was considered statistically significant at 95% confidence interval. Quantitative content analysis was also conducted with the aim of quantifying emerging characteristics and concepts. Concept analysis is the process of analyzing verbal or written communications in a systematic way to measure variables quantitatively (Polit&Hungler 1995). Tables, pie charts and histogram were used to present the data for the study.

3.8 Ethical Considerations

As this study utilized human participants, certain issues were addressed. The consideration of these issues is necessary for the purpose of ensuring the privacy as well as the security of the participants. These issues were identified in advance so as to prevent future problems that could have risen during the research process. Among the significant issues that were considered included consent, confidentiality and data protection. In the conduct of the research, the survey was drafted in a very clear and concise manner to prevent conflicts among respondents. People who participated in the research were given an ample time to respond to the questions posed on them to avoid errors and inaccuracies in their answers. The respondents were given a waiver regarding the confidentiality of their identity and the information that they did not wish to disclose. The respondents' cooperation was eagerly sought after, and they were assured that the data gathered from them would be treated with the strictest confidence, so that they would be more open. This was done with the hope that it would promote trust between the researcher and the respondents.

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3.9 Data Validity and Reliability

3.9.1 Validity

The validity of an instrument is the degree to which an instrument measures what it is intended to measure (Polit & Hungler 1993). Content validity refers to the extent to which an instrument represents the factors under study. To achieve content validity, questionnaires included a variety of questions about the research topic (Polit & Hungler 1993). Content validity was further ensured by the process of questionnaire development. The validity of the study was achieved by ensuring that the questionnaires reflect the content of the literature review and correction of ambiguous items. These were checked and discussed with supervisor.

3.9.2 Reliability

Polit and Hungler (1993) refer to reliability as the degree of consistency with which an instrument repeatedly producing the same results. The study reliability was tested by conducting the pre-test or pilot test. The pilot study involved administration of the questionnaire to three (3) employees in three construction companies in Ashanti Region (all of whom were not included in the sample for the study) This was done to serve as the preliminary testing of the research questions to provide insights into ideas not yet considered and problems unanticipated, which could challenge the data analysis. Furthermore, it helped to check and try the planned statistical tests of association between variables. Besides these, the pre-test enabled the researcher to revise the contents of the questionnaire, thereby revising the instruments to achieve the reliability and validity standards required in scientific research.

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Cronbach's coefficient alpha reliability values were calculated for all the Likert scale variables involved in this study to assess the degree to which the items that make up the scales are all measuring the same underlying attribute. Nunally and Bernstein (1994) recommend a value of 0.60 is considered as the lower limit of acceptability for Cronbach's alpha, however, values above 0.8 are preferable. The test for reliability of the study revealed that the Likert scale items obtained a decent Cronbach's reliability alpha value of 0.899, which is more than the limit of acceptability (0.60).

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CHAPTER FOUR

RESULTS/FINDINGS

4.1. Introduction

The chapter focuses on the presentation, interpretation of empirical data emanated from the study into the effects of schedule delay analysis in construction projects using a case study of time impact analysis method. Eighty (80) employees participated in this study (constituting a response rate of 100%) returned their questionnaires. The chapter is divided into two major sections. The first section provides demographic characteristics of respondents whilst the second section presents the answers to the study research aims and hypothesis and also discusses the findings of the study.

4.2 Demographic Characteristics of Respondents

The background of respondents in any information obtained for research purpose is very crucial as it has the tendency to affect credibility and outcome of the findings obtained. On this premise, the researcher sought to obtain the background characteristics in the following areas to help him appreciate their relevance: Age range, Gender, Profession and Specialty of Respondent's Company. The results are presented in Table 4.1.

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Table 4.1: Demographic Characteristics of Respondents (N=80)

Variable	Frequency	Percentage %
Age Group (years)		
18-25	6	7.5%
26-35	19	47.5
36-45	26	32.5%
45-60	10	12.5%
Gender		
Male	76	95.5%
Female	4	5.0%
Profession		
Mason /Brick Layer	16	20.0%
Architect	4	5.0%
Steel Bender / Plumber	22	27.5%
Glass Worker / Carpenter		
Labourer	38	47.5%
Specialty of Company		
Building Contractors	16	20%
Lighting Technicians	12	15%
Plumbing	12	15%
Other	40	50%

***Source: Author's Field Data (2016)**

Table 4.1 shows the demographic characteristics of respondents sampled in this study in the areas of Age range, Gender, Profession, and Specialty of Respondent's Company were examined. First on the age distribution respondents, Table 4.1 reveals that more than half (55.5%) of the sample were aged 35 years or belowwhile 32.5% were aged between 36 to 45 years. Those who were above 45 years recorded a percentage of 12.5% which represented a little over tenth of the study sample. This appears to suggest

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that respondents within the youth bracket dominante the work force in the various professions involved in the execution of construction projects.Furthermore, the doiminance of the youth team in the finding confirms an assertion by O'Connor and Mangan (2004) that, the presence of youth in a working team have positively affect workrate and effectiveness as they exhibit greater energy and strengthin the performance of their activities.

With regards to the gender distribution of respondents, out of a sample size of Eighty (80) respondents, Table 4.1 shows that female's representative was 5.0% as compared to their male counterparts which had a greater chunk (95.0%) of the respondents. The indication of this is that construction activities are more or less male dominant and also an indication of the femininity of the calibre of works in the construction industry.

On the issue of respondents' profession, Table 4.1 indicates that most employees (47.5%) within the construction sampled for the study seemed to be common labourers with no particular skills followed by artisans (27.5%), comprising mainly steel benders, plumbers, glass workers and carpenters, with architects appearing to be the least (2.0%) within the workers professional distribution. Again, according to Table 4.1, about one-fifth (2.0%) of the respondents belonged to the masonry and brick layers profession. Concerning the specialty of the companies respondents are engaged, the study discovered that about half (50.0%) of the respondents were not directly employed by their firms on full time basis and therefore declined to fill this role. Out of the remaining respondents, one-fifth (20.0%) worked for the building contracting companies, while 15.0% each, worked with lighting technicians and plumbing sectors in the industry.

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4.3 Analysis of Main Findings

The general objective of this research work is to examine the effects of schedule delay analysis in construction projects using a case study of time impact analysis method. The specific objectives were framed to adequately answer the general objective.

4.3.1 The Objectives and Importance of Project Scheduling

Research question one sought to study and understand project scheduling as pertained to the construction industry in Ghana. The study therefore examined the objectives and importance of scheduling in construction projects. The respondents were asked to indicate their level of agreement on underlying statements measuring the objectives of scheduling in construction projects on a five point Likert scale. The results are presented in Table 4.2.

Table 4.2: Descriptive Statistics on Objectives of Scheduling in Construction Projects

Objectives	N	M	STD	Std. Error Mean
To calculate the project completion date	80	4.063	.24313	.02723
To calculate the start or end of a specific activity	80	4.137	.34655	.03875
To expose and adjust conflicts between trades or subcontractors	80	4.775	.42022	.04698
To predict and calculate the cash flow	80	4.175	.38236	.04275
To evaluate the effect of changes	80	4.400	.49299	.05512
To improve work efficiency	80	4.313	.46644	.05215
To resolve delay claims	80	4.675	.47133	.05270
To serve as an effective project control tool	80	4.763	.42824	.04788
Average mean value		**4.415**		

N= number of respondents; M= mean score; STD= standard deviation

**Source: Author's Field Data (2016)*

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Table 4.2 shows a summary of the mean statistics on the objectives of scheduling as practiced during the execution of construction projects in Ghana. The average mean for all the eight (8) variables was 4.415 (SD=0.40645).The study showed that the coefficient of variation was large; indicating that the data has a great deal of variability with respect to the mean but there is no general consensus among the sample. This finding means that, the employees surveyed have significantly divergent views on the actual objectives of scheduling in construction projects. Results from the table show that the objectives of scheduling in construction projects include to “calculate the project completion date” (M=4.063; SD=0.24319), “calculate the start or end of a specific activity” (M=4.131; SD=0.34655), and to “expose and adjust conflicts between trades or subcontractors” (M=4.775; SD=0.42022). Other objectives also include to “predict and calculate the cash flow” (M=4.175; SD=0.36236), “evaluate the effect of changes” (M=4.400; SD=0.44299), “serve as an effective project control tool” (M=4.763; SD=0.42824), “resolve delay claims” (M=4.675; SD=0.47133), and “to improve work efficiency” (M=4.313; SD=0.46644).As noted in the table, the major objectives of scheduling in construction projects in the construction industries include “to expose and adjust conflicts between trades or subcontractors” (M=4.775; SD=0.42022) to serve as an effective project control tools (M=4.763; SD=0.42824)and to “resolve delay claims” (M=4.675; SD=0.47133).

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Table 4.3: Descriptive Statistics on the Importance of Scheduling to Construction Projects

Statement	N	Mean Score	Std. Deviation	Std. Error Mean
To finish project on time	80	4.625	.48718	.05447
To finish project within budget	80	4.250	.43574	.04872
To ensure customer satisfaction	80	4.513	.50300	.05624
*Average mean value		**4.462**		

N= number of respondents; M= mean score; STD= standard deviation

**Source: Author's Field Data (2016)*

Table 4.3 presents responses on the importance of scheduling to construction projects. The importance was assessed using a 5-point Likert scale. Three (3) items/questions comprised of importance of scheduling index from which a composite score was obtained (M=4.462; SD=0.4753). This index measured the number of correct responses on the importance of scheduling to construction projects. The study showed that the importance of scheduling was to "finish projects on time" (M=4.625; SD=0.48718), "finish project within budget" (M=4.252; SD=0.43574), and to "ensure customer satisfaction" (M=4.513; SD=0.50300).This finding implies that finishing project on time and ensuring customer satisfaction was the primary motive of project scheduling (with a mean score above the average mean). However, in the opinion of the researcher, construction companies needs to clearly define the need to emphasis on project scheduling in order to yield a better performance in construction projects.

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Table 4.4: Perception on the Effects of Lack of Scheduling to Construction Projects

Statement	N	Mean Score	Std. Deviation	Std. Error Mean
Delays	80	4.750	.43574	.04072
Disruptions	80	4.500	.50315	.05625
Cost and schedule overruns	80	4.275	.44933	.05024
*Average mean value		**4.508**		

N= number of respondents; M= mean score; STD= standard deviation

**Source: Author's Field Data (2017)*

The study examined the perception of the respondents on the effects of lack of scheduling to construction projects. Mean and Standard deviation analysis on the lack of scheduling to construction projects was conducted as shown on Table 4.4. The average mean score and standard deviation for respondents' perception on the effects of lack of scheduling to construction projects were 4.508 and 0.46274 respectively. This index measured the number of correct responses. As shown in the table (Table 4.4) above, the major effects of lack of scheduling to construction projects as reported by the respondents is delays construction projects (M=4.750; SD=0.43574), and disruptions of construction projects (M=1.40; SD=.496). Some of the respondents also perceived that lack of scheduling brings about cost and schedule overruns (M=4.225; SD=0.44933). These findings depict the relevance of project scheduling to the construction companies in Ghana.

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4.3.2 Major Causes of Construction Delays

Research question two sought to determine major causes of construction delays as pertained to the construction industry in Ghana. The results are presented in Table 4.5 below. All variables were measured using a 5-point Likert scale (1=strongly agree to 5=strongly disagree).

Table 4.5: Major Causes of Construction Delays

Statement	N	Mean	Std. Deviation	Std. Error Mean
Delayed payments	80	4.650	.47998	.05366
Financial processes and difficulties	80	4.300	.46115	.05156
Contract modification	80	4.688	.46644	.05215
Economic problems	80	4.300	.46115	.05156
Materials procurement	80	4.625	.48718	.05447
Changes in drawings	80	4.313	.46644	.05215
Staffing problems	80	4.350	.47998	.05366
Equipment unavailability	80	4.438	.49921	.05581
Poor supervision	80	4.800	.40252	.04500
Construction mistakes	80	4.838	.37124	.04157
Poor coordination on site	80	4.788	.41166	.04602
Changes in specifications	80	4.750	.41660	.04872
Labour disputes and strikes	44	4.225	.42022	.04698
*Average mean value		**4.543**		

M= mean score, sd= standard deviation,

Source: Field Data Analysis, 2017

Table 4.5 above shows the major causes of construction delays as pertained to the construction industry in Ghana. Thirteen (13) items/questions that comprised of major causes of construction delay index were captured (M= 4.543; SD=0.44798). These items include delayed payments (M=4.650; SD=.47998), financial processes and

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difficulties on the part of contractors and clients (M=4.300; SD=.46115), contract modification (M=4.688; SD=.46544), economic problems (M=4.300; SD=.46115), materials procurement (M=4.625; SD=.48718), and changes in drawings (M=4.313; SD=.46644). Other causes identified in the study are staffing problems (M=4.350; SD=0.47998), equipment unavailability (M=4.438; SD=.49921), poor supervision (M=4.800; SD=0.40252), construction mistakes (M=4.838; SD=.37124), poor coordination on site (M=4.788; SD=0.41166), labour disputes and strikes (M=4.225; SD=.42022) and changes in specifications (M=4.750; SD=.45574).

Results from the table (Table 4.5) identified seven (7) major causes of construction delays as reported by the respondents. These seven variables had a mean and a standard deviation, which was above the average mean, and standard deviation of 4.543 and 0.44798 respectively. As noted in the table, the major causes of construction delays has been enumerated in other of highest mean value to include construction mistake (M=4.838; SD=0.37124), follow by poor supervision (M=4.803; SD=0.40252), poor coordination on site (M=4.788; SD=0.41166), changes in specification (M=4.750; SD=0.45574)contract modification (M=4.688; SD=0.46544) delayed payments (M=4.650; SD=.47998)and as well as materials procurement (M=4.625; SD=0.40718).

4.3.3 Effectiveness of Time Impact Analysis on Project Scheduling

Research question three sought to assess the effectiveness of time impact analysis on project scheduling. The study therefore analyzed the effects of time on the effectiveness of project groups, both within a group and between groups. The results are shown in Table 4.6.

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Table 4.6: Effectiveness of Time Impart Analysis in Project Scheduling (Regression ANOVA)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.459	1	3.459	26.600	.001
Within Groups	4.941	38	.130		
Total	8.400	39			

Source: Field Data Analysis, 2016

The analysis as presented in the regression ANOVA Table 4.6 above shows a perfect relationship of time effectiveness both within and between groups at a statistical significance of 0.001 and F value of 26.600.Furthermore, the study sought to identify the strength of time impart analysis on project scheduling. This was done using simple linear regression analysis statistics. Presented in Table 4.7 are the results of the outcome.

Table 4.7: Regression of the Time Impact Analysis on Project Scheduling

Model		Unstandardized Coefficients		Coefficients Standardized	R	R^2	t	Sig.
		B	Std. Error	Beta				
1	(Constant)	.176	.062				2.854	.001
	Time impart Analysis	.824	.160	.642			5.158	.001
					0.76	0.67*		

*Predictor: (Constant), Time impart Analysis

a. Dependent Variable: Project Scheduling

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Source: Author's Field Data (2016)

Table 4.7 shows the linear regression of effects of time impact of delays in project scheduling in the construction industries as pertained to pr6ject execution in Ghana. Table 4.7 also displays Unstandardized (b) and standardized (beta) regression coefficients, the correlation coefficient (R), adjusted R^2 and the value of t and its associated p-value for the variable that entered into the equation. Results of regression analysis indicate that much of the variation in the dependent variable (project scheduling) is explained with adjusted R-square of 0.67 (p-value of 0.001) with the independent variable (time analysis) as shown in Table 4.7.

The adjusted R-square value of 0.67 indicates that 67% of the variation in project scheduling can be attributed to Time analysis. This appears to suggest that the present regression model appears to be statistically significant predictor of project scheduling. It could also be seen from Table 4.9 that Time analysis explained the bulk of the variance in Project scheduling (beta= .642, t=5.158, p<.001). In summary, it appears that Time analysis is a best predictor of project scheduling in the execution of construction projects among the construction firms in Ghana.

4.3.4 Impacts of Construction Delays on an As-planned Project

Research question four sought to measure the impacts of construction delays on an as-planned project. The outcome is presented in Table 4.8.A regression analysis was conducted to assess the relationship between construction delays and as-planned projects and to determine by the relationship if construction delays have any significant effect on as-planned projects.

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Table 4.8: Regression of the Impact of Delays on As-planned Project

Model		Unstandardized Coefficients		Coefficients Standardized	R	R^2	t	Sig.
		B	Std. Error	Beta				
1	(Constant)	2.2717	.030				1.000	.001
	Delays	.941	.053	.943			17.544	.001
					0.78	0.70		

a. Dependent Variable: As planned projects

Source: Author's Field Data (2016)

Table 4.8 shows the results of regression analysis of the impact of delays on as-planned project in Ghana. Table 4.8 also displays Unstandardized (b) and standardized (beta) regression coefficients, the correlation coefficient (R), adjusted R^2 and the value of t and its associated p-value for the variable that entered into the equation. The results of linear regression analysis showed that the adjusted R square was 0.70 and significant level of 0.001. This indicates that 70% of variation in as planned projects can be attributed to construction delays. It could also be seen from Table 4.8 that construction delays explained the bulk of the variance in as-planned project (beta= .943, t=17.544, p<.001). In summary, it appears that a construction delay is a best predictor of as-planned project in Ghana.

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CHAPTER FIVE

DISCUSSIONS OF RESULTS

5.1Introduction

This section of the chapter presents the discussion of results in relation to the set objectives. The main objective of the study was to assess the schedule delay analysis in construction projects using the time impact analysis method. Specifically, the study sought to determine the objectives and importance of scheduling in construction projects, general causes of construction delays, effectiveness of time impact analysis of project scheduling, and the impact of construction delays on as-planned project.

5.2 Objectives and Importance of Scheduling in Construction Projects

Results from the study showed that the major objectives of scheduling in construction projects in the construction industries include: to expose and adjust conflicts between trades or subcontractors (M=4.775; SD=0.42022), to serve as an effective project control tool (M=4.763; SD=0.42824) and to resolve delay claims (M=4.675; SD=0.47133). Further analysis revealed that the importance of scheduling was to finish projects on time (M=4.625; SD=0.48718, to ensure customer satisfaction (M=4.513; SD=0.50300) and finish project within budget (M=4.250; SD=0.43574). In addition, the respondents perceived that lack of scheduling to construction projects results in delays in construction projects (M=4.750; SD=.43574).It is suffice to say that the construction industry is complex in its nature because it comprises large numbers of parties as owners (clients), contractors, consultants, stakeholders, and regulators. Despite this complexity, the industry plays a major role in the development and achievement of society's goals. It is one of the largest industries and contributes to about 10% of the gross national product (GNP) in industrialized countries (Navon

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2005). However, many local construction projects report poor performance due to many evidential project-specific causes which include poor scheduling of projects (UNRWA 2006). As noted by Razaque et al. (2012), the objectives of project scheduling approach are to focus on critical chain schedule and risk management. The authors further asserted that the manager is responsible for a project to focus for answering the fundamental questions related to the project throughout the different phases of project. In reality based on project, the critical approach is always changed critic of with progress of project, and the project manager has no prediction to project future time. Therefore, risk management is very necessary to project success and it is as a critical component of managing any project (Abdelgawad & Fayek, 2010).

5.3 Major Causes of Construction Delays

A look at the major causes of construction delays the study identified seven (7) major causes of construction delays. These include construction mistake (M=4.838; SD=0.37124), follow by poor supervision (M=4.803; SD=0.40252), poor coordination on site (M=4.788; SD=0.41166), changes in specification (M=4.750; SD=0.45574) contract modification (M=4.688; SD=0.46544) delayed payments (M=4.650; SD=.47998) and as well as materials procurement (M=4.625; SD=0.40718).

Other notable causes of construction delays were financial processes and difficulties on the part of contractors and clients (M=4.300; SD=.46115), economic problems (M=4.300; SD=0.4611), and changes in drawings (M=4.313; SD=0.46644). Others also include staffing problems (M=4.354; SD=.47998), equipment unavailability (M=4.438; SD=.49921), and labour disputes and strikes (M=4.225; SD=.42022).

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The study also showed that the means of the various variables under major causes of construction delays as pertained to the Ghanaian construction industry are statistically significant variables in other studies in other places as well. Assaf et al. (1995), for instance studied the main causes of delay in large building projects in Saudi Arabia and their relative importance. In their study, the largest number of causes of delay (56 causes) was listed and the respondents were asked to point out their degree of importance. The authors grouped the delay factors into nine major groups: financing, materials, contractual relationships, project changes, government relations, manpower, scheduling and control, equipment, and environmental factors. The financing group of delay factors was selected as the most significant delay factor by all parties and that environment group was selected as least significant.

In another observation, Odeh and Battaineh (2002) carried out a study to determine the most significant causes of construction delays with traditional type of contracts with regard to contractors and consultants. According to the results of the study, owner interference, inadequate contractor experience, financing and payments, labour productivity, slow decision making, improper planning, and subcontractors are among the top ten most significant causes of delays. Another study was by Kaliba et al. (2009) which aimed to determine the causes and effects of cost escalation and schedule delays in road construction projects in Zambia. The authors compile the main causes of delays in road construction projects which are determined according to their survey, as in the following: delayed payments, financial processes and difficulties on the part of contractors and clients, contract modification, economic problems, materials procurement, changes in drawings, staffing problems, equipment unavailability, poor

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supervision, construction mistakes, poor coordination on site, changes in specifications and labour disputes and strikes.

Similarly, Frimpong et al. (2003) carried out a study to determine and assess the relative importance of causes of delays and cost overruns in Ghana groundwater construction projects. The research showed that monthly payment difficulties from agencies, poor contractor management, material procurement, poor technical performances, and escalation of material prices were the main causes in the study. Odabaşı (2009) also investigated factors affecting construction durations and models for estimating construction durations. The author selected from the literature and listed the most significant ones under eleven headings as: cost, cash flow, productivity on site, material procurement, project related factors, technology, and methodology of construction, experience, coordination, weather, construction site, and the degree of completeness of design project.

5.4 Effectiveness of Time Impact Analysis on Project Scheduling

The results from this study also indicated that a relationship exist between time impact analysis and project scheduling. It was revealed that project scheduling was explained by 67.0% (R^2= 0.67) of the variance in time impact analysis. This appears to suggest that the present regression model is a good predictor of project scheduling. In summary, it appears that Time impact analysis is a best predictor in the execution of Project scheduling in construction projects in Ghana. The results indicate that there was significant correlation between Time impact Analysis and Project Scheduling and that a lack of Time impact Analysis can have significant effects on Project Scheduling. Callahan et al. (1992) claim that schedules have an important role in construction

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delays; since the effects of delays on the project completion date can be displayed and future delays can be anticipated by rescheduling the project through the computer.

Callahan et al. (1992) claimed that the probabilities of on-time, on-budget, dispute-free completion may be increased by means of a schedule and the purpose of the schedules is specified by the individual using the schedule and its effective within and between project teams or work groups. Nguyen (2007) indicated that the Time Impact Analysis method (TIA) is one of the most reliable techniques presently. In addition, Alkass et al. (1996) stated that this method is a variation of the window analysis technique, also in this method, the analyst focuses on a specific delay or delay activity, whereas in the window analysis the analyst focuses on time periods (also known as window or snapshot). This method analyzes the impacts of delays chronologically, starting with the first delay, by incorporating each delay (sometimes using a fragnet- or subnet-works) into an updated CPM schedule.

The analyst determines the amount of project delay resulted from each of the delaying activity successively by calculating the difference between the project completion date of the schedule after the addition of each delay and that prior to the addition (Ndekugri et al. 2008). According to Ndekugri et al. (2008), Time Impact Analysis is the most appropriate method for specifying the amount of time extension that the contractor should have been given at the time that an excusable risk appeared. However, in order to apply this method successfully, the daily records and diaries should be noted very meticulously and accurately. Otherwise, the analysis will not give correct results.

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5.5 Impacts of Construction Delays on As-planned Project

Furthermore, this current study assessed the impact of construction delays on as-planned project. The results of linear regression analysis showed that the adjusted R square was 0.70 and significant level of 0.001. This indicates that 70% of variation in as planned projects can be attributed to construction delays. This appears to suggest that the present regression model is a good predictor of as-planned project. It was revealed that construction delays explained the bulk of the variance in as-planned projects (beta= .943, t=17.544, p<.001). In summary, it appears that construction delay is a best predictor of as-planned project in Ghana. The results indicate that there was significant correlation between delays and project planning and that a lack of delay or inefficient scheduling can have significant effects on as-planned projects. This finding agrees with assertions made by other authors.

A study by Aibinu and Jagboro, (2002), for instance, revealed six effects of delay on project delivery in Nigerian construction industry, which are time overrun, cost overrun, dispute, arbitration, total abandonment, and litigation. Ramabodu and Verster (2010) identified critical factors that cause cost overruns in construction projects as changes in scope of work on site, incomplete design at the time of tender, contractual claims (extension of time with cost), lack of cost planning and monitoring of funds, delays in costing variations and additional works. These critical factors in turn are the delay factors. Chileshe and Berko (2010) indicated that causes cost overrun in Ghanaian road construction sector are delays in monthly payments to contractors; variations; inflation, and schedule slippage. Again, these explain the causes of delays and the effect of cost overrun.

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Furthermore, Callahan et al. (1992) claimed that this is because, project scheduling predicts project completion for contractors is that they can arrange crew sizes, shifts or equipment to speed or slow progress. While, for architects or engineers the purpose is to determine how long design and construction will take for completion of the project. The authors add that subcontractors use the information of specific activities' start and finish times to predict when they are needed at the site. In addition, the activity completion dates are used by owners in order to decide when to deliver owner-furnished equipment and to coordinate partial occupancy. Another purpose of scheduling for contractors is to reveal and resolve conflicts between firms or subcontractors. Both for contractors and owners schedules are used to plan cash flow. Callahan et al. (1992) also indicate that schedules are used for measuring delay and time extensions. If the schedules are regularly updated including work sequences, unanticipated delays, actual activity completion dates and change orders, then the owner and contractor can measure the effect of additional works and unanticipated delays, thus avoiding disputes.

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CHAPTER SIX

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the summary of the major findings of the study, conclusions and recommendations for further studies.

6.2 Summary of Findings

The purpose of the study was to assess the effects of schedule delay analysis in construction projects using a case study in Ashanti, Brong-Ahafo, and Eastern Region of Ghana. The summary of the findings are as follows:

6.2.1 Objectives and Importance of Scheduling in Construction Projects

The first research objective sought to study and understand project scheduling as pertained to the construction industry in Ghana. The study showed that the major objectives of scheduling in construction projects in the construction industries include "to expose and adjust conflicts between trades or subcontractors" and to "resolve delay claims". The study further showed that the importance of scheduling was to finish projects on time, ensuring customer satisfaction and finish project within budget. In addition, the respondents perceived that lack of scheduling to construction projects results in delay of construction projects.

6.2.2 Major Causes of Construction Delays

Research objective two sought to determine major causes of construction delays as pertained to the construction industry in Ghana. The study identified seven (7) major causes of construction delays, which are construction mistakes, poor supervision, poor

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coordination on site followed by changes in specifications, contract modification, delayed payments and, as well as materials procurement. Other minor notable causes of construction delays were financial processes and difficulties on the part of contractors and clients to release money or resources for the project, misunderstanding between contractor and client in terms of scope of work and choice of materials, economic problems, and changes in drawings, staffing problems, equipment unavailability, labour disputes and strikes.

6.2.3 Effectiveness of Time Impact Analysis of Project Scheduling

Research objective three sought to assess the effectiveness of time impact analysis on project scheduling. The results from this study indicated that a relationship exist between time analysis and project scheduling. It was revealed that project scheduling was explained by 67.0% (R^2= 0.67) of the variance in time analysis. This appears to suggest that the present regression model is a good predictor of project scheduling in construction projects in Ghana.

6.2.4 Impacts of construction delays on As-planned project

Research objectives four sought to measure the impacts of construction delays on an as-planned project. The results of linear regression analysis showed that the adjusted R square was 0.70 and significant level of 0.001. This indicates that 70% of variation in as planned projects can be attributed to construction delays. This appears to suggest that the present regression model is a good predictor of as-planned project. It was revealed that construction delays explained the bulk of the variance in as-planned projects (beta= .943, t=17.544, p<.001). In summary, it appears that construction delay is a best predictor of as-planned project in Ghana.

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6.3 Conclusions

Theoretically, this study has provided several empirical evidences on Schedule Delay Analysis in construction projects. It is suffice to say that scheduling in construction projects is important in finishing projects on time and within budgets, as well as to ensure customer satisfaction. However, construction schedule delays in a project can cause major problems for contractors and owners resulting in costly disputes controversial issues and adverse relationships between all the project participants such as poor supervision, contract modification and construction mistakes, materials procurement and poor coordination on site, as well as delayed payments. Again, it may be concluded that time impact analysis has an impact on project scheduling, whereas construction delays also affects as-planned project in Ghana.

6.4 Recommendations

Based on this study, some general recommendations are presented here, which could also have been useful in minimizing or avoiding the impacts of the construction delays In the project analyzed.

The design of the project should be finalized with all details before tendering the work so as to avoid change orders by the owners.

1. Owner should allocate sufficient time and adequate finances for the design stage of the project.
2. The selection of the contractor should be done through pre-qualification of the firms.
3. The owners should mobilize all resources and get the necessary permissions before signing the contract.
4. The contract should include clauses of incentive for early completion.

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5. The schedule should be prepared and agreed over by both the contractors and the consulting companies.
6. The contractor should employ qualified work teams and provide in-house worker training in order to improve managerial and technical skills.
7. The contractor should also have a project manager in his team to check the progress of work and ensure timely delivery of materials.
8. The last but most important issue is to establish a healthy communication between all parties in order to solve problems in a timely manner.

University of Education,Winneba http://ir.uew.edu.gh

REFERENCES

Abd El-Razek, M. E., Bassioni, H. A. & Mobarak, A. M. (2008).“Causes of Delay in Building Construction Projects in Egypt”*, Journal of Construction Engineering and Management, Vol. 134, No. 11, pp.831-841.*

Abdelgawad, M. & Fayek, A. R (2010). A comprehensive hybrid framework for risk analysis in the construction industry using combined FMEA, fault trees, event trees, and fuzzy logic. *Journal Constriction Engineering Management. ASCE* (Submitted 29- March).

Abdul-Rahman, H., Berawi, A.R., Berawi, A.R., Mohamed, O., Othman, M. &Yahya, I.A. (2006). *‘Delay Mitigation in the Malaysian Construction Industry’,* Journal of Construction Engineering and Management**,** *132 (2), 125-133*

Acharya, N.K., Lee, Y.D. &Im, H.M. (2006). *‘Investigating delay factors in construction industry: A Korean perspective’,* Korean Journal of Construction Engineering and Management, ***10****, 177-190*

Adnan, H., Jusoff, K. &Salim, M.K. (2008). *‘The Malaysian Construction Industry’s Risk Management in Design and Build’,* Journal of Modern Applied Science*,* ***2*** *(5), 27-33*

Ahmed, S. M., Azhar, S., P. Kappagantula, & Castillo, M. (2003).“Construction Delays in Florida: An Empirical Study”*, (http://www.scribd.com/doc/28215106 (Construction-Delays-in-Florida-a- Study) Accessed on: 08/07/2010.*

Ahmed, S., Azher, S., Castillo, M. & Kappagantula, P. (2002).*Construction delays in Florida; an empirical study, Florida, 2002.http://www.cm.* fiu.edu/publication/Delays .pdf

University of Education,Winneba http://ir.uew.edu.gh

Aibinu, A.A. &Jagboro, G.,O. (2002). The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management,* Vol. 20, pp. 593–

Aibinu, A.A &. Odeyinka, A. (2006). *'Construction delays and their causative factors in Nigeria',* Journal of Construction Engineering Management, ***132** (7), 667-677*

Aiyetan, O.A., Smallwood, J.J., & Shakantu, W. (2008). Influences on construction project delivery time performance. *In the proceeding* of Third Built Environment conference, Cape Town, South Africa

Ajanlekoko, J.O. (1987). *'Controlling cost in the construction industry',* Lagos QS Digest*, Lagos,* ***1** (1), 8–12*

Akinsola, A.O. (1996). *'Neural network model for predicting building projects' contingency', In* Conference proceedings of association of researchers in construction management*, ARCOM 96, Sheffield Hallam University, England, 507–16*

Akubia, J. E.,K. (2014). Geo-Information Technology Application to Changing Climate and Land-Use-Cover Impacts on Water Resources and Socio-Economic Conditions in the Lower Volta Basin, Ghana. Unpublished thesis submitted to the Institute for Environment and Sanitation Studies, for the award of a MPHIL degree

Alaghbari, W., Kadir, M.R.A., Salim, A. & Ernawati (2007).*'The significant factors causing delay of building construction projects in Malaysia. Engineering',* Construction and Architectural Management Journal, ***14** (2), 192-206*

Alkass, S., Mazerolle, M. & Harris, F. (1994). *'Construction delay analysis techniques',* Journal of Construction Management Economics, ***14** (5), 375–94*

University of Education,Winneba http://ir.uew.edu.gh

Alkass, S., Mazerolle, M. & Harris, F. (1996). "Construction delay analysis techniques", *Construction Management and Economics, Vol. 14, Issue 5, pp 375-394.*

Al-Khalil, M. & Al-Ghafly, M. (1999). *'Important causes of delay in public utility projects in Saudi Arabia',* Journal of Construction Management Economics, *17 (5), 647–55*

Al-Moumani, A. (2000). *'Construction delay: a quantitative analysis',* International Journal of Project Management, *20, 51–59*

Arditi, D. & Pattanakitchamroon, T. (2008)."Analysis Methods in Time- Based Claims", *Journal of Construction Engineering and Management, Vol. 134, No. 4 pp. 242-252.*

Arditi, D., Akan G. T. & Gurdamar, S. (1985). "Reasons for Delays in Public Projects in Turkey", *Construction Management and Economics, Vol. 3, pp 171-181.*

Arıkan, M. & Dikmen, İ. (2004). "Construction Engineering and Management, Lecture Notes", *Middle East Technical University, Department of Civil Engineering.*

Assaf, S. A., Al-Khalil, M. & Al-Hazmi, M. (1995). "Causes of delay in large building construction projects", *Journal of Management in Engineering, Vol. 11, Issue 2, pp. 45-50.*

Assaf, S.A. (2006). Causes of delay in large construction projects. *International Journal of Project Management,* 24 (2006): 349–357.

Baldwin, J. R., Manthei, J. M., Rothbart, H. & Harris, R. B. (1971). "Causes of Delay in the Construction Industry", *Journal of the Construction Engineering Division, Vol. 97, No. 2, pp. 177-187.*

University of Education,Winneba http://ir.uew.edu.gh

Baloi, D. & Price, A.D.F. (2003). Modelling global risk factors affecting construction cost performance, International *Journal of Project Management*, 21, pp. 261-269.

Barrie, D. S. & Paulson, B. C. (1992).“Professional Construction management: Including CM, Design-Construct, and General Contracting”*, McGraw-Hill, USA.*

Behboudi, S.F. (2009). A Model to predict the impact of Excusable and Non-Excusable Delays on selected residential construction projects: Carleton University.

Bennett, J. & Grice, T. (1990). *‘Procurement systems for building’, In: Brandon, P. (ed)* Quantity Surveying Techniques: New Directions*, Blackwell Scientific Publications, Oxford*

Bennett, J., Flanagan, R., Goodacre, P., Gray, C., McLaughlin, N. & Norman, G. (1979). UK and US Construction Industries: A comparison of Design and Contract Procedures Surveyors Publications, UK London

Bowen, P.A., Hall, K.A., Edwards, P.J., Pearl, R.G. & Cattell, K.S. (2002). *‘Perceptions of Time, Cost and Quality Management on Building Projects’,* the Australian Journal of Construction Economics and Building*, **2**, 48-56*

Bramble, B.B., D’Onofrio, M.F., &Stetson, J.B. (1990). Avoiding & Resolving Construction Claims. Kingston, Massachusetts: R.S. Means Co., 1990.

Callahan, M. T., Quackenbush, D. G. & Rowings, J. E. (1992).“Construction Project Scheduling”*, McGraw-Hill, USA.*

Chileshe, N. & Berko, P. D. (2010).Causes of project cost overrun within Ghanaian road construction sector. *In the proceeding* of ASOCSA 5th Built Environment Conference, Durban South Africa.

University of Education,Winneba http://ir.uew.edu.gh

Chileshe, N., Haupt, T. & Fester, F. (2007).Assessing the readiness of building diplomates for the South African construction industry. *Journal for Education in the Built Environment*, 2 (2).

Clough, R.H., Sears, G.A., & Sears, S.K. (2000).Construction Project Management.Fourth Edition. New York: John Wiley & Sons, 2000.

Cohen, M.W. &Palmer, G.R. (2004).Project risk identification and management, AACE International Transactions.

Cohen P.A. (1981) Student Ratings of Instruction and Student Achievement: A Meta-analysis of Multisection Validity Studies. Sage journal

Cullen, J., O' Connor, M. and Mangan, J. (2004) "Matching management tools and techniques with management challenges", Strategy & Leadership, Vol. 32 Issue: 3, pp.27-30

De-looffL. A. (1996) Information Systems Outsourcing Decision Making: A Managerial Approach. IGI Publishing Hershey, PA, USA

De Marco, A. (2011). *Project Management for Facility Constructions*, DOI 10.1007/978-3-642-17092-8_8, C _ Springer-Verlag Berlin Heidelberg 2011 A. De Marco, *Project Management for Facility Constructions*, DOI 10.1007/978-3-642-17092-8_8, C _ Springer-Verlag Berlin Heidelberg 2011

Durrheim, K. & Painter, D. (2006). Research in practice: Applied methods for the social sciences. 2nd ed. Cape Town: University of Cape Town Press.

Faridi, A. S., & El-Sayegh, S. M. (2006)."Significant factors causing delay in the UAE construction industry", *Journal of Construction Management and Economics, Vol. 24, Issue 11, pp. 1167 – 1176.*

Finke, R. M. (1999). "Window analyses of compensable delays," *Journal of Construction Engineering and Management*, Vol. 125, No.2, pp. 96-100.

University of Education,Winneba http://ir.uew.edu.gh

Finnerty, J. D. (1996). Project Financing. Asset- Based Financial Engineering. New York, New York. John Wiley & Sons.

Flanagan, R., Norman, G., Ireland, V. & Ormerod, R. (1986). *A Fresh Look at the UK and US construction Industry Building Employers' Confederation, UK, London*

Fraenkel, J.R, & Wallen, N.E. (1996). How to Design and Evaluate Research in Education, New York: McGraw-Hill.

Frimpong, Y., Oluwoye, J. & Crawford, L. (2003)."Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study"*, International Journal of Project Management, Vol. 21, Issue 5, pp 321-326.*

Giridhar, P. &Ramesh, K. (1998).*Effective management of Turnkey projects, Aace Transactions, PM7- PM11. Istanbul*

Halpin, D. W & Woodhead, R. W. (1998)."Construction management*", John Wiley, New York.*

Hancher, D. E. & Rowing, I. E. (1981)."Setting Highway construction contract duration," *Journal of Construction Engineering and Management*, ASCE, 1981, 107(2), pp. 69-79.

Haseeb, M., Xinhai-Lu, A. Bibi, A. & Maloof, U. D., & Dyian, R. W. (2011). Problems of projects and effects of delays in the construction industry of Pakistan. *Australian Journal of Business and Management Research, 1 (5) pp 41-50.* www.qsspace.qu.edu.qa/handle/10576/7921 Accessed 4/9/2012

Hegazy, T., & Menesi, W. (2008)."Delay Analysis under Multiple Baseline Updates"*, Journal of Construction Engineering and Management, Vol. 134, No. 8 pp. 575-582.*

University of Education,Winneba http://ir.uew.edu.gh

Hegazy, T., & Zhang, K. (2005). "Daily Windows Delay Analysis", *Journal of Construction Engineering and Management, Vol. 131, No. 5 pp. 505-512.*

Hinze JW (2004). Construction planning and scheduling, 2nd edn. Pearson Prentice Hall, Upper Saddle River, NJ

Hinze, J. (1993)."Construction contracts", *McGraw-Hill, New York.*

Howick, S., Ackermann, E.,& Terry, W. F. (2009). Understanding the causes and consequences of disruption and delay in complex projects: How system dynamics can help. School of Management, Southampton, University Southampton SO171BJ, UK, www.ce.berkeley.edu/.../Ibbs_ Liu_SystemDynamic_2005.pdf Accessed8/7/2011intl.com/brochures/ WindowsSchedAnal.pdf.

Kaliba, C., Muya, M. & Mumba, K. (2009). "Cost escalation and schedule delays in road construction projects in Zambia", *International Journal of Project Management, Vol. 27, Issue 5, pp 522-531.*

Kaming, P., Olomolaiye, P., Holt, G., & Harris, F. (1997).Factors influencing construction time and cost overruns on high-rise projects in Indonesia. Construct Management and Economics Vol 15 pp.83-94

Kaoa C. & Yangb, J. (2009)."Comparison of windows-based delay analysis methods", *International Journal of Project Management, Vol. 27, Issue 4, pp 408-418.*

Kartam, S. (1999)."Generic Methodology For Analyzing Delay Claims", *Journal of Construction Engineering and Management, Vol. 125, No. 6 pp.409-419.*

Kelleher, T. J. (2005)."Smith, Currie & Hancock LLP's common sense construction law: a practical guide for the construction Professional", *John Wiley, New Jersey, USA.*

University of Education,Winneba http://ir.uew.edu.gh

Kikwasi, G. J. (2012). Causes and Effects of Delays and Disruptions in Construction Projects in Tanzania: *Australasian Journal of Construction Economics and Building: Conference Series* 1 (2), 52-59.

Kim, Y., Kim, K. & D. Shin (2005).“Delay Analysis Method Using Delay Section”, *Journal of Construction Engineering and Management, Vol. 131, No. 11 pp. 1155-1164.*

Knoke, J.R. &Jentzen, G.H. (1996). “Developing an As-Built Schedule From Project Records.” *Transactions of AACE International*, 1996.

Kombo, D.,K. & Tromp, D.A. (2006). Proposal and thesis writing; an introduction; 2nd reprint; Pauline Publication Africa; Kenya. www.wagner.nyu.edu /.../whatisresearch.php Accessed18/5/2011.

Koushki, P.A., Al-Rashid, K. & Kartam, N. (2005). *‘Delays and cost increases in the construction of private residential projects in Kuwait’,* Journal of Construction Management and Economics, ***23*** *(3), 285-294*

Kumaraswamy, M.M. & Chan, D.W.M (1997). *‘A comparative study of causes of time overruns in Hong Kong construction projects’,* International Journal of Project Management, ***15*** *(1), 55-63*

Kumaraswamy, M.M. & Chan, W.M.C. (2002). *‘Compressing construction durations: lessons learned from Hong Kong building projects’,* International Journal of Project Management, *20, 23-35*

Kumaraswamy, M.M., & Chan, W.M. (1998). What contributes to construction delays. *Journal of Construction Management & Economics*, pg 17-29.

Latham, M. (1994). *Constructing the Team, HMSO, London, 87-92*

Lawrence F. B. (200).The Management of Construction Project Life Cycle Approach.1ed. Butterworth Heinemann New York.

University of Education,Winneba http://ir.uew.edu.gh

Lee, H., Ryu, H. J. Yu, B.& Kim, J. (2005).“Method for Calculating Schedule Delay Considering Lost Productivity”, *Journal of Construction Engineering and Management, Vol. 131, No. 11 pp. 1147-1154.*

Leedy, P.D & Ormrod, J.E. (2005).*Practical Research*. Planning and Design. 8th Ed. Pearson Education, Upper Saddle River, New Jersey

Le-Hoai, L., Lee, Y.D. & Lee, J.Y. (2008). *‘Delay and Cost Overruns in Vietnam Large Construction Projects: A comparison with other selected countries’,* KSCE Journal of Civil Engineering, *367-377*

Levy, S. M. (2006).“Project Management in Construction”*, McGraw-Hill, USA.*

Lo, T.Y., Fung, I.W.H. & Tung, K.C.F. (2006). *‘Construction delays in Hong Kong civil engineering projects’,* Journal of Construction Engineering Management, ***132*** *(6), 636-649*

Long, N.D., Ogunlana, S., Quang, T. & Lam, K.C. (2004). *‘Large construction projects in developing countries: a case study from Vietnam’,* International Journal of Project Management, ***22****, 553-561*

Luu, T.V., Kim, S., Tuan, N.V. & Ogunlana, S.O. (2009). *‘Quantify schedule risk in construction projects using Bayesian belief networks’,* International Journal of Project Management, ***27****, 39-50*

Manavazhi, M. R. & Adhikari, D.K. (2002).“Material and equipment procurement delays in highway projects in Nepal,” *International Journal of Project Management*. 20(8), pp. 627-632.

Mansfield, N. R., Ugwu, O. O. & Doran, T. (1994).“Causes of delay and cost overruns in Nigerian construction projects”*, International Journal of Project Management, Vol. 12, Issue 4, pp. 254-260.*

Marshall, (1997). How to design and conduct a successful project

University of Education,Winneba http://ir.uew.edu.gh

Mbabazi, A., Hegazy, T. & Saccomanno, F. (2005).“Modified But-for Method for Delay Analysis”*, Journal of Construction Engineering and Management, Vol. 131, No. 10, pp. 1142-1144.*

Meredith J,& Mantel S (2006). Project management: a managerial approach, 6th edn. Wiley, New York, NY

Mezher, T. & Tawil, W. (1998). *‘Causes of delays in the construction industry in Lebanon’,* Engineering Construction Architecture Management Journal, ***5*** *(3), 252–60*

Miller, R., &Lessard, D. (2001).Understanding and managing risks in large engineering projects, *International Journal of Project Management*, 19, pp. 437-443.

Mills, A. (2001). A systematic approach to risk management for construction, *Structural Survey*, 19(5), pp. 245-252.

Mohamad, M.R.B. (2010). The factors and effect of delay in government Construction project, Case study in kuantan: University Malaysia Pahang.

Mohan, S.B., & Al-Gahtani, K.S. (2006).Current delay analysis techniques and improvements. *Cost Engineering*, 48(9), 12-21.

Mubarak, S. (2005). “Construction Project Scheduling and Control”*, Pearson Prentice Hall, USA.*

Navon, R. (2005) Automated Project Performance Control of Construction Projects. Automation in Construction, 14, 467-476.

University of Education,Winneba http://ir.uew.edu.gh

Ndekugri, I., Braimah, N. & Gameson, R. (2008).“Delay Analysis within Construction Contracting Organizations”, *Journal of Construction Engineering and Management, Vol. 134, No. 9, pp.692-700.*

NEDO (1988).*Faster Building for Commerce HMSO, UK. London*

Newitt, J. S. (2005). *Construction Scheduling: Principles and Practices*. Upper Saddle River, NJ: Pearson Prentice Hall.

Ng, S.T., Skitmore, M., Deng, M. Z. M., & Nadeem, A. (2004).Improving existing delay analysis techniques for the establishment of delay liabilities. *Construction Innovation*, 4(1), 3-17.

Nguyen, L. D. (2007).“The Dynamics of Float, Logic, Resource Allocation, and Delay Timing in Forensic Schedule Analysis and Construction Delay Claims”, *Ph. D. Dissertation Thesis, Department of Engineering-Civil and Environmental Engineering, University of California, Berkeley.*

Nguyen, L. D. & Ibbs, W. (2008).“FLORA: New Forensic Schedule Analysis Technique”, *Journal of Construction Engineering and Management, Vol. 134, No. 7, pp. 483-491.*

Noulmanee, A., Wachirathamrojn, J., Tantichattanont, P. & Sittivijan, P. (1999).Internal causes of delays in highway construction projects in Thailand.www.ait.c1et.comAccessed 9/5/2011.

Nunnally, *J. C., &*Bernstein, I. H. (*1994*). Psychometric theory (3rd ed.). New.York; McGraw-Hill.

Oberlender, G. D. (2000).“Project Management for Engineering and Construction”, *McGraw-Hill, Singapore.*

University of Education,Winneba http://ir.uew.edu.gh

Odabaşı, E. (2009).“Models for Estimating Construction Duration: An Application for Selected Buildings on the Metu Campus”, *Unpublished Master Thesis, METU, Turkey.*

Odeh, A. M. and Battaineh, H. T. (2002).“Causes of construction delay: traditional contracts”, *International Journal of Project Management, Vol. 20, Issue 1, pp 67-73.*

Odeyinka, H.A. & Yusif, A. (1997).‘The causes and effects of construction delays on completion cost of housing project in Nigeria’, *Journal Financial Manage Property Construction,* **2** (3), 31–44.

Ogunlana, S. O. & Promkuntong, K. (1996). Construction delays in a fast-growing economy: company Thailand with other economies. *International Journal of Project Management,* 14(1): 73-45.

Okpala, D.C. & Aiekwu, A.N. (1988). *‘Causes of high costs of construction in Nigeria’,* Journal of Construction Engineering and Management*, **114** (2), 233-244.*

Oliveros, A. V. O. & Fayek, A. R. (2005).“Fuzzy Logic Approach for Activity Delay Analysis and Schedule Updating”, *Journal of Construction Engineering and Management, Vol. 131, No. 1 pp. 42-51.*

Oxley, R. & Poskitt, J. (1996).“Management Techniques Applied to the Construction Industry”, *Blackwell Science Publishing, Great Britain.*

Pickavance, K. (2005). Delay and disruption in construction contracts, 3rd edition. Informa Legal Publishing UK.

Polit, D. F. & Hungler, B. P. (1993).*Nursing Research: Principles and methods*. Philadelphia: JB Lippincott Company.

University of Education,Winneba http://ir.uew.edu.gh

Pourrostam, T. & Ismail, A. (2011). Significant Factors Causing and Effects of Delay in Iranian Construction Projects: Australian Journal of Basic and Applied Sciences, 5(7): 450-456.

Project Management Institute (PMI) (2008).*A guide to the Project Management Body of Knowledge, Fourth Edition, PMBOK, Atlanta.*

Rahsid, Y., ulHaq, S., & Aslam, M. S. (2013). "Causes of delay in construction projects of Punjab-Pakistan: An empirical study," *Journal of Basic and Applied Scientific Research,* 3(10), pp. 87-96.

Ramabodu, M.S. &Verster, J.J.P. (2010).Factors Contributing to Cost Overruns of Construction Projects. *In the proceeding* of ASOCSA 5th Built Environment Conference, Durban South Africa.

Razaque, A., Bach, C., & Alotaibi, N.A. (2012). Fostering Project Scheduling and Controlling Risk Management .*International Journal of Business and Social Science Vol. 3 No. 14, pp. 118-127*

Reiss, G. (1995). "Project Management Demystified: Managing multiple projects", E &FN Spon, UK.

Rider, R.J. & Long, R.J. (2013).Analysis of Concurrent/Pacing Delay. New York: Long International Inc.

Sambasivan, M. & Soon, Y.W. (2007).*'Causes and effects of delays in Malaysian construction industry',* International Journal of Project Management, ***25****, 517-526.*

Sekaran, U. (1981). *Research methods for managers: A skill-building approach.* New York: John Wiley and Sons.

Shapiro, J., (2001). *Evaluation: Judgement Day or Management Tool?* Olive 1996

University of Education,Winneba http://ir.uew.edu.gh

Shi, J. J., Cheung, S. O. & Arditi, D. (2001).“Construction Delay Computation Method”*, Journal of Construction Engineering and Management, Vol. 127, No. 1 pp. 60-65.*

Smith, N. J. (2002).“Engineering Project Management”*, Blackwell Science Publishing, USA.*

Society of Construction Law (2002).“The Society of Construction Law Delay and Disruption Protocol”*, Oxfordshire, England.*

Sunjka, B. P. & Jacob, U. (2013). Significant causes and effects of project delays in the Niger delta region, Nigeria: SAIIE25 Proceedings: Stellenbosch, South Africa © 2013 SAIIE.

Swies, G., Swies. R., Hammad. A. A. & Shboul, A. (2008).*‘Delays in construction projects: The case of Jordan’,* International Journal of Project Management, ***26****, 665-674.*

Syed M., Ahmed, S. A., Mauricio, C. & Pragnya, K. (2002). Construction Delays in Florida: An Empirical Studywww.cm.fiu.edu/pdfs/Research-Reports Accessed 4/9/2012.

The Hindu (2007). *Hit by delays and cost escalation http://www.hindunnet.com/2007*

Theodore, T. (2009).Types of Construction Delays. Understanding them clearly, analysing them correctly. 2nd Edition. Oxford: Elsevier Inc. Pages 25-36.

Trauner, J.T., Manginelli, W.A., Lowe, J.S., Nagata, M.F. and Furniss, B.J. (2009) *Construction Delays: understanding them clearly and Delay Analysis in Construction Analyzing them correctly*. London: Elsevier Inc.

Tumi. S.A.H., Omran. A. & Pakir. A. H. K. (2009).*‘Causes of delay in construction Industry in Libya’,* The International Conference on Administration and Business*, 265-272.*

University of Education,Winneba http://ir.uew.edu.gh

United Nation Relief and Work Agency (2006)

Wahdan, M. I., Farid, A. T., & Abu Yousef, M. S. M. (2013). Study and Assessment of the Reasons for Project Delay or Stalled from Project Management View

Wei, K. S. (2010). "Causes, effects and Methods of minimizing delays in construction projects," Bachelor, UniversitiTeknologi Malaysia, Skudai.

Wickwire, J.M., Driscoll, T.J., Hurlbut, S.B. & Hillman, S. B. (2003)."Construction Scheduling: Preparation, Liability, and Claims Construction Library Law", 2nd ed., Aspen Publishers, USA. http://www.long.

William, M. &Trochim, K. (2006).*Research methods knowledge bases*.

Yang, J.B. & Yin, P.C. (2009). Isolated Collapsed But-For Delay Analysis Methodology. *Journal of Construction Engineering and Management, ASCE,* 135(7), 570-578.

Yang.J.,Yang.C. & Kao. C. (2010). 'Evaluating schedule delay causes for private participating public construction works under the Build-Operate-Transfer model', *International Journal of Project Management,* 28, 569-579.

Zou, P. X.W., Zhang,G. a& Wang, J. (2006). Identifying key risks in construction projects: life cycle and stakeholder perspectives. www.prress. net/papers/Zou_risks-constru Accessed 4/9/2012

University of Education,Winneba http://ir.uew.edu.gh

APPENDIX A

UNIVERSITY OF EDUCATION

ASSESSING THE EFFECT OF SCHEDULE DELAY ANALYSIS IN CONSTRUCTION PROJECTS:

A CASE STUDY IN ASHANTI, BRONG – AHAFO AND EASTERN REGION IN GHANA

QUESTIONNAIRE

This questionnaire is to collect information that would be used for academic purpose only. Your responses will be kept anonymous and confidential. Thank you for sparing your time to participate in the study.

Background of Respondent and Company

Please tick [√] in the appropriate box provided to indicate your answers.

1. Age.

18-25 [ ] 26-35[ ].36-45[ ] 45-60[ ] Over 60 yrs [ ]

2. Sex:

Male [ ] Female [ ]

3. How would you classify your profession?

Mason /Brick Layer [ ] Steel Bender [ ] Carpenter [ ] Planner [ ]

Plumber [ ] Labourer [ ] Glass Worker [ ] Architect [ ]

[ ]Other (please specify)……………………….

4. Please State the Specialty of Your Company

………………………………………………………………………………………

5. For how long has your company been in construction?

[ ] 1-10 [ ] 11-20 [ ] 21-30 [ ] 31 and above

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Section B

1. **To study and understand project scheduling,**

Is project scheduling a key activity in construction projects?

[ ] Yes [ ] No [ ] other, (Specify).....................................

Do delays affect construction projects?

[ ] Yes [ ] No [ ] other, (Specify).....................................

What are the objectives of scheduling in construction projects?

Statements	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
To calculate the project completion date					
To calculate the start or end of a specific activity					
To expose and adjust conflicts between trades or subcontractors					
To predict and calculate the cash flow.					
To evaluate the effect of changes					
To improve work efficiency					
To resolve delay claims.					
To serve as an effective project control tool					

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What is the importance of scheduling to construction projects?

Statements	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
To finish project on time					
To finish project within budget					
To ensure customer satisfaction					

What are the effects of a lack of scheduling to construction projects?

Statements	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
Delays					
Disruptions					
Cost and schedule overruns					

What are the major causes of construction delays?

Statements	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
Delayed payments					
Financial processes and difficulties on the part of contractors and clients					
Contract modification					
Economic problems					
Materials procurement					

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Changes in drawings					
Staffing problems					
Equipment unavailability					
Poor supervision					
Construction mistakes					
Poor coordination on site					
Changes in specifications					
Labour disputes and strikes					

What are the common schedule delay analysis techniques?

Statements	**Strongly Disagree**	**Disagree**	**Uncertain**	**Agree**	**Strongly Agree**
Global impact					
Net impact					
Adjusted as-built CPM					
Time impact					

On a scale of 1 to 5, 1 being "No Impact" and 5 being "Greatest impact", rate the effectiveness of time impact analysis in curtailing project delays.

1	**2**	**3**	**4**	**5**

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On a scale of 1 to 5, 1 being "No Impact" and 5 being "Greatest impact", rate the impact of construction delays on an as-planned project.

1	**2**	**3**	**4**	**5**

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APPENDIX B

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ASSESSING THE EFFECT OF SCHEDULE DELAY ANALYSIS IN CONSTRUCTION PROJECTS:

A CASE STUDY IN ASHANTI, BRONG – AHAFO AND EASTERN REGION IN GHANA

INTERVIEW GUIDE

This interview guide seeks to collect information that would be used for academic purpose only. Your responses will be kept anonymous and confidential. Thank you for sparing your time to participate in the study.

Section A

Background of Respondent and Company

Please provideappropriate response to the questions below.

1. What is your Age?………………………………….
2. What is the highest level of education you have received?
3. How would you classify your profession? ……………………….
4. Please State the Specialty of Your Company ………………
5. For how long has your company been in construction? …………………

Section B

To study and understand project scheduling

1. Is project scheduling a key activity in construction projects?

   [ ] Yes [ ] No

2. Do delays affect construction projects?

   [ ] Yes [ ] No

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3. What are some objectives of scheduling in construction projects?

   ……………………………………………………………………………

   ……………………………………………………………………………..

   ……………………………………………………………………………….

   ………………………………………………………………………………..

4. In your opinion what are importance of scheduling to construction projects?

   ……………………………………………………………………………

   ……………………………………………………………………………

   ……………………………………………………………………………

   ……………………………………………………………………………

5. What will be the effects of lack of scheduling to construction projects?

   ……………………………………………………………………………

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6. In your opinion what are the major causes of construction delays?

   ………………………………………………………..…………..

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7. What is the common schedule delay analysis techniques used in construction industries.

   ………………………………………………………..…………..

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   ……………………………………………………………..………

8. What are the impacts of using delay analysis techniques?

   ………………………………………………………..…………..

   ………………………………………………………………………....

   ……………………………………………………………..………