CONSTRUCTION SCHEDULE BASED DELAY ANALYSIS IN ROAD AND BUILDING PROJECTS

BY

J.K.T.A.Jayawickrama

Supervised by

Dr. L.L. Ekanayake

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Department of Civil Engineering

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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 inter library loans, and for the title and summary to be available to outside organization.

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The above particulars are correct, to the best of my knowledge.

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ABBREVIATIONS AND ACRONYMS

BOQ	-	Bill of Quantities
CAPC	-	Cabinet Appointed Procurement Committee
CE	-	Chief Engineer
CIDA	-	Construction Industry Development Authority
CPM	-	Critical Path Method
DPC	-	Department Procurement Committee
EE	-	Executive Engineer
EOT	-	Extension of Time
GOSL	-	Government of Sri Lanka
HD	-	Head of the Department
ICTAD	-	Institute of Construction Training and Development
MPC	-	Ministry Procurement Committee
PD	-	Provincial Director / Project Director
PMBOK	-	Project Management Body of Knowledge
RDA	-	Road Development Authority
SBD	-	Standard Bidding document
TEC	-	Technical Evaluation Committee
VO	-	Variation Orders

ABSTRACT

The delays in the construction projects are a global phenomenon and are considered as a standout amongst the most tireless issues all through the world. Therefore, it is essential to analyze the delay accurately, and various delay analysis methods are used for quantifying the magnitude of the delay and it can be observed that the construction schedule plays a vital role for all these methods. With the advancement of the technology, various project management soft wares have been invented under different brand names to do the delay analysis processes and they have the potential to assist plan, prepare construction schedule, arrange and control resource tools and develop resource estimates.

Even though that there are so many project management softwares have been invented with the development of technology, the proper usage of a construction schedule is questionable. According to the survey carried out by the Department of Census and Statistics Srilanka, it has been revealed that the majority of the Srilankan construction industry comprises with the roads and building sector by the year 2015. Thus, this study was focused on improvement of the construction schedule-based delay analysis in Road and Building Construction sector in Sri Lanka.

Initially a literature survey was done in order to identify the currently used methods for analyzing delays and applicability of construction schedule for each method. Accordingly, it was revealed that the construction schedule is a mandatory item for each and every method. Thereafter a multiple case study and in-depth study was carried out on 26 past completed road and building projects separately to identify that how the delay has been established in these two sectors and the significance of the delay claim in each sector. The analysis reveals that the significance of the claims obtained from the road projects are very high and mostly a construction schedule has been used there. Having done that by doing an in-depth analysis on those projects it was identified that what are the reasons for the difference in significance of delay claims obtained road and building projects and under that 11 factors were identified. By doing a questionnaire survey on these identified factors, their severities were identified and to find out the solutions to overcome the top five factors among them, an expert interview process was carried out.

Finally, the findings can be concluded that the applicability of construction schedule-based delay analysis is vital in establishing claims in road and building projects. The significance of the delay claims established in road projects are much higher than the delay claims established in building projects. To bridge this gap in the building construction sector, it is required to have much more contribution from the professional bodies and the other relevant organizations related to the construction industry. In addition to that it is required to breakdown the monopoly which has been created some certain professions involved in the construction industry and avoid discriminations among the professionals involving in the building construction sector.

Key words: Claims, Delays, Delay Analysis, Construction Schedule

CHAPTER ONE

1.0. INTRODUCTION TO THE RESEARCH

1.1Background

In any country, the construction industry considered as an economical controller which provides a significant contribution to the gross national product. It has built a substantial correlation with other sectors as well (Ofori, 1990). Thus, the well-being of the national construction industry is of paramount importance for economic development and long-term growth of a country.

The construction work includes a wide variety of activities depending on the size and type of projects and the professional and trade skills required. Projects can vary from work, worth a few hundred pounds to costing several million pounds, where the principles of execution are similar to any projects, scale, complexity, and intricacy may vary enormously (Ashworth, 2004).

An important measure of success in the management of construction projects is the achievement of the completed project within the prescribed timescale. The principal objectives of construction projects are time, cost, quality, and safety. Unfortunately, the phenomenon of delays adversely impacts all the stakeholders of the projects. Projects which overrun time will typically produce financial penalties, either in lost profits that would be accrued through use of the completed project or expected benefits to the public not being realized. The cause of the overrun will probably be a direct result of delays that have occurred throughout the construction process and that have had a knock-on effect on the project as a whole.

The delays in the construction projects are a global incident and are considered as an exceptional issue amongst the most tireless issues all through the world (Gardezi, Manarvi, & Gardezi, 2014). The party suffers the damages from delay needs to be able to recognize the delays and the parties responsible for them. Delay may be defined as an event which results in or causes an extension of time to complete a whole or some part of a project. Delay may also define as the time during which some part of the construction project has been extended or not performed due to

unanticipated circumstances Sambasivan & Soon (as cited in Gardezi, Manarvi, & Gardezi, 2014)

Usually, delay situations in construction are complex. The effectivity of a delay in a single activity of a project may not result in the same amount of the total delay of the project. As a result of that, an activity delay can be affected or not affected on the project completion date. A delay can be caused by more than one party; however, it can also be created by none of the parties. (Divya & Ramya, 2015)

Thus, it is essential to analyze the delay accurately, and various delay analysis methods are using for understanding the magnitude of the delay. Delay analysis refers to an in-depth inspection for identifying the issue which has caused a project to run late. That is the delay to the completion of work or contract milestones caused by the time impact of events such variations, late information, excessively inclement weather, poor performance, remedial works and the hundreds of other delay-causing circumstances that arise on construction projects (Lyulina, Onishi, & Kobayashi, 2015).

By analyzing the delay properly, an exact figure for the delay impact can be calculated which is reasonable for both the parities. Based on that the party who sued by the delay can make claims to recover his loss or damage. Normally a claim has two components as Cost and Time. Depending on the situation, the party who affected by the delay gets the opportunity of claiming both these aspects or one of them. There are several types of claims are practiced in the industry to claim the cost component associated with a delay.

According to (Arditi & Pattanakitchmroon, 2006) there are four methods in the construction literature that are professionally acceptable. They are (1.) the as planned vs. as built schedule analysis method, (2) the impact as planned schedule analysis method, (3) the collapsed as built schedule analysis method, and (4) the time impact analysis method.

In considering the aforementioned delay analysis methods, it can be observed that the construction schedule plays a vital role. Therefore, various project management soft wares have been invented under different brand names. Project management software has the potential to assist plan, arrange, and control resource tools and develop

resource estimates. With the advent of computers and sophisticated logic-linked construction schedules, the interest in the techniques of delay analysis has significantly increased (Eggleston, 2009).

1.2Problem Statement & Research Question

Sri Lankan construction industry continues to occupy an important position in the national economy. Nevertheless, major criticisms faced by the industry are the large rate of delays in project delivery. The delay occurs in almost all construction projects in Sri Lanka and the magnitude of these delays varies considerably from project to project. (Jayalath D. U., 2010) Through the survey of construction industries carried out by the Department of Census and Statistics 2015, construction activities in Sri Lanka were categorized according to International Standards of Industrial Classifications Revision 4 (I.S.I.C.Rev 4).Results of the categorization according to the above classifications has been shown below.

1. General Construction
    - 1.1 Construction of residential buildings
    - 1.2 Construction of non-residential buildings
    - 1.3 Construction of roads, railways, tunnels, air field runner ways, bridges etc.
    - 1.4 Construction of utility projects
    - 1.5 Construction of other civil engineering projects
2. Specialized Construction Activities
    - 2.1 Electrical wiring, plumbing, computer networks etc.
    - 2.2 Building completion & finishing
    - 2.3 Other constructions

The table 1.1 indicates the distribution of value of work done by type of construction activity within the year 2015

Type of Construction Activity	Value of work done (Rs. Mn)	Percentage (%)
Buildings (Residential)	52,078	13.1
Non-residential Buildings	51,930	13.1
Roads & Railways	192,559	48.4
Utility Projects	37,049	9.3
Other Civil Engineering Projects	16,364	4.1
Electrical, Plumbing and Other Construction Installation Activities	20,667	5.2
Building Completion & Finishing	1,278	0.3
Other Construction	25,845	6.5
Total	**397,770**	**100.0**

Table 1.1Distribution of Value of Work Done by Type of Construction Activity within the Year 2015

Source: Survey of Construction Industries (2015)

Therefore, the above table depicts that the highest value of work done was recorded from Roads & Building constructions by the year 2015. From the total percentage of construction works these two has acquired nearly seventy-five percent by that time. As they are representing the majority of the Sri Lankan construction, it is imperative to analyze the delay accurately in these kinds of construction projects to determine the magnitude of it. As mentioned in the previous section, the construction schedule plays a vital role in analyzing the delays. Even though there are so many project management softwares has been invented with the development of technology, the proper usage of a construction schedule is questionable. Most of the previous research studies have done regarding the various delay analysis methods and causes for delays. However, it is questionable whether the sufficient attempts have been taken to

examine the proper practice of delay analysis by using a construction schedule. As the majority of the Srilankan construction industry comprises with the roads and building sector, it is essential to identify the usage of a construction schedules for analyzing of delays. Therefore, the problem arises that ***"How the Construction Schedule-Based Delay Analysis is Practiced in Road and Building Construction Sector in Sri Lanka?"***

1.3 Research Objectives

The main aim of this research is to improve the construction schedule-based delay analysis in Road and Building Construction sector in Sri Lanka and what are the steps to be taken to improve them. It is going to meet through following objectives.

I. To identify the methods currently uses to analyze delays and the claims associated with delays.
II. To identify the applicability of construction schedule for such methods.
III. To identify the level of significance of the delay claims in road and building projects.
IV. To identify the reasons for difference in significance of the delay claims in road and building projects and the severities of these reasons.
V. To make suggestion which can be taken to improve the efficient usage of construction schedules in the relevant sector based on the results of the above objectives.

1.4 Problem Justification

This research highlights the importance of following a schedule-based delay analysis of the roads and building construction projects in Sri Lanka. As these two sectors have acquired a vast portion of the construction industry, failure to follow a proper practice in analysis of delays open the door to a list of uncountable disputes. According to the research carried out by ICRA Management Consulting Services Limited, it has been found out that the present Sri Lankan construction industry contributes to about 70% of the Gross Domestic Fixed Capital Formation and about 8 percent to the country's Gross Domestic Product (GDP). Therefore, the problems occur in construction projects can be imposed a great danger on the national economy as well. In addition to that consider about the composition of the parties of a gigantic building or road

construction project, it can be observed that sometimes they comprise with international companies and organizations instead of individuals and a small group of people. Thus, project delays under these contexts can pave way to a global disaster as well, and magnitude of the impact of delay is snowballing if it is not analyzed properly. Therefore, this research encourages all the construction professionals to pay more serious attention to the proper scheduling of the construction projects. Through that, all the parties of a project get an opportunity of overcoming the disputes associated with the delays without facing many more difficulties.

1.5 Significance of the Research

Delays may occur at any time on a project. The importance of studying this research is to improve the accuracy of delay analysis in construction projects. With that sued party due to the delay gets the opportunity of receiving a reasonable compensation or remedy for the losses they faced. It is required to have a properly prepared construction schedule for that, and proper use of such construction schedule is a must here. The benefits of a properly prepared construction schedule are not only limited to analysis of delays, and a lot of beneficiaries can be gained simultaneously by using that in addition to that. Furthermore, this research indicates an area where the construction professionals should improve their computer literacy. With that, there is a high possibility of creating new information technology-based job opportunities related to the construction industry.

1.6 Methodology

As stated above, to achieve the aim of the research, it is required to fulfill several objectives. Therefore, fulfilling objectives individually ultimately paves the way to reach the set target. At the same time, the way of achieving these objectives are not always same. A literature survey would be conducted to find out the available literature and extent to which research has been carried out on methods to use analysis of delays and applicability of construction schedules for such methods and it covers the first two objectives. In addition to that through that literature survey, it also identified the claims associated with the delays. Prior to achieve the third objective, it is required to identify that how the delay was established in road and building projects. In addition to that it is required to identify the applicability of construction schedules for establishing the delays and compensating claims in road and building

projects. These things are found out by analyzing case studies. Data are collected through in-depth analysis of each case, to achieve the required outcome of the objective. The findings from the case study analyses are listed and their severities are determined through the severity index to achieve the fourth objective. To do that questionnaire survey was distributed among a sample which comprises with the construction contractors who are listed out under grade C3 to grade CS2 as per the CIDA categorization. The purpose of the research was informed to the Contractor through the phone and it was e-mailed to each contractor. Then it was reminded again to them and collected the details of each questionnaire. Then the suggestions are made for the identified important factors to overcome them through an expert interview process. A combination of all these outcomes while achieving these objectives paves the way to the accomplishment of the aim of the research.

1.7 Limitations of the Study

This study is limited to the Road and Building Projects as they have a significant impact on the Sri Lankan construction industry as stated above. As the details associated with a building or a road project is increasing with its contract sum and the importance of proper planning and scheduling also increases as a result of that, projects which have over LKR.500 Million contract sums has selected for this study. Furthermore, as it is required to have much more capacity and potential to handle these types of Projects, the details of the past completed projects were obtained from the contractor's those who are categorized under the grade CS2 according to national registration and grading scheme for construction contractors which has been introduced by CIDA. At the same time, this study focuses only from the Contractor's point of view as it is one of the mandatory requirement which the Contractors always try to skip without having an idea of the importance of it. Thus, the questionnaires are also distributed among the contractors' grade C3 to grade CS2 as categorized by the CIDA. Apart from that most of the contract documents of the construction projects in Srilanka are prepared based on the FIDIC Red Book 1999 and SBD 2, construction projects which the contract documents have been prepared based on the FIDIC Red Book 1999 and SBD 2 has been considered here. In addition to that the research is done from the contractor's point of view as they are obliged to prepare and submit construction schedules according to FIDIC Red Book 1999 and SBD 2. Moreover, for this research study, projects were selected which were started after the year 2008 as

these projects get high opportunity of scheduling at least by using MS Project 2007. For conducting the expert interviews, five expert interviews are conducted among a panel of experienced professionally qualified construction claims specialists those who have over 10 years of experience in the industry and processed Bachelor's Degree in Engineering or a Bachelor's Degree in Quantity Surveying through a recognized university. At the same time this study focuses on the phenomenon's in the construction industry related to road and building projects by the year 2015, as the sectors which acquires the highest value of work done in construction industry are varying chronologically.

1.8 Guide to the Report

For the easiness of the reference, this research will be divided into following chapters.

Chapter 01: - This provides the background for the research. It discusses the aims, objectives, and research problems, scope of the research, its limitations and brief introduction about the methodology.

Chapter 02: - This provides the information obtained from the literature review about the methods which use to analyse the delay and applicability of a construction schedule for such methods.

Chapter 03: - This provides the information about the research methodology, and as the research designed by using the both case study research approach and survey research approach, the method of data collection and analysis are stated here.

Chapter 04: - This provides the detail analysis qualitatively of the cases mentioned in the previous chapter and quantitative analysis according to their findings.

Chapter 05: - This provides the conclusions derived from the research findings and recommendations to improve usage of construction schedule-based delay analysis in Srilankan context.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1 Introduction

In the upcoming pages of literature review, demonstrates the theoretical works which have been done already related to the delay analysis in the construction industry. While doing that it is expected to achieve part of the objectives of this research simultaneously to reach the answer the research question. This literature review initially summarizes the existing knowledge not only in the Sri Lankan context but also international perspective and attempt to recognize the methods used to analyze the delay.

Secondly by analyzing the received results, it identifies the applicability of a construction schedule for such methods and it further highlights the importance of the schedule delay analysis in construction projects.

2.2 Delays in the Construction Industry

A construction project is commonly admitted as successful when it completes on time, within budget, according to the specifications, and stakeholder satisfaction. However, most of the projects did not finish within the expected timetable. Instead, they completed before or after the schedule due to uncertainties of events and its uniqueness. (Aibinu and Jagboro,2002)

Due to the delays in construction, a vast array of changes can happen in a project such as late completion, lost productivity, acceleration, increased costs, and contract termination. (Divya & Ramya, 2015).

Various interpretations have been made by various people to define the delays in construction projects. According to O'Brien (as cited in Marzouk & El-Rasas, 2014), construction delay means a time overrun either beyond the contract date or beyond the date that the parties have agreed upon for the delivery of the project. Delay was also defined as an act or event which extends required time to perform or complete work of the contract manifests itself as additional days of work. Zack (as cited in Marzouk & El-Rasas, 2014). According to (Tumi , Omran, & Pakir , 2009), delay can be defined as the time during which some part of the construction projects has been extended or not performed due to an unanticipated circumstances.

2.3 Types of Delay

Delays in construction projects have been put in various classifications by several authors but most of these classifications have a lot in common in terms of their fundamentals. Although various types of delays have been put in several studies, they are somewhat linked to one another and most importantly, by looking at a delay in different angles, it can be devided into four major categories (Nagata, Manginelli, Lowe, & Trauner, 2017). For the convenience of reference, they have been illustrated in the figure 2.1.

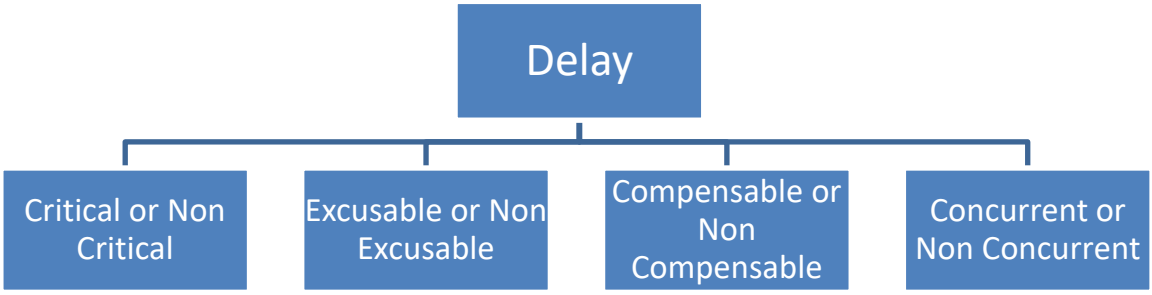

Figure 2.1 Classifications of Delays

2.3.1 Critical or Noncritical Delays

Critical delays are those activity delays that affect the progress of the project in such a way that result in a predicted delay to the project completion date. However, many delays occur that do not delay the project completion date. Delays that affect the project completion are considered critical delays, and delays that do not affect the project completion are considered as noncritical delays. The concept of “critical” delays emanates from Critical Path Method (CPM) scheduling. While the determination of the critical path and the identification of critical activities is a major feature of CPM scheduling, all projects, regardless of the type of schedule, have “critical” activities. (Nagata, Manginelli, Lowe, & Trauner, 2017)

A key concept of CPM scheduling is that only delays to the critical path result in a delay to the scheduled project completion date. This is because the critical path is the longest path through the schedule network and, as such, is the path that determines the length of the project and the date upon which the project is predicted to be complete. Thus, the delay to the completion date is a predicted delay based on the then-current project plan. A change in that plan may either mitigate or exacerbate that delay. Determining which activities truly control the project completion date depends on the following factors.

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

Regardless of how one analyzes a project and the schedule to find the delays, there is one overriding criterion: The analysis must accurately consider the contemporaneous information when the delays were occurring. "Contemporaneous information" refers to the daily reports, the schedule in effect, and any other job data available that show the circumstances at the time of the delays. Proper research and documentation eliminate the "but-fors" and any other hypotheses contrived to advance predisposed conclusions or desired results. (Nagata, Manginelli, Lowe, & Trauner, 2017)

2.3.2 Excusable or Non-Excusable Delays

2.3.2.1 Excusable Delays

Generally, an excusable delay is a delay that is due to an unforeseeable event beyond the contractor's control. Normally, based on common general provisions in public agency specifications, delays resulting from the following events would be considered

- Acts of God
- Floods
- Owner-directed changes
- Errors and omissions in the plans and specifications
- Differing site conditions or concealed conditions
- Unusually severe weather
- Intervention by outside agencies (such as the EPA)
- Lack of action by government bodies, such as building inspection
- Constructive changes

These conditions may be reasonably unforeseeable, not within the contractor's control, and not the contractor's fault or responsibility. When a delay is determined to be excusable, the contractor will be entitled to an extension of the time to complete the project work. The characterization of a delay as excusable must be made within the context of the specific contract. The contract should clearly define the factors that might justify entitlement to a time extension to the contract completion date. For example, some contracts may not allow for time extensions caused by weather

conditions, regardless of how unusual, unexpected, or severe, even though such delays would be beyond the control of the contractor. (Nagata, Manginelli, Lowe, & Trauner, 2017)

2.3.2.2 Non-Excusable Delays

Non excusable delays are events that are within the contractor's control, are the contractor's responsibility, or that are foreseeable. These are some examples of non-excusable delays:

- Late performance of subcontractors
- Untimely performance by suppliers
- Faulty workmanship by the contractor or subcontractors
- A project-specific labor strike caused by either the contractor's unwillingness to meet with labor representatives or by unfair labor practices

Again, the contract is the controlling document that determines if a delay would be considered non-excusable. For example, some contracts consider supplier delays to be excusable if the contractor can prove that the materials were requisitioned or ordered in a timely manner, but the material could not be delivered due to circumstances beyond the contractor's control, such as national or worldwide material shortage. Other contracts may not consider such delays to be excusable. Therefore, both owners and contractors should recognize the importance of clear and unambiguous contract documents when defining excusable and non-excusable delays. (Nagata, Manginelli, Lowe, & Trauner, 2017)

2.3.3 Compensable or Non-Compensable Delays

A compensable delay is a delay for which the contractor is entitled to both a time extension and additional delay-related compensation. Relating back to excusable and non-excusable delays, only excusable delays can be compensable. A non-compensable delay means that the contractor is not entitled to additional delay-related compensation resulting from the delay. Some excusable delays may be compensable. All non-excusable delays are non-compensable. (Nagata, Manginelli, Lowe, & Trauner, 2017)

Whether or not a delay is compensable depends primarily on the terms of the contract. In many cases, the contract specifically defines the kinds of delays that are excusable, non-compensable, for which the contractor does not receive any additional money but may be allowed a time extension. (Nagata, Manginelli, Lowe, & Trauner, 2017)

The combination between above four claims has been clearly illustrated through the figure 2.2.

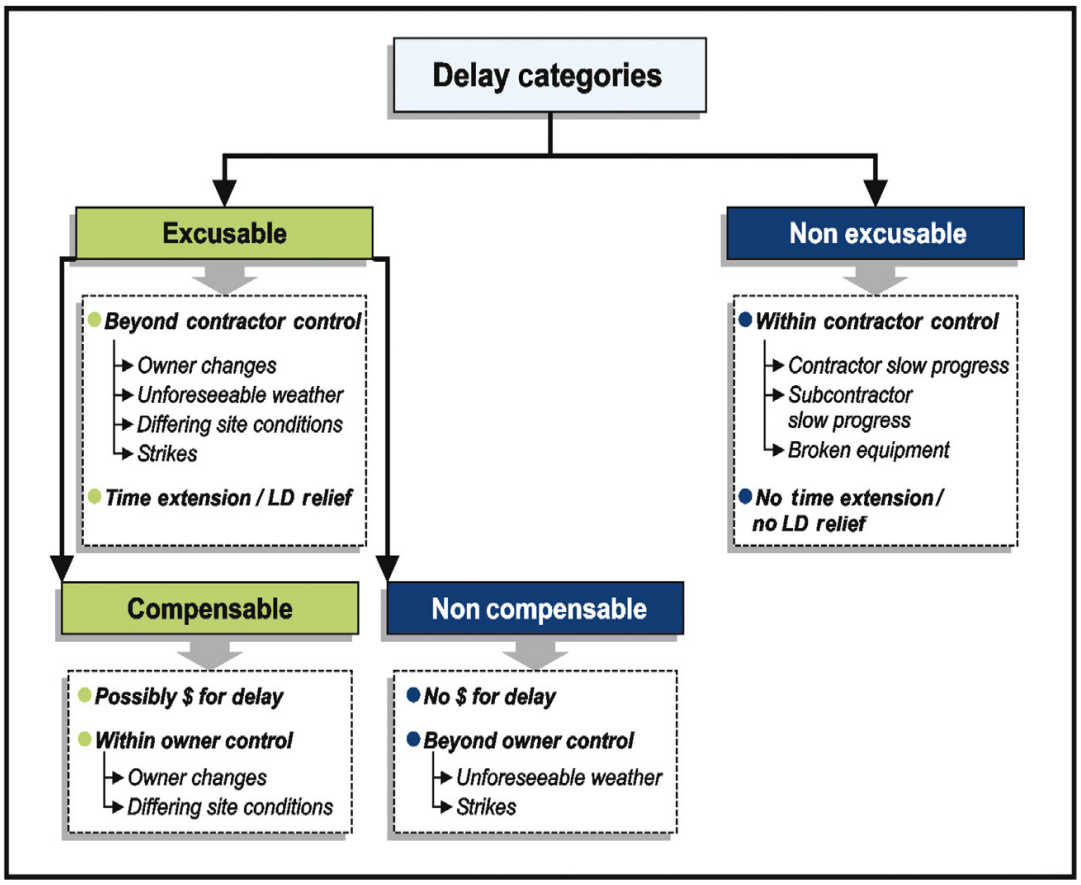

Figure 2.2 Descriptions of Excusable, Non-Excusable, Compensable and Non-Excusable Delays.

Source: (Nagata, Manginelli, Lowe, & Trauner, 2017)

The delays fallen under Excusable and Non-Compensable according to the above figure can be easily interpreted according to the Standard Bidding Document – Major contracts (SBD 2) and Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer (FIDIC Red Book 1999). According to the Sub-Clause 19.1 of FIDIC Red Book 1999 and Sub-Clause 20.1 of SBD 2 it has been clearly specified that what the Force Majeure Situation is.

In standard FIDIC contract forms, the term 'Force Majeure' is more broadly defined as an exceptional event or circumstance (Robinson, 2011). Accordingly, 'Force Majeure' is an event exceptional event or circumstance;

(a) 'Which is beyond a Party's control and prevented the affected Party from performing any of its obligations

(b) Which such Party could not reasonably have provided against before entering into the Contract

(c) Which having arisen, such Party could not reasonably have avoided or overcome

(d) Which is not significantly attributable to the other Party.

Force Majeure may include but is not limited to:

- War, hostilities etc.
- Rebellion, terrorism, revolution, civil war etc.
- Riot, commotion, disorder etc. other than by the Contractor's Personnel and other employees' munitions of war, explosive materials
- Natural catastrophes such as an earthquake, hurricane, etc.'

(Robinson, 2011) says that the relationship of this sub-clause to Sub - Clause 17.3 of FIDIC Red Book 1999 'Employer's Risk' will be noted. The following criteria need to be satisfied:

(a) It must be exceptional not merely unusual.

(b) It must be beyond the control of the Party who is affected by it. Notice is to be given in accordance with Sub - Clause 19.2.

(c) The affected Party could not reasonably have provided against it before the Contract was made.

(d) The affected Party could not reasonably have avoided or overcome it.

(e) It must not have been substantially attributable to the other Party. If it were attributable to the other Party, then the liability of the other Party would not be limited to the consequences of Force Majeure.

Consider about the above aspects mentioned by (Robinson, 2011) relating to the Sri Lankan context; it can be clearly seen that the same Sub-Clause 17.3 in SBD 2 says the same things above about the Employer's Risks. Thus, the same relationship which found in FIDIC Red Book 1999 can be observed between the Sub-Clause 20.1 and Sub-Clause 17.3 of SBD 2.

2.3.4 Concurrent Delays

The concept of concurrent delay is a very important aspect of delay analysis. Concurrency is relevant, not just to the determination of critical delays, but also to the assignment of responsibility for delay-related costs. Owners may cite concurrent delays by the contractor as a reason for issuing a time extension without additional

compensation. Contractors may cite concurrent delays by the owner as a reason why liquidated damages should not be assessed for its delays. Unfortunately, few contract specifications include a definition of "concurrent delay" or define how concurrent delays affect a contractor's entitlement to additional compensation for time extensions or responsibility for liquidated damages. (Nagata, Manginelli, Lowe, & Trauner, 2017). The Society of Construction Law and Disruption Protocol defines that the concurrent delay is the occurrence of two or more delay events at the same time, one an Employers Risk Event, the other a Contractor Risk Event and the effects of which are felt at the same time. For concurrent delay to exist, each of the Employer Risk Event and the Contractors Risk Event must be an effective cause of Delay to Completion. This means both these delays must affect the critical path. (The Society of Construction Law Delay and Disruption Protocol, 2017)

2.4 Analysis of Delay

The objective of delay analysis is to calculate the project delay and work backwards to try to identify how much of it is attributable to each party (contractor, owner, or neither) so that time and/or cost compensation can be decided. (Braimah , 2013). Not all delay impacts result in a critical delay to the project's scheduled completion. Therefore, it becomes necessary to determine which delays were critical and which were not. In order determine the net time impact, all delay events, whether alleged or not, must be assessed using industry recognized delay analysis methodologies. Generally, time extensions are based upon the contractor's demonstration that a particular delay event or a series of delay events had a critical impact contributing a delay to the project's overall completion. Therefore, non-critical delaying events till and if they become critical, never provide a basis for entitlement to any time extension. It is only when the impacts are fallen on the critical path can a particular activity become critical. A critical path never exists for ever but continuously changing over the time till the completion of the project. (Jayalath C. , 2013)

2.4.1 Reasons for Delay Analysis

Much, if not the majority, of delay analysis work in the construction industry is undertaken to assess, to prove or re-but the time related claims of one sort or another. These may be extension of time claims, reasonable time claims, prolongation claims,

acceleration claims or delay claims (Eggleston, 2009). Accordingly, there three primary reasons why one might want to analyze delay are as follows.

I. To help establish lines of investigation

An exploration of a construction project will involve consideration of a wide variety of issues. These include: where the delays occurred and which part of the project; when did the rate of progress decline; where did the late information or materials cause delay; the instance of competing delays; poor productivity; insufficiency of resources; lack of design information; failure to progress; excessive rainfall and so on.

II. To demonstrate entitlement

The delay analysis methodologies do not provide the ultimate answer in a case concerning the extension of time. The methodologies are tools for assisting in describing or analyzing complex sets of facts. It is the engineer or architect, or ultimately an arbitrator or a judge, who has to consider and weigh up all the competing evidence and form an opinion. The delay analysis exercise will assist in this process, but it will only be part of the evidential matrix.

III. To present the case

Having interrogated the project records and analyzed the delays, it is necessary to convince the opposing party. Visual aids can help this process (primarily graphs and charts) and these can be produced using IT tools used by the delay analyst.

2.4.2 Delay Analysis Methodologies

Delay is quite common in construction projects. So by considering the above categorization made for the delay it can be observed that the delay can be caused by the Employer, the Contractor, and the third party or the force majeure that the parties to a contract cannot control. Delay to completion of a project could bring significant losses to society as well as the project cost. The damage caused by a project delay is compensated by the Contractor in principle in the form of ‘liquidated damage’. However, the Contractor shall claim the extension of time or the recovery of the financial burden if the Employer is liable for the cause of the delay. In fact, a variety of factors contribute to the delay of project completion in complex interdependencies of a number of tasks. Hence determining the contractual responsibility of delay is the

most likely source of dispute in construction projects for transportation infrastructure. Methods used for forensic investigation of delay are called as 'delay analysis methods'. (Lyulina, Onishi, & Kobayashi, 2015)

According to (Arditi & Pattanakitchmroon, 2006) and (Eggleston, 2009), the following methods in the construction literature are professionally acceptable for analysis of delay. They are (1.) the as planned vs. as built schedule analysis method, (2) the impact as planned schedule analysis method, (3) the collapsed as built schedule analysis method, and (4) the time impact analysis.

But in the 2nd edition of the Society of Construction Law Delay and Disruption Protocol, it has been introduced another two methods such as Time Slice Window Analysis and Retrospective Longest Path Analysis apart from the previous methods.

2.4.2.1 The Time Slice Analysis

This method requires the analyst to verify or develop a reliable series of contemporaneously updated baseline construction schedules or revised contemporaneous construction schedule reflecting an accurate status of the works at various snapshots throughout the course of the works. Through this process, the progress of the works is divided into time slices. The time slices are typically carried out at monthly intervals. The series of time slice construction schedule reveals the contemporaneous or actual critical path in each time slice period as the works progressed and the critical delay status at the end of the time slice, thus allowing the analyst to conclude the extent of actual critical delay incurred within each window. Thereafter, the analyst investigates the project records to determine what events might have caused the identified critical delay in each time slice period. For each time slice construction schedule, the analyst needs to verify that the historical components reflect the actual progress of the works and that its future sequences and durations for the works are reasonable, realistic and achievable and properly logically linked within the construction schedule. (The Society of Construction Law Delay and Disruption Protocol, 2017)

2.4.2.2 The As Planned vs. As Built Analysis Method

This method is distinct from the time slice analysis; it is less reliant on construction schedule and usually applied when there is concern over the validity or reasonableness of the baseline construction schedule and/or contemporaneously updated construction schedule and/or when there are too few contemporaneously updated constructions

schedule. In this method, it simply determines the net impact of all delay events as a whole rather than scrutinizing each delay event separately (Arditi & Pattanakitchmroon, 2006). Here the duration of the works is broken down into windows. The analyst determines the contemporaneous or actual critical path in each window by a common-sense and practical analysis of the available facts. As this task does not substantially rely on project management software, it is important that the analyst sets out the rationale and reasoning by which criticality has been determined. The incident and extent of critical delay in each window is then determined by comparing key dates along the contemporaneous or actual critical path against corresponding planned dates in the baseline construction schedule. Thereafter, the analyst investigates the project records to determine what delay events might have caused the identified critical delay. The critical delay incurred and the mitigation or acceleration achieved in each window is accumulated to identify critical delay over the duration of the works. (The Society of Construction Law Delay and Disruption Protocol, 2017). This method is restricted by its inability to identify concurrency, resequencing, mitigation or acceleration. It is useful as a starting point in relation to other, more complex methods of analysis. (The Society of Construction Law Delay and Disruption Protocol, 2002)

2.4.2.3 The Impacted As Planned Analysis

This method involves introducing delay event sub-networks into a logic linked baseline construction schedule and its recalculation using CPM project management software in order to determine the prospective impact these events have on the predicted contract completion dates shown within the baseline construction schedule. Before do the analysis, the analyst needs to confirm that the sequences and durations for the works shown in the construction schedule are reasonable, realistic and achievable and properly logically linked within the schedule, to deal with the risk that the baseline construction schedule contains fundamental flaws which cannot be overcome. In general, this is thought to be the simplest and least expensive from of delay analysis, but has material limitations, principally because it does not consider actual progress and changes to the original planned intent. The product of this method of analysis is a conclusion as to the likely effect of the modelled delay events on the baseline construction schedule. In limited circumstance this analysis may be deemed sufficient for assessing EOT entitlement. Such circumstances include where the

impacted as-planned method is dictated by the terms of the contract and/or where the delay events being considered occur right at the outset of the works. (The Society of Construction Law Delay and Disruption Protocol, 2017)

2.4.2.4 The Time Impact Analysis

This method involves introducing delay event sub-networks into a logic-linked baseline construction schedule and recalculation of this updated construction schedule using CPM project management software in the order to determine the prospective impact the delay event would have on the then predicted completion dates. The baseline construction schedule for each analysis can be a contemporaneous construction schedule or a contemporaneously updated baseline construction schedule, the difference being the revised contemporaneous construction schedule may have logic changes/ activity/ resource changes from the original baseline construction schedule. In either case, analyst needs to verify that the baseline construction schedule's historical components reflect the actual progress of the works and its future sequences and durations for the works are reasonable, realistic and achievable and properly logically linked within it. Mitigation and acceleration already incorporated into the updated baseline construction schedule need to be considered as these can conceal or distort the projected impact of the delay events. The number of delay events being modelled has a significant impact on the complexity and cost of deploying this method. The product of this method of analysis is a conclusion as to the likely delay of the modelled delay events on the construction schedule /critical path that is most reflective of the contemporaneous position when the delay events arose. This method usually does not capture the eventual actual delay caused by the delay events as subsequent project progress is not considered. (The Society of Construction Law Delay and Disruption Protocol, 2017)

2.4.2.5 The Collapsed as-Built Method

This method involves the extraction of delay events from the as-built construction schedule to provide a hypothesis of what might have happened had the delay events not occurred. This method does not require a baseline construction schedule. This method requires a detailed logic-linked as-built construction schedule. It is rare that such a construction schedule would exist on the project and therefore the analyst is usually required to introduce logic to a verified as-built construction schedule. This can be a time consuming and complex endeavor Once completed, the sub-networks

fro the delay events within the as-built construction schedules are identified and they are ‘collapsed’ or extracted in order to determines done in windows, using interim or contemporaneous construction schedules which contain detailed and comprehensive as-built data. A limitation to this method is that it measures only incremental delay to the critical path, because the completion date will not collapse further than the closest near critical path. (The Society of Construction Law Delay and Disruption Protocol, 2017)

2.4.2.6 Retrospective Longest Path Analysis Method

In this method, the analyst must first verify or develop a detailed as-built construction schedule. Once completed, the analyst then trace the longest continuous path backwards from the actual completion date to determine the as- built critical path. The incidence and extent of critical delay is then determined by comparing key dates along the as-built critical path against corresponding planned dates in the baseline construction schedule. Thereafter, the analyst investigates the project records to determine what events might have caused the identified critical delay. A limitation to this method is its more limited capacity to recognize and allow for switches in the critical path during the course of the works. (The Society of Construction Law Delay and Disruption Protocol, 2017)

2.5 Claims Associated with Delays

Most standard form of contract contain provisions that list out relevant events that allow a contractor to apply time extensions; the contract often expressly states that the claim should be made and dealt with timely as possible with the delaying events. (Yusuwan & Adnan, 2013).

When there is a delay in a construction project, it has to be analyzed and quantify the magnitude of it. At the same time delaying a construction project means that there is an Extension of Time for Completion or Extension of Defects Notification Period based on the Party who is liable for delay according to the Sub-Clause 8.4 and 11.3 of FIDIC Red Book 1999 and SBD 2.

The Sub-Clause 8.4 of FIDIC Red Book 1999 refers to the Extension of Time for Completion and according to that the Contractor is entitled to subject Sub-Clause 20.1 which is Contractors Claim. This scenario is exactly same in SBD 2 and the only difference is the relevant Sub-Clause for Contractor’s Claim in SBD2 is Sub-Clause

19.1. Delays in construction activities may give rise to a need for an application of extension of time, to provide sufficient time to complete the project. So the Sub-Clause 20.1 of FIDIC Red Book 1999 and the Sub-Clause 19.1of SBD2 deals with Contractor's Claims and both these Sub-Clauses clearly say that the Claim is either an additional time or payment. Therefore, through a proper analysis of delay the Contractor gets the opportunity of compensating his losses reasonably and recovering to a neutral position.

As mentioned previously, the beneficiaries of the proper analysis of delay is applicable to the both parties of the construction contract. Therefore, if the Contractor caused a delay, then the Employer also has the opportunity of claiming his losses from the Contractor through a proper delay analysis. The Sub-Clause 8.7 of FIDIC Red Book 1999 and SBD2 deals with the Delay Damages and the Liquidated Damages and there it has been clearly mentioned that if the Contractor fails to perform according to the Sub-Clause 8.2 then he shall subject to Sub-Clause 2.5 to pay delay damages to the Employer. Sub-Clause 8.2 of FIDIC Red Book 1999 and SBD2 refers to the Time for Completion and Sub-Clause 2.5 of FIDIC Red Book 1999 and SBD2 refers to the Employers Claim. Therefore, by referring all these clauses, it can be observed that the Employer also gets the opportunity of compensating his losses and that also has to be done through a proper analysis of delays.

Therefore, through a proper delay analysis, the magnitude of the delay can be quantified accurately. Based on that, the party who sued by the delay can make claims to recover his loss or damage. Normally a claim has two components as Cost and Time. Depending on the circumstances, the party who affected by the delay gets the opportunity of claiming both these components or one of them. There are several types of claims which are practiced in the construction industry in this regard and which are fallen under the above-mentioned Employers Claims and the Contractors Claims. (Jayalath C. , 2013) has categorized the delay associated claims into seven.

I. Disruption Claims.

II. Prolongation Claims.

III. Liquidated Damages.

IV. Unabsorbed Overhead Claims.

V. Acceleration Claims.

VI. Price Fluctuation Claims.

VII. Financial Claims.

2.5.1 Disruption Claims

Disruption is the hindrance to actual progress by reducing the output of the construction resources. This means labour and plant. It is obvious that the contractor has to allocate resources for the projects he is doing. Sometimes these resources may be hired by the contractor. In a situation where a delay caused by the employer, the contractor loses the opportunity of achieving the planned output of such resources. But he has to pay the rentals or the charges of those resources. At the same time, if this delayed project is not there, he had the opportunity of allocating these resources to some other project where the workflow is smoothly going on. Therefore, all these issues are severely affecting the contractor's cash flows and he can claim these losses under such circumstances. There are two essential things the contractor should do here. First thing is analyzing the magnitude of the delay. The second thing is identifying the resource allocation through that delayed period. If the contractor uses a construction schedule in which the resources are allocated, the contractor can directly calculate the cost associated with these resources directly.

2.5.2 Prolongation Claims

The contract sum of a contract depicts the entitlement of the contractor to have for his work done. The contract sum comprises three components. They are the value of work done, the overhead expenditures and the reasonable profit which the contractor entitled to receive. The overhead expenditures are the indirect costs associated with the work done. They can be divided into two as site overhead and head office overheads. The site overheads are the indirect costs connects with the site operations, and they are claiming under the preliminary bill. Some of them are time related. Therefore, they are claiming according to the way of defining in the BOQ. Examples for these types of expenses are the electricity expenses of the site, salaries of the site management staff, water bills, telephone bills, etc. Head office overheads are the indirect expenditures which the contractor has to bear to run the projects in connected to the head office. The examples for these types of expenses are electricity bills of the head office, salaries of the head office staff, rentals, etc. In a situation where the

project gets delayed due to a delay caused by the employer, the contractor has to bear the site overhead expenses and the head office overhead expenses beyond the time for completion. Therefore these expenditures should be compensated to the contractor by the employer. For that, the delay should be adequately analyzed by the contractor and should quantify the magnitude of it. Then the actual expenses of the time-related preliminaries should claim on the real basis through that period. This is the Prolongation Claim. (Thomas, 2001)

2.5.3 Liquidated Damages

Having entered into a construction contract, the contractor is liable to complete the project within the time for completion. If he is unable to do it within that period due to his fault, the other party faces a lot of difficulties. For an Employer, a delay will mean that the asset being constructed will not be able to be used when originally intended. This means the Employer has to incur additional costs or suffer a delay in receiving income from the project. For the Contractor, delay to the completion of the project may result in likability for delay damages to the Employer. As a result of these risks, most building contracts fix the damages that will be payable to the Employer for late completion in advance. These are called as 'liquidated damages' (LDs). At the same time, it is fallen under the Employer's Claim, and Most of the time the daily claimable amount for LD's are mentioned in the Particular Conditions of the Contract Document. Here also a proper delay analysis has to be done first, and the magnitude of the delay has to be quantified. Then by using the figure mentioned in the particular conditions, the LD amount can be calculated. (Ranasinghe, 2015)

2.5.4 Unabsorbed Overhead Claims

The Prolongation Claim, talks about how the site overheads are recovered in a delay situation. Not only the site overheads, the Contractor has to bear additional head office overheads also when the projects get delay. Therefore, this issue so affects badly on his cash flows. Thus, it should be compensated to the Contractor. Even though there are formulaic methods are available to calculate them, their validity and the reasonability is questionable. Therefore this has to be done through a proper delay analysis and through that the magnitude of the delay should quantify, and after that, the head office overhead expenditures should calculate on the real basis throughout that period. (Jayalath C. , 2013)

2.5.5 Acceleration Claims

By accelerating the work progress both the parties get the opportunity of completing the works before the scheduled date. There are several ways in which the work can be accelerated including but not limited to, providing additional labour and equipment, implementing a new shift and resequencing activities. There are three primary types of acceleration on construction projects and they are (1.) Directed Acceleration (2.) Constructive Acceleration (3.) Voluntary Acceleration.

Directed Acceleration occurs when the Engineer instructs the Contractor to complete the project earlier than the originally scheduled completion date. In addition to that in a situation where a variation has added to the original scope and the Contractor has to complete all of them within the initial time for completion then also directed acceleration occurs. Constructive acceleration occurs in a situation where the Contractor is entitled to an Extension for Time for Completion. Though the Contractor is entitled to an Extension of Time for Completion sometimes, the Employer may not grant additional time. In such a situation, the Contractor has to accelerate the works to meet the mandatory completion date. This is called as constructive acceleration. Voluntary acceleration occurs when a contractor decides to accelerate its own work. (Long, 2017)

Therefore, the contractor should be compensated for all the situations as mentioned above. To prepare that claim it is required to have a proper construction schedule by assigning resources. Here the task type should be assigned as “Fixed Duration” as this construction schedule is prepared for the initial project period. Through that the total cost of the project can be got easily. Then the accelerated construction schedule is prepared by assigning additional working hours for the resources. Here the task type should be fixed as “Fixed Work” because as the work is fixed even though the duration is altered. By doing this, the revised cost of the accelerated construction schedule can be calculated. The cost difference between these two construction schedules is the acceleration cost.

2.5.6 Price Fluctuation Claims

For construction projects, it is required to have materials and resources. Prices of them are increasing with the time factor. If the project gets delayed, this scenario gets worst. Therefore, it severely affects the contractor. So, a formulaic method has been introduced by CIDA to overcome this problem, and it is included in the Sub-Clause13.7 of SBD2. A similar method has been presented in the FIDIC 1999 Red

Book under Sub-Clause13.8. Through this, the contractor gets the opportunity of claiming the time associated cost of the resources.

2.5.7 Financial Claims

Money has a time value and when the time goes the value of the money depreciates. This scenario affects the construction projects as well. When a contractor enters into a contract with the employer, he has to deposit some amount of money as bonds and guarantees as per the conditions of the contract. This money is deposited only for the time for completion of the project, and if the project gets delay due to a fault of the employer, the contractor loses the opportunity of releasing that money within the intended date and has to keep them deposit further. Therefore, this issue is severely affected on the contractor as he loses the real value of money with the affectivity of time and the same time if this delay was not there the contractor at least had the opportunity of depositing that money in a bank account and enjoy the interest. Therefore, to overcome that issue the interest is calculated on these deposited amounts based on the prevailing lending rate of the Central Bank of the country. Usually, to do the calculation more reasonably, it is calculated based on the Average Weighted Prime Lending Rates (AWPLR) indicated on the website of the central bank of the relevant country.

In addition to that, there is another situation where the above scenario can apply. Generally, according to the contractor's work done, he gets paid, and if he is performing a good work progress rate, he has the opportunity of claiming the total contract sum at the end of the time for completion. But if the project delays beyond the contractors' control, he is unable to complete the project within the time for completion. As a result of that, he loses the opportunity of claiming the total contract sum within the time for completion. Thus, the contractor's opportunity of claiming money is delaying, and parallel with that, the impact of depreciating the money value of the balance work is getting bigger. Therefore, to overcome this issue the interest is calculating based on the AWPLR and it is compensated to the contractor.

Under both these situations, it is required to analyze the delay. Accordingly, the magnitude of the delay can be calculated and based on that the interest also can be calculated. (Jayalath C. , 2013)

2.6 Required Materials to do the Delay Analysis

By looking at the delay claims which were mentioned previously, it can be clearly seen that a proper analysis of delay is a salient feature of it. (Alnaas, Khalil, & Nassar, 2014) states seven steps should follow in order to do a proper delay analysis as shown below.

(1) Preparing the baseline construction schedule (planning stage).

(2) Proper construction schedule updates.

(3) Accurate construction schedule revisions.

(4) Defining and introducing the delays to the construction schedule updates.

(5) Identifying the concurrent delays and splitting between the contractor and employer delays.

(6) Defining the contractual basis for the entitlement.

(7) Preparing the evidences of delay.

At the same time in the Society of Construction Law Delay and Disruption Protocol, 2nd edition it has identified the required materials to do a proper delay analysis according to the method as shown in table 2.1.

Method of Analysis	Requirement
Impact As Planned Analysis	• Logic Linked Baseline Programme • A Selection of Delay Events to be modelled.
Time Impact Analysis	• Logic Linked Baseline Programme • Updated Programmes or Progress Information with which to update the Baseline Programme. • A selection of Delay Events to be modelled
Time Slice Window Analysis	• Logic Linked Baseline Programme • Updated Programmes or Progress Information with which to update the Baseline Programme.
As Planned vs. As Built Analysis Method	• Baseline Programme • As- Built Data
Retrospective Longest Path Analysis	• Baseline Programme • As- Built Programme

Method of Analysis	Requirement
Collapsed As-Built Anaysis	• Logic Linked As- Built Programme • A Selection of Delay Events to be modelled

Table 2.1 Required Materials to do a Delay Analysis According to the Method.
Source: Society of Construction Law Delay and Disruption Protocol, 2nd edition

Thus, it is apparent that the construction schedule plays a vital role in analyzing a delay and establishing a delay claim. Thus, attention should be given to proper scheduling while analyzing the delay. As the proper delay analysis is the basement of many delay claims and the construction schedule is the basement of delay analysis, much attention should be given to the construction schedule.

2.7 Construction Schedule

Before starting a project, it is necessary to visualize all the operations of it. By using the contractor's experience, the contractor arranges these operations in a sequence by assigning necessary resources in each operation. (Gupta, 2010). Construction Schedule creates an orderly sequence of events, defines the principles to be followed in carrying forth the plan, and describes the ultimate disposition of the results. It serves the manager by pointing out the things to be done, their sequence, how long each task should take, and who is responsible for which tasks or actions. (Knutson, Schexnayder, Fiori, & Mayo, 2015)

The goal of proper construction schedule is to minimize resource expenditures while satisfactorily completing a given task. Planning aims at producing an efficient use of equipment, materials, and labor, and ensuring coordinated effort. Effective project management requires continual monitoring of task accomplishment ager identify problems early and permits development of revised plans to maintain the proper course toward the objective. (Knutson, Schexnayder, Fiori, & Mayo, 2015)

The Sub-Clause 8.3 of FIDIC Red Book 1999 requires the Contractor to submit a detailed construction schedule to the Engineer within 28 days after receiving the notice of the Commencement Date. The Contractor will obviously have started to prepare his construction schedule at the Tender stage and continued to plan his work

during any negotiations and when he has received the Letter of Acceptance or Contract Agreement. However, he cannot prepare his final construction schedule until he learns the actual calendar dates for the construction period which is when he receives the notice of the Commencement Date. The detailed construction schedule may also include reduced or unproductive working days during certain periods of the year. (Totterdill, 2006)

This Sub-clause gives detailed requirements for the information to be included in this construction schedule and these requirements may be amplified or extended in the Particular Conditions or Specifications. When deciding on the form of the construction schedule and the detail to be included, the Contractor should remember that the construction schedule will be used to demonstrate whether any delay situation will cause a delay to completion. (Totterdill, 2006)

In SBD 2 also the Sub-Clause 8.3 defines the construction schedule and the only difference with FIDIC 1999 Red Book is the time bar for the Contractor to submit the construction schedule to the Engineer and the time bar for the Engineer to give notice to the Contractor stating the extent to which it does not comply with the Contract. For the above mentioned both the cases, the time allocation in SBD2 is 14 days.

As the construction projects are subjected to so many changes, the program also has to be altered comparatively to the baseline construction schedule. To analyze the magnitude of the impact of these changes, it is required to update the construction schedule continuously throughout the time for completion. (Alnaas, Khalil, & Nassar, 2014)

2.8 Summary

Delays in construction projects have badly affected every party who involved in the project. Delays can be categorized into several ways. To get an idea about the delays and to quantify the magnitude of them, it is required to analyze them accurately. Various delay analysis methodologies are available to do that and based on their results various claims associated with the delays can be established. Through that, the party who suffers from the delay can get a remedy to overcome their problems. To do a proper analysis of delays a construction schedule is very essential. Therefore, it is essential to prepare proper construction schedules to get rid the problems associated

with delays. With the help of computer software, it can be done more easily and accurately. Through this literature survey, the methods which currently use to analyze the delays were identified and further identified that the applicability of a construction schedule is essential to do that. Thus, the first two objectives of this research were able to achieved.

CHAPTER THREE

3.0. RESEARCH METHODOLOGY

3.1 Introduction

For a research to be systematic it should follow a series of steps what is called as research process (Tan, 2008). According to the achievement of those aims and objectives research should be designed systematically to conduct successful research. Research methodology can use as a basis of making knowledgeable decisions through a systematical manner and research methodology is simply can be identified as process followed by a researcher to achieve the aims and objectives of a research (Chaudhry, 1991)

Followings are the research objectives

I. To identify the methods currently uses to analyze delays and the claims associated with delays.
II. To identify the applicability of construction schedule s for such methods.
III. To identify the level of significance of the delay claims in road and building projects.
IV. To identify the reasons for difference in significance of the delay claims in road and building projects and the severities of these reasons.
V. To make suggestion which can be taken to improve the efficient usage of construction schedules in the relevant sector based on the results of the above objectives.

A literature survey would be conducted to find out the available literature and extent to which research has been carried out on methods to use analysis of delays and the applicability of construction schedules for such methods. The third and fourth objectives are achieved by analyzing the case studies. Data are collected through in-depth analysis of each case, to achieve the required outcome of the objective. The findings of the case studies analysis are listed and their severities are analyzed through the Severity Index (SE.I) to achieve the balance half of the fourth objective. Then suggestions are made to overcome these issues and to improve the efficient usage of construction schedules and to achieve the fifth objective.

3.2 Research Process

3.2.1 Literature Review

The literature review was extended gradually while holding the focus on the first two objectives. By including the definitions, concepts, gaps of this area, techniques dissemination mechanisms and establishing the significance of research problem the comprehensive literature review was conducted to explore the delay analysis methodologies which are in use currently and applicability of construction schedule for them.

To prepare the literature review including appropriate breadth and depth, consistency, clearness and efficient analysis and synthesize the literature search carried out through publications such as journal articles which are available in academic databases, thesis, books, conference papers which are available in the university library.

3.2.2 Research Problem Statement

The background study was carried out with the objective of identification of the impact of delays on construction projects and what are the available methods for analyzing the magnitude of the delays. Through the background study, it was understood that the construction schedule plays a vital role in analyzing delays. Even though that there are so many sophisticated computer softwares are available on the market to prepare construction schedules, proper usage of them is still questionable. Moreover, as the majority of the Srilankan construction sector has been acquired by the buildings and road projects, it is essential to study the ways of establishing delays under them. Thus, it has become a problem that how the construction schedule-based delay analyses are practiced in the road and building sector of Sri Lanka.

3.2.3 Research Design

The research design is the basic plan for a research and it includes four main ideas such as following what approach, within what framework, from whom will the data be collected and how will the data be collected and analyzed (punch, 2005).

3.2.3.1 Research Approach

This study has adopted both the Qualitative Research Approach as well as the Quantitative Research Approach methods to carry out the research and to fulfill the above dealt aims and objectives. Qualitative methods are not concerned with numerical representativity, but with the deepening of understanding a given problem.

The objective of this methodology is to produce in depth and illustrative information in order to understand the various dimensions of the problem under analysis. On the other side, in Quantitative Research, the data can be quantified. Because the samples are generally large and considered representative of the population, the results are taken as if they constituted a general and sufficiently comprehensive view of the entire population. Disciplines such as mathematics and statistics assume a fundamental importance in the process of analysis and generalization of the results obtained (Queiros, Faria, & Almeida, 2017).

Here for this research Case Study Method is doing under the Qualitative Research Approach and the Survey Method is doing under the Quantitative Method.

Case Study Method.

According to (Robson, 2002) a case study is 'a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence'. The case study strategy will be of particular interest to researcher if the researcher wishes to gain a rich understanding of the context of the research and the processes being enacted. The case study strategy also has considerable ability to generate answers to the question 'why?' as well as the 'what?' and 'how?' questions, although 'what?' and 'how?' questions tend to be more the concern of the survey strategy. For this reason, the case study strategy is most often used in explanatory and exploratory research. The data collection techniques employed may be various and are likely to be used in combination. They may include, for example, interviews, observation and documentary analysis. Sometimes someone can be suspicious of using a case study strategy because of the 'unscientific' feel it has. But the case study strategy can be a very worthwhile way of exploring existing theory. In addition, a well-constructed case study strategy can enable the researcher to challenge an existing theory and also provide a source of new research questions. (Saunders, Lewis, & Thornhill, 2009)

Justification of Using Case Study Method for the Research.

The case study approach allows, amongst other things, critical events, interventions, policy developments and construction schedule -based service reforms to be studied in detail in a real-life context. Here under this research the main concern is identifying how the construction schedule-based delay analyses are practiced in road and building

projects in Srilanka. In addition to that it has to be identified that what are the problems for practicing such methods. As mentioned previously, the answer for the research question is achieved through a set of objectives and the first two objectives are achieved through a literature survey. To achieve the third and fourth objectives, the data has to be extracted from a set of past completed projects from the contractors who are categorized under the grade CS2 according to national registration and grading scheme for construction contractors which has been introduced by CIDA. Therefore, details of two road projects and two building projects are obtained from each contractor. Hence a project automatically becomes a case here and data are extracted from them by using a suitable data collection technique.

CS2 Graded Contractors: -

The registration of main construction contractors is considered under eleven grades on financial terms and main five of them are shown in the table 3.1.

Grade	**Financial Limit (X) (Rs. Million)**
CS2	X > 3000
CS1	3000 ≥ X > 1500
C1	1500 ≥ X > 600
C2	600 ≥ X > 300
C3	300 ≥ X > 150

Table 3.1 Categorization of the Construction Contractors According to the Financial Limit.

Source: Criterion for Registration, Grading and Monitoring of Main Construction Contractors. CIDA.

The Financial limit of a registered construction contractor is based on its capacity. The capacity assessment takes into account the maximum value of a single project (Contract) or total number of projects which the particular construction contractor has the capacity to undertake at any given time. To assess the financial capacity of the CS2 level contractors, they are required to submit their audited statements for last 03

years. The financial capacity of construction contractors of this grade will be assessed on the basis of working capital or net worth, and the availability of Permanent Overdraft Facilities, Credit Facilities, Fixed Deposits, Bonds and Gurantee Facilities from a reputed bank. In addition to these factors, the capital structure of the company may also be assessed if necessary. (Criterion for Registration,Grading and Monitoring of Main Construction Contractors, 2017)

According to the CIDA categorization, following Construction Contractors have been awarded the CS2 level by the year 2015.

1. Access Engineering Plc.
2. CML-MTD Construction Ltd.
3. Consulting Engineers and Contractors (Pvt) Ltd.
4. Edward & Christie
5. Hovael Construction (Pvt) Ltd.
6. K D A Weerasinghe & Company (Pvt) Ltd.
7. Maga Engineering (Pvt) Ltd.
8. N E M Construction (Pvt) Ltd.
9. Nawaloka Construction Company (Pvt) Ltd.
10. Sanken Construction (Pvt) Ltd.
11. Sathuta Builders (Pvt) Ltd.
12. Sierra Construction Ltd.
13. Tudawe Brothers (Pvt) Ltd.

Therefore details of 2 completed road projects and 2 completed building projects are obtained from the each contractor, whom are mentioned above and these details are taken for analyzing the case studies. Moreover some contractors only do road or building projects and not the both. In such situation more than 2 projects were selected from some contractors under each category to cover the target of 26 projects.

Survey Research Method.

There is an important distinction between surveys and survey research. A survey is a means of "gathering information about the characteristics, actions or opinions of a large group of people referred to as a population, Surveys that are conducted to advance scientific knowledge are referred to as a survey research. (Kraemer & Pinsonneault, 1993)

The study of (Kraemer & Pinsonneault, 1993) has identified that, surveys conducted for research purposes have three distinct characteristics.

1. Survey research is quantitative method, requiring standardized information from and/or about the subjects being studied. The subjects studied might be individuals, groups, organizations or communities; they also might be projects, applications or systems.

2. Second, the main way of collecting information is by asking people structured and predefined questions. Their answers, which might refer to themselves or some other unit of analysis, constitute the data to be analyzed.

3. Third information is generally collected about only a fraction of the study population, a sample, but it is collected in such a way as to be able to generalize the findings to the population. Usually, the sample is large enough to allow extensive statistical analyses.

Justification of Using Survey Method for the Research.

Surveys are popular as they allow the collection of a large amount of data from a sizeable population in a highly economical way. Often obtained by using a questionnaire administered to a sample, these data are standardized, allowing easy comparison. In addition, the survey strategy is perceived as authoritative by people in general and is both comparatively easy to explain and to understand. The survey strategy allows researcher to collect quantitative data which the researcher can analyze quantitatively using descriptive and inferential statistics. Using a survey strategy, it gives us more control over the research process and, when sampling is used, it is possible to generate findings that are representative of the whole population at a lower cost than collecting the data for the whole population. Under the fourth objective of this research, it is required to identify the severities of the reasons for difference in significance of delay claims in road and building projects in Srilanka. Therefore, it is

required to have a quantitative answer in this regard and should be able to generalize the answer obtained from a sample to an entire population. Due to those reasons it is more suited to use survey research method to achieve that objective.

3.2.3.2 Research Techniques

Having selected the research approach, appropriate research techniques had to be identified to operate the research. These techniques could be discussed under two broad types as data collection techniques and data analysis techniques. They will be discussed in detail in section 3.2.4 and 3.2.5

3.2.4 Data Collection

3.2.4.1 Semi Structured Interviews

A semi-structured interview is a type of interview in which the interviewer asks only a few predetermined questions while the rest of the questions are not planned in advance. In semi-structured interviews, some questions are predetermined and asked all candidates, while others arise spontaneously in free-flowing conversations. Semi structured interviews are specially used to collect data in order to obtain the data to achieve the third objective. Major purpose of this semi structured interview was simply to corroborate certain facts that the investigator already thinks that have been established (Yin, 2003). In semi structured interview the interviewers seek for clarifications and elaborations on the answers given where the interview is balanced between free flow and directed conservations (Punch, 2005). The semi structured interviews is most important form of interviewing in case study research and it is a productive tool on a clear structure which carefully developed and practiced (Yin, 2003).

Composition of a Sample

Here a sample consists with a set of cases. As mentioned previously, a case means a Project here and required data are collected from a set of Construction Projects which have over LKR.500 Million contract sum and are did by the CS2 graded contractors in Srilanka. Thus, a sample consists with a set of Construction Projects which are fallen under that category.

Sample Size Justification

The sample size is dependent on the research question and objectives – in particular, what is required to find out, what will be useful, what will have credibility and what

can be done within the available resources. This particularly applies when the qualitative data are collecting through interviews. The validity, understanding and insights which are gained from the data, will be more to do with the data collection and analysis skills than with the size of the sample and it is possible to offer guidance as to the sample size to ensure that the sufficient number of interviews have been conducted. (Patton, 2002)

In addressing this issue, many research text books simply recommend continuing to collect qualitative data, such as by conducting additional interviews, until data saturation is reached: in other words until the additional data collected provides few, if any, new insights. However, this does not answer the question, how many respondents are required to need in a sample? Consider about the research it is need to determine how many cases are sufficient enough in this regard. As stated by (Guest, G., Bunce, A., & Johnson, L., 2006) for research where the aim is to understand commonalities within a fairly homogenous group, 12 in-depth interviews is enough. However, they also note that 12 interviews are unlikely to be sufficient where the sample is drawn from a heterogeneous population or the focus of the research question is wide ranging. Thus, for a general study, the researcher should expect to undertake between 25 and 30 interviews (Saunders, Lewis, & Thornhill, 2009). Thus, for this research it has to be extracted data from a number of Projects in between 25-30. As the project details are obtaining from the CS2 graded contractors and there are 13 contractors in the industry, details of two road projects and two building projects are obtained from each Contractor. Therefore 26 past completed road projects and 26 past completed building projects have been considered as a sample for obtaining data.

3.2.4.2 Un Structured Interviews

Unstructured interviews generate qualitative data through the use of open questions. This allows the respondent to talk in some depth, choosing their own words. This helps the researcher develop a real sense of a person's understanding of a situation. There is no predetermined list of questions to work through in this situation, although it is required to have a clear idea about the aspect or aspects that are needed to explore. The interviewee is given the opportunity to talk freely about events, behavior and beliefs in relation to the topic area, so that this type of interaction is sometimes called 'non-directive' (Saunders, Lewis, & Thornhill, 2009).

Under this research the unstructured interviews are carried out among five experienced professionally qualified construction claims specialists. Having analyzed the most severe factors which are found from the questionnaire survey, they are undergone to an expert interview process to windup the research and for that an unstructured interview is used.

3.2.4.3 Questionnaire Survey

The questionnaire is one of the most widely used data collection techniques within the survey strategy. Because each person (respondent) is asked to respond to the same set of questions, it provides an efficient way of collecting responses from a large sample prior to quantitative analysis. Here the Questionnaire Survey is carried out in order to achieve the fourth objective of this research and through that it identifies the severities of the identified factors received from the case study analysis. The questions are needed to be a rated in a Likert scale questionnaire to do this.

A Likert scale is a psychometric scale that has multiple categories from which respondents choose to indicate their opinions, attitudes, or feelings about a particular issue. Likert-scale questionnaires have most frequently been used in investigations of individual difference variables, freely without affecting the mental condition of the respondent. Some advantages of Likert-scale questionnaires are that (a) data can be gathered relatively quickly from large numbers of respondents, (b) they can provide highly reliable person ability estimates, (c) the validity of the interpretations made from the data they provide can be established through a variety of means, and (d) the data they provide can be profitably compared, contrasted, and combined with qualitative data-gathering techniques, such as open-ended questions, participant observation, and interviews.

Composition of a Sample

Here the questionnaires are distributed among a sample of CIDA registered contractors from the grade C3 to grade CS2 as they only have the capacity of doing the projects with considerable amount of gravity in which the construction schedule-based delay analyses are much more essential.

Sample Size Justification

The Likert-scale questionnaire determines the severities of the factors received through the case study analysis. For that a questionnaire is distributed within a

particular sample which comprises of CIDA graded contractors from C3 to CS2 as they have the capacity of doing projects under this scale. Proper determination of the sample size is essential prior to do the questionnaire survey, as it is required to generalize the findings of the sample to the entire population. To do that it is required to determine the population as explained above, the considered population is comprised with the CIDA graded contractors from C3 to CS2. The table 3.2 shows the total number of contractors who are fallen under the above grades.

Grade	**Financial Limit (X) (Rs. Million)**	**Number of Contractors**
CS2	X > 3000	13
CS1	3000 ≥ X > 1500	2
C1	1500 ≥ X > 600	39
C2	600 ≥ X > 300	41
C3	300 ≥ X > 150	72
Total		167

Table 3.2 Categorization of the Construction Contractors According to the Financial Limit.

Source: Criterion for Registration, Grading and Monitoring of Main Construction Contractors. CIDA.

Having calculated the population size properly, it is required to determine the sample size based on that. For that a greatly simplified, good decision model shown on Table 3.3 and through that it can be easily determined the size of a sample which is required to be generalized from a given population. (Morgan & Krejcie, 1970)

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Table 3.3 Determining Sample Size which is required to be generalized to a Given Population

Source: (Morgan & Krejcie, 1970)

As the size of the population based for this research is 167 and therefore the required sample size to generalize the research for the entire population is 118. The questionnaire was distributed through e-mails among the construction contractor companies which the CIDA grading varies from CS2 to C3 and prior to that, it was informed them through a phone call to answer it by a construction industry related professional who is currently working in the firm.

3.2.5 Data Analysis

The collected data through the semi structured interviews and observations were analyzed separately to achieve the research objectives. As there are two separate data entities are involved in this research, their analyzing techniques are also different to each other.

Qualitative Data Analysis

In qualitative approach data analysis consists of three activities: data reduction, data display and conclusion drawing and verification. Data reduction is the process of selecting, focusing, simplifying, abstracting and transforming the data that appear in written-up field notes or transcriptions (Miles and Humberman, 1994). After acquiring the free flowing texts from semi-structured interviews, data reduction and concept identification will be through code-based content analysis.

Content analysis is a technique for gathering data, involves codifying qualitative information into pre-defined categories (e.g. codes) in order to derive patterns in the presentation and reporting of information (Guthrie, Petty, Yongvanich, & Ricceri, 2004). Data display is an organized, compressed assembly of information that permits conclusion drawing and action. Conclusion drawing and verification concerns the emerging or inducting of meanings from the data and testing for their plausibility, their sturdiness, their validity (Miles and Huberman, 1994).

Unit of Data Analysis

One of the most important ideas in a research project is the unit of analysis. The unit of analysis is the major entity that the researcher analyses the study. For instance, any of the following could be a unit of analysis in a study. Here the cases are analyzed till it reaches to the saturate point. Therefore “A Project” becomes a unit of data analysis here.

Quantitative Data Analysis

In Quantitative Data Analysis researcher expects to turn raw numbers into meaningful data through the application of rational and critical thinking. Quantitative Data is defined as the value of data in the form of counts or numbers where each data-set has an unique numerical value associated with it. This data is any quantifiable information that can be used for mathematical calculations and statistical analysis, such that real-life decisions can be made based on these mathematical derivations. The first step in Quantitative Data Analysis is to identify the levels or scales of measurement as Nominal, Ordinal, Interval or Ratio. A scale is a tool or mechanism by which individuals are distinguished as to how they differ from one another on the variables of interest to the study. There are four basic types of scales: Nominal, Ordinal, Interval, and Ratio. (Uma Sekaran, 2003)

(I.) Nominal scale: In this scale, categories are nominated names (hence “nominal”). There is no inherent order between categories. Put simply, one cannot say that a particular category is superior/ better than another.

(II.) Ordinal scale: The various categories can be logically arranged in a meaningful order. The ordinal scale not only categorizes the variables in such a way as to denote differences among the various categories, it also rank-orders the categories

(III.) Interval scale: An interval scale allows performing certain arithmetical operations on the data collected from the respondents. Whereas the nominal scale allows us only to qualitatively distinguish groups by categorizing them into mutually exclusive and collectively exhaustive sets and the ordinal scale to rank-order the preferences, the interval scale lets us measure the distance between any two points on the scale.

(IV.) Ratio scale: The ratio scale overcomes the disadvantage of the arbitrary origin point of the interval scale, in that it has an absolute (in contrast to an arbitrary) zero point, which is a meaningful measurement point. Thus, the ratio scale not only measures the magnitude of the differences between points on the scale but also taps the proportions in the differences.

In order to achieve the third objective of this research, it is required to identify the level of significance of the delay claims in road and building projects and in order to achieve the portion of the fourth objective of this research, it is required to find out the severities of the reasons which were affected to make a difference in significance of the delay claims in road and building projects. Thus, ratio scale is applicable for the third objective as it makes a comparison between two factors and the ordinal scale is applicable for the fourth objective as a Likert scale is used there for identifying the severities of the identified factors.

Unit of Data Analysis

One of the most important things in a research project is the unit of analysis. The unit of analysis is the major entity that the researcher analyzes the study. Here there are two instances, which are required to consider the unit of data analysis under the quantitative data analysis as shown on table 3.4.

Number of the Objective	Objective
III	Identify the level of significance of the delay claims in road and building projects.
IV	Find out the severities of the reasons which were affected to make a difference in significance of the delay claims in road and building projects

Table 3.4 Objectives based for the Quantitative Analysis

a) Level of significance of the delay claims in road and building projects:-

It is determined by the following formula.

$$\text{Level of Significance of the Delay Claim} = \frac{\text{Amount of Money Received through the Delay Claim}}{\text{Total Turnover gained from the Project}}$$

Here as it has been considered the Projects which have over KR.500 Million Contract Sums, the bottom margin of the Level of Significant is considered as 10% of the Contract Sum. This means at least LKR.50 Million should be received from the Delay Claims. Thus, the factor which is subjected for analyzing data is delay claim. Therefore "Delay Claim" is the unit of Data Analysis for this objective.

b) Find out the severities of the reasons which were affected to make a difference in significance of the delay claims in road and building projects

Here to find out the severities of the aforementioned reasons, a rated questionnaire based on 1-5 Likert-scales of these factors is distributed among the Construction Industry Professionals as shown below.

1= Very Low Affected

2= Low Affected

3= Normal

4= Highly Affected

5= Very Highly Affected

SE.I is computed as:

$$\sum (an/5N) \times 100$$

Where **a=**Value representing weighting given to each response, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree)

n= The Frequency of Responses.

N= Total Number of Responses.

As all the respondents for this questionnaire survey are CIDA graded construction contractors, the unit of Data Analysis for this objective is the 'Construction Contractors'.

3.3 Summary

This chapter has presented the research design and data analysis procedures. Both the Case Study Method and the Survey Research Method has used here. As it is required to use both Qualitative and Quantitative Data Analysis process here, the sample sizes were selected accordingly which has the potential for generalizing to a population. Accordingly, 26 past completed Building Projects and 26 past completed Road Projects were selected from the CS2 graded contractors by CIDA. This was done for case study analysis and for quantitative analysis a questionnaire which is prepared based on Likert Scale was distributed among 118 Construction Contractors as shown in Table 3.4.According to the received outputs, the suggestions are made to overcome the situation and to make familiar the construction schedule based delay analysis in relevant sector through an expert interview.

CHAPTER FOUR

4.0. ANALYSIS AND RESULTS

4.1 Introduction

In the upcoming pages it shows the analysis of the details obtained from road projects and the building projects did by CS2 graded contractors. As mentioned under chapter three, two building projects and two road projects are selected from each CS2 graded contractor and there are 26 projects has been chosen under each category.

The obtained data are analyzed both qualitatively and quantitatively. As the way of doing these analyses are different from each other, they have been shown separately and qualitative data analysis has been shown initially because the quantitative analysis is doing based on the results get from the qualitative analysis.

4.2 Qualitative Data Analysis

To do a qualitative data analysis it is required to extract data initially. Thus, the extracted data from each 26 building and 26 road projects are separately shown under Annexure III and Annexure IV. To extract the data from all the projects, it is used the semi structured interview guide line shown in Annexure I.

4.2.1Date Extraction

The details are obtained through the semi structured interviews by using the interview guide line mentioned in Annexure 1 for all the projects mentioned under Chapter Four. Results obtained from each project have been shown below.

4.2.1.1Building Projects

Case Number 1 Project Details: -

This Project is an Apartment Complex Building Project situated in Nawala and started on 02nd December 2014 and the scheduled end date as per the Contract was 02nd October 2016. But it was actually completed on 28th February 2018. The main reason for delaying this Project is the inaccuracy of the Soil Report. As the construction procurement arrangement used this Project is design and built, no any in detailed BOQ was available. Moreover, no any detailed construction schedule has been prepared as

the Contractor lost the opportunity of preparing a detailed construction schedule due to non-availability of a BOQ and detailed drawings. Therefore, the Contractor lost the opportunity of establishing the Claim by using a construction schedule. The Contractor has claimed an Extension of Time Claim and a Prolongation Claim on Ex-Gratia Basis, only the Extension of Time Claim has been approved by the Employer. No any specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor has faced a lot of difficulties to finalize the scope of the Project as the design scope lies on him within a fixed Contract Sum. The Contract Sum of this Project is LKR.800 Million and additional LKR.18, 488,575.10 has been claimed as variation. As there is no any claim involvement of this project, the cost significant of claims is zero.

Case Number 2 Project Details: -

This Project is a Hotel Building Project situated in Kosgoda and started on 18th April 2012 and the scheduled end date as per the Contract was 18th April 2014. But it was actually completed on 18th April 2019. The main reason for delaying this Project is intervention of a hotel operator at the middle stage of the project. As the construction procurement arrangement used this Project is design and built, therefore no any in detailed BOQ was available. Moreover, no any detailed construction schedule has been prepared as the Contractor lost the opportunity of preparing a detailed construction schedule e due to non-availability of a BOQ and detailed drawings. Therefore, the Contractor lost the opportunity of establishing the Claim by using a construction schedule. The Contractor has claimed an Extension of Time Claim and a Prolongation Claim of LKR 120Million on Ex-Gratia Basis, and both of them has been approved by the Employer. No any specifically appointed planning engineer, but there was a claim consultant from the contractors' end. The Contractor has faced a lot of difficulties to finalize the scope of the Project as the design scope lies on him within a fixed Contract Sum. The Contract Sum of this Project is LKR.1806 Million and ended up with LKR 3100 Million which includes the claims and variations. Thus, the cost significant of claims is 3.87%.

Case Number 3 Project Details: -

This Project is Urban Regeneration Project – City of Colombo, Construction of 872 Houses, and started on 3rd April 2012 and the scheduled end date as per the Contract

was 3rd April 2014. But it was actually completed on 17th September 2015. The main reason for delaying this Project was delaying the possession to all parts of the site and it was given by the Employer after one year from the start date, additional pile depths and adverse weather condition. As the construction procurement arrangement used this Project is Design by the Employer with Fixed Lump Sum Price, therefore no in detailed BOQ was available. A construction schedule has been prepared by the Contractor. No any specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor has claimed an Extension of Time Claim and a Prolongation Claim on Sub Clause 8.1, 8.4 and 19.1 of CIDA SBD2. Only the EOT Claim has been approved by the Employer as the contractor was unable to maintain proper documentation from his end. Moreover, the contractor was unable prove how the impact of the variations affects to raise a financial claim associates with the EOT as there were no any sound staff from his end for this matter. The Contract Sum of this Project is LKR.2180 Million and ended up with LKR 2349 Million with the variations. Thus, the cost significant of claims is zero.

Case Number 4 Project Details: -

This Project is Urban Regeneration Project – City of Colombo, Design & Construction of 792 Houses at Salamulla and started on 7th January 2015 and the scheduled end date as per the Contract was 7th July 2017. But it was actually completed on 8th November 2017. The main reason for delaying this Project was the Variation Instruction given by the Engineer and adverse weather condition. As the construction procurement arrangement used for this Project is design and built, therefore no any in detailed BOQ was available. No any specifically appointed claim consultant or a planning engineer from the contractors' end. A detailed construction schedule has been prepared by the Contractor. The Contractor has claimed an Extension of Time Claim on Sub Clause 13.1, 8.4 and 19.1, and EOT Claim, but not based on the construction schedule and the EOT has been approved by the Employer. The Contractor has faced a lot of difficulties to finalize the scope of the Project as the design scope lies on him within a fixed Contract Sum and Contractor has to finance 50% of the Project as per the Letter of Acceptance. The Contract Sum of this Project is LKR.2133 Million and ended up with LKR 2147 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero.

Case Number 5 Project Details: -

This Project is Constriction of 717 Housing Units at Aramaya Place, Dematagoda and started on 29th April 2014 and the scheduled end date as per the Contract was 28th October 2016. But it was actually completed on 20th May 2017. The main reason for delaying this Project was adverse weather condition, additional works and increase in pile depth. As the construction procurement arrangement used this Project is design and built, therefore no any in detailed BOQ was available. However, Contractor had their own BOQ prepared for their reference. Moreover, Contractor has submitted a detailed construction schedule at the initial stage of the project. There was a specifically appointed claim consultant and a planning engineer from the contractors' end. The contractor was able to do the impacted as planned analysis and get an extension of time and a prolongation claim of LKR.53 Million from the Client. However, the Contractor had faced a lot of difficulties to finalize the scope of the Project as the design scope lies on him within a fixed Contract Sum. The Contract Sum of this Project is LKR.2400 Million and ended up with LKR 2620 Million which includes the income gained from the additional works, variations and claims. Thus, the cost significant of claims is 2.02%.

Case Number 6 Project Details: -

This Project is Constriction of New Building for Post Graduate Institute of Medicine, University of Colombo and started on 15th May 2015 and the scheduled end date as per the Contract was 15th November 2017. But it was actually completed on 15th May 2018. The main reason for delaying this Project was delay in getting the CMC approval for the building which was come under the Client's Scope. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), therefore detailed BOQ and Drawings were available. Moreover Contractor was able to submit a detailed construction schedule at the initial stage of the project. No any specifically appointed claim consultant or a planning engineer from the contractors' end. The contractor has not submitted any claim, but both the parties came into some amicable settlements time to time. The Contract Sum of this Project is LKR.1800 Million and ended up with LKR 1940 Million which includes the income gained from the additional works and variations. Thus the cost significant of claims is zero

Case Number 7 Project Details: -

This Project is Commercial Development for Cargills (Ceylon) PLC at Jaffna and started on 15th September 2011and the scheduled end date as per the Contract was 29th January 2013. But it was actually completed on 20th December 2013. The main reason for delaying this Project was drawing issuing delay by the Client and Extension of some floor areas. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), therefore detailed BOQ and Drawings were available. But the Contractor was unable to submit a detailed realistic construction schedule at the initial stage of the project. No any specifically appointed claim consultant or a planning engineer from the contractors' end. The contractor has not submitted any claim, but both the parties came into some amicable settlements time to time. Due to the poor document maintenance and as there was not any sound staff, the contractor was unable to raise voice properly for his entitlements. The Contract Sum of this Project is LKR.533, 750,000 and ended up with LKR 596, 820,000 which includes the income gained from the additional works and variations. Thus the cost significant of claims is zero.

Case Number 8 Project Details: -

This Project is Relocation of Tangalle Prison to Eraminiyaya, Angunukolapelessa and started on 01st May 2014 and the scheduled end date as per the Contract was 29th February 2016. But it was actually completed on 10th January 2017. The main reason for delaying this Project was variations. As the construction procurement arrangement used this Project is Measure & Pay, there is set of detailed BOQ for different kind of buildings were available. Moreover, detailed construction schedule has been prepared by the Contractor based on scope of works and had the opportunity of establishing the Claim by using a construction schedule. But the Contractor has claimed an Extension of Time Claim and a Prolongation Claim for the delay on ex gratia basis, and both of them have been approved by the Employer with some adjustments. The approved amount of claim is LKR. 20Million and the Contract Sum of this Project is LKR.3509 Million and ended up with LKR 3548 Million which includes the income gained from the claims and variations. Thus, the cost significant of claims is 0.56%.

Case Number 9 Project Details: -

This Project is a Multistory Office Building Complex situated in Dudley Senanayake Mawatha, Colombo 08 and started on 12thJune 2011 and the scheduled end date as per the Contract was 12th June 2013. But it was actually completed on 14th July 2014. The main reason for delaying this Project was variations on the scope. As the construction procurement arrangement used this Project is design and built, there is not any detailed BOQ available. Moreover, detailed construction schedule has not been prepared by the Contractor and he lost the opportunity of establishing the delay. No any specifically appointed claim consultant or a planning engineer from the contractors' end. An extension of time was given to the contractor as a result of an amicable settlement between the parties. The Contract Sum of this Project is LKR.650 Million and ended up with LKR 674 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero.

Case Number 10 Project Details: -

This Project is a multistory apartment building project situated in Rajagiriya. The scheduled start date of the Project is 25thMay 2015 and the scheduled end date as per the Contract was 25th May 2013. But it was actually completed on 12th February 2019. The main reason for delaying this Project was instructions for the variations given by the employer. As the construction procurement arrangement used this Project is design and built, there is not any detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor and a claim consultant had been appointed from the contractors' end though there was not any planning engineer. The Contractor has claimed an Extension of Time Claim and a Prolongation Claim, Interest Claim and a Price Fluctuation Claim by analyzing the delay based on impacted as planned method, and all of them have been approved by the Employer with some adjustments. The approved claim amount is LKR 23 Million. The Contract Sum of this Project is LKR.650 Million and ended up with LKR 702 Million which includes the income gained from the variations and claims. Thus, the cost significant of claims is 3.28%.

Case Number 11 Project Details: -

This Project is a multistory commercial building project situated in Union Place, Colombo. The scheduled start date of the Project is 27thFebruary 2014 and the

scheduled end date as per the Contract was 31st August 2016. But it was actually completed on 31st August 2017. The main reason for delaying this Project was the contractor's poor controlling ability of the sub-contractors as most of them were appointed within the group which the main contractor belongs to. In addition to that there was delay due to the variations caused by the employer. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor, but no any specifically appointed claim consultant or a planning engineer from the contractors' end. Though there is a concurrent delay scenario has happened here, the contractor unable to establish his entitlement as has not any way to analyze the delay. Thus, an extension of time was given on ex-gratia basis. The Contract Sum of this Project is LKR.3250 Million and ended up with LKR 3400 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero.

Case Number 12 Project Details: -

This Project is Urban Regeneration Project in the City of Colombo – Construction of 1137 Housing Units, Colombo. The scheduled start date of the Project is 1st December 2011 and the scheduled end date as per the Contract was 31st May 2014. But it was actually completed on 14th November 2014. The main reason for delaying this Project was the unexpected weather conditions and MEP variations happened on the scope. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor, but no any specifically appointed claim consultant or a planning engineer from the contractors' end. Though there is an opportunity for the contractor to raise a financial claim associated with the EOT, he was unable to do so as he did not have a knowledgeable staff or a suitable staff to analyze the delay. Thus, an extension of time was given on ex-gratia basis. The Contract Sum of this Project is LKR. 2899.35Million and ended up with LKR 2984, 367,854.96 which includes the income gained from the variations. Thus, the cost significant of claims is zero.

Case Number 13 Project Details: -

This Project is Design & Construction of Fifteen Stories, Four Buildings with 941 Housing Units, in Colombo. The scheduled start date of the Project is 8th July 2014 and the scheduled end date as per the Contract was 10th January 2017. But it was actually completed on 31st March 2018. The main reason for delaying this Project was the unexpected weather conditions and drawing delays and extra works on the scope. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor, but no any specifically appointed claim consultant or a planning engineer from the contractors' end. Though there is an opportunity for the contractor to raise a financial claim associated with the EOT, he was unable to do so as he did not have a knowledgeable staff or a suitable staff to analyze the delay. Thus, an extension of time was given on ex-gratia basis. The Contract Sum of this Project is LKR. 3246,450,000 Million and ended up with LKR 3647, 122,236.96 which include the income gained from the variations. Thus, the cost significant of claims is zero.

Case Number 14 Project Details: -

This Project is the Proposed Addition and Improvements to Upgrade Ayurvedha Hospital, Borella to a Teaching Hospital. The scheduled start date of the Project is 10th April 2015 and the scheduled end date as per the Contract was 16th November 2016. But it was actually started 27th May 2015 and completed on 24th July 2018. The main reason for delaying this Project was an advance payment issuing delay, progress payment issuing delay, delay of checking drawings by consultant, delaying approvals, delaying attending inspection by consultant, design changes of pile arrangements and adverse weather conditions. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor, and there was a specifically appointed claim consultant and a planning engineer from the contractors' end. The delay was analyzed by using As Planed –As Built method. The contractor raised and extended preliminary claim, EOT claim, Interest Claim for delay payment and Interest for Delaying Half of Retention. He was able to make approve all these claims which is amount to LKR. 74,931,708.00. The

Contract Sum of this Project is LKR. 900 Million and ended up with LKR 1290,769,887.57 which includes the income gained from the variations and Claims. Thus, the cost significant of claims is 5.81%.

Case Number 15 Project Details: -

This Project is a Construction of Private Hospital in Kandy. The scheduled start date of the Project is 26th June 2016 and the scheduled end date as per the Contract was 26th December 2017. Though the Project was timely started, it was completed on 5th April 2018. The main reason for delaying this Project was scope change by the employer by adding variations on the scope. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor, but there was not any specifically appointed claim consultant or a planning engineer from the contractors' end. The contractor raised only an EOT claim on Ex-Gratia basis. He was able to make approve that but there was not any cost claim. The Contract Sum of this Project is LKR. 1500 Million and ended up with LKR 2100 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero.

Case Number 16 Project Details: -

This Project is a Construction of New 154 key Resort Hotel at Tangalle. The scheduled start date of the Project is 19th April 2013 and the scheduled end date as per the Contract was 16th August 2015. Though the Project was timely started, it was completed on 25th April 2016. The main reasons for delaying this Project were Client Supply Material Delay, Poor Performances of the Nominated Sub-Contractors, Late Instructions and some variations. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor and there was a specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor raised an EOT Claim on As Planned As Built basis and a Prolongation Claim and a Loss of Overhead and Profit Claim. He was able to make approve all of them and the cost claim is LKR 293 Million. The Contract Sum of this Project is LKR. 3200 Million and ended up with

LKR 4100 Million which includes the income gained from the variations and Claims. Thus, the cost significant of claims is 7.15%.

Case Number 17 Project Details: -

This Project is a Construction of Business Centre at Colombo 04. The scheduled start date of the Project is 15th July 2014 and the scheduled end date as per the Contract was 15th January 2016. Though the Project was timely started, it was completed on 23rd July 2016. The main reasons for delaying this Project were Delayed Drawings, Poor Performances of the Nominated Sub-Contractors and some variations. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor and there was a specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor raised an EOT Claim on As Planned-As Built basis and a Prolongation Claim and a Loss of Overhead and Profit Claim. He was able to make approve all of them and the cost claim is LKR 35 Million. The Contract Sum of this Project is LKR. 550 Million and ended up with LKR 625 Million which includes the income gained from the variations and Claims. Thus, the cost significant of claims is 5.60%.

Case Number 18 Project Details: -

This Project is an Urban Regeneration construction schedule Initiated by the Urban Development Authority in Sri Lanka which comprised with 546 Housing Units. The scheduled start date of the Project is 3rd May 2012 and the Time for Completion of Works is 2 years. But it was actually completed on 27th October 2015. The main reason for delaying this Project was delayed instructions and drawings, additional pile depths and adverse weather condition. As the construction procurement arrangement used this Project is Design by the Employer with Fixed Lump Sum Price, therefore no in detailed BOQ was available. A construction schedule has been prepared by the Contractor. No any specifically appointed claim consultant or a planning engineer from the contractors' end. Moreover, the contractor was unable prove how the impact of the variations affects to raise a financial claim associates with the EOT as there were no any sound staff from his end for this matter. The Contract Sum of this Project

is LKR.2050 Million and ended up with LKR 2343 Million with the variations. Thus, the cost significant of claims is zero.

Case Number 19 Project Details: -

This Project is Construction of Apartment Building at Bulathgama. The scheduled start date of the Project is 19th November 2012 and the scheduled end date as per the Contract was 19th November 2015. Though the Project was timely started, it was completed on 20th July 2016. The main reasons for delaying this Project were Delayed Drawings, Unforeseeable Physical Conditions and some variations. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor, but there was not any specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor raised an EOT Claim on Ex Gratia Basis. Though he was able to make approve that EOT, he was unable to get a cost claim in this regard. The Contract Sum of this Project is LKR. 600 Million and ended up with LKR 642 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero.

Case Number 20 Project Details: -

This Project is a Construction of 12 Storied Residential Tower Comprising 94 Apartments in Malambe. The scheduled start date of the Project is 12th February 2013 and the scheduled end date as per the Contract was 12th February 2015. Though the Project was timely started, it was completed on 24th May 2016. The main reasons for delaying this Project were Delayed Drawings, Unforeseeable Physical Conditions and some variations. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor and there was a specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor raised an EOT Claim on As Planned As Built basis and a Prolongation Claim and a Loss of Overhead and Profit Claim. He was able to make approve all of them and the cost claim is LKR 200 Million. The Contract Sum of this Project is LKR. 2400 Million and ended up with LKR 3000 Million which

includes the income gained from the variations and Claims. Thus, the cost significant of claims is 6.67%.

Case Number 21 Project Details: -

This Project is a construction of 8 storey city hotel with 181 rooms in Colombo. The scheduled start date of the Project is 8th February 2012 and the scheduled end date as per the Contract was 8th February 2014. Though the Project was timely started, it was completed on 10th July 2016. The main reasons for delaying this Project were Delayed Drawings, Poor Performances of the Nominated Sub-Contractors and Some variations. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor, but there was not any specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor raised an EOT Claim on ex gratia basis as he has not any resources to raise a proper claim. He was able to make approve the EOT claim, without charging liquidated damages. The Contract Sum of this Project is LKR. 1200 Million and ended up with LKR 1364 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero.

Case Number 22 Project Details: -

This Project is a Construction of a six-storey office building as an extension to the existing public building. The scheduled start date of the Project is 12th September 2013 and the scheduled end date as per the Contract was 12th September 2015. Though the Project was timely started, it was completed on 23rd June 2016. The main reasons for delaying this Project were Delayed Drawings, unforeseeable physical conditions and some variations. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor but there was not any specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor raised only an EOT Claim on ex-gratia basis and was able to make approve it. The Contract Sum of this Project is LKR. 650 Million and ended up with LKR 718 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero.

Case Number 23 Project Details: -

This Project is a Construction Sixteen Storey Hotel Building in Colombo. The scheduled start date of the Project is 03rd August 2013 and the scheduled time for completion of work is 3 years. Though the Project was timely started, it was completed on 15th January 2017. The main reasons for delaying this Project were Delayed Drawings, Poor Performances of the Nominated Sub-Contractors and Some variations due to Hotel Operator's Issue. As the construction procurement arrangement used this Project is Design and Built, a detailed BOQ was not available. Thus, a proper construction schedule also was not available. The Contractor was only able raise an EOT Claim on ex-gratia basis. He was able to make approve it and the Contract Sum of this Project is LKR. 1800 Million and ended up with LKR 2422 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero.

Case Number 24 Project Details: -

This Project is Construction of 6 Storey Luxurious Housing Scheme in Colombo 07. The scheduled start date of the Project is 12th March 2013 and the scheduled Time for Completion as per the Contract was two years. Though the Project was timely started, it was completed on 17th October 2016. The main reasons for delaying this Project were Unforeseeable Physical Conditions and some variations. As the construction procurement arrangement used this Project is Design and Build, there was not any detailed BOQ available. However, a construction schedule had been prepared by the Contractor and but there was not any specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor raised an EOT Claim on Ex-Gratia basis and was able to make approve it. The Contract Sum of this Project is LKR. 802 Million and ended up with LKR 933 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero

Case Number 25 Project Details: -

This Project is a Construction of New Head Quarters Building for a Banking Institute in Borella. The scheduled start date of the Project is 10th January 2014 and Time for Completion as per the Contract was two years. Though the Project was timely started, it was completed on 23rd June 2017. The main reasons for delaying this Project were

progress payment issuing delay, delay of checking drawings by consultant, delaying approvals, delaying attending inspection by consultant and some variations. As the construction procurement arrangement used this Project is Traditional Separated Arrangement (Measure and Pay), there was a detailed BOQ available. Moreover, a construction schedule had been prepared by the Contractor and there was a specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor raised an EOT Claim on Impacted As Planned basis and a Prolongation Claim and a Loss of Overhead and Profit Claim. He was able to make approve all of them and the cost claim is LKR 132 Million. The Contract Sum of this Project is LKR. 2100 Million and ended up with LKR 2822 Million which includes the income gained from the variations. Thus, the cost significant of claims is 4.68%.

Case Number 26 Project Details: -

This Project is a Construction of 5-star hotel building which comprises with fifty-four rooms in Pasikuda. The scheduled start date of the Project is 11th May 2011 and the scheduled end date as per the Contract was thirty months. Though the Project was timely started, it was completed on 10th June 2015. The main reasons for delaying this Project were Delayed Drawings, Poor Performances of the Nominated Sub-Contractors and some variations. As the construction procurement arrangement used this Project is Design and Build, there was not any detailed BOQ available. However, a construction schedule had been prepared by the Contractor and but there was not any specifically appointed claim consultant or a planning engineer from the contractors' end. The Contractor raised an EOT Claim on Ex-Gratia basis and was able to make approve it. The Contract Sum of this Project is LKR. 840 Million and ended up with LKR 974 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero

4.2.1.2Road Projects

Case Number 1 Project Details: -

This Project is a rehabilitation and improvement of A029 Vauniya, Horowapathana Road and started on 16th July 2015 and the scheduled completion date as per the Contract was 16th July 2016. But it was actually completed on 28th January 2017. The main reason for delaying this Project is delay in finalizing the drawings. As the

construction procurement arrangement used this Project is Measure & Pay, an in detailed BOQ was available. Moreover, a detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor has claimed an Extension of Time Claim on Impacted as Planned basis and a Prolongation Claim and interest claim. All of them had been approved by the Employer. The approved amount of all of these claims is LKR 54 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.570 Million and ended with LKR.748, 498,785.10 which consists the amounts obtained from claims and variations. Thus, the cost significant of claims is 7.21%

Case Number 2 Project Details: -

This Project is a rehabilitation and improvement of A006 Ambepussa, Kurunegala and Trincomalee Road and started on 27th June 2011 and the scheduled completion date as per the Contract was 27th June 2012. But it was actually completed on 15th November 2012. The main reason for delaying this Project is some variation works. As the construction procurement arrangement used this Project is Measure & Pay, a detailed BOQ was available. Moreover, a detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed only an Extension of Time Claim and it had been approved by the Employer. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.864, 710,000 and ended with LKR.865, 738,000 which consists the amounts obtained from variations. Thus, the cost significant of claims is zero.

Case Number 3 Project Details: -

This Project is the Northern Road Connectivity Project (NP3) and started on 10th February 2011 and the scheduled completion date as per the Contract was 10th August 2012. But it was actually completed on 29th September 2014. The main reasons for delaying this Project are substantial increase of embankment quantities, delay in finalizing drawings, exceptional adverse climatic conditions, and quantity increase for double bituminous surface treatment and prime coat. As the construction procurement

arrangement used this Project is Measure & Pay, a detailed BOQ was available. Moreover, a detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim. Both of them had been approved by the Employer and the approved prolongation claim is amount to LKR.96 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.529, 000,000 and ended with LKR.642, 000,000 which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 14.95%.

Case Number 4 Project Details: -

This Project is the Mallawapitiya-Rambodagalla-Kappitigala Road Project and started on 26th September 2014 and the scheduled completion date as per the Contract was 25th September 2016. But it was actually completed on 29th October 2017. The main reasons for delaying this Project are delay in finalizing drawings, exceptional adverse climatic conditions. As the construction procurement arrangement used this Project is Measure & Pay, a detailed BOQ was available. Moreover, a detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim and an idling claim. Both of those claims had been approved by the Employer and the approved claim is amount to LKR.294 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.2267, 652,290.08 and ended with LKR.2829 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 10.39%.

Case Number 5 Project Details: -

This Project is the rehabilitation improvement to B-157 (West): Aluthgama to Southern Expressway and started on 15th May 2015 and the scheduled end date as per the Contract was 15th January 2017. But it was actually completed on 30th July 2018. The main reason for delaying this Project is settlement issues in marshy areas and 60% of additional rock filling had to be done as a result of that. To determine the

settlements, settlement gauges had to be built and analyze the settlement and it took a considerable amount of time. In addition to that adverse climatic conditions and the piling quantities increments also affected for this delay. As the construction procurement arrangement used this Project is Measure & Pay, a detailed BOQ was available. Moreover, a detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim and an idling claim. While evaluating the EOT, the Employer asked the possibility of completing the project 2 months beyond the date mentioned in the EOT and thus an acceleration claim also submitted. The delay was analyzed based on Impacted-As Planned method. The contractor was able to make approve all these claims except the acceleration claim and the approved claim amount is to LKR.37 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.1689 Million and ended with LKR.1934 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 1.91%.

Case Number 6 Project Details: -

This Project is the Integrated Road Investment construction schedule, Rehabilitation/Improvements of Rural Roads in Galle District. This was started on 18th May 2015 and the scheduled completion date as per the Contract was 18th May 2017. But it was actually completed on 30th June 2018. The main reasons for delaying this Project are the scarcity of the soil with the soil permit issuing problem, adverse climatic conditions and extra works on the scope. As the construction procurement arrangement used this Project is Measure & Pay, a detailed BOQ was available. Moreover a detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim and an idling claim. All of those claims had been approved by the Employer and the approved claim is amount to LKR.63 Million. The delay was analyzed based on Impacted-As Planned method. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.1763 Million and ended with

LKR.2132 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 2.95%.

Case Number 7 Project Details: -

This Project is a Flyover Project across near the Ganemulla railway station across the railway. This was started on 20th April 2016 and the scheduled completion date as per the Contract was 20th June 2017. But it was actually completed on 01st December 2017. The main reason for delaying this Project was land acquisition issue. As the construction procurement arrangement used this Project is Design and Built, a detailed BOQ was not available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim and an idling claim. All of those claims had been approved by the Employer and the approved claim is amount to LKR.29 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.529 Million and ended with LKR.583 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 4.97%.

Case Number 8 Project Details: -

This Project is Rehabilitation of Anamaduwa - Uswewa - Galgamuwa Road. This was started on 1st November 2012 and the scheduled completion date as per the Contract was 30th April 2015. But it was actually completed on 27th December 2015. The main reason for delaying this Project was land acquisition issue, adverse climatic conditions, extra works on the scope and delay in issuing the drawings. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim. Both of those claims had been approved by the Employer and the approved claim is amount to LKR.28 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.

655,717,729.59 and ended with LKR.783 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 3.58%.

Case Number 9 Project Details: -

This Project is Improvements to Wattala - Mahara Road. This was started on 4th May 2014 and the scheduled completion date as per the Contract was 4th July 2015. But it was actually completed on 16th December 2016. The main reason for delaying this Project was land acquisition issue and delay in issuing the drawings. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim. Both of those claims had been approved by the Employer and the approved claim is amount to LKR. 32,051,190.51. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR. 573,676,092.99 and ended with LKR. 860,428,077.17 which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 3.73%.

Case Number 10 Project Details: -

This Project is Rehabilitation of Galigamuawa/Ruwanwella/Karawella Road. This was started on 6th January 2014 and the scheduled completion date as per the Contract was 6th July 2016. But it was actually completed on 18th March 2017. The main reason for delaying this Project was land acquisition issue, delay in issuing the drawings and some settlement problems. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim. Both of those claims had been approved by the Employer and the approved claim is amount to LKR. 274 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR. 1800Million and ended with LKR. 2470 Million which

includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 11.09%.

Case Number 11 Project Details: -

This Project is Development of Nawalapitiya – Ginigathhena Road. This was started on 15th May 2015 and the scheduled completion date as per the Contract was 15th May 2016. But it was actually completed on 12th March 2017. The main reason for delaying this Project was land acquisition issues, unforeseen physical conditions and an additional benching excavation which had to be done. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim. Both of those claims had been approved by the Employer and the approved claim is amount to LKR.89 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.624 Million and ended with LKR.793 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 11.22%.

Case Number 12 Project Details: -

This Project is Development of Hulandawa South – Gamunupura, Helagama – Baddayaya Roads, Monaragala and Provincial Roads. This was started on 25th June 2015 and the scheduled time for completion as per the Contract was one year. But it was actually completed on 29th March 2017. The main reason for delaying this Project was land acquisition issues and the variation of new road pavement with sub-base, graded aggregate base course & hard shoulders. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim. Both of those claims had been approved by the Employer and the approved claim is amount to LKR.61 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer.

The Contract Sum of this Project is LKR.510 Million and ended with LKR.683 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 8.93%.

Case Number 13 Project Details: -

This Project is Development of Southern Provincial Roads Improvement Project – Phase IV. This was started on 24th June 2016 and the scheduled time for completion as per the Contract was one year. But it was actually completed on 26th March 2018. The Project was delayed as the Contractor had to put New Box Culverts in Swampy Areas. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim and a prolongation claim. Both of those claims had been approved by the Employer and the approved claim is amount to LKR.73 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.550 Million and ended with LKR.725 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 10.07%.

Case Number 14 Project Details: -

This Project is Rehabilitation and Upgrading the Roads of Bibile-Pitakumburra-Namaloya-Iginiyagala. This was started on 17th December 2012 and the scheduled time for completion as per the Contract was three years. But it was actually completed on 28th September 2017. The Project was delayed due to delayed instructions and drawings. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, a Prolongation Claim and an Idling Claim. All of those claims had been approved by the Employer and the approved claim is amount to LKR.322 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.3220 Million and ended with LKR3984 Million which includes

the amounts obtained from variations and claims. Thus, the cost significant of claims is 8.08%.

Case Number 15 Project Details: -

This Project is Rehabilitation & Improvement to A029 Vavuniya - Horowpathana Road. This was started on 01st July 2015 and the scheduled time for completion as per the Contract was one year. But it was actually completed on 24th March 2017. The Project was delayed due to delayed instructions and drawings and unexpected weather conditions. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, a Prolongation Claim and an Idling Claim. All of those claims had been approved by the Employer and the approved claim is amount to LKR.148 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.575 Million and ended with LKR883 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 16.76%.

Case Number 16 Project Details: -

This Project is Rehabilitation & Improvement to Improvements to Priority Road Project II Galagedara–Rambukkana Road. This was started on 18th June 2012 and the scheduled time for completion as per the Contract was 18 months. But it was actually completed on 17th December 2014. The Project was delayed due to land acquisition issues and had to do the variations of additional retaining walls. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, a Prolongation Claim and an Idling Claim. All of those claims had been approved by the Employer and the approved claim is amount to LKR.188 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.1250

Million and ended with LKR1723 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 10.91%.

Case Number 17 Project Details: -

This Project is Rehabilitation of Nawathkuli-Kerathivu-Mannar Road (A32). This was started on 10th January 2012 and the scheduled time for completion as per the Contract was 24 months. But it was actually completed on 16th September 2014. The Project was delayed due to land acquisition issues and the unexpected weather conditions. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, a Prolongation Claim. Both of those claims had been approved by the Employer and the approved claim is amount to LKR.27 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.1013 Million and ended with LKR1544 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 1.75%.

Case Number 18 Project Details: -

This Project is Ambepussa – Kurunegala -Trincomalee Road (A06) & Kantale – Perathuweli Road (B196). This was started on 11th July 2011 and the scheduled time for completion as per the Contract was 24 months. But it was actually completed on 17th March 2014. The Project was delayed due to land acquisition issues the unexpected weather conditions. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, a Prolongation Claim and an Idling Claim. All of those claims had been approved by the Employer and the approved claim is amount to LKR.96 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.865 Million and ended with

LKR1142 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 8.41%.

Case Number 19 Project Details: -

This Project is Improvements to Ibbagamuwa - Kubukgate - Madagalle Road. This was started on 08th March 2012 and the scheduled time for completion as per the Contract was 24 months. But it was actually completed on 12th October 2015. The Project was delayed due to land acquisition issues and progress payments delay by the employer. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, Prolongation Claim, Idling Claim and a Interest Claim. All those claims had been approved by the Employer and the approved claim is amount to LKR.364 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.2861 Million and ended with LKR 3487 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 10.44%.

Case Number 20 Project Details: -

This Project is Improvements to Mannar Puttalam Road. This was started on 31stAugust 2012 and the scheduled time for completion as per the Contract was 24 months. But it was actually completed on 17th October 2015. The Project was delayed due to land acquisition issues and progress payments delay by the employer. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, Prolongation Claim, Idling Claim and a Financial Claim. All those claims had been approved by the Employer and the approved claim is amount to LKR. 47 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.1215 Million and ended with LKR1786 Million which includes

the amounts obtained from variations and claims. Thus, the cost significant of claims is 2.63%.

Case Number 21 Project Details: -

This Project is Rehabilitation and Improvements to Bangadeniya – Andigama - Anamaduwa Road. This was started on 18th June 2012 and the scheduled time for completion as per the Contract was 24 months. But it was actually completed on 25th October 2015. The Project was delayed due to land acquisition issues and progress payments delay by the employer and unforeseen physical conditions. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, a Prolongation Claim, an Idling Claim and an Interest Claim. All those claims had been approved by the Employer and the approved claim is amount to LKR.72 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.2571 Million and ended with LKR3223 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 2.23%.

Case Number 22 Project Details: -

This Project is Jaffna-Pannai-Kayts (AB-19) Road. This was started on 12th September 2012 and the scheduled time for completion as per the Contract was 24 months. But it was actually completed on 14th December 2015. The Project was delayed due to land acquisition issues, variations and unforeseen physical conditions and unexpected weather conditions. As the construction procurement arrangement used this project is Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, a Prolongation Claim and an Idling Claim. All of those claims had been approved by the Employer and the approved claim is amount to LKR.78 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.1285 Million and ended with

LKR1774 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 4.40%.

Case Number 23 Project Details: -

This Project is Improvement of Padeniya - Anuradhapura Road. This was started on 10th September 2010 and the scheduled end date as per the Contract was 31st May 2012. But it was actually completed on 06th June 2013. The Project was delayed due delay of checking drawings by consultant, delaying approvals, delaying attending inspection by consultant, variations and adverse weather conditions. As the construction procurement arrangement used this Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, a Prolongation Claim and an Idling Claim. All of those claims had been approved by the Employer and the approved claim is amount to LKR.126 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.578 Million and ended with LKR786 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 16.03%.

Case Number 24 Project Details: -

This Project is Rehabilitation and Improvements to Jaffna-Kankasanthurai Road (Ab016), Puttur–Meesalai (Ab032) & Jaffna–Palali Road (Ab018). This was started on 11th February 2011 and the scheduled end date as per the Contract was 13th October 2013. But it was actually completed on 20th December 2014. The Project was delayed due to land acquisition issues, progress payments delay by the employer and unforeseen physical conditions. As the construction procurement arrangement used this Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an Extension of Time Claim, a Prolongation Claim, an Idling Claim and an Interest Claim. All of those claims had been approved by the Employer and the approved claim is amount to LKR.294 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer.

The Contract Sum of this Project is LKR. 3,662 Million and ended with LKR4623 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 6.36 %.

Case Number 25 Project Details: -

This Project is Widening and Improvements to Jaffna – Ponnali – Point Pedro Road. This was started on 15th September 2013 and the scheduled end date as per the Contract was 31st March 2014. But it was actually completed on 14th October 2014. The Project was delayed due to land acquisition issues and adverse weather conditions. As the construction procurement arrangement used this Measure and Pay, a detailed BOQ was available. There was not any specifically appointed claim consultant or a planning engineer from the contractors' end though the contractor's staff also appointed having gained the certification from the Employer. The Contractor raised an EOT Claim on Ex-Gratia basis and was able to make approve it. The Contract Sum of this Project is LKR. 562 Million and ended up with LKR 632 Million which includes the income gained from the variations. Thus, the cost significant of claims is zero

Case Number 26 Project Details: -

This Project is Rehabilitation and Improvement of B-528 Road from Bodagama to Hambegamuwa to Kaltota. This was started on 15th December 2014 and the scheduled time for completion as per the Contract was 30 months. But it was actually completed on 18th December 2016 and this means it was completed four months prior to the scheduled completion date of the project. As the construction procurement arrangement used this Measure and Pay, a detailed BOQ was available. A detailed construction schedule has been prepared as the Contractor and established the Claim by using a construction schedule. The Contractor claimed an acceleration claim. It was approved by the Employer and the approved claim is amount to LKR.84 Million. Specifically, appointed claim consultant or a planning engineer from the contractors' end and the contractors staff also appointed having gained the certification from the Employer. The Contract Sum of this Project is LKR.2150 Million and ended with LKR2723 Million which includes the amounts obtained from variations and claims. Thus, the cost significant of claims is 3.08%.

4.2.2Data Analysis

The table 4.1 shows a summarized the outcomes of the significant of the claims, how the delay was established and the applicability of construction schedule s in road and building projects based on the results got from the analyses of the aforementioned case studies.

Case Number	Significance of the Claims		How the Delay was Established?		Applicability of Programes for Establishing Delays	
	Building Projects	Road Projects	Building Projects	Road Projects	Building Projects	Road Projects
1	0.00%	7.26%	Ex-Gratia Basis	Program Basis	No	Yes
2	3.87%	0.00%	Ex-Gratia Basis	Program Basis	No	Yes
3	0.00%	14.95%	Ex-Gratia Basis	Program Basis	No	Yes
4	0.00%	10.39%	Ex-Gratia Basis	Program Basis	No	Yes
5	2.02%	1.91%.	Program Basis	Program Basis	Yes	Yes
6	0.00%	2.95%	Amicably Settled	Program Basis	No	Yes
7	0.00%	4.97%	Amicably Settled	Program Basis	No	Yes
8	0.56%	3.58%	Ex-Gratia Basis	Program Basis	No	Yes
9	0.00%	3.73%	Amicably Settled	Program Basis	No	Yes

Case Number	Significance of the Claims		How the Delay was Established?		Applicability of Programes for Establishing Delays	
	Building Projects	**Road Projects**	**Building Projects**	**Road Projects**	**Building Projects**	**Road Projects**
10	3.28%	11.09%	Program Basis	Program Basis	Yes	Yes
11	0.00%	11.22%	Ex-Gratia Basis	Program Basis	No	Yes
12	0.00%	8.93%	Ex-Gratia Basis	Program Basis	No	Yes
13	0.00%	10.07%	Ex-Gratia Basis	Program Basis	No	Yes
14	5.81%	8.08%	Program Basis	Program Basis	Yes	Yes
15	0.00%	16.76%	Ex-Gratia Basis	Program Basis	No	Yes
16	7.15%	10.91%	Program Basis	Program Basis	Yes	Yes
17	5.60%	1.75%	Program Basis	Program Basis	Yes	Yes
18	0.00%	8.41%	Ex-Gratia Basis	Program Basis	No	Yes
19	0.00%	10.44%	Ex-Gratia Basis	Program Basis	No	Yes

Case Number	Significance of the Claims		How the Delay was Established?		Applicability of Programes for Establishing Delays	
	Building Projects	**Road Projects**	**Building Projects**	**Road Projects**	**Building Projects**	**Road Projects**
20	6.64%	2.63%	Program Basis	Program Basis	Yes	Yes
21	0.00%	2.23%	Ex-Gratia Basis	Program Basis	No	Yes
22	0.00%	4.40%	Ex-Gratia Basis	Program Basis	No	Yes
23	0.00%	16.03%	Ex-Gratia Basis	Program Basis	No	Yes
24	0.00%	6.36%	Ex-Gratia Basis	Program Basis	No	Yes
25	4.68%	0.00%	Program Basis	Ex-Gratia Basis	Yes	No
26	0.00%	3.68%.	Ex-Gratia Basis	Program Basis	No	Yes

Table 4.1 Significance of the Claims in Road and Building Projects and Applicability of a construction schedule

By looking at the above analysis from the sample of road and building projects, it can be seen that the significances of the claims obtained from the Road Projects are much higher than the Building Projects. By looking at this issue further, it can be identified that all the claims obtained from road projects are established based on a logic linked construction schedule except one project, which have been prepared based on computer software and detailed logic linked construction schedules are available for

almost all of the road projects. Consider about the building projects, there are not such method is available in most of the cases. With this the third objective of this research has been achieved.

It is apparent that proper practices of delay analyzing by using a construction schedule is done in road projects and consider about the building projects, it is very negligible. Consider about the reasons for not using construction schedules which had been prepared by using computer software for the analysis of delays, following reasons were clearly highlighted repeatedly while analyzing the case studies. These reasons had been also directly affected for the difference in significance of the delay claims in road and building projects as well. Moreover, with this the fourth objective of the research has been achieved.

1. *Availability of Different Types of Procurement Systems*

   The available procurement system for all the road projects are Traditional Separated Arrangement (Measure and Pay) and 42.31% of the building projects are Non-Traditional Integrated Arrangement (Design and Built). When there is a Design and Built type of Procurement System is available, the design responsibility lies on himself. Under the traditional procurement arrangement, the design is done by the Employer of the Project and it takes a considerable period of time. The bidders who bid for the Project are well aware about the design and they can prepare a realistic proper construction schedule accordingly. But in Design and Built Arrangement, the Contractor has not got any enough time to prepare a realistic design at the point of signing the Contract and therefore they cannot prepare any realistic construction schedule. In addition to that when the design and build procurement systems are available, a leading role and the controlling power of the projects are going to the hand of the architects. Architects do not know what is the time value of a project and the realisticity of the structure. Normally architects do not have that much of contractual and technical knowledge as well. Therefore, the architects try to implement their designs anyhow. As a result of that unnecessary time is wasted and the contractor also become helpless in this regard, without having a proper design as well s the delay create by the architects.

2. *Non-Availability of Proper Planning Engineer*

   In all of the Road Projects a Planning Engineer is specifically applied for the Project. But this can be rarely seen in Building Projects. Reason for this is as the presence of a Planning Engineer is mandate in the Contract Documents of the Road Projects and that much of importance is not given in the Building Projects. With the help of a Planning Engineer, a proper construction schedule construction schedule can be easily prepared.

3. *Non-Availability of Proper Claim Consultant*

   In most of the Road Projects, there was a Claim Consultant who has been appointed by the contractor. But in Building Projects, this issue cannot be seen. The main reason for this is the uncertainty of a road project is high as the project deals with the unforeseeable physical conditions till the completion. But in road projects that uncertainty is very less comparative to the road and once the sub structure is completed, the contractor does not need to worry about the uncertainty. Therefore, most of the cases, the service of a claim consultant is got by the contractors for road projects. When there is a claim consultant, they get a proper construction schedule for establishing the claims.

4. *Non-Proper Document Maintenance*

   Another issue which was observed in these two types of projects is significant difference in document maintenance. Though the maintenance process of relevant documents which are required for keeping evidences for raising claims are not practiced very well in building projects, this process is very well practicing in road projects. As the Road Development Authority is the employer for the most of the road projects in Srilanka and most of the Road Projects are doing on donation basis, the donor request document from the employer which illustrates the progress of the works. Thus, this process is very well practicing in road projects. But in building projects, these kinds of requests are very less and the contractors also reluctant to maintain such documents. As a result of that the contractor misses the opportunity of identifying the claimable situations. In addition to that when he prepares revised construction schedules according to current labor forces; he misses the

opportunity of calculating the magnitude of an activity if he does not maintain the documents like daily site reports.

5. *Availability of Much More Details*

   Consider about a building project it comprises various types of works comparative to the road projects. Therefore, the details associated with a building project are much higher than a road project. In such a case it affects for the proper preparation of a correct construction schedule and cannot do a proper delay analysis as the details can be missed in the construction schedule.

6. *Maintaining a Low-Grade Staff to Get Much Profit*

   In road projects, the staff appointed by the contractor should be approved by the road development authority. Thus, most of the staff members appoint by the contractor has a sufficient amount of qualifications and experience. But in building projects where there is private employer, these types of mandatory requirements cannot be seen. As it is an expensive process to maintain such a qualified staff and as it is not mandated in the contract documents, the contractors are tending to do the projects with low qualified staff. As these kinds of staff does not know what the proper usage of a construction schedule then the contactor loses the opportunity of establishing the claim.

7. *Poor knowledge in Standard Contract Forms.*

   To prepare a proper claim, it is required to link the relevant incident with available clauses in the contract document. These contract documents are mostly prepared based on the FIDIC 1999 Red Book or SBD2. Therefore, it is required to have a sound knowledge of these documents in order to establish the claim. Thus, if someone does not know those standard forms of contract properly, then he loses the opportunity of raising the claim. There are certain clauses which stipulate the extension of time or delay claims of such standard forms of contract. Thus when there are a lot of details available in a building project and if a delay incident link with any of those details, then a person who does not have a good knowledge in standard forms of the contract loses the opportunity of raising a by using a construction schedule Consider about the road projects, the end product of the project becomes a property of the government. Thus, here the Road development Authority acts as the employer

of the project on behalf of the government. Thus, all the processes are strictly undergone the government auditory process and contract documents are prepared by addressing all the issues and illustrating the transparency. When there is a quality contract document available, the sued party can easily raise a claim by linking that issue to a construction schedule. But consider about a building project there are so any instances where client can be a private entity. Though there are auditing processes involved in some instances in most of the cases it is not practicing. With the lethargic mindset of most of the private employers, they are not focusing on the pre contract works such as preparing so accurate contract documents. Thus, so many mistakes can be seen in the contract documents in these types of projects. Though the general conditions of contract are extracted from the relevant standard forms of contract and they should be altered according to the nature of the project at the time for the particular conditions at the time of preparing the contract document, these cannot be seen in most of the cases. When there are a lot of mistakes in the document, then the contractor loses the opportunity of raising the claim as he is confusing. Thus, construction schedule-based delay analyses are rarely seen in the building projects.

8. *Fear of Losing the Relationship to Get the Next Job*

Consider about the road projects, the government involves as the employer in most of the cases. Thus, projects are handed over to a contractor having evaluated them properly and therefore all the bidders get an equal opportunity and there is not any differentiation on them. Thus, the connections between the parties are quite official and therefore the contractor gets an opportunity raise a claim when a situation is aroused. But consider about the building projects, the situation is quite different than this and the private sector involvement as the employer of the project is high. Some times when a private sector employer involves for a project, there are opportunities that the projects are awarding to the contractor on relationship basis without following a systematic evaluation process. In such a situation, the relationship between the employer and the contractor is quite different and as the projects are awarding on relationship basis, the contractor is hesitate to raise a voice against them as the contractor has the attitude and the mindset up of they are losing the next job if they raise

a voice against the employer. Thus, construction schedule-based delay analyses are rare in building projects.

9. *Not mandating the construction schedule preparation and tracking in the Contract Document*

   In the conditions of contract, it has been mentioned about the construction schedule. At the same time in the particular conditions of the contract, it has been mentioned that how the construction schedule should be prepared, how it should be updated and tracked and the other details related to the construction schedule If it has been mandated and penalized a charge in a situation where the contractor was unable to prepare and update the construction schedule as it mentioned in the contract document, then the contractor automatically tends to follow those conditions. While analyzing the case studies it was observed that in all the contract documents of the road projects, it has been clearly mentioned the information like that how the construction schedule should be prepared, what should be included in it, how it should be maintained and what are the action take if the contractor does not adhere to those conditions. But these things cannot be seen in the building projects and therefore the contractor does not take seriously of that. Thus, if a delay situation occurs, the contractor lost the opportunity of establishing delays and no usage of the construction schedule.

10. *Not mandating the construction schedule preparation and tracking in the Contract Document*

    In the conditions of contract, it has been mentioned about the construction schedule. At the same time in the particular conditions of the contract, it has been mentioned that how the construction schedule should be prepared, how it should be updated and tracked and the other details related to the construction schedule If it has been mandated and penalized a charge in a situation where the contractor was unable to prepare and update the construction schedule as it mentioned in the contract document, then the contractor automatically tends to follow those conditions. While analyzing the case studies it was observed that in all the contract documents of the road projects, it has been clearly mentioned the information like that how the construction schedule should be prepared, what should be included in it, how it should be maintained and what

are the action take if the contractor does not adhere to those conditions. But these things cannot be seen in the building projects and therefore the contractor does not take seriously of that. Thus, if a delay situation occurs, the contractor lost the opportunity of establishing delays and no usage of the construction schedule.

11. *Lack of Quality in the Contract Documents.*

    Consider about the road projects, the end product of the project becomes a property of the government. Thus, here the Road Development Authority acts as the employer of the project on behalf of the government. Thus, all the processes are strictly undergoing the government auditory process and contract documents are prepared by addressing all the issues and illustrating the transparency. When there is a quality contract document is available, the claimant can easily raise a claim by linking these issues to the construction schedule. But consider about a building project, there are so many instances where client can be a private entity. Though there are auditing processes involved in some instances, it is not practicing in most of the cases. With the lethargic mindset of most of the private sector employers, they are not focusing on the pre contract works such as preparing so accurate contract documents. Thus, there so many mistakes can be seen in the contract documents in these types of projects. Though the general conditions of contract are extracted from the relevant standard forms of contract and they should be altered according to the nature of the project for particular conditions, at the time of preparing the contract documents. These can not be seen in most of the cases when there are a lot of mistakes in the documents, then the contractor lost the opportunity of rising the claim as he is confusing. Thus, construction schedule-based delay analyses are rarely seen in the building projects.

Though the above-mentioned issues are affected for not to use construction schedule which had been prepared by using computer softwares for the analysis of delays, there severities are not same. Therefore, it is required to find out the severities of them and go for a final solution accordingly.

4.3 Quantitative Data Analysis

To make familiar the construction schedule-based delay analyses in building projects, answers are required for the aforementioned issues. Here as it can not exactly say that the found issues are equally affecting for the less usage of construction schedule-based delay analysis in building projects. Therefore, it has to be calculated their severities first in order to determine their affectivities. For that the severity index is calculated of each issue and accordingly determine their severities.

4.3.1 Date Extraction

Here a Likert scale questionnaire which was prepared based on the factors found through the case study analysis as shown in Annexure 11. It was distributed among a sample comprises engineers and quantity surveyors as mentioned in chapter 3 and it was distributed among 167 construction contractors with the aim of achieving the targeted sample size of 118.

4.3.2 Data Analysis

Though the questionnaire was distributed among 118 construction contractors, answers were able to obtain only from 43 respondents and based on that sample the Severity Index of each issue was calculated and their values are shown in table 4.2. They have been ranked based on their severity index values and a partial of the fifth objective has been achieved with this.

Issue	Severity Index	Rank
Availability of different types of procurement systems	88.4	1
Non availability of proper claim consultant	82.8	3
Non proper document maintenance	78.3	4
Non availability of proper planning engineer	85.4	2
Fear of losing the relationship to get the next job	71.3	9
Availability of much more details	67.3	10
Maintaining a low-grade staff to get much profit	75.2	5

Issue	Severity Index	Rank
Lack of quality in the Contract documents	64.4	11
Poor knowledge in Standard Contract Forms.	73.4	8
Not mandating the construction schedule preparation and tracking in the Contract Document	74.9	6
Attitudes-Willingness to go for amicable settlements without establishing the entitlement properly	73.6	7

Table 4.2 Severity Index of the Identified Factors

Thus, by looking at the above table, it can be clearly seen that much more attention should be given to the below mentioned issues to make improve the usage of construction schedule-based delay analysis in building projects. For the convenience of the study the attention was given on top five factors, based on the above analysis.

1. Availability of different types of procurement systems
2. Non availability of proper planning engineer.
3. Non availability of proper claim consultant.
4. Non proper document maintenance.
5. Maintaining a low-grade staff to get much profit.

Therefore, to find a solution for this matter, it is required to find out the answers for the above issues separately. Under this research an expert interview is conducted among the five professionally qualified construction claim specialists in order to find out the answers and the recommendations to overcome these issues and these results. Through that the balance partial of the fifth objective has been achieved to windup the research.

4.4 Recommendations to Overcome the Most Severe Factors

Having analyzed the data obtained from the above analysis, it was identified that availability of different type of procurement systems in the building construction sector has become the most severe issue reasons which affected to less significance of

the construction schedule-based delay analysis by using computer softwares. As a result of that the architects influence is higher in the building sector. Normally architects do not have that much of sound knowledge with project management softwares and contract administration process. Therefore, much more attention should be given on the syllabus of the architects which they learn as undergraduates and the aforementioned things should be added. In addition to that, the monopoly of the architects in the building sector should be decreased and other professionals like engineers and quantity surveyors also should get an equal opportunity in this regard. Therefore, new rules should be enforced in addition to the existing rules with the collaboration of the government and the professional bodies. In addition to that it is important to include the subject matters like contract administration and project planning in deeper level to the syllabuses of the architect's degree programmes.

Non availability of a proper planning engineer and a proper claim consultant has become the most severe issues among the reasons which affected to less significance of the construction schedule-based delay analysis by using computer softwares. According to the expert interview results, it is identified that it is important to create separate professions under these two entities in the construction industry. Through that the opportunities are created to make establish a dignity in the industry. For that it is required to create a professional path such as charted memberships for these professions by the relevant professional bodies like I.E.S.L. and I.Q.S.S.L. In addition to that to maintain their grades in the highest caliber or to upgrade their present grades, the contractors have to fulfill certain criteria's. Under such circumstances, the institutions like CIDA can introduce new regulations by mandating the availability of professionally qualified planning engineer and a claim specialist within the firm who is seeking to upgrade their grades. In addition to that as it is impossible to create a planning engineer or a claim consultant at once, it is important to make educate the people those who are connected with the construction industry. For that the institutions like CIDA and the professional bodies like I.E.S.L. and I.Q.S.S.L. can conduct lectures or courses by using qualified resource personnel's in this regard. Though the courses were conducted, proper participation of the contractors for them is questionable. Therefore, these institutions and the professional bodies can introduce new regulations by mandating the participation and completion of these courses by defining a certain number of contractor's staff members, which affects the upgradation

or maintenance of the contractors' grade. In addition to that courses which are emphasized the importance of the availability of proper planning engineer and a proper claim consultant should be conducted under the aforementioned contexts. Moreover, to bloom up the young buds from the undergraduate level itself, these things can be included in the syllabuses of the universities and other relevant higher educational institutes in wider level. In addition to that the things about the project management soft wares in addition to the normally used softwares also should be included to the syllabuses. As the proper document maintenance is an integral part of the preparation of claims by conducting courses related construction claims under the aforementioned contexts help to bridge the gap of non-availability of the proper document maintenance up to certain extend.

Consider about overcoming the issue of non-proper document maintenance, the workshops can be conducted by the relevant professional bodies and the institutions by highlighting the importance of it.To make familiar this concept among the contractors, these courses can be conducted under the scenarios which were previously mentioned to overcome the problems of non-availability of proper planning engineers and claim specialists. Moreover, to make impregnate this concept, the frequency of holding these courses can be increased within a particular year and introduce new regulations by mandating the participation of staff members of the contractors for these courses according to that frequency.

To overcome the problem of maintaining a low-grade staff also a set of specific action should be introduced. Consider about the government sector projects, the required capacity and the quantity of the contractor's management staff has been clearly identified, and if the contractor unable to fulfill those requirements, he will not be paid under the sum allocation in the preliminary bill. But this is not practiced in the private projects as the private sector employer does not put much more attention on these things. To overcome these situations a government committee has to be established which comprised the knowledge experts in this area and affiliated to the professional bodies related construction industry to monitor and evaluate these processes. Then, the new rules and regulations has to be introduced to submit the draft copy of the contract document except engineering estimate of each project and it should be make approved by this committee with the necessary alterations where required. With these alterations, the committee can be introduced the required management staff for the

contractor according to the magnitude of the project. In addition to that rules and regulations has to be introduced by the committee to not to give the approval to start the projects if these requirements are not fulfilled by the employer. Moreover, it can be seen that the composition of the staff members of a contractor's staff according to the contractors' grade has been defined in the CIDA classification. That composition should be altered by increasing the composition of the staff at least in the top grades of the contracts.

CHAPTER FIVE

5.0. CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The preceding chapter analyzed and discussed the findings through the study and in this chapter; it is more focused on drawing out conclusions and recommendations from the analysis and discussion performed in the previous chapter. Further this chapter intends to summarize and conclude the study while explaining limitations that the study carried out. Moreover, the chapter explains recommendations of this research study and future research directions which will help to expand the knowledge recommended.

5.2 Summary of the Study

The construction industry provides a significant contribution to the economy of any country. The delay in the construction projects has affected on them adversely and as a result of that many negative outcomes occurs. To overcome this issue, it is important to prevent delays but it cannot be prevented completely. Thus, it is important to analyze the delay accurately and for that various delay analysis methods are used. For each and every of these methods a construction schedule is essential and with the usage of construction schedules which means the construction schedules made by using the computer soft wares, it can be easily done. Though there are so many project management soft wares are available in the market, the proper usage of them to analyze delays is questionable. According to the survey done by the Department of Census and Statistics, it has been identified that nearly seventy-five percentage of the construction industry in Srilanka has been acquired by road and building projects. Thus, the main aim of this research is to identify how the schedule delay analyses are practiced in road and building sector in Srilanka and what are the steps to be taken to improve them. It is going to meet through by achieving a set of objectives. The first objective of this research is to identify the methods currently uses to analyze delays and the second objective of this research is to identify the applicability of construction schedule for such methods. The next objective of this research is to identify the level of significance of the delay claims in road and building projects. Then the next objective is to identify the reasons for difference in significance of the delay claims in

road and building projects and the severities of these reasons. The final objective of this research is to make suggestion which can be taken to improve the efficient usage of construction schedules in the relevant sector based on the results of the above objectives.

5.3 Limitations of the Research

This study is limited to the Road and Building Projects as they have a significant impact on the Sri Lankan construction industry as stated above. As the details associated with a building or a road project is increasing with its contract sum and the importance of proper planning and scheduling also increases as a result of that, projects which have over LKR.500 Million contract sums has selected for this study. Furthermore, as it is required to have much more capacity and potential to handle these types of Projects, the details of the past completed projects were obtained from the contractor's those who are categorized under the grade CS2 according to national registration and grading scheme for construction contractors which has been introduced by CIDA. At the same time, this study focuses only from the Contractor's point of view as this issue directly affects on the Contractor. Thus, the questionnaires are also distributed among the contractors' grade C3 to grade CS2 as categorized by the CIDA. Apart from that most of the contract documents of the construction projects in Srilanka are prepared based on the FIDIC Red Book 1999 and SBD 2, construction projects which the contract documents have been prepared based on the FIDIC Red Book 1999 and SBD 2 has only considered here. In addition to that the research is done from the contractor's point of view as they are obliged to prepare and submit construction schedule according to FIDIC Red Book 1999 and SBD 2. Moreover, for this research study, projects were selected which were started after the year 2008 as these projects get high opportunity of scheduling at least by using MS Project 2007. Expert interviews were conducted among a panel of five members which consisted of experienced professionally qualified construction claims specialists.

5.4 Summary of the Findings

As stated above the aim of the research was achieved by achieving the aforementioned objectives. Each of the summarized finding of the above objectives has been described here.

Objective One- To identify the methods currently uses to analyze delays and the claims associated with delays.

This objective was achieved by doing a comprehensive literature survey as mentioned under chapter two of this report and accordingly it was identified that six methods are currently used to analyze delays. They are Impacted As Planned Analysis, Time Impact Analysis, Time Slice Window Analysis, As Planned vs. As Built Analysis Method, Retrospective Longest Path Analysis and Collapsed As-Built Analysis. In addition to that, having identified these methods, attention was drawn to identify the applicability of construction schedule for them. At the same time seven types of claims were identified which are associated with delays. They are Disruption Claims, Prolongation Claims, Liquidated Damages, Unabsorbed Overhead Claims, Acceleration Claims, Price Fluctuation Claims and Financial Claims.

Objective Two- To identify the applicability of construction schedules for such methods.

This objective also achieved through the literature survey as mentioned under chapter two of this report and accordingly it was identified that for each of these methods, a construction schedule is mandatory required.

Objective Three- To identify the level of significance of the delay claims in road and building projects.

To achieve this objective, initially it was identified that how the delay was established in road and building projects. At the same time, it was identified the applicability of construction schedule for establishing the delays and compensating claims in road and building projects. These things were done by analyzing case studies. For that past completed road and building projects which were done by CS2 graded contractors were selected. As there are thirteen CS2 graded contractors in Srilanka according to the CIDA categorization, past completed 26 road projects and 26 building projects were selected for this study. Data were collected through in-depth analysis of each project and it was observed that all the delay claims of the road projects has been established through a construction schedule which has been prepared by using a project management software. That practice was rarely observed in the building projects and the delay claims had been established on ex-gratia basis in most of the

cases. Consider about the significance of the delay claims, it was observed that the significance of the delay claims obtained from the road projects are very higher than the delay claims obtained from the building projects. The significance of the delay claims was measured through the ratio between total revenue gained from the claims of the project and the total revenue gained from the project. Through that the third objective of this research also achieved.

Objective Four- To identify the reasons for difference in significance of the delay claims in road and building projects and the severities of these reasons.

The reasons for the differences in significance of the delay claims were also identified, having analyzed the aforementioned cases. Moreover, it was identified that there are eleven reasons which were mainly caused for that. Through a severity analysis of those reasons by distributing a Likert scale questionnaire among 118 participants; their severities were also measured according to the received responses and only able to obtain 43 answered questionnaires. By doing them the fourth objective of this research was also achieved.

Objective Five- To make suggestion which can be taken to improve the efficient usage of construction schedule in the relevant sector based on the results of the above objectives.

Having done the severity analysis of the aforementioned reasons most severe issues were identified and the methods to overcome them were identified, by conducting five expert interviews. Through that the fifth objective was achieved.

5.5 Conclusion

According to the findings of this study, it can be seen that the level of significance of the delay claims of road projects are very high than the building projects and most of the cases in the road projects, the delay has been established by using a construction schedule which is prepared by using a project management software. As the samples were selected for the analysis according to the set statistical theories, we can say that the applicability of computer software-based schedule delay analysis is vital in establishing claims in road and building projects.

At the same time according to the results obtained from the case study analyses, the reasons for the aforementioned level of significance differences, it was identified eleven factors and top five factors among them were identified by doing a severity index analysis. Accordingly, the recommendations to overcome the most severe factors were given and having sum-up all the suggestions to bridge this gap in the building construction sector, it is revealed that as the influence of the architects is high on the building projects due to availability of different type of procurement methods such as design and build in building projects. Therefore, it is required to breakdown that monopoly of the Architects in the building construction sector and introduce new rules and regulations to give equal basis of authority to the other professions as well. In addition to that it is much more required to include the subject matters like contract administration, construction scheduling and project planning in much deeper level to overcome this barrier. Therefore, it is much more required to have significant collective contribution from the professional bodies such as I.E.S.L. and I.Q.S.S.L. as well as the other relevant organizations related to the construction industry.

5.6 Recommendations

Based on research findings the followings can be recommended, in order to make familiar with the construction schedule-based delay analysis for increasing the significance of these claims.

1.It is required to avoid discrimination among the professions involved in the building construction sector and no monopoly should be given to specific profession involved in the building construction projects. Therefore, it is required to introduce new rules and regulations to give equal basis of authority to the other professions such like Engineers and Quantity Surveyors as well.

2.Keeping at least a one experienced (at least 10years) planning engineer with recognized academic qualifications (Bachelor's Degree in Engineering from a recognized University) and a one experienced (at least 10years) claim consultant (at least Bachelor's Degree in Engineering or a Bachelor's Degree in Quantity Surveying from a recognized University) with the private sector building contractors.

3.Take steps to make proper document maintenances within the private sector building contractors. Under this, a proper set of documents named "Guidelines for Effective

Construction Management" has been published by CIDA. It is a mandatory to take steps to make familiarize this document at least among the contractors.

4.The private sector building contractors should keep a qualified staff with them and take actions to improve the computer literacy with the project management staff which can be used to prepare the construction schedule.

5.The professional bodies and the other relevant organizations related to the construction industry should take much more steps to enhance their contribution to uplift the knowledge level of the building contractor's staff.

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ANNEXURES

ANNEXURE – 1

CONSTRUCTION SCHEDULE BASED DELAY ANALYSIS IN ROAD AND BUILDING PROJECTS.

M.Sc. in Construction Project Management

Department of Civil Engineering

University of Moratuwa

Dear Sir/Madam,

I am a Post Graduate student at Department of Civil Engineering, Faculty of Engineering, University of Moratuwa. As a partial fulfillment to the M.Sc. Degree construction schedule, I need to carry out a research project in the study area. The study area details are as follows:

Title:

Comparison of construction schedule Based Delay Analysis in Road and Building Construction Sector in Sri Lanka.

Aim:

This research is aimed to answer the question "How the construction schedule based delay analysis are practiced in Road and Building Construction sector in Sri Lanka and what are the steps to be taken to improve them?."

Objectives:

I. To identify the methods currently uses to analyze delays.

II. To identify the applicability of construction schedule for such methods.

III. To identify the level of significance of the delay claims in road and building projects.

IV. To identify the reasons for difference in significance of the delay claims in road and building projects and the severities of these reasons.

V. To make suggestion which can be taken to improve the efficient usage of construction schedule in the relevant sector based on the results of the above objectives.

To achieve the third objective and the fourth objective, it is required to do a SEMI **STRUCTURED INTERVIEW**. The semi-structured interview is a type of interview in which the interviewer asks only a few predetermined questions while the rest of the questions are not planned in advance. In semi-structured interviews, some questions are predetermined and asked all candidates, while others arise spontaneously in free-flowing conversations. Semi structured interviews are specially used to collect data in order to achieve the data from the third objective to seventh objective.

I am pleased to inform you that you have been selected to take part of this survey and kindly request your fullest participation and cooperation. This interview guide line will be used for academic purpose only.

I assure that this information will be kept confidential and only the summarized results will be provided in the report and therefore no specific reference will be made to experts who take part of this survey.

Thank you.

Yours Faithfully,

…….
J.K.T.A.Jayawickrama
M.Sc. Candidate
Mobile: 0701232324,076023234

Research Supervisor:
Dr.Leslie Ekanayake
Department of Civil Engineering
Faculty of Engineering
University of Moratuwa
Mobile : 0714212355

SEMI STRUCTURED INTERVIEW GUIDELINE

1. Project Name
2. Start Date
3. End Date
4. Actually Started Date
5. Actually Completed Date
6. Reason for elapsing
7. Standard Form of Contracts used
8. Remedies got by the sued party due to delay
9. What are the claims raised?.
10. What are the claims approved?.
11. How the delay was established?.
12. Was there a logic linked construction schedule.
13. How many activities were there for a construction schedule?.
14. What is the Construction Procurement Arrangement used for this project?.
15. What is the method used for analysis of delay?.
16. Total income generated from the project?.
17. Total income generated from original scope of work done of the project?.
18. Total income generate from variations of the project?.
19. Total income generated from claims of the project?.
20. Significant of the Claim?.
21. What is the position of a construction schedule in the Contract?.
22. Difficulty level of preparing the construction schedule for the project?.

23. Do the progress reports are specifically concern though they are mentioned in the Contract?.
24. Availability of a detailed Bill of Quantities?.
25. How the construction schedule was used to establish the claim
26. Who lies the design responsibility?.
27. Presence of a specified planning engineer and a claim specialist. Have they been mandated in the contract document?.
28. Who is the Engineer (Consultant) to the Project?.

ANNEXURE – 11

CONSTRUCTION SCHEDULE BASED DELAY ANALYSIS IN ROAD AND BUILDING PROJECTS .

M.Sc. in Construction Project Management

Department of Civil Engineering

University of Moratuwa

Dear Sir/Madam,

I am a Post Graduate student at Department of Civil Engineering, Faculty of Engineering, University of Moratuwa. As a partial fulfillment to the M.Sc. Degree construction schedule, I need to carry out a research project in the study area. The study area details are as follows:

Title:

Comparison of construction schedule Based Delay Analysis in Road and Building Construction Sector in Sri Lanka.

Aim:

This research is aimed to answer the question "How the construction schedule-based delay analysis are practiced in Road and Building Construction sector in Sri Lanka and what are the steps to be taken to improve them?"

Objectives:

I. To identify the methods currently uses to analyze delays.

II. To identify the applicability of construction schedule s for such methods.

III. To identify the level of significance of the delay claims in road and building projects.

IV. To identify the reasons for difference in significance of the delay claims in road and building projects and the severities of these reasons.

V. To make suggestion which can be taken to improve the efficient usage of construction schedule s in the relevant sector based on the results of the above objectives.

To achieve the fourth objective, it is required to do a QUESTIONAIRE SURVEY. The questionnaire is one of the most widely used data collection techniques within the survey strategy. Because each person (respondent) is asked to respond to the same set of questions, it provides an efficient way of collecting responses from a large sample prior to quantitative analysis. Here through the Questionnaire Survey we get the opportunity of identifying the severities of the identified factors through the case study analysis. To do this as the questions are needed to be rated a Likert scale questionnaire is used here.

A Likert scale is a psychometric scale that has multiple categories from which respondents choose to indicate their opinions, attitudes, or feelings about a particular issue. Likert-scale questionnaires have most frequently been used in investigations of individual difference variables, freely without affecting the mental condition of the respondent. I am pleased to inform you that you have been selected to take part of this survey and kindly request your fullest participation and cooperation. This interview guide line will be used for academic purpose only.

I assure that this information will be kept confidential and only the summarized results will be provided in the report and therefore no specific reference will be made to experts who take part of this survey.

Thank you.

Yours Faithfully,

…….

J.K.T.A.Jayawickrama
M.Sc. Candidate
Mobile: 0711322399

Research Supervisor:

Dr.Leslie Ekanayake
Department of Civil Engineering
Faculty of Engineering
University of Moratuwa
Mobile : 0714212355

CONSTRUCTION SCHEDULE BASED DELAY ANALYSIS IN ROAD AND BUILDING PROJECTS.

This questionnaire survey consists 14 questions and each question would take less than a minute to answer and completely anonymous. Therefore, please take a few minutes of your valuable time to express your genuine views on or before 31st of January 2019.

Section A: General Information of Research Participants

1. Name of the Organization: -

2. Participant's Profession on behalf of the Organization: -

3. Participant's Educational Level

I. Diploma ( )
II. Degree ( )
III. Charter ( )
IV. Masters ( )
V. Phd ( )

Section B: Factors affecting for construction schedule-based delay Analysis
Note: - The questions which are listed from here onwards are the factors which affects the less usage of construction schedule-based delay analysis in building projects. You are required to mark one answer of each of them

4. Availability of different types of procurement systems has affected the less usage of construction schedule-based delay analysis in building projects.

I. Very Low Affected (…..)
II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)

5. Non availability of proper claim consultant has affected the less usage of construction schedule-based delay analysis in building projects.

I. Very Low Affected (…..)
II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)

6. Non proper document maintenance has affected the less usage of construction schedule-based delay analysis in building projects.

I. Very Low Affected (…..)

II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)

7. Non availability of proper planning engineer has affected the less usage of construction schedule-based delay analysis in building projects.
I. Very Low Affected (…..)
II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)

8. Fear of losing the relationship to get the next job has affected the less usage of construction schedule-based delay analysis in building projects.
I. Very Low Affected (…..)
II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)

9. Availability of much more details has affected the less usage of construction schedule-based delay analysis in building projects.
I. Very Low Affected (…..)
II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)

10. Maintaining a low-grade staff to get much profit has affected the less usage of construction schedule-based delay analysis in building projects.
I. Very Low Affected (…..)
II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)

11. Lack of quality in the Contract documents has affected the less usage of construction schedule-based delay analysis in building projects.
I. Very Low Affected (…..)
II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)

12. Poor knowledge in Standard Contract Forms has affected the less usage of construction schedule-based delay analysis in building projects.
I. Very Low Affected (…..)

II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)

13. Not mandating the construction schedule preparation and tracking in the Contract Document has affected the less usage of construction schedule-based delay analysis in building projects.

I. Very Low Affected (…..)
II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)

14. Attitudes-Willingness to go for amicable settlements without establishing the entitlement properly has affected the less usage of construction schedule-based delay analysis in building projects.

I. Very Low Affected (…..)
II. Low Affected (…..)
III. Normal (…..)
IV. High Affected (…..)
V. Very High Affected (…..)