A STUDY ON APPLICABLE DELAY ANALYSIS TECHNIQUES OF THE BUILDING CONSTRUCTION INDUSTRY IN SRI LANKA

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A STUDY ON APPLICABLE DELAY ANALYSIS TECHNIQUES OF THE BUILDING CONSTRUCTION INDUSTRY IN SRI LANKA

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DECLARATION

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university to the best of my knowledge and believe it does not contain any material previously published, written or orally communicated by another person or myself except where due reference is made in the text. I also hereby give consent for my dissertation, if accepted, to be made available for photocopying and for inter library loans, and for the title and summary to be available to outside organizations.

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DEDICATION

Dedicated

To my beloved parents,

wife & kids

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ABBREVIATIONS

EOT	: Extension of Time
LD	: Liquidated Damages
SCL	: Society of Construction Law
PMBOK	: Project Management Body of Knowledge
US	: United State
TIA	: Time Impact Analysis
IPA	: Impact As-Planned
CAB	: Collapsed As-Built
CPM	: Critical Path Method
FIDIC	: Fedaration International Des Ingenieurs-Conseils

ABSTRACT

The construction industry in Sri Lanka are being implemented various standards to complete the projects in time to achieve satisfaction of stakeholders and to face the competitiveness over getting contracts in order to ensure their business sustainability. The successful completion of a project to an intended in time is not easy. Failure to complete the works is a breach of contract and normal remedy for breach is claim for damages. Extension of Time due to construction delays being a popular topic among researchers and many researches have been carried out covering different aspects of delays. However, the completion of project on time is somewhat unusual in the field of construction in Sri Lanka when considering complexity of civil engineering contracts and the tendencies for delays to occur.

This research makes a contribution by providing insights on the current status of project delay analysis practices and proposing ways as to how extension of time claim could be effectively analyze by the applicable techniques in Sri Lankan construction industry. The findings of the study disclose that the construction professionals in Sri Lanka are not conscious enough of the available sophisticated techniques for delay analysis. It is also established that the cost incurred for implementing proper delay analysis techniques, poor awareness about delay analysis techniques among construction professionals, unavailability of adequate records to adapt a proper analysis techniques and lack of experts in their project or organization are the major barriers for submitting proper extension of time claim.

Under this background recommendation were developed to improve an effective construction programme, a good record keeping at site level and awareness of delay analysis techniques to prepare for proper time extension claims.

CHAPTER 1

INTRODUCTION

There are many delay analysis standards available for "Extension of Time" (EOT) in respect of constructions but, most of construction industries in Sri Lanka reluctant to utilize such standards while implementing their projects. Based on late completion of a project, Liquidated Damages (LD) are implemented for the contractors or they are liable to EOT for cause beyond their control. Therefore it is required to be knowledgeable about such claims as well as the selection of the most appropriate delay analysis techniques among various techniques. This chapter briefly explains the framework carried out for this study.

1.1 Background

Extension of Time due to construction delays being a popular topic among researchers and many researches have been carried out covering different aspects of delays. However, the completion of project on time is somewhat unusual in the field of construction in Sri Lanka when considering complexity of civil engineering contracts and the tendencies for delays to occur. There are three factors that shape every project (PMBOK Guide, Fifth Edition).

- **Time –** The time to complete the project reflected in the project schedule.
- **Cost –** The project budget based on the cost of the resources, the people, equipment, and materials required to do the task.
- **Scope –**The goals and tasks of the project and the works required to complete them.

These three factors are directly linked together maintaining the equilibrium of the same until the project completion is vital requirement of the contractor so that to achieve the intended project goals and measuring the standard of project management.

Project management is the methodical application of skills, tools and techniques to accomplish a defined objective, usually within constraints of time, resources or cost (Deviprasadh, 2007). In Sri Lanka, lot of projects are delayed beyond its original time period impacting to the management of the project and the delay to completion of civil engineering projects has become a general practice. Therefore it is necessary that the construction professionals understand how they are dealt with in standards.

The construction industry in Sri Lanka are being implemented various standards to complete the projects on time in construction works to enhance satisfaction of stakeholders and, to face the competitiveness over getting contracts in order to ensure their business sustainability. The successful completion of a project to an intended in time is not easy. Failure to complete the works is a breach of contract and usual remedy for breach is claim for damages. Construction delays can be defined as time overrun either beyond the contract date or date that the parties agreed upon for delivery of a project (Assaf & Al-Helli, 2006).

Unlike other economic sectors, the construction industry is characterized by which discontinues, having distinct strategies and concerns in providing project deliverables to the clients under different contract obligations according to the nature and size of the project. If the proper management practices are engaged in Sri Lanka, construction projects can be delivered with better success in terms of enhanced project objectives.

Therefore, this research makes a contribution by providing insights on the current status of project delay analysis practices and proposing ways as to how EOT claims could be effectively analyze by the applicable techniques in Sri Lankan construction industry.

1.2 Aim

This research is aimed to answer the question “how the proper delay analysis practices could be promoted and enhanced for the extension of time claims in Sri Lankan construction industry?”

1.3 Objectives

In order to achieve the aim of the research, the following objectives were established:

1. To study what delay analysis techniques are actually used for the EOT claims at the project level or organization level.

2. To identify the barriers to the adoption, usage, and implementation of the delay analysis techniques in Sri Lankan building construction projects.

3. To establish through conclusions as to how delay analysis practices could be effectively implemented for the EOT claims and recommendations.

1.4 Scope and Limitations

This research was only based on building construction sector in Sri Lanka. The research questionnaires were based on data accessibility of industry comprising senior project managers and senior engineers in three different rounds comprising contractor, consultant and client. The conclusions and findings of the research were derived based on the feedbacks provided by the industry experts.

1.5 Structure of the report

The report is organized in to five logically related chapters as following order:

Chapter One Presents a general overview of the dissertation comprising a brief introduction, background of the study, aim and objectives, scope and limitation of the research, and the guidance of the report.

Chapter Two Reports on the review of the literature of the study area. It covers the existing knowledge on the set objectives of the research. The literature review established on which

is known about the subject matter and delivers the background for identification of the research gap and the preparation of the research questions.

Chapter Three Describes the research methodology and collection of the data.

Chapter Four Elaborates discussion and data analysis in detail.

Chapter Five Presents the conclusions and recommendations.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this section, an extensive review of technical, professional and academic literature was undertaken for the purpose of identifying what was already known and briefly explains of delay in construction industry, and describes about the extension of time claims.

2.2 Construction Delays

Construction delays can be considered as time lag in completion of activities from a fix time as per contract or they can be defined as late completion or late start of activities to the planned schedule or contract schedule (Kikwasi, 2012). When project delays occur, it implies that project cannot be completed within stated time which means that there will be Liquidated Damages (LD) or Extension of Time (EOT) required fulfilling the agreed work. During the literature review, it was found out various definitions provided by different scholars about delays. Table 2.1 shows some of the major definitions provided by the scholars on delays.

Table 2.1: Definitions to delay

Author	Delay
Kikwasi, 2012	*"Delay as referred in construction is prolonged construction period and disruptions are event that disturb the construction programme".*
Assaf & Al-Hejji, 2006	*"Construction delays define as the time overrun either beyond the contract date or beyond the date that the parties agreed upon for delivery of a project".*
Pickavance, 2005	*"Delay refers to something happening at a later time than planned, expected, and specified in a contract or beyond the date that the parties agreed upon for the delivery of a project".*

The summary of above definitions concludes that delay is 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. There are challenges faced in the course of executing construction projects.

2.2.1 Classification of Delay Events

Different approaches have been used to categorize the delay events. Keane and Caletka (2008) have categorized construction delays in the following broad categories according to how they operate contractually.

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

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

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

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

e) **Excusable delay** – Excusable delay is a delay for which a contractor will have relief from damages and potential financial entitlement depending on contractual circumstances.

f) Non excusable delay – The delay caused by contractor and responsibility on the contractor.

The journal *Buildings July 2013* published the following three main categories of delay events according to the project stated as scheduled and progress of project.

- **Non-excusable Non-compensable delays (NN):** The contractor assumes the risk of cost and the time consequences.

- **Excusable Compensable delays (EC):** The contractor is entitled to both time extension and recovery of extra cost consequential upon the delay.

- **Excusable Non-compensable delays (EN):** Those events for which no party has control over bears the risks involved.

2.2.2 Type of Delay

Delay events in United Kingdom construction industry is categorized through the principle of causation and apportionment of the risk of the contract parties. As a result of risk event in following three types of delays are occurred.

i. Contractor's Cause Delay – The contractor will not be able to claim extension of time for delay caused by him. Liquidated damages shall be payable to the employer in the event of the contractor caused the delay affecting the date of completion. Contractor caused delays generally arrive from the risks taken by the contractor once he agrees to undertake the obligations of the contract. The contractor's slow progress, poor management and lack of resources are some of the most often used basis that leads to delay. These causes are under the control of the contractor and could be eliminated by the contractor with good planning and management in order to achieve the best results in executing the contract.

ii. Employer's Cause Delay - Employer's cause delay can arise from the act of the employer or the person hired by him and have a contractual responsibility on him**.** In other words, circumstance or cause which under the contract or by

subsequent determination of a formal tribunal is at the risk and the direct responsibility of the employer.

iii. **Neutral Event –** A neutral event is the events which are out of the control of the parties. The employer and the contractor shall share the risk for a neutral event. In the occurrence of neutral events, the contractor will normally be entitled for an extension of time. Civil commotion, force majeure and strikes etc. can be considered as the neutral events which may entitle the contractor for an extension of time. It is a non-compensable and excusable event which may result in the contractor being awarded time, but no damages for delay. Whether an event is excusable or not will be determined by the terms of the contract exceptionally adverse weather.

2.3 Delay Analysis Techniques

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Delay analysis is used to calculate the project delays and work backwards to try to identify how much of it is relevant to contractor or client. According to that attributable delays to each party, the time and the cost compensation can be decided. Delay analysis techniques are known by many generic titles. The various delay analysis techniques have varying capabilities and the widely known methods of delay analysis are subjected to frequent misuse (Keane & Caletka, 2008). This can be commonly experienced in the modern day construction industry. The application of the same techniques by two opposing experts often produces varying and inconsistent conclusions. The name applied to a technique is not as important as the application of that method. Keane & Caletka say, though there are many variations on the themes, all of the commonly applied forensic delay analysis techniques generally conform to one of the following four primary categories:

1. As – planned versus As-built
2. Impacted As-planned (IAP)
3. Time impact Analysis (TIA)
4. Collapsed As-Built (CAB)

To operate these delay analysis techniques, the core principle is work programme which should be prepared and the Engineer agrees to a baseline programme. This programme should be updated to reflect actual progress and any extension of time granted. It is also recommended that the parties should agree on the type of records that should be kept to identify the cause and extent of delays. The model specifications are provided for the preparation, submission, updating and revising of construction programmes as well as a model records specification. Penalties and sanctions are offered to deal with failures and comply with the provisions of programme.

In developed countries many projects are moving towards web-based document managements system, which allow for real-time collaboration between all parties. This also allows the web-based server document control application to act as a central filling system available to all project parties who are granted access.

2.3.1 As-planned versus As-built method

This analysis method is typically utilized when reliable baseline and as-built schedule information exists. It is a retrospective and statics method which involves comparing the baseline, or as-planned, construction schedule against the as-built schedule or a schedule that reflects progress through a particular point in time.

When applying this method, the analyst needs to gain a detailed understanding of the project to depict all delaying events on the as built schedule. In this method, the incidence, extent and causes of actual delay is established to completion and operates on the principle that actual delay to completion must by definition be found on the actual critical path of the project. Therefore, this method seeks to first locate and identify the project's actual critical path, and only then the causes of delay.

It operates on actual delay to completion must be found on the actual critical path of the project. Hence, first locate and identify the project's actual critical path and once this is established, then identifies the causes of delay. To easy application of this As-planned versus As-built technique, the understanding about their strengths and weakness are important. Table 2.2 shows the major strengths and weakness.

Table 2.2: Strengths & Weaknesses of the As-planned versus As-built technique

Strengths	Weaknesses
• Intuitive and easy to understand • Conclusions are readily supported by as-built records • Does not require frequently updated progress schedules • Does not require logical relationship or float to be expressly provided in as-planned programme • Can identify concurrency in the period work was actually carried out • Can identify critical delay in the period in which the work was actually carried out, and the period in which the costs were actually being incurred	○ As-built sequence must relate to as-planned sequence for activity level variance method ○ Requires analyst to deduce the as-built critical path absent monthly progress updates ○ As-built programme required ○ Constructing proper as-built programme could be resource intense and expensive

2.3.2 Impacted As-planned (IAP)

This technique is use to forecasts or predicts the effect of delay on a project's completion date. It is involved the addition of activities representing delays or changes in to the baseline schedule to determine the impact of those delay activities. This method is also known as 'what if' method and involves prospective delay analysis. Keane & Caletka (2008) describe the IAP technique as the simplest form of critical path–based analysis.

The SCL protocol states that: 'Impacted as-planned is based on the effect of employer risk events on the planned programme of work. This is thought to be the simplest form

of delay analysis using CPM techniques since it involves the least amount of variables. The usefulness of the feasibility of the impacted as-planned technique is restricted due to the theoretical nature of the projected delays that are determined using this technique and uncertainty as to the feasibility of the contractor's as planned programme.' The SCL protocol envisaged the IAP technique as one which would assist in demonstrating extension of time entitlement only, and not prolongation costs. Use of as-planned schedule analysis method is generally restricted to the quantification of delays for contemporaneous requests for time extension. Table 2.3 shows the major strengths and weakness of the impacted as-planned delay analysis technique.

Table 2.3 Strengths and Weaknesses of the Impacted As-Planned technique

Strengths	Weaknesses
• Least amount of variable in 'cause-effect' equation • Does not require as-built programme • Can be carried out contemporaneously • Does not require progressed programmes • Easy to understand	○ Does not account for changes to logic or durations of planned activities ○ Produces theoretical results based on a hypothetical question ○ Cannot identify true concurrent delay

2.3.3 Time Impact Analysis (TIA)

This method is use to determine the extent of the impact of potential delays in the construction process. When a delay event is occurred, this method involves the addition of activities indicating delays or changes in a schedule representing progress. The TIA is applied to forecast the construction process & analyzes what is going on & what is the outcome. This process can be preferred way to promote negotiation and later agreements on delay claims. It allows for an assessment of the impact of the activities. Such an assessment is done using existing schedules, analyzed with all relevant impact entered in to the schedule to demonstrate the reason or possible effects on the schedule.

Keane and Caletka (2008) describe Time Impact Analysis as an evolution of the impacted as-planned method. There are many names used in the construction industry for the TIA approach, probably because there are as many ways to apply the technique. The main difference between the IAP and TIA methods is the use of 'multiple base' programme in the TIA, as opposed states that the TIA method is the 'preferred technique to resolve complex disputes related to delay and compensation for that delay'. The analysis is not project reality simulation. It is intended to understand the time impact caused by a single event or series of events and how they will impact the project schedule. It is a useful tool for projects that are currently ongoing and will present a real time idea of how the contract adjustment is required. Table 2.4 shows the major strengths and weakness of Time Impact Analysis.

Table 2.4 – Strengths and Weaknesses of the TIA technique

Strengths	Weaknesses
• Easy to understand • Can be carried out contemporaneously • Can identify approximate concurrency • Considers dynamic critical path • Does not requires as-built programme • Relies on contemporaneous intensions (accounts for changes to logic and duration of remaining activities from time to time)	○ Produces theoretical results based on a hypothetical question ○ Cannot identify actual concurrent delay ○ Labour intensive ○ Technically complex ○ Requires frequently prepared progress schedules

2.3.4 Collapsed As-Built (CAB)

This analysis methodology is a retrospective technique that begins with the as-built schedule and then subtracts activities representing delays or changes to demonstrate the effect on the completion date of a project but for the delay or change. Generally, this method is applied in cases where reliable as-built schedule information exists, but baseline schedule or contemporaneous schedule updates either do not exist or are flawed to the extent that they are not reliable to support a delay analysis.

Implementation of the collapsed as-built delay analysis involves identify project delays or changes, and then subtracting activities representing these delays or changes from the as-built construction schedule. The resulting "CAB" schedules demonstrate when a project would have been completed but for delays or changes; demonstrating the effect of the delays or changes on a project's completion date.

The SCL protocol is justifiably cautious about recommending the CAB approach. On anything but the most simple, intuitive and linear of projects, the layers of assumptions and subjective logic required to establish the as-built. Table 2.5 shows the major strengths and weakness of Collapsed As-Built Analysis.

Table 2.5 Strengths and Weaknesses of the CAB technique

Strengths	Weaknesses
• Relies on as-built programme • Based on simple, easy to understand principles • Can isolate impact of employer's delay events from contractor's delay event (when iterative application are applied) • Only relies on as-built • Does not require progress updates • Does not require a baseline programme	○ Reconstructing sufficiently detailed as-built is laborious ○ Constructing as-built logic is subjective ○ Does not calculate delay based on contractor's contemporaneous intentions, 'at the time' ○ Unable to distinguish pacing activities from critical delays ○ Cab identify as-built periods of compensable delay ○ Cannot identify as-built (contemporaneous) critical path ○ Requires many subjective assumptions when creating the CAB as-built model for analysis, in content and level of detail, as well as logic and durations of the as-built activities

2.3.5 Use of CPM Techniques

CPM is a step-by-step technique for process planning that defines critical and non-critical tasks with the goal preventing time –frame problems and process bottlenecks. The CPM is ideally suited to projects consisting of numerous activities that interact in a complex manner.

The CPM was developed in the 1950s by Dupont, and was first used in missile defense construction projects. Since that time, the CPM has been adapted to other

fields including hardware and software product research and development. Various computer programs are available to help project managers use the CPM.

The practice of CPM scheduling is supported by many international professional bodies though not regulated by any one institution. Firstly, one must accept that a CPM programme is simply a model of only on possible sequence of events required to complete a given project. The assumptions that were relevant to establishing that sequence are also relevant to the analyst carrying out a forensic delay analysis. Each assumption relied upon when creating the original CPM programme (e.g. Labour levels, activity durations, activity sequences and relationships) are risks which could be affected by unforeseen events, conditions, or implemented change. These all require management, regular monitoring and intervention to keep a project on course or move the goal-posts when necessary.

2.4 Elements of time extension claim

Extension of time claims is unsuccessful when the contractor fails to adequately demonstrate its case through its submission of detailed particulars (Badman, 2007). It has listed out eight essential elements that must be addressed in a time claim as,

1. The event
2. Liability for the event
3. Contractual entitlement
4. Contractual compliance
5. Cause and effect
6. Analysis of delay
7. Statement of claim
8. Substantiation

The event

Identify the event: the circumstance which gives rise to change causing delay.

Liability for the event

Once an event has been identified, the next step is to determine liability for the event. If responsibility rests with the employer or it is a neutral event, such as force majeure or exceptionally adverse climatic conditions, the contractor may be entitled to an extension of time. However, this is dependent upon the terms and conditions of the particular contract. In circumstances where the contractor is responsible for the event then the consequences remain with the contractor.

Contractual entitlement

Typically, construction contracts contain provisions entitling the contractor to an extension of time on the occurrence of a particular event provided the progress of the works or time for completion is delayed as a consequence.

For example FIDIC 1987 provides for an entitlement for extension of time in the event of: late drawings (Clause 6.4).

Contractual compliance

Generally within an extension of time clause, the contractor will be obligated to submit notice(s) and detailed particulars within a specified time frame. However currently in ICTAD specifications, noticing is not compulsory for the entitlement of the time claim.

For example, clause 44.2 of FIDIC 1987 provides: "provided that the engineer is not bound to make any determination unless the contractor has (a) within 28 days after such an event has first arisen, notified the engineer with a copy to the employer , and (b)within 28 days, or such other reasonable times as may be agreed by the engineer, after such notification submitted to the engineer detailed particulars of any extension of time to which he may consider himself entitled in order that such submission may be investigated at the time."

Cause and effect

A common mistake made by many contractors when attempting to demonstrate the cause and effect of an event is that they merely list in chronological order the pertinent exchanges of correspondences between the parties. A story should be prepared to demonstrate cause and effect based on the facts describing the effect(s) of the event upon the works. It should be included details of the planned works affected , referring to the planned sequence, durations, and methodology ; the status of the works in relation to that planned at the time of the event ; and, description of the changes to that plan as a consequence of the event.

Analysis of delay

Conduct a delay analysis to demonstrate the effect of the event on the contractor's programme. There are a number of internationally recognized delay analysis methods. Ultimately, the choice of delay analysis methodology will be dependent upon such matters as level of records available; the robustness of the baseline programme and any updates; time available; degree of accuracy; and, level of proof required.

Statement of claim

Every extension of time claim must contain s succinct statement of what the contractor is claiming.

Substantiation

Extract and provide documentary evidence (letters, method statements, instructions, progress reports and photos, minutes of meetings, programmes and schedules), statements of fact and expert witness statements (if required) in support of the assertions made within the claim submission. According to Badman (2007) adopting these eight elements as a check list will give a good starting point for drafting any extension of the time claim, in spite of each construction project being unique.

2.5 Accepted Guideline for delay Analysis

First, in the UK, the society of construction law published its delay and disruption in protocol in October 2002. The aim of the SCL protocol is stated as being to:

'provide useful guidance on some of the common issues that arise on construction contracts, where one party wishes to recover from another an EOT and/or compensation for the additional time spent and the resources used to complete the project. The purpose of the protocol is to provide a means by which the parties can resolve these matters and avoid unnecessary disputes'.

The SCL protocol recognize that the application of common sense and reality checks are required when applying delay analysis techniques (Keane & Caletka, 2008)

Recently the association for the advancement of cost engineering international (AACEI) published relevant guidance, similar to the SCL protocol, in the form of its 'Recommended practice' No29R-03- forensic schedule analysis (RP-FSA) which was issued on 1st July 2007 and officially launched on 15th July 2007. The RP-FSA is primarily focused on the terminology and the application of forensic analysis and is a much more a technical document. However, it acknowledges that the SCL protocol had a 'wider scope'. The stated purpose of the AACEI's recommended practice guide is 'to provide a unifying technical reference for the forensic application of the CPM scheduling 'and to 'reduce the degree of subjectivity involved in the current state of the art'. Whereas the SCL protocol provides guidance to contract administrator and forensic analysts alike, the RP-FSA has an expressed emphasis on 'minimizing procedural subjectivity' forensic scheduling.

2.6 Previous Studies

Al-Momani (2000) also has investigated the quantitative analysis of construction delays based on the records of 130 public building projects constructed in Jordan. It was presented regeneration models of the relationship between actual and planned project duration for different types of building facilities. It also included the reported frequencies of time extension for the different cases of delays. The research has concluded that the main case of delay in construction projects are related to site

condition, weather, designers, economic condition, user changes and late deliveries and increase in quantities.

Samarakoon (2009) has researched to identify the causes and effects of delay for medium scale building construction project in Sri Lanka. It has found that the improper project management as the main case of project delays and labour shortage as the other cause. Interviewing the professionals who are involving in the medium scale building construction project in Sri Lanka, the researcher has first identified the causes and effects of the project delays from the findings of previous researches. In that research, a questionnaire had been prepared from the findings and a comprehensive study had been done with the help of professionals who were working in the medium scale building construction project in Sri Lanka. Samarakoon has calculated the importance and severity of each cause and effects from the important index and severity index. Then relative important index was derived and rank to identify cause and effects. Finally guidelines have been developed for the purpose of minimizing project delays in the medium scale building construction project in Sri Lanka. Further the major effects of project delays have been identified and ranked as follows.

i. Cost overrun
ii. Time overrun
iii. Disputes
iv. Arbitrations
v. Litigation
vi. Total abandonment

Kikwasi (2012) has studied about the causes and effects of delays and disruptions in construction projects in Tanzania. The population of the study comprised of clients, architectural and quantity surveying consulting firms, construction firms and regulatory bodies. The sample size of 60 respondents was estimated comprising of 33 construction firms, 10 quantity surveying, 10 architectural consulting firms, 5 clients and 2 statuary bodies. Two sapling procedures have been used. List of contractors and consultant who are had their officers based in Dar-es-Salaam had obtain from respective regulatory bodies officers and websites. The random sampling was used to

select contractors and consultants. This researcher has also ranked the causes for delays and effects of delays.

Braimah & Ndekugri (2008) have studied on factors influencing the selection of delay analysis methodologies. These researches had adapted a mixed research methodology considering the multiplicity of the research's aims and objectives, coupled with the diversity in types and sources of data to be collected as the most appropriate methodology. It has involved the collection of data at two different stages. The quantitative research strategy involving the use of a cross-sectional survey was opted in the first stage to explore current delay and description analysis practice, followed by an in-depth qualitative investigation of issues informed by the survey. The major factor that influenced the choice of the survey strategy was mentioned as the large and diver nature of the research population as delay claims are prevent in various forms and in various types of organizations. Braimah & Ndekugri have pointed out that there is no better method of research than a survey for collecting information about large populations. They have adopted non-probability sampling technics in selecting sample due to the absence of a specific sampling frame for construction industry with experience.

Yates (1993) developed a decision support system for construction delay analysis called delay analysis system (DAS). DAS is a software program that adds the capability for determining possible causes for project delays and suggests alternative courses of action to prevent further delays. The main categories of delays in DAS include engineering, equipment, external delays, labor, management, material, owner, subcontractors, and weather. He has further discussed industrial participation in the development of the delay analysis system program and describes the purpose and development of the program, its technical parameters, usage, and program output. A sample case study was also presented that demonstrates how the program is utilized and the type of output it provides. He has gathered the required details for the development of the software through a questionnaire survey.

Ogunlana and promkuntong (1996) studied the delays in building projects in Thailand, as an example of developing economies. They had carried out their study with the help of a questionnaire survey. They concluded that the problems of the construction industry in developing economies could 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.

Mansfield and Ugawu (1994) studied the cause of delay and cost overrun in construction projects in Nigeria. He had first identified significant causes of cost overrun in the building projects through literature review and discussions with some parties involved in construction industry. There after findings of the literature reviews were implemented and a questionnaire developed. 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.

Fernando (2013) has conducted a research on clients delay in infrastructure projects considering cases from Road Development Authority (RDA). It has identified client delay factors through the literature review and thereafter data was collected by recording the EOT claims details of RDA projects to identify the impact of these client delay factors on RDA projects Researcher has used statistical analysis to quantify the amount of client delay in RDA Projects.

Jeyakanthan & Jayawardana (2012) have researched on understanding and mitigating of project delays in donor funded road projects in Sri Lanka. In this research detailed literature review has been done through e-resources, books, government publications, articles, journals etc. and generated the problem inventory. Then Jeyakanthan has conducted the interviews and surveys with construction professionals for the findings.

In this study 26 cases were referred by implementing quantitative and qualitative technics. Finally researcher has developed strategies to mitigate the delays in projects.

A number of research have examined relevant to the study area. The summery of previous studies are shown in table 2.6.

Table 2.6: Summary of previous studies

Researcher	Context of research	Findings:
Al-Momani (2000)	*Investigated the quantitative analysis of construction delays based on the records of 130 public building projects constructed in Jordan*	• *The research has concluded that the main case of delay in projects are related to site condition, weather, designers, economic condition, user changes, late deliveries & increase in quantities*
Samarakoon (2009)	*Research was carried out to identify the causes and effects of delay for medium scale building construction project in Sri Lanka*	• *Improper project management as the main case of project delays* • *Labour shortage as the other cause* • *Major effects of project delays have been identified and ranked as Cost overrun, Time overrun, Disputes, Arbitrations, Litigation & Total abandonment respectively.*
Kikwasi (2012)	*Studied about the causes and effects of delays and disruptions in projects in Tanzania*	• *This researcher has also ranked the causes for delays and effects of delays.*
Braimah & Ndekugri (2008)	*Studied on factors influencing the selection of delay analysis methodologies*	• *The major factor that influenced the choice of the survey strategy was mentioned as the large and diver nature of the research population as delay claims are prevent in various forms and in various types of organizations.*
Yates (1993)	*Developed a decision support system for construction delay analysis called delay analysis system (DAS)*	• *DAS is a software program that adds the capability for determining possible causes for project delays and suggests alternative courses of action to prevent further delays* • *The main categories of delays in DAS include engineering, equipment, external delays, labor, management, material, owner, subcontractors, and weather*
Ogunlana & promkuntong (1996)	*Studied the delays in building projects in Thailand*	• *They concluded that the problems of the construction industry in developing economies could 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; &* *3. Problems caused by incompetence of contractors.*
Mansfield & Ugawu (1994)	*Studied the cause 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.*
Fernando (2013)	*Research was conducted a research on clients delay in infrastructure projects considering cases from Road Development Authority (RDA)*	• *Quantified the amount of client delay in RDA Projects*
Jeyakanthan & Jayawardana (2012)	*Researched on understanding and mitigating of project delays in donor funded road projects in Sri Lanka*	• *researcher has developed strategies to mitigate the delays in projects*

2.7 Conclusion

It was found that there are significant amount of researches on management of claims for EOT in construction industries around the world but there are only few researches on delay analysis techniques in Sri Lanka. This extensive review of literature could be found what was already known and established in connection with the area of research for the purpose of identifying problematic issues and difficulties associated with the delay analysis technics in the construction industry.

It was found that there are four main delay analysis techniques and derivatives of the four categories are being practiced in the industry. It clearly indicates that there is a strong need to conduct further researches in order to select a most suitable delay analysis technique and the factors depends on project situation in Sri Lankan construction industry. It was also found that there are eight essential elements of a time extension claim as the event, liability of the event, contractual compliance, contractual entitlement, substantiations, cause and effect, statement of claim and analysis of delay.

Existing studies have focused to delays were of descriptive type researches that include surveys and facts enquiries of different kinds. The main characteristics of these methods were that the researcher had no control over the variables and only reported what has happened or what was happening. Further, it can be said that proper delay analysis in Sri Lankan construction industry is relatively a less matured knowledge area and most of the projects do not pay significant attention to engage delay analysis techniques for the proper EOT claims, which resulted in bad consequences on construction projects. Therefore the present study is conducted in order to answer the question “How the delay analysis technique practices could be promoted and enhanced in Sri Lankan construction industry?”

The present study will explore the current practices regarding delay analysis and the barriers to implementation of such standards, to answers for this question. The study will also attempt to propose suggestions to overcome identified barriers from the findings.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The research methodology defines the research methods and techniques used in the research. The data for the study need to be clear-cut and accurate to fulfill the objectives of the research. This chapter will elaborate the processes of data collection for the research. This chapter will also justify the reasons behind the selection of the data collection method.

The survey was focused on application of delay analysis techniques in building construction industry in Sri Lanka, identifying the barriers, principal problems or failures in the process of EOT claims and whether there exists scope for positive beneficial improvements, from the perspective of the industrial practice. The information required for this study was composed through a detailed literature from published books, reputed journals and websites. In addition to that one of the projects was selected as pilot study based on the data accessibility and extensive investigation done on area of delay analysis, granting extension of time and other areas related to time extension.

The information gathered from the sources like literature survey and pilot study were the basis to get a profound understanding of delay analysis techniques applications. Then a questionnaire developed with the help of the above findings and this survey attempts to explore the opinions of experts engaged in construction industry in Sri Lanka. To achieve the main objectives, the survey was focused on following areas.

1. Identification of the frequency of time extension claims and observations.
2. Awareness of delay analysis techniques among the construction Professionals.
3. Level of record keeping at site.
4. Management and analysis operations related to EOT claims.
5. Assessment of the success or failures in EOT claims.
6. Particulars of the construction programmes.

The summarized structure of the methodology is illustrated in figure: 3.1.

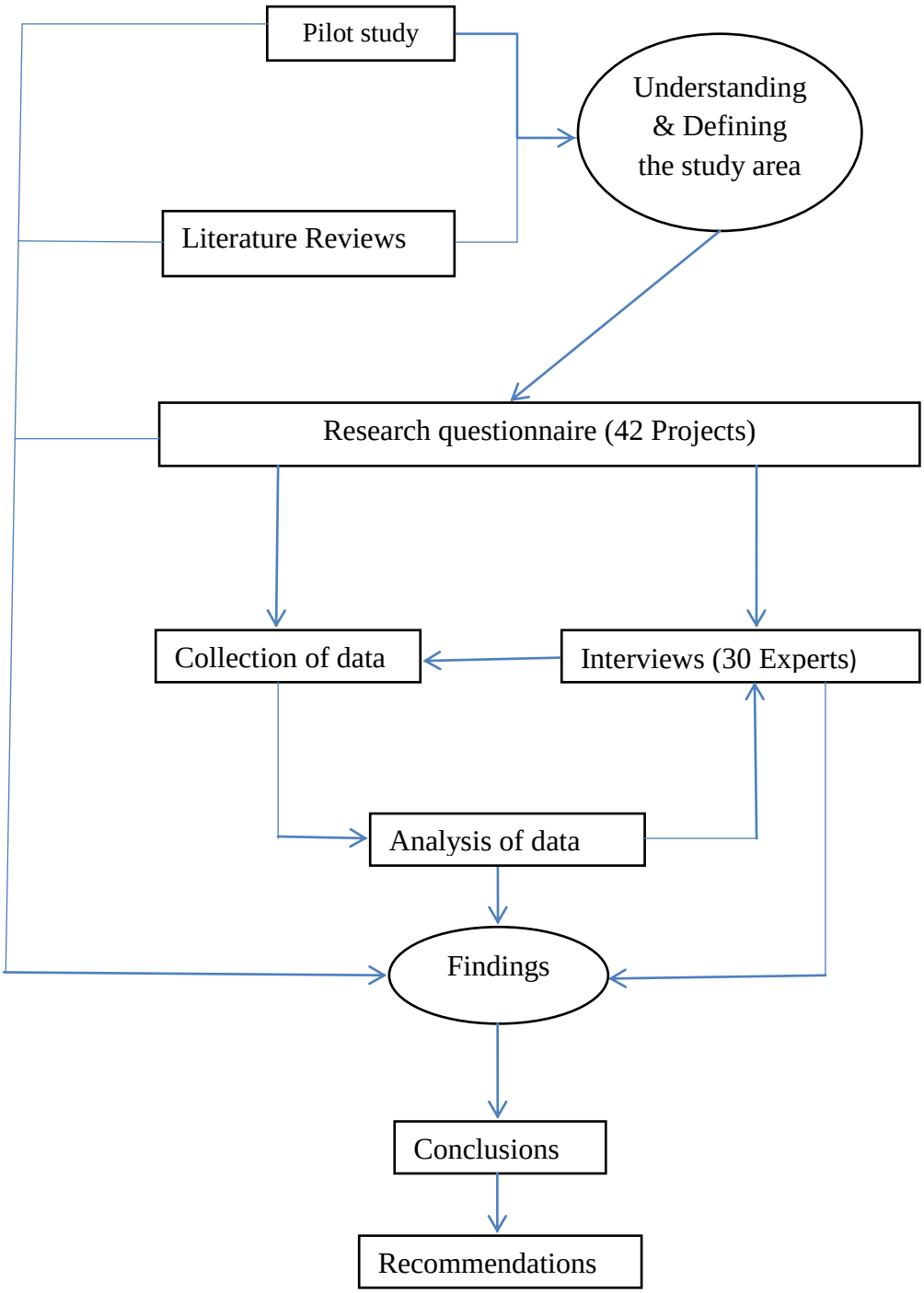


Figure: 3.1 Structure of the Methodology

3.2 Survey Method

Mainly, the research questionnaire was developed to gather the existing knowledge, practices, failures and barriers and sound base for delay analysis techniques in the building construction industry of Sri Lanka. Interviews and questionnaire survey were used to collect primary data from various construction professionals working in Sri Lankan building construction industry. Then identified lapses on current practice in Sri Lankan construction industry and results of analysis were used to reach conclusions by formulating the objectives. In this study both the quantitative and qualitative research methods were used together. The generally accepted use of combined method is to being with a qualitative exploration of some little-studied problem so that measurement instruments can be developed for later quantitative research

As the literature review, it was disclosed that most of the researchers who had investigated the aspects of construction delays were using non probability sampling techniques. Some had selected the sample considering the fact of easy accessibility. Few researchers had selected their samples based on the findings of the previous researchers.

The sampling is a procedure that uses a small number of units of a given population as a basis for drawing conclusions about the whole population. Sampling is often necessary because it would be practically impossible to conduct census measure characteristics of all elements of population. (Zikmund, 2003)

According to Zikmund (2003) there are two major sampling methods namely probability and Non probability sampling. Non probability techniques include convenience sampling, judgment sampling, quota sampling and snow ball sampling and whereas probability sampling technique includes random sampling, systematic sampling, stratified sampling and cluster sampling. A simple rule of thumb is that the more homogeneous a population the samples can be smaller and vice-versa. Therefore, sample size is a judgment based on the amount of variability that is known to exist within the population. Judgment sampling which is one of the non-probability sampling techniques is used to select the sampling.

As a sample of this survey, 42 building construction projects were considered. All projects were based on the data accessibility under three categories with respect to the project cost. In this study, all the projects were categorized in to three categories only for the easy representation. The project cost up to one billion was considered as low scale project; the project cost ranging from one billion to five billion was considered as medium scale and otherwise as large scale projects. Table 3.1 shows the composition of the sample.

Table 3.1 Composition of the Sample

Project Category	No of Projects
Low (< 1 Billion)	16
Medium (1 – 5 Billion)	20
Large (> 5 Billion)	6
Total	**42**

3.3 Data Collection Method

The method of collecting data had to be chosen after selecting the sample. The following data collection methods were implemented.

i. Observation
ii. Pilot study
iii. Personal interview
iv. Questionnaire

According to Taylor and Steele (1996) observation method can be very time consuming and resource intensive and is susceptible to observer bias, subjective bias on the part of the observer. The observation method considered not appropriate for this type of study, thus it was used undermining the reliability and hence the validity of the data gathered.

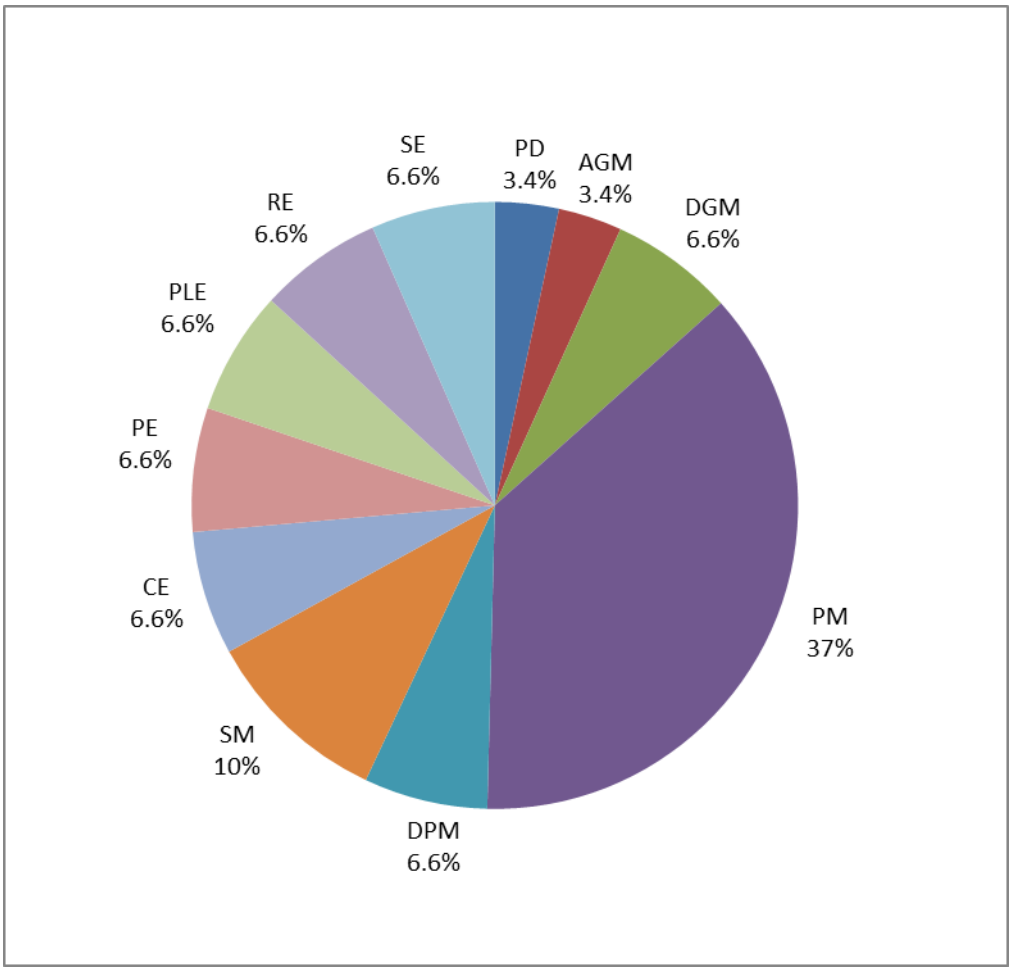
Combination of other three methods, pilot study, personal interviews and questionnaire method was used. As an approach to the design of questionnaire and to have a clear picture of the industry practices, a pilot study was considered. Some projects were examined by interviewing the relevant persons, going through documents and by record analyzing and so on. Self-completion questionnaire is used as the major data colleting method of this research. The main advantages of this method being:

- The sample could be collected from a much wider area.
- It was the least costly compared to the alternatives.
- The respondent is not asked to give instant replies so that answers could be considered and records consulted before responding if necessary.
- The bias of the interviewer is removed.

For a high response rate as possible, most of the time questionnaires were sent through personal contacts to reach the correct person of the organization and followed up the process until the questionnaire was reached to the targeted person. Each questionnaire carried a request for a telephone interview with a positive response rate of 78 % of respondents willing to provide additional information. One of the main disadvantages of this type of self-completion questionnaire is that it might not be answered in sequential order. In this case the data would not have been affected.

In this survey, expert's opinions were involved for verifications of the analysis data as well as gather the data from their construction projects. Thirty numbers of experts were selected in two ways; some experts were selected and interviewed based on the best answers provided for question numbers 08 to 12 in the research questionnaire. Other experts were identified from the construction industry in Sri Lanka considering willingness to answer questions regarding the research area and their experiences. The interviewed experts who were represented various positions of the industry are illustrated as shown in figure 3.2.

Figure 3.2 - Interviewed Experts



Legend

Project Directors	- PD
Additional General Managers	- AGM
Deputy General Managers	- DGM
Project Managers	- PM
Deputy Project Managers	-DPM
Site Managers	- SM
Chief Engineers	- CE
Project Engineers	- PE
Planning Engineers	- PLE
Resident Engineers	- RE
Site Engineers	- SE

3.4 Questionnaire Design

A well-designed questionnaire should meet the research objectives and no survey can achieve success without well-designed questionnaire. The questionnaire was developed mainly from the data, and facts disclosed from the pilot study and literature survey. It was targeted towards very senior individuals within the organizations with many more important priorities on their hand far greater than completing a questionnaire. Therefore, it was essential that the questionnaire be as short as possible, easy to read, understand and capable of completion within a matter of minutes.

Hence, the number of questions was limited to 20 and elected for closed-ended questions requiring only a "tick in the appropriate box" response. The layout of the questions was carefully considered to prevent as far as possible confusion or ambiguity, and to ensure the offered alternative answer were clearly associated with the questions being asked. Purpose and usage of each and every question is discussed later in this section and the questionnaire is attached in appendix – A.

Every attempt was made to construct the questionnaire with the greatest clarity, neutrality, and to avoid the building of any hidden bias. The reasonable balanced response rate suggests that no serious bias or distortion will seriously affect the findings as a result of those that did not return the questionnaire.

Once the questionnaire was finalized up to content and layout, five draft copies were provided for pilot studies for five engineers of different capacity. The purpose of pre testing the questionnaire was to determine:

1. Whether the questions have been placed in the best order
2. Whether the question as they were worded will achieve the desired results.
3. Whether the questions are understood by all respondents
4. Whether additional or specifying questions are needed or whether some questions should be eliminated
5. Whether the instructions to interviewers are adequate.

It was disclosed that some wording of the questionnaire was difficult to understand. Those were simplified with the concurrence of the participants. Order of the questions was also changed to have a better flow after the comments made by the respondents.

The majority of the respondents of pilot study were unaware of the delay analysis techniques such as impacted as-planned, collapsed as-built. In the initial questionnaire there was a question to indicate them the technique followed by them for the delay analysis. Under this situation it was revealed that the correct answer was suspicious. Therefore, that question was replaced with more elaborative question to select the relevant answer including none of the above to get the correct picture.

Purpose and usage of the questions are as follows:

01. Detail Survey

Purpose: To identify the respondent background.

Usage : To compare the responses.

02. Investigation of claims for EOT

Purpose: To establish incident of EOT claims.

Usage : This information use to assess in validation of the problem chosen.

03. If your EOT claim/Claims rejected either in part or in total, please indicate the reason/s?

Purpose: To identify predominance of the most common reasons for claim rejection.

Usage : This data is used to further assist in validation of the problem chosen.

04. How often has the need arise to submit extension of time claims?

Purpose: To identify the frequency of the EOT claims.

Usage : To establish link with research problem & to compare with other findings.

05. When do you normally submit the EOT claims?

Purpose: To identify frequency of the EOT claims.

Usage : Information used to develop recommendations.

06. Who prepare the time claims?

Purpose: To identify resources level of the organization.

Usage : This information is reviewed when solutions are being structured.

07. Are you aware of the contractor's claims as per the condition of contract?

Purpose: To check the basic awareness.

Usage : This information is used with responses given to other questions when formulating the recommendations.

08. Which of the following used delay analysis techniques to evaluate the EOT claims in your project?

Purpose: To check the awareness of delay analysis techniques.

Usage : This information is used with responses given to other questions when formulating recommendations.

09. Are you aware of the above delay analysis techniques?

Purpose: To check the awareness about delay analysis techniques.

Usage : This information is used with responses given to other questions when formulating recommendations.

10. If yes and provide last answer (None of the above) for question no.08, please indicate the reason/s?

Purpose: Find out the reasons to deviate.

Usage : This information is used with responses given to other questions when formulating recommendations.

11. What are the factors selecting a delay analysis technique?

Purpose: To identify the factors affecting in adopting a particular delay analysis technique.

Usage : This information is used with responses given to other questions when formulating recommendations.

12. In your opinion, what would be the following for the above?

Purpose: To identify the gravity of the problem in EOT claims.

Usage : To establish barriers in the EOT claims.

13. Have EOT claims lead to disputes which resort to adjudication or arbitration?

Purpose: To study the behavior of EOT claims.

Usage : This information is used with responses given to other questions when formality recommendations.

14. Is it possible to use project planning software in your site?

Purpose: To identify exposure to the technologies.

Usage : Recommendations are developed to suit the site resources level.

15. How many occasions is your construction programs prepared/Edited with respect to the EOT claims?

Purpose: To establish the utilization of resources.

Usage : This information is contrasted with responses given to other questions with developing recommendations.

16. What details do you normally include in your work program?

Purpose: To identify main component of the work programme in practice

Usage : This information is used to identify the gap of information that is required to adopt a proper delay analysis technique.

17. When do you normally update your work program?

Purpose: To identify the industry practice on updating the program.

Usage : Information is used to recommend improvements for delay analysis practices.

18. What are the records maintained at site?

Purpose: To identify the records maintain by the contractor.

Usage : To identify the gap of record requirement.

19. Where computers are used on site locations, please indicate the task they perform?

Purpose: To identify in more detail the specific task most frequently performed on site where computer technology used.

Usage : This information is used to verify the type of problems being identified prior to make recommendations.

20. Would you like to answer for brief additional questions?

Purpose: To get more details from the respondents

Usage : To Get clarifications for incomplete questionnaires and get additional data if required.

CHAPTER 4

ANALYSIS AND DISCUSSION OF RESULTS

4.1 Introduction

The basic problematic issues in the practice of construction delay analysis were identified with the assistance of existing technical and professional literature in chapter two. A pilot study was carried out for a construction project in Sri Lanka. Then questionnaire survey and interviewing were carried out including 30 experts in this study as mentioned in the previous chapter. This chapter will illustrate results of data analysis and the findings of the research, that is the existing and in success or failure experiences.

Further the problematic issues were considered to isolate by deduction one particular problem for which a solution could be devised, and this in turn led to conclude and develop the recommendations in order to improve delay analysis techniques practices for the EOT claims in the Sri Lankan construction industry.

4.2 Pilot Study

Based on data accessibility, one of the projects was selected in middle magnitude of contract price ranging from LKR one billion to five billion as discussed in previous chapter. The project was on going but, almost completed in main scope. Descriptive and exploratory in-depth analyses were carried through interviews and documents of that project.

The project was a construction of fourteen stories two buildings having 6,048 m^2 and cost of LKR 3.7 billion. Initial contract period was 2 years & 06 months but, it has taken 4 years & 2 months to completion of 95% at the time of evaluation. Remaining 5% is depended on incompletion of underground electrical cables due to delay of importing the cables. However contractor had taken additional one & half years to complete up to 95% of project. The contractor had submitted five EOT claims and got the

extension for the extended period without cost of preliminaries. The preliminary charges may be disclosed at the arbitration later.

In this project, the claim of the contractor and engineer's approvals were revealed that the claim was a list of delay events including the number of delayed days and adding up to get the total delay and engineer's approval had followed the same pattern. The contractor has only submitted copies of the relevant minutes of the meeting and instruction of the Engineer's representatives to justify the dates quoted in the claim but, there was no reference to the critical path or the construction programme. The contractor has only instruction of the engineer with the copies of minutes of the meeting to justify the dates quoted in their claims.

In some quoted EOT claims were the delay to meet the deadline by the other suppliers or service providers assign by employer or alternatives behind the issues. The contractor for civil works had deprived of completing works on time and it was a straight forward reason for the eligibility of EOT as per the condition of that particular contract. In addition to that few other reasons were quoted as adverse weather conditions, delay in issuing details, change of scope of work, restrictions of working hours or material utilization and variations etc.

During the interviews of Project Manager, Deputy Project Manager, Resident Engineer and both of Site Engineers in this construction project, it was found that neither contractor's staff nor the engineer's staffs know delay analysis techniques. They admitted that they had not maintained proper records, had no expertise knowledge to follow the delay analysis techniques. Project manager of the contractor said that their company was not prepared to spend time and money on advance delay analysis techniques under this crisis of construction field in Sri Lanka. The contractor further had mention that delay case by reasons of this project were concurrent delays and the project completion was depend on the completion of employer's direct works like construction of storm water drain, laying of electrical cable enclosing the adjacent projects but, the contractor failed to justify this facts with reference to the master programme of the project.

Almost all records had been computerized and in some situations contractor was using those records to calculate his profit or loss in particular work items and to establish work norms to be used in their future works. However, the contractor and the engineer's representative have not kept timely joint records. This issue had been lead to disputes due to the separate record keeping practice. They were of the view that if both the parties agreed to the common format to maintain contemporaneous records, such kind of disputes could have been avoided.

4.3 Questionnaire Survey

As described in chapter three, the questionnaire survey was done by selecting a sample of 42 projects and interviewing some of them. The questionnaires were delivered through e-mails, by hand and by post. Personal contacts were used to make sure that the questionnaires were reached to the relevant individuals of the organization. The survey was targeted to achieve the followings;

- Identification of current methodology used by construction professionals in their projects for delay analysis when claiming EOT.
- Identification of frequency of EOT claims.
- Identification of barriers for proper EOT claims.
- Identification of most suitable delay analysis technics with respect to the governing factors.
- Identification of resources level of the project and particulars of the construction programme.

Thirty nine responses were also received through e-mails, by hand or by post, but four questionnaires were not fully completed and three questionnaires were not received. It was assumed that response had not been taken good care to fill the questionnaire and their response cannot be considered as accurate response as they were not fully completed. Hence, thirty two responses were taken in to analysis by ignoring the incomplete questionnaires. Figure 4.1 shows the sample distribution.

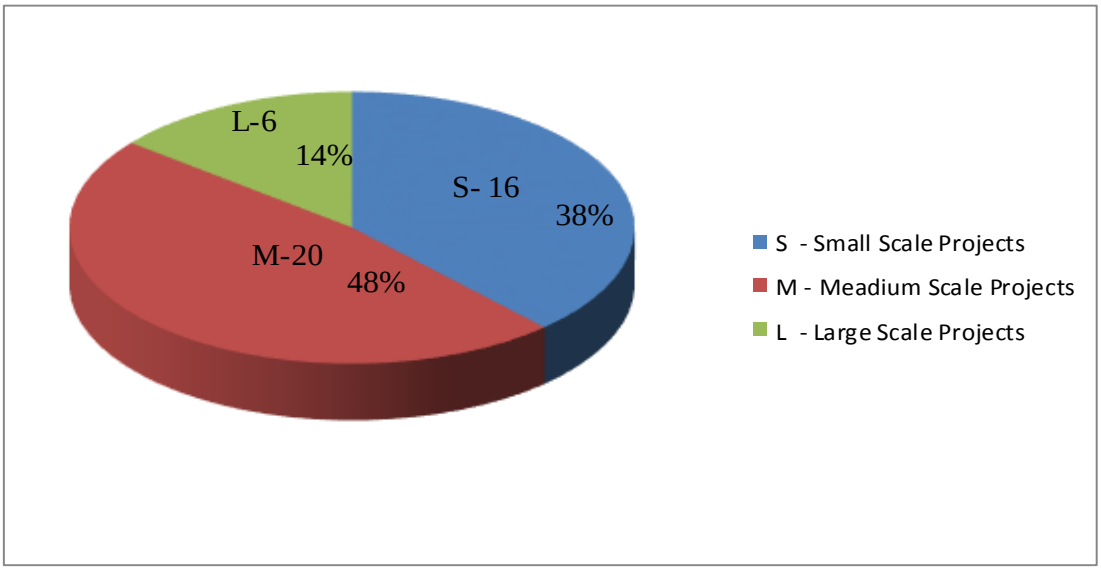


Figure 4.1 - Sample Distribution

The response rates are higher from medium scale projects compared to large or small scale projects. It was observed that those who are having medium scale projects are more interested than large scale projects or low scale projects, towards research and development activities. Table 4.1 shows the summary of response of the sample.

Table 4.1 – Response Rate

Projects	No of Delivered Questionnaires	No of Returned Questionnaires	Response Rate
S	16	11	68%
M	20	18	90%
L	06	03	50%
Total	42	32	76%

4.4 Analysis of Survey Results

The response was disclosed that 96% projects have experienced involving for the extension of time claims and 70% of them experienced two or more occasions. The considerable number of claims had been rejected (51% of incidents). This is a serious issue in preparation of EOT claims. It was noticed that EOT claims become an integral part of the construction industry in Sri Lanka.

4.4.1 Frequency of the Extension of Time Claims

It is disclosed that 69% of incidents were being awarded with 50% or lesser with respect to delay events. Only 9% of their projects have the experience and awarding with respect to delay events for more than 75% of their projects. Hence, it is resulted that there is a high risk of rejection and improper awarding for the extension of time claims in Sri Lankan construction industry. Table 4.2 and figure 4.2 are shown the frequency of EOT claims with respect to delay events.

Table 4.2 – Frequency of EOT Claims

	Frequency	No of Respondents	Rate of Respondents
A	0% - 25%	9	28%
B	26% - 50%	13	41%
C	51% - 75%	6	19%
D	76% - 100%	3	9%
E	Not at all	1	3%

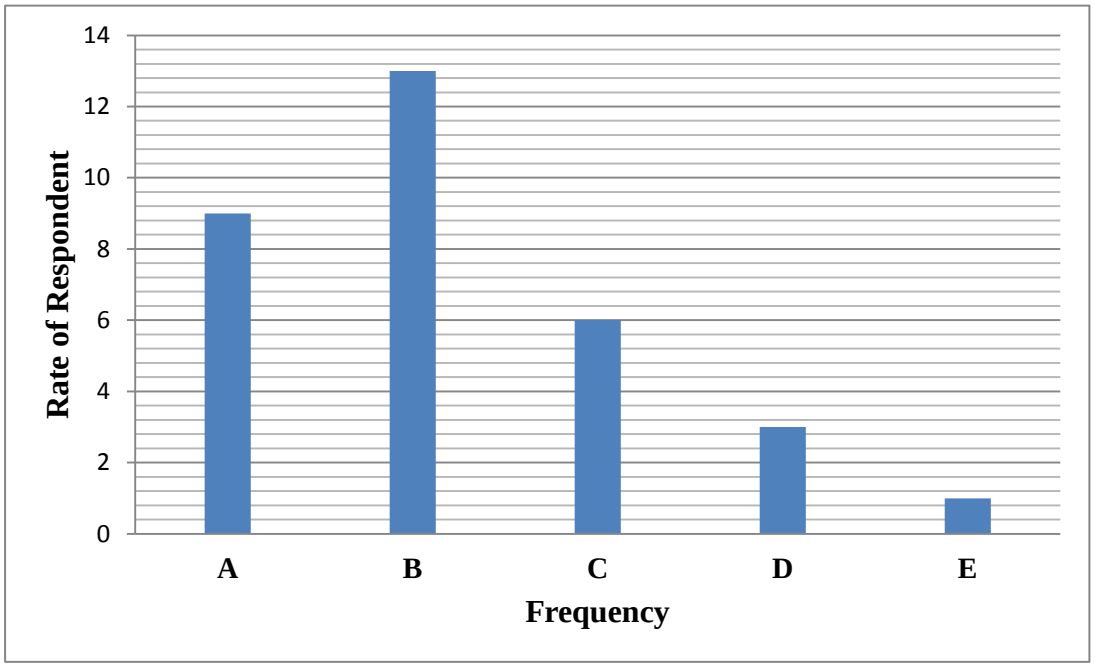


Figure 4.2 – Frequency of EOT Claims.

4.4.2 Main Reasons for Rejection of Extension of Time Claims

Mainly, it was observed that the claims being rejected mainly due to submission of informal EOT claims. The claims were also rejected due to falling to provide insufficient support documentation etc. Table 4.3 and figure 4.3 are shown that on what ground EOT claims they were rejected.

Therefore it is required to improve the preparation of EOT claims maintaining predominance of guidelines. Those rejection factors were ranked according to their predominance by evaluating with the consent of 30 experts. The evaluation results have been illustrated in section 4.5.

Table 4.3 – Main Reasons for Rejection of EOT Claims.

	Reason	No of Incidents	% of Incidents
1	Claim not formal	17	53%
2	Insufficient / incorrect notice	0	0%
3	Insufficient support documentation	9	28%
4	Claim content disputed	3	10%
5	No acknowledgement given	2	6%
6	Other	1	3%

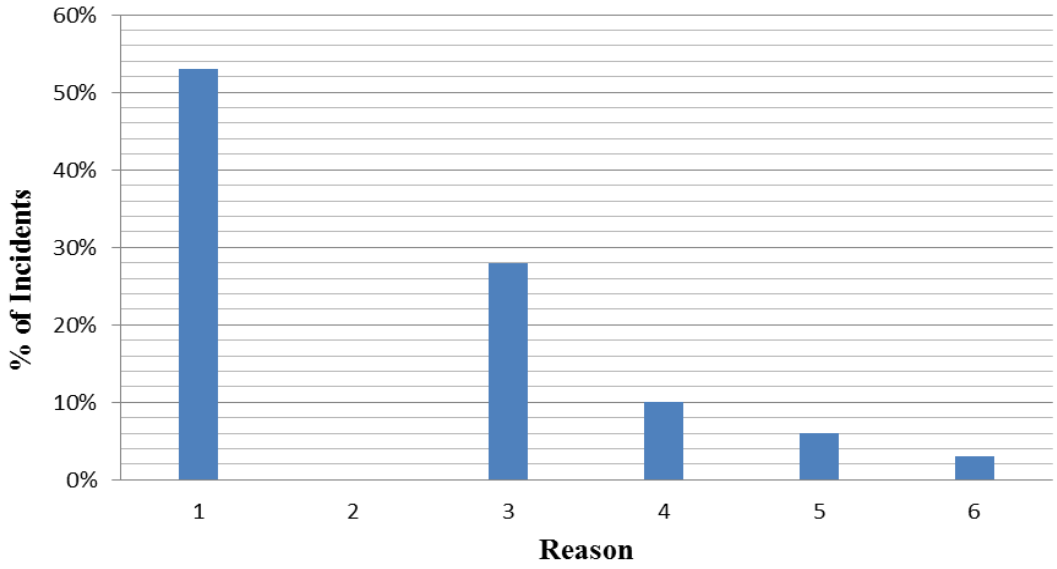


Figure 4.3 – Main Reasons for Rejection of EOT Claims.

4.4.3 Analysis of Extension of Time Claim Practices

It was observed that 18 % of incidents have been declared after the delay event. The highest numbers of time claims were submitted after the laps on contract period (74 %). This scenario is shown in table 4.4 and figure 4.4.

As a result of this scenario, the project may not lead to execute in proper way and then informal claim or insufficient documentation like issues may happen when preparing time claims. Therefore, the prediction about construction activities is important after the delay event and not having laps on contract period to control the project.

Table 4.4 – Submission of Extension of Time Claims.

	Submission of EOT Claims	No of Respondents	% of Respondents
A	After the laps on contract period	45	74%
B	After a delay event	11	18%
C	Monthly	3	5%
D	Other	2	3%

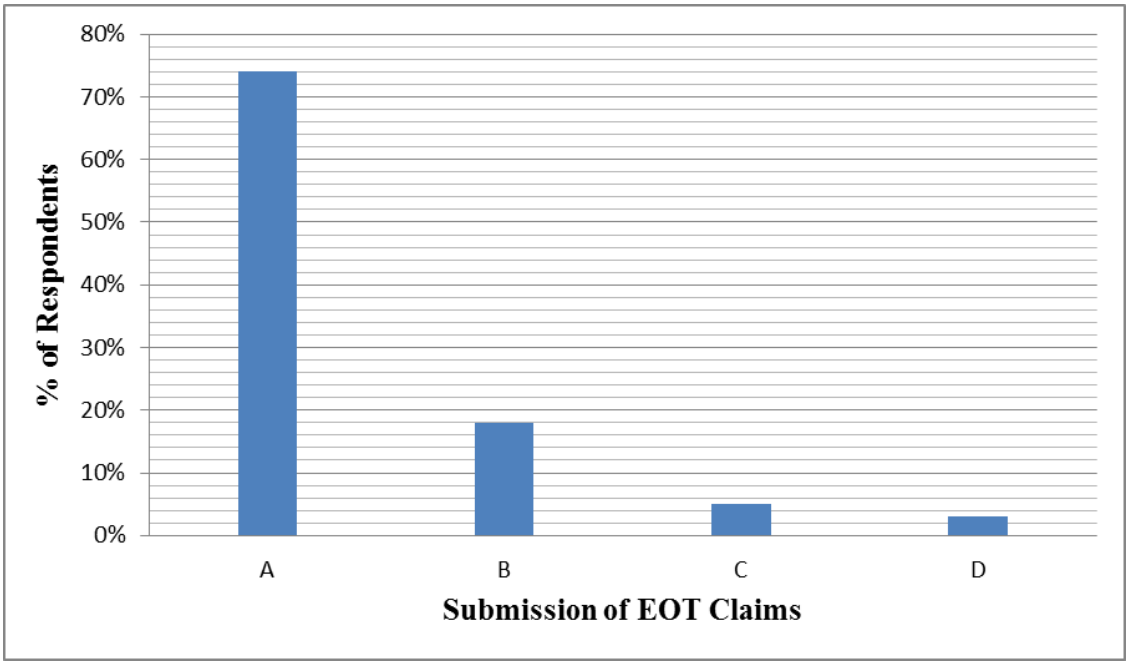


Figure 4.4 – Submission of Extension of Time Claims.

4.4.4 Analysis of Resources Level for Preparation of EOT Claims

The majority of claims (79 %) were prepared by the respective project staff and 19 % of the incident was having in house experts. The very low cases (2%) were followed the external consultants to prepare their EOT claims. During the interviews, it was further disclosed that there is a risk of preparing EOT claims by the project staff due to the lack of expertise knowledge of the subject and unable to allocate required resources and time. It is shown in table 4.5 and figure 4.5.

Table 4.5 – Preparation of EOT Claims.

	Preparation of EOT claims	No of Respondents	% of Respondents
1	Project staff	48	79%
2	In house experts assigned to work on money & time claims	12	19%
3	External consultant	1	2%

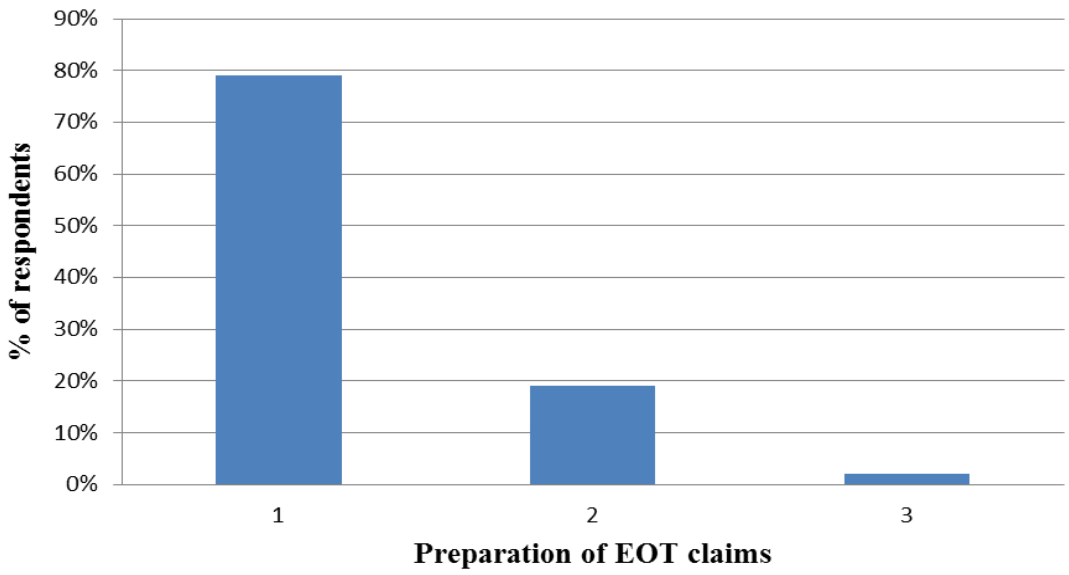


Figure 4.5 – Preparation of EOT Claims.

4.4.5 Analysis of Application of Delay Analysis Techniques

It was surprise that 84 % respondents were not used any of the delay analysis techniques in their evaluations. The table 4.6 and figure 4.6 are shown the application of delay analysis techniques.

Table 4.6 – Application of Delay Analysis Techniques

	Delay Analysis Technique	No of Respondents	% of Respondents
A	As-planned Vs. As Built	3	10%
B	Impacted As-Planned	1	3%
C	As Planned but For	0	0%
D	Time impact Analysis	1	3%
E	Collapsed As-Built	0	0%
F	Window Analysis	0	0%
G	None Of the Above	27	84%

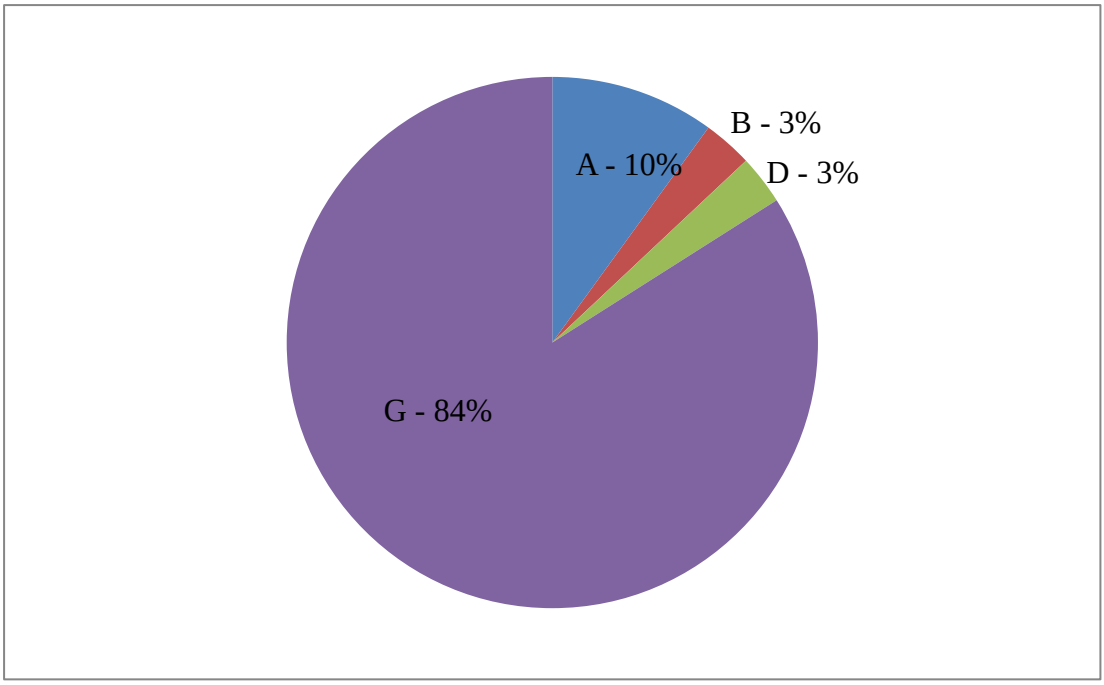


Figure 4.6 – Application of Delay Analysis Techniques

4.4.6 Analysis of Main Barriers for Proper EOT Claiming Practices

It was noticed that mainly three reasons with weighting 47%, 34% and 19% as table 4.7 and figure 4.7. The major reason of not maintaining adequate records to adapt a proper analysis technique is lead to investigate utilization of resource and record maintaining level also.

Table 4.7 – Main Barriers for Proper EOT Claiming Practices

	Reasons	No of Respondents	% of Respondents
L	Inability to spend time/money on advance techniques	11	34%
M	Not maintaining adequate records to adopt a proper analysis technique	15	47%
N	Not having the expertise to follow other factors	6	19%
O	The contract specifies a particular method	0	0%
P	Other	0	0%

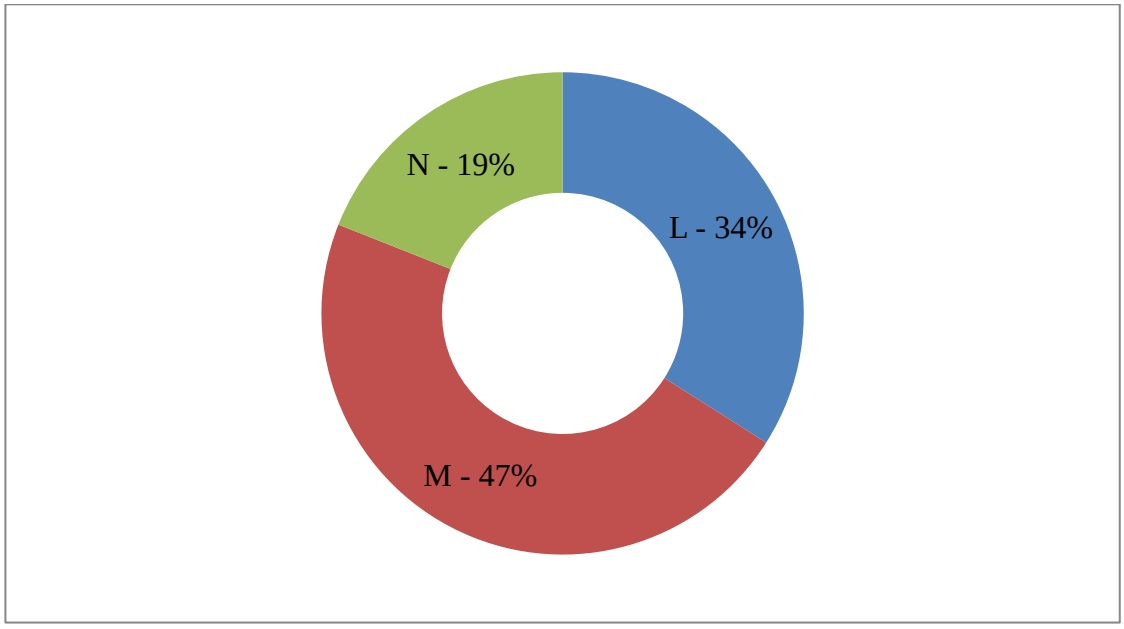


Figure 4.7 – Main Barriers for proper EOT claim

4.4.7 Utilization of Construction Programmes for the EOT claims

As described in section 2.3, the work programme of the construction project is key element in the management of extension claims. In Sri Lankan construction industry, it was observed that in modern day contracts, construction programme is compulsory but proper utilization of program for the practice of extension of time claims is not at reasonable level. According to this study, it is evident from responses that the highest of 53% responses are being implemented with 25% or lesser usage of the construction programmes for analyzing their EOT claims of the projects. It is a negative impact on the practice of delay analysis techniques. It is indicated in table 4.8 and figure 4.8.

Table 4.8 Use of Construction Programme for the EOT claims

	% of use of construction program for the EOT claims	No of Respondents	% of Respondent
1	0% - 25%	17	53%
2	26% - 50%	8	25%
3	51% - 75%	5	16%
4	76% - 100%	2	6%

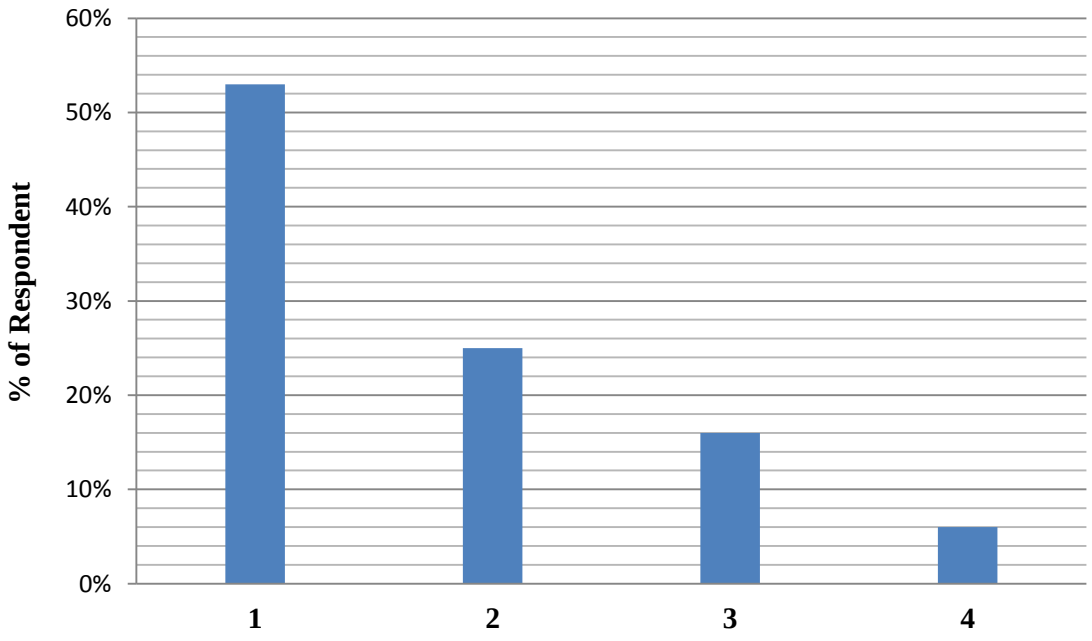


Figure 4.8 – Use of Construction Programme for the EOT claims

4.4.8 Practice of the Construction Programmes

As described above, the programme is required to use delay analysis techniques for EOT claims by updating at least after delay event. That means updating of programme is a must for an accurate delay analysis. It was observed that 84% of respondents update with their programme on Engineers' request, 9% of respondents update after delay event and 7% of respondents update monthly. When the fact is compared with these results, maintaining of construction programmes are to be improved in Sri Lankan Construction industry. It is shown in table 4.9 and figure 4.9.

Table 4.9 Practice of the Construction Programmes

Details Included	No of Respondents	% of Respondents
On Engineers Request	27	84%
After Delay Event	3	9%
Monthly	2	7%

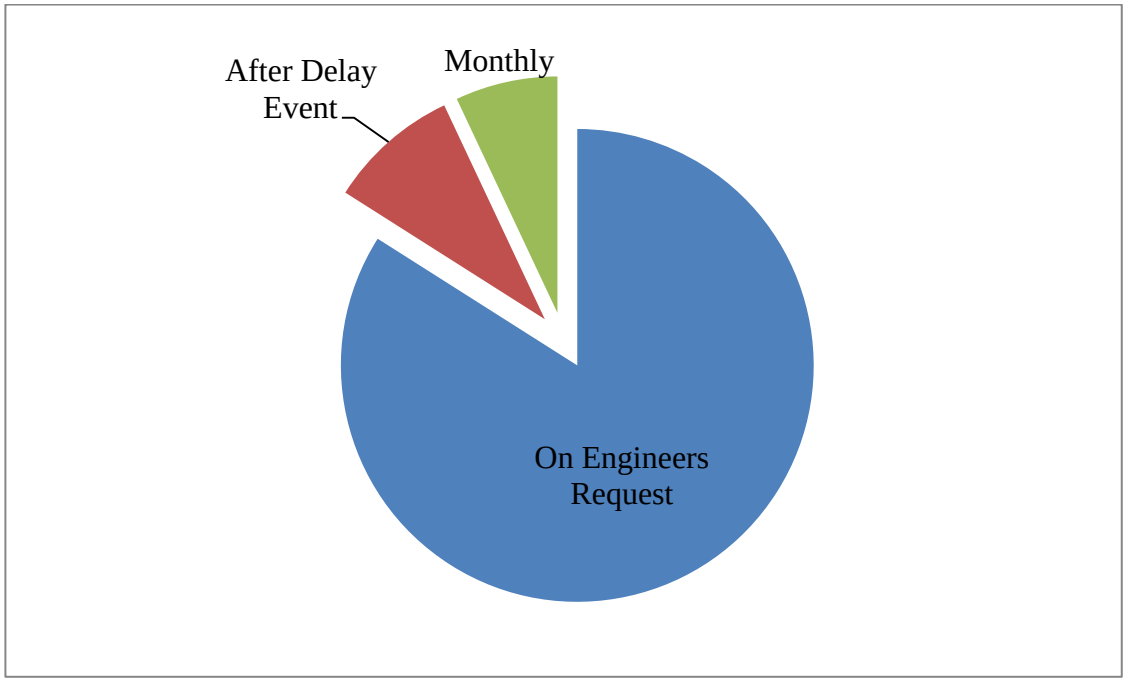


Figure 4.9 – Practice of the Construction Programmes

4.4.9 Record keeping at site

According to the analysis, the most common reason for why many potentially valid claims are rejected is the claimant's failure to maintain adequate records. In this survey, it was observed that 98% were keeping work programme at site, but priority of baseline and updated work programme is 57% compared to priority of other record keeping at sites. In the selected sample priority list of records kept at site are shown in table 4.10.

Table 4.10 – Priority list of records

Priority	Type of records	% of Respondent's Priority
1	Weather records	100%
2	Variation Orders	94%
3	Photographs	81%
4	Correspondence	75%
5	Work programmes	57%
6	Progress records	44%
7	Delivery notes	31%
8	Site diaries	22%

It shows that construction programme was given fifth priority though that is one of the key elements in the extension of time claims. Furthermore, another key record, progress records required for claim management are further down in the priority list with only 44% of the project maintaining progress records. The records of photographs were got a more priority (81%) with third place although the photographs are not widely accepted by some consultants or engineers in substantiating their claims.

4.5 General Findings from the Interviewees

From the interviews, it was disclosed that most of the contractor's staff and engineer's staff are not aware about delay analysis techniques like "as-planned vs. as-built", "impacted as planned", "collapsed as-built', and "time impact analysis". They admitted that lot of contractors are not maintaining proper records enough to use above techniques for their EOT claim analysis and have not experts to follow the above delay analysis techniques. Further they admitted that their programmes were not in to utilize for those kinds of techniques. Otherwise, it was revealed that engineer's requirement also not compiled to that kind of standard.

When examining the projects, several instructions from the engineer to update the programme and keeping poor records at sites were found. Engineer's representative confirmed that the contractor's record keeping at site was poor and granting EOT was very difficult in the absence of the contemporaneous records. Interviewees mentioned that the content of the program and how it should be prepared were not emphasized in contracts although it is compulsory to submit a work programme in almost in every contract.

By experiencing above fact, it was observed that most of contractors are submitting programmes ranging from just excel sheets having complex programmes prepared using project management software. In the pilot study project, the contractor had taken good effort to substantiate his claim and recorded his intention to claim in events when there was a likely possibility of delaying the project.

Some of the ideas expressed in the interviews were that separate records were kept due to the contractors' failure to submit the timely records. Engineer's representatives mentioned that in some situations they are reluctant to accept photographs as one of the tool in submitting claims without proper record keeping at site and contractor fail to submit the records on time. Their main concern of EOT claims were contractor's failure to give notice on time to be eligible for the claims, insufficient supporting documentation and failing to demonstrate cause and effect. The rejection factors of the EOT claims as discussed under section 4.4.2 were evaluated during the interviews of experts in order to validate. The results are illustrated in able: 4.11.

Table: 4.11 Ranking of EOT Rejection Factors

Rejection Factors	% from the Data Analysis	Ranking with Experts' Validation
Time claims not formal	53%	1
Insufficient support documentation	28%	2
Claim content disputed	10%	3
No acknowledgement given	6%	4

As discussed under section 4.4.6, the main barriers for the proper EOT claiming practices in industry were also evaluated during the interviews of experts and results are illustrated in table: 4.12.

Table 4.12 – Ranking of Main Barriers for the proper EOT claims

Reasons	% from the Data Analysis	Ranking with Experts' Validation
Not maintaining adequate records to adopt a proper analysis technique	47%	1
Inability to spend time/money on advance techniques	34%	2
Not having the expertise to follow other factors	19%	3
The contract specifies a particular method	0%	

The interviewers further were of the view that the initial contract period set for this contract was unrealistic and unachievable in the existing conditions such as material shortage and labor shortage against the parallel construction boom. As answer for this issue, engineer stated that contract period was set mainly based on urgent need of the employer and other factors were not considered. They further confirmed that the factors like traffic restriction, time restriction and noise restriction were also not evaluated in detailed when setting the period of contract.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

It is concluded that EOT claims become an integral part of the construction projects in Sri Lanka and almost all projects which were investigated during the survey have experienced time overruns. The EOT claims requests are amongst the most frequent made. Furthermore, it was observed that there is a high risk of rejection or improper awarding for their EOT claims in Sri Lankan construction industry.

The study further explores main reasons for rejection of EOT claims. Those factors were ranked with the experts' opinion and analysis of survey results as following order.

1. Time claims not formal (53%)
2. Insufficient support documentation (28%)
3. Claim content disputed (10%)
4. No acknowledgement given (6%)

The higher rejection rate has indicated as "time claims not formal". It is resulted due to improper submission of EOT claims with respect to delay events. Therefore, it is disclosed that Sri Lankan construction industry is lacking in good widely accepted practices in EOT claims.

Then, this study brings main barriers not to implement accurate delay analysis techniques. Those barriers were gathered with the experts' opinion in addition to the analysis of survey results. Those are,

- Not maintaining adequate records to adopt a proper analysis techniques
- Inability to spend time/money on advance techniques
- Not having experts to follow other factors
- Inadequate contract period comply with the resources level

In real sense, the findings of this study will be more beneficial to bring on the construction professionals' consciousness towards applicable delay analysis techniques of building construction industry in Sri Lanka.

5.1 Construction Programmes

As per the findings from interviews and result of data analysis, there is high tendency to prepare the construction programme using project management software but, very little effort is being taken to include the essential component to the programme in Sri Lankan construction industry. It was found that 53% of such programme has been made with 25% or lesser implementation for the EOT claim analysis. Otherwise, construction programme is submitted for the sake of submitting a programme and as a contractual requirement only, and importance of the construction programme in analyzing time claims is very much unfamiliar. As an example, the pilot study project had failed to include the critical path in their construction programme. In the interviews, it was further revealed that the highly unsatisfactory situation in the preparation of construction programmes properly in Sri Lankan construction industry.

It is concluded that lot of construction contracts are compulsory construction programmes but, there is no recognized standards for those programmes and well updating method in order to make use for EOT claim analysis. Therefore, it is proposed to predefine in contract document, what standard will be governed for construction programmes and their updating process complied with analysis of relevant delay claims.

5.2 Record keeping at site

To succeed in an application for EOT claims, one fundamental requirement is for the claiming contractor to produce adequate documentation and records of a supportive nature that sufficient to persuade the assessor of the claim. When proper records keeping procedures are established and maintained, stake holders of the projects are often able to access key information quickly and in a timely manner to respond to

crises and manage problems when they arise. This reduces the disputes in delay analysis as well.

It is recommended to maintain records jointly with the agreement of the consultant or engineer and contractor in formats agreed upon at the inspection of the work. It is further recommended to have a more elaborate record keeping clause in the conditions of contract. In the meantime, it is necessary to take initiatives to move towards web-based document process for record keeping in construction site, which allow for real time collaboration between all parties. As revealed in this study, the most construction sites are already having computers, implementation cost would be minimal. This can firstly be implemented in mega projects. This also allows the web-based server document control application to act as a central filling system available to all project participants. It is recommended that parties have back up and archive all documents which are made available to them for future reference. Once access is denied, or restrictions are placed on a party's access to the web-based document portal, gaining access to historical records will be difficult. There by record keeping process can be streamlined and disputes can be minimized on records.

5.3 Awareness of Delay Analysis Techniques

Many construction professionals were unaware of the widely used delay analysis techniques. Due to this unawareness they submit global claims without substantiating the cause and effect and these claims are highly liable for rejection or improper awarding. Therefore, it is a timely need to make awareness of delay analysis techniques among Sri Lankan construction professionals. Workshops and seminars can be used for the purpose and professional bodies such as ICTAD, the Institute of Engineers, Sri Lanka (IESL) and the National Construction Association of Sri Lanka (NCASL) can play pivotal role in this regard. It is further proposed that fundamental theoretical knowledge about delay analysis techniques to be included in the syllabus of undergraduate programmes in the universities.

5.4 Selecting a most applicable Delay Analysis Technique

A fair and effective evaluation of delay impact is possible if the most appropriate delay analysis technique is selected, that provides a reliable solution with the information available and within the time and cost allocated for this purpose. However, the transient nature of construction projects do not often allowing scheduling data being well documented as well as time and budget limitations lead a number of researchers to suggest that the choice of a simpler method may be sensible. As planned vs. as-built and collapsed as-built methods are efficient in some situations. The impact as-planned method falls behind these three as it has so many critical flaws.

The reliability of delay analysis depends on the selection of a suitable analysis method and on the availability of scheduling data. An analyst should meticulously review the data obtained from the project records because none of the methods yields reliable results if the information used is invalid. It is necessary to be very familiar with the capabilities of the software used in project scheduling and progress control in order to be able to generate legitimate schedules for the analysis. The other controversial issues such as the treatment of concurrent delays and the ownership of float should be clearly specified in the contract. Project participants should settle these issues early in the project so as to maintain proper scheduling administration. The best practice is to be prepared for delay management throughout the project by adopting these recommendations as a routine procedure. Since time impact analysis is by far the most effective method in proving time-based claims for the reasons discussed in this paper, ideally speaking, all project managers should engage in practices that will generate adequate information to allow the use of time-impact analysis in case a time-based claim needs to be proven. However, given the different circumstances in different projects, it is not always possible to generate such information. In such cases, the recommendations made in this paper should allow a claims analyst to pick the most effective delay analysis method that is compatible with the information at hand at the time of analysis.

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APPENDIXES

Appendix - A

Appendix - B

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APPENDIXES

Appendix - A

Appendix - B

Research Questionnaire

Note: i) This data will be used only for the research propose and will be kept confidential

ii) This data will be specified only in building construction sector

Please write / select answers for following questions.

01. Detail Survey

1.1 Name of the Organization :
1.2 ICTAD Grade :
1.3 Name of the Project :
1.4 Employer :
1.5 Project Cost (Excluding Vat.) :
1.6 No of Building blocks in Project :
1.7 Building Area :
1.8 No of Stories in Building :
1.9 Type of Building :
1.10 Contract Period :
1.11 Original Starting date of Project :
1.12 Original Ending date of Project :

02. Investigation of claims for "Extension of Time (EOT)"

2.1 Number of EOT claims submitted :
2.2 From the above - a) Succeeded (S) :
b) Failed (F) :
c) Pending (P) :

Nos.	State (S/F/P)	Reason/s for the claim
1		
2		
3		
4		

03. If the EOT claims were rejected either in part or in total, please indicate the reason/s?

- ☐ Claim not formal
- ☐ Insufficient / incorrect notice
- ☐ Insufficient support documentation
- ☐ Claim content disputed
- ☐ No acknowledgement given
- ☐ Other (Please state) ……

04. How often has the need risen to submit extension of time claims with respect to the delayed events?

- ☐ 0 % – 25 %
- ☐ 26 % – 50 %
- ☐ No at all
- ☐ 51 % – 75 %
- ☐ 76 % – 100 %

05. Normally how EOT claims are submitted in your project?

- ☐ After the laps on contract period
- ☐ After a delay event
- ☐ Monthly
- ☐ Other (Please state) ……

06. Who prepare the time claims?

- ☐ Project Staff
- ☐ In house expertise assigned to work on time & money claims
- ☐ External consultant

07. Are you aware of the contractor's claims as per the condition of contract? **Yes/No**

08. Which of the following delay analysis techniques were used to evaluate the EOT claims?

- ☐ As-planned versus as-built
- ☐ Impacted as-planned
- ☐ As planned but for
- ☐ None of the above
- ☐ Window analysis
- ☐ Time impact analysis
- ☐ Collapsed as-built

09. Are you aware of the above delay analysis techniques? **Yes / No**

10. If the answer **for question no 09 is "Yes"** and answer **for question no 08 is "None of the above"** please indicate the reason/s?

……

11. What are the factors considered for a delay analysis technique?

- ☐ Timing of analysis
- ☐ Cost of the technique
- ☐ Characteristics of the project
- ☐ Characteristics of baseline program
- ☐ Other (Please state) …….
- ☐ Availability of records
- ☐ Contractual requirements
- ☐ Being the familiar technique

12. In your opinion, what would be the following reason for the above selected answer?

- ☐ Not having the expertise to follow other factors
- ☐ Not maintaining adequate records to adopt a proper analysis technique
- ☐ Inability to spend time / money on advanced techniques
- ☐ The contract specifies a particular method
- ☐ Other (Please state) ……

13. Have EOT claims lead to disputes which were resorted to adjudication or arbitration? **Yes / No**

14. Is it possible to use a project planning software in your site? **Yes / No**

15. On how many occasions construction programs were prepared or edited with respect to the EOT claims?

- ☐ 0 % – 25 %
- ☐ 26 % – 50 %
- ☐ 51 % – 75 %
- ☐ 76 % – 100 %

16. What details do you normally include in your work program?

- ☐ Material
- ☐ Resources
- ☐ Activity links
- ☐ Critical paths

17. Normally how work programs are updated in your project?

- ☐ On Engineers request
- ☐ After a delay event
- ☐ Monthly
- ☐ Other (Pleasestate) ……

18. What are the records maintained at site? (Please number the following items as priority to record in your project)

- ☐ Weather records
- ☐ Correspondences
- ☐ Delivery notes
- ☐ Site diaries
- ☐ Day work sheets
- ☐ Other (please state) …….
- ☐ Photographs
- ☐ Progress records
- ☐ Variation orders
- ☐ Work programs

19. If the computers are used in site, please indicate the tasks they perform?

- ☐ Labour/Materials/Plant records
- ☐ Drawing register
- ☐ Construction / Log notes register
- ☐ Progress monitoring
- ☐ Cost management
- ☐ Cost value reconciliation
- ☐ Contract programming
- ☐ Other (Please state) …….

20. Would you like to answer some brief additional questions? **Yes / No**

If "Yes" please indicate

- ☐ Via telephone
- ☐ Via interview
- ☐ Via E-email
- ☐ Other (Please state) ……

Questionnaire completed by:

Position :

Contact Number :

E-mail :

THANK YOU FOR YOUR ASSISTANCE

Appendix - B

Details of Pilot Study Project

Project Name	Employer	Engineer's Representative	Contractor	Contract value LKR	Contract Period	
					Initial	Adjusted
Urban Regeneration Project – City of Colombo Construction of 1080 Housing Units at Mattakkuliya	Urban Development Authority	Central Engineering Consultancy Bureau	Sanken Construction (Pvt) Ltd.	3.7 Billion	2 Years & 6 Months	4 Years & 2 Months