METHODS FOR ANALYSING CONCURRENT DELAYS IN SRI LANKAN CONSTRUCTION INDUSTRY

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Ch.QS. (Dr.) G. I. Karunasena Date

Dissertation Supervisor

ABSTRACT

Methods for Analysing Concurrent Delays in Sri Lankan Construction Industry

Difficulties arise when two or more events occur at exactly the same time or simultaneously, that have the effect of delaying the project completion date. This is known as concurrent delay. Concurrent delays have been labelled as the most complex and challenging aspect of delay analysis. However concurrency in construction delay claims can be evaluated using methods such as "Apportionment" method, "Malmaison" approach, "Dominant cause" approach, "But for test" and "First in line" approach. Most of the concurrency delay analysis methods have been tested in the court of law for assessing concurrent delay claims. However, in Sri Lankan context it is not much popular among industry practitioners.

Hence it was expedient to carry out a proper research to find out the way of treating concurrent delays in Sri Lankan Construction Industry with the aim of identifying the appropriate method/s for assessing concurrency in construction delays in Sri Lankan Construction Industry. The research was approached through a mixed research approach, which comprised of qualitative data collected via semi structured interviews and quantitative data collected via structured questionnaire survey. Relative Important Index (RII) was mainly used in the data analysis.

Results revealed that Malmaison approach is the most suitable method for analysing concurrency in construction delays claims Sri Lankan Construction Industry which has been accepted and applicable in the court of law. Further according to the research findings poorly updated programmes, lapses and omissions in documents, absence in acceptable quality in documentation, absence of potential impacts of delays and lack of knowledge in Case Laws were lead low usage of concurrent delay analysis methods in Sri Lankan Construction industry. It can be recommended that SCL protocol 2002 to be used as guidance for assessing concurrent delays in the contracts and clear method for preparing programmes to be included in the contracts to encourage better concurrent delay analysing practice.

Keywords: *concurrent delay, construction industry, construction programme, delay analysis, SCL protocol*

DEDICATION

This is dedicated to all

The devotees and the

well-wishers in the

field of native construction……

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This research may not be a success without the help and support of others. I would like to express my deepest gratitude to my supervisor, Ch.QS. (Dr.) Gayani Karunasena for leading me to the right path, her guidance, comments and sharing of experience throughout the process of conducting this research.

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ABBRIVIATIONS

AACE	-	The Association for the Advancement of Cost Engineering
CPA	-	Contemporaneous Period Analysis
CPM	-	Critical Path Method
DAT	-	Delay Analysis Techniques
EOT	-	Extension of Time
IDT	-	Isolated Delay Type
JCT	-	Joint Contracts Tribunal
MDWA	-	Modified Daily Windows Analysis
RCPM	-	Resource-constrained Critical Path Method
RCS	-	Resource Constrained Schedules
SCL	-	The Society of Construction Law

1. INTRODUCTION TO THE RESEARCH

1.1. Background

Balancing time, cost, and quality of a project is major challenge to the construction professionals in the construction industry. Time is critical in almost every construction project. According to Cushman, Carter, Gorman, and Coppi (2001), owner cannot get any benefit until the project is completed and the risk of market collapse, the loss due to delayed use of the project and financing penalties are some of the problems faced by owners due to delay in completion. Still, due to uncertainties in construction projects such as bad weather, soil conditions, disputes and unavailability of labour, material and plant, the construction projects get delayed. Ahmed, Azhar, Kappagntula, and Gollapudil (2003) identified that delays are a key problem in construction projects and the extent of these delays varies from project to project. It is also a source of frequent disputes and claims due to overriding importance of time for both the owner and the contractor.

Many researchers have conducted researches to identify causes of delays in construction projects some of them are Koufic and Wissam (1998); Sambasivan and Soon (2007); Sadi and Sadiq (2006); Al-Khalil and Al-Ghafly (1999); Alaghbari, Kadir, Salim, and Ernawati (2007); Azlan, Smith, Pitt, and Chan (2010); Assaf, Al-Khalil, and A-Hazmi (1995); Ahmad, Torrance and Hamid (2006); Afshari, Khosravi, Ghorbanali, Borzabadi, and Valipour (2010); Koushki, Al-Rashid and Kartam (2005) and Doloi, Sawhney, and Iyer (2012). Having summarizing the facts of those researches it is noted that most of them have categorized the causes into several groups like Client related factors, Contractor related factors, Consultant related factors, Labour and equipment related factors, Material related factors and External factors. As per the above researches, most critical causes across the above main groups are change orders, contractor's improper planning, inadequate client's finance and payments of completed work, shortage in materials, labour supply and subcontractor problems and approval of shop drawings.

Further, studies from Aibinu and Jagboro (2002), Sambasivan and Soon (2007); and Azlan et al. (2010) identified many effects of delay in construction projects such as time overrun, cost overrun, disputes, total abandonment, rescheduling, productivity and efficiency loss of labourers, late payment by the client and affect company reputation.

Armando (2002) identified the delays in four categories as Excusable delays and Non - compensable delays, Excusable and Compensable delays, Non-Excusable and Non-Compensable delays and Non-Excusable and Compensable delays. JCT (1980) Standard Form of Contract recognizes three broad categories of delays, namely excusable and compensable, excusable but non-compensable and inexcusable. According to delays can be classified based on their origin, based on compensability of delay and based on timing of delay. Concurrent delays and Non-concurrent delays are the delays classified by Singh and Trivedi (2012) based on timing of delay.

Situations where more than one factor delays the project at the same time or in overlapping periods of time, those delays are called concurrent delays (Alaghbari, 2005). The SCL Protocol (2002) defines "true concurrent delays" as "*the occurrence of two or more delays events at the same time, one an employer risk event, the other a contractor risk event and the effects of which are felt at the same time".*

Thapiyal (2004) pointed out that "Claims in concurrent delays are argued as both a sword and shield in fighting delay claims". In addition, Mohan and Al-Gahtani (as cited in Menesi, 2007) specified three major difficulties in calculating concurrent delays as follows:

- When concurrent delay events occur in two or more concurrent activities which have different start and finish dates, it is difficult to agree on the concurrency period, because only part of these activities is concurrent.
- New critical paths could be formed because of consuming the total floats for non-critical activities.

- If the concurrent delays are on critical paths, and if the owner delays the critical path, the contractor can slow down his work on the parallel critical paths in order to be critical.

Therefore concurrent delay can be identified as mostly, troubled, complicated and challenging topic in construction industry and it requires consideration of the interaction of different factors such as contractual provisions, legal principles, technical assessment of the construction programme, methods for proof of delay claims, float ownership and definition of criticality (Doyle, 2005). Further there have been many case laws regarding concurrent delays such as Henry Boot Construction (UK) Ltd. v. Malmaison Hotel (Manchester) Ltd., City Inn Ltd. v. Shepherd Construction Ltd., Smith V. The United States and Klingensmith Inc. v. United States.

However avoiding delays in construction projects is very difficult task. When projects are inexcusably delayed, the parties to the Contract tend to use concurrent delay as a global excuse for their failure to perform (Peters, 2013).

Many delay analysis techniques have been present in the literature. Researchers for example Alkass, Mazerolle and Harris (1996),Bordoli and Baldwin (1998), Singh and Trivedi (2012), Kim (2009) and Lee and Diekmann (2011) identified several delay analysis methods and developed a new method by addressing weaknesses of the existing methods. Equally some researchers like Menesi (2007), Ng, Skitmore, Deng and Nadeem (2004), Braimah (2013) and Yang and Kao (2009) have discussed the improvement needs of existing delay analysis methods and proposed approaches to select suitable delay analysis methodology. Therefore reasonably analysing concurrent delay is also important analysing other delay claims. Reasonably analysing concurrent delay is also important as analysing other delay claims.

Even if, in previous researches have been subjected to many areas in construction delays, there are only few researchers concern about concurrent delays. Corresponding to Sri Lankan Construction Industry, Baduge and Jayasena (2012) verified their

personal observation of low application of concurrency in Sri Lankan construction delay claims was in fact true via pilot expert survey and tried to identify significant causes affecting low consideration of concurrency in delay claims in Sri Lanka. Further it can be identified that concurrent delays are not much popular within Sri Lankan Construction industry. Therefore, it is expedient to carry out a proper research to find out the way of treating concurrent delays in Sri Lankan Construction Industry. Thus, research problems emerged as "what are the applied methods for analysing concurrency in construction delay claims in Sri Lankan Construction Industry?" and "What are the barriers for applying those methods in Sri Lankan construction industry?"

1.2. Aim

The aim of the study is to identify the most appropriate method/s for analysing concurrency in construction delay claims in Sri Lankan Construction Industry.

1.3. Objectives

1. Analysing case law regarding concurrent delays and investigate methods for analysing concurrent delays.
2. Identify the occurrence and degree of consideration of concurrent delays in Sri Lankan Construction Industry.
3. Identify the Sri Lankan professionals' opinion towards concurrent delays.
4. Identify the methods for analysing concurrent delays and their applicability to Sri Lankan Construction Industry.
5. Identify compatible method/s for analysing concurrency in construction delay claims in Sri Lankan construction industry and barriers for their application.

1.4. Research Methodology

Initially, a comprehensive preliminary literature survey was carried out to identify the construction delays, causes of delays, delay analysis methods, the concept of concurrent delays, case laws with respect to concurrent delays and ways of analysing

concurrent delays by which the first aim was achieved. Simultaneously, preliminary expert suvey was done by interviewing four claim experts to verify research problems and get help to develop questionnaire for detailed survey.

Questionnaire survey was carried out among professionals in Sri Lankan construction Industry, working for both Contractor and Consultant to find out the occurrence of concurrent delays,the degree of consideration of concurrent delays and their opinion of concurrent delays. Then, the collected data were analyzed statistically, to achieve the 2nd and 3rd objectives.

Questionnaire survey also focused on discovering the approaches for analysing concurrent delays, their awareness, usage, success and their applicability to Sri Lankan Construction Industry as well as identifying the barriers for usage of analysing concurrency in construction delays in Sri Lankan construction industry.

Finally results of the detailed questionnaire survey were verified by conducting structured interviews with two claims experts in the industry.

1.5. Scope and Limitations

According to the researcher's experince and the review of preliminary survey, it is noted that mainly the Quantity Surveyors, Engineers and Project Managers are the professionals who deal with construction claims. Therefore the distribution of questionnaires was limited to among the Quantity Surveyors, Engineers and Project Managers in the Sri Lankan construction industry. Additionally the experience of those professionals were considered to be more than 5 years.

1.6. Chapter Breakdown

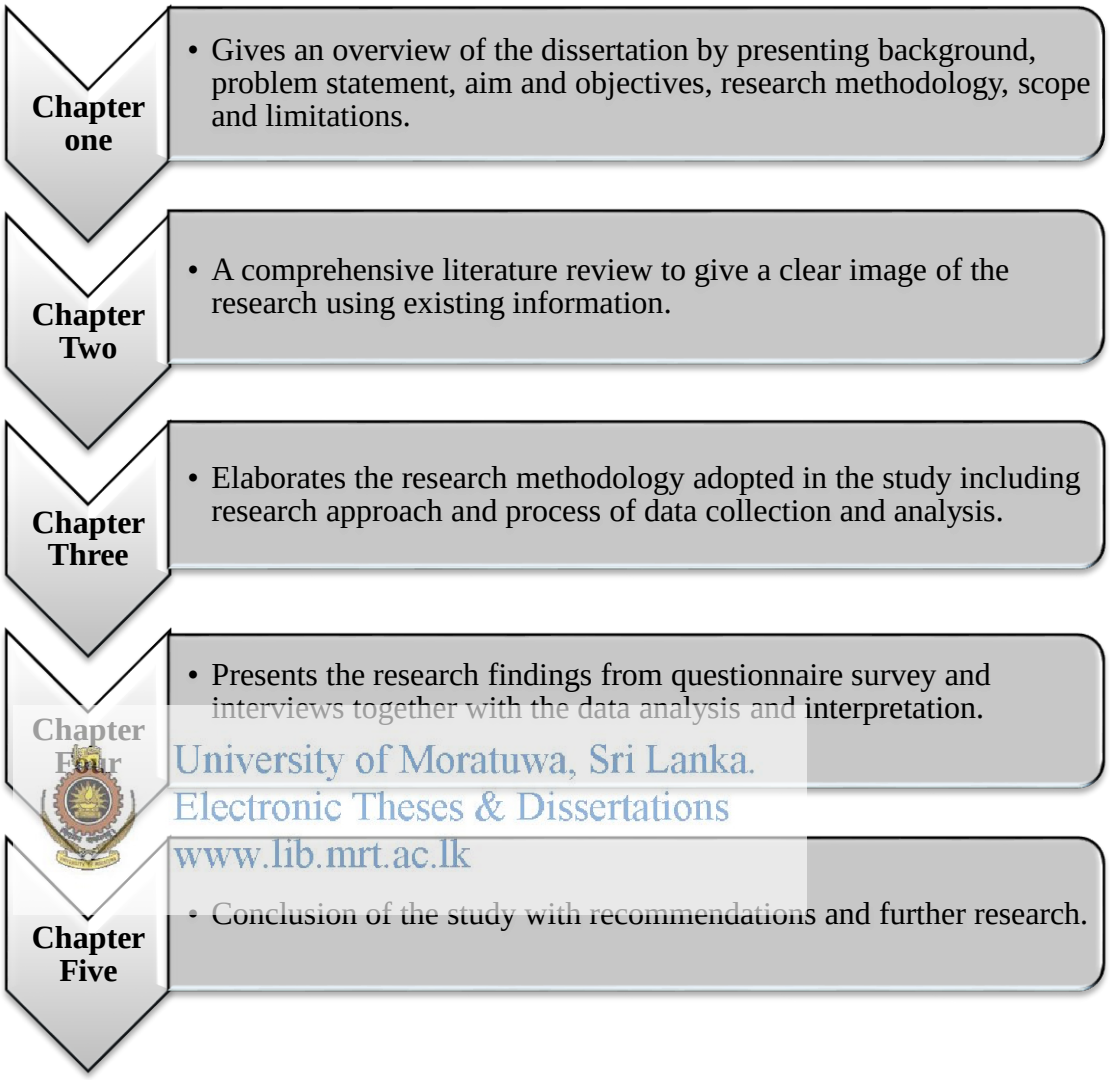

Figure 1.1: Chapter Breakdown

2. LITERATURE REVIEW

2.1. Introduction

This chapter is intended to give a detailed explanation about research using existing information and resources. Initially the chapter describes what is construction delay, causes and effects of those delays and the different types of delays. Then focused on delay analysis methods.

Subsequently, the concept of concurrent delay is discussed with the analysis of case laws related to concurrent delays to accomplish the objectives of this research study. Further, the ways of analysing concurrent delays are examined in order to identify existing practice regarding concurrent delays as per available literature which are ultimately used for achieving aim of the research.

2.2. Construction Delays

Construction management focus on best practices of managing resources such as materials, equipment and labour (Singh and Tiwedi, 2012). Balancing time, cost, and quality of a project is major challenge to the construction professionals in the construction industry. Time is critical in almost every construction project. According to Cushman et al. (2001), owner cannot get any benefit until the project is completed. However, due to the uncertainties in construction projects such as weather, soil conditions, disputes and unavailability of labour, material and plant, the construction projects get delayed. Generally when the projects are delayed, they are either extended or accelerated and that both remedies incur additional cost (Sambasiva and Soon, 2007).

Delay is a source of frequent disputes and claims due to overriding importance of time for both the owner and the contractor. So it is essential to identify the actual causes of delay in order to minimize and avoid delay in any construction project (Ahmed et al., 2003). Bordoli and Baldwin (1998) stated that standard forms of construction contract use in most countries may initially appear to cover all eventualities and be detailed in

their requirements with regard to time, delays and extensions to the contract period, but in practice there are different interpretations placed on the situations that have occurred.

However avoiding delays in construction projects is very difficult task. Therefore it is important to assess delays in proper way. As such Lee and Diekmann (2011) highlighted that delays must be analysed logically and objectively so that the participants can mutually understand the problem without generating unnecessary arguments.

2.3. Causes of Delays

Toufic and Wissam (1998) identified 64 causes of delays in construction projects and categorized them in 10 main groups namely materials, manpower, equipment, financing, changes, government relations, project management, site conditions, environment and contractual relationships. Further Sambasivan and Soon (2007) took 28 well recognized construction delay factors and categorized them into eight major groups as Client related factors, Contractor related factors, Consultant related factors, Labour and equipment related factors, Material related factors, Contract related factors, Contract relationship related factors and External factors.

Sadi and Sadiq (2006) studied frequency, severity and importance of causes of delay in construction projects in Saudi Arabia. They identified 73 causes of delays via survey including contractors, consultants and owners and those are combined into nine groups. Five groups are similar to the groups named by Sambasivan and Soon (2007). Those are Client related factors, Contractor related factors, Consultant related factors, Material related factors, and External factors. Other than those groups Sadi and Sadiq (2006) also categorized factors of delays into Design team related factors, Labour related factors, Project related factors and Plant/ Equipment related factors.

Al-Khalil and Al-Ghafly (1999) conducted a research to determine the most important causes of delay in public utility projects. Like most of the researchers they also categorised causes of delay into six major groups. Cash flow problems and financial

difficulties by the contractor, difficulties in obtaining permits, and the requirement to select the lowest bidder without regard to prequalification are the most important causes found by them. Moreover Alaghbari et al. (2007) identified the 31 factors causing delay in building construction projects in Malaysia which were grouped into four major categories by responsibility – contractor factors, owner factors, consultant factors and external factors. As per their research financial problems are most important factor causing delay in construction projects in Malaysia.

Azlan et al. (2010) mainly identified seven factors that contribute to delay in construction projects those were contractors' financial difficulties, construction mistakes and defective work, labour shortage, coordination problem, shortage of tools and equipment, material shortage and poor site management. From those seven factors they found that labour shortage, contractors' financial difficulties and construction mistakes and defective works are the three most important delay factors according to the perspective of contractors.

Assaf, Al-Khalil, and Al-Hazmi (1995) identified that approval of shop drawings, delays in payment to contractors and the resulting cash problems during construction, design changes, conflicts in work schedules of subcontractors, slow decision making and executive bureaucracy in owner's organizations, design errors, labour shortage and inadequate labour skills as the most important causes of delay in large building construction projects in Saudi Arabia.

Ahmad, Torrance and Hamid (2006) conducted a survey to identify the variables related to project characteristics and the variables associated with excusable delay that have significant effects on the construction time performance of public sector civil engineering projects in Malaysia. They found that the construction time performance of the public projects in Malaysia was mostly affected by variables related to excusable delays than variables related to project characteristics.

Afshari et al. (2010) investigated causes of non-excusable delays using thermal power plant, steam and power and utility projects and to determine the important level of

those causes via the panel of experts. In this research the experts was demonstrated that not selecting competent subcontractors is the most important cause of non-excusable construction delays.

Faridi and El-Sayegh (2006) identified the top 10 most significant causes of construction delays in the UAE construction industry through their research. Approval of drawings, inadequate early planning and slowness of the owners' decision-making process are in the higher level of top 10 causes of delay. Koushki, Al-Rashid and Kartam (2005) also identified three main causes of time-delays. Those are the number of change orders, financial constraints and owners' lack of experience in construction.

Doloi, Sawhney, and Iyer (2012) found that client's influence is one of the most significant factors affecting time performance on Indian projects as suggested by the structural equation model used in their research.

Consequently, it reveals that several researchers conducted researches on causes of construction delays in several countries. They have identified many delay factors and some of them categorized those factors into main groups.

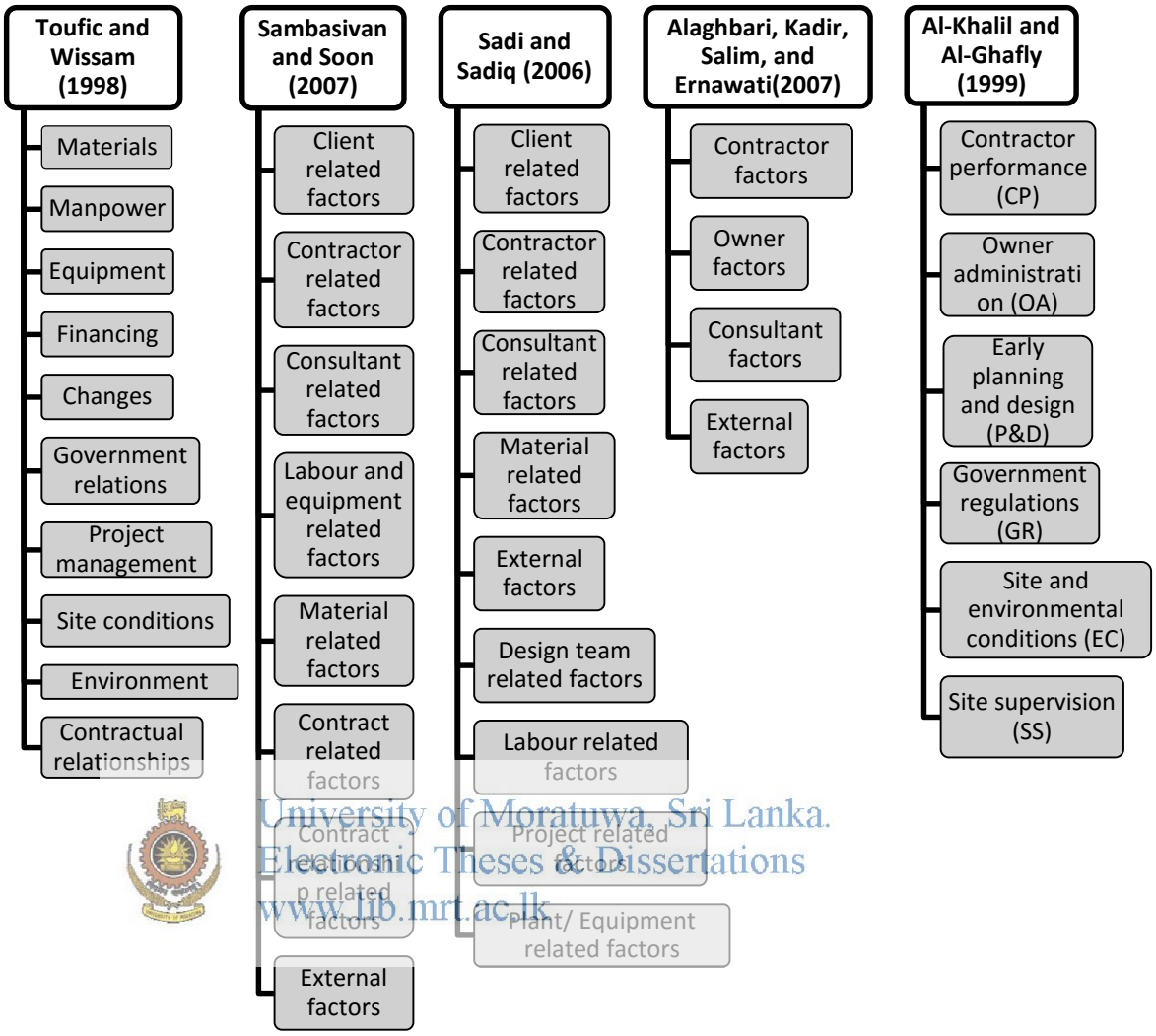

Figure 2.1: Classification of Delay Causes

2.4. Effects of delays

Studies from Aibinu and Jagboro (2002), Sambasivan and Soon (2007); and Azlan et al. (2010) identified many effects of delay in construction projects. According to their researches, eight most common effects of delay were identified and discussed below.

2.4.1. Time overrun

Contractor's improper planning, contractor's site management, inadequate contractor experience, and delay in payments for completed work by clients which belong to

contractor- related and client-related factors are the main factors affecting time overrun (Sambasivan and Soon, 2007). Further Othman et al. (2006) identified that if the cause of delay is beyond the control of the contractor and it is due to client-related factors, contractors can claim suitable Extension of Time (EOT).

2.4.2. Cost overrun

Aibinu and Jagboro (2002) found that cost overrun is the most frequent effect of delay in Nigeria. This is further supported by Azlan et al. (2010). They identified that cost overrun is the most common effects of delay in construction projects which ranked first. Sambasivan and Soon (2007) also found that cost overrun was second most common delay effect in the Malaysian construction industry. Contract related factors such as mistakes and discrepancies in the contact document ad change orders are mainly result in cost overrun (Sambasivan and Soon, 2007).

2.4.3. Disputes

Client-related factors, Contract-related factors, Contract relationship related factors and External factors are mainly caused to arise disputes between various parties such as delay in payments for completed work, frequent owner interference, changing requirements, problems with neighbours and unforeseen site conditions. If the parties cannot settle disputes, those can be lead to arbitration or litigation (Sambasivan and Soon, 2007).

2.4.4. Total abandonment

According to Sambasivan and Soon (2007), Client related factors, Consultant related factors, Labour related factors, Contract related factors and External factors contribute to the total abandonment of the projects. Financial difficulties of the clients, economic condition of the country and regulatory changes are some of the factors that lead to total abandonment of the projects.

2.4.5. Rescheduling

Liu and Shih (as cited in Azlan et al., 2010) stated that schedules of the construction projects are updated in order to monitor the time and work in construction projects and it is important in several ways as follows;

- compare the original schedule with the actual progress of the project
- identify all delayed activities
- identify who or what is responsible for delays
- forecast and modify projected work progress based on actual progress

Therefore due to the delay in work rescheduling is required to identify delayed activities of the construction projects.

2.4.6. Productivity and Efficiency loss of labourers

As said by Bramble and Callahan (as cited in Azlan et al, 2010) productivity and efficiency loss of the labourers always occurs when delays happen. Acceleration of the schedule, pressure to complete the work and rework lead to reduce the productivity and efficiency of the working labourers (Azlan et al, 2010).

2.4.7. Late Payment by the client

During delay periods mainly due to contractor related delays, late payment by the clients may occur more severely. The client may use delay of the project as a reason to hold-up the payment to the contractor (Azlan et al, 2010).

2.4.8. Affect Company Reputation

The reputation of a company is very important to a business to survive. Thus, as mentioned by Azlan et al. (2010), delay in construction projects will affect the company reputation indirectly.

2.5. Types of Delays

According to Alaghbari et al (2007), delays can be divided into three major types, namely:

1. Excusable and non-excusable delays
2. Compensable and non-compensable delays
3. Concurrent delays

Those delays can be further categorised based on how they operate contractually as follows.

1. Non-excusable delays
2. Excusable non-compensable delays;
3. Excusable compensable delays
4. Concurrent delays

According to Singh and Trivedi (2012) delays can be classified in different ways as follows;

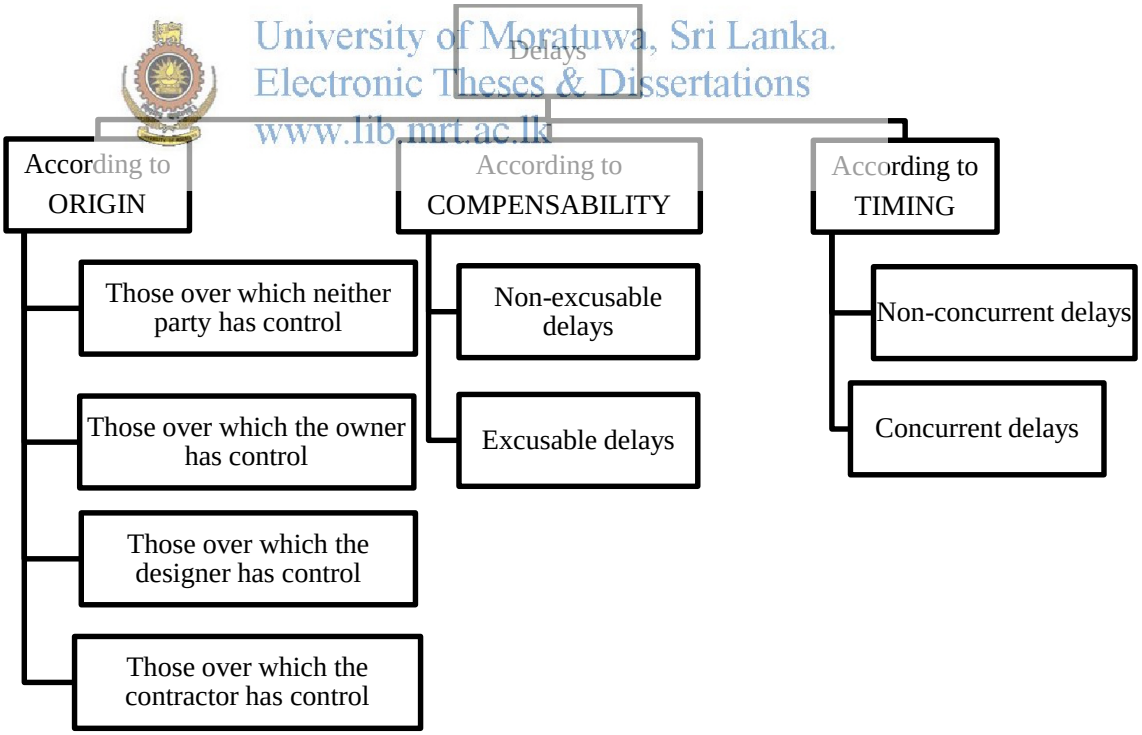

Figure 2.2: Classification of Delays

When the delays are analysed based on the responsible party for the delay, it is the classification of delays according to their origin. Those responsible parties for the delay can be the owner, the designer, or the contractor. Based on compensability of delay delays are classified into excusable delays and non-excusable delays. Next classification of delay is based on timing of delay. That is concurrent delays and Non-concurrent delays (Singh and Trivedi, 2012). Armando (2002) identified the delays in four categories as Excusable delays and Non - compensable delays, Excusable and Compensable delays, Non-Excusable and Non-Compensable delays and Non-Excusable and Compensable delays. JCT (1980) Standard Form of Contract recognizes three broad categories of delays, namely excusable and compensable, excusable but non-compensable and inexcusable.

Subsequently four types of delays were mainly identified and described as follows;

2.5.1. Excusable delays and Non - compensable delays

Delays due to causes beyond the contractor's control and causes those are not foreseeable are excusable delays. For those delays contractor is excused from liability (Cushman et al, 2004). Most contracts allow for the contractor to obtain an extension of time for excusable delays (Alaghbari et al, 2007). Excusable delays are mainly due to "acts of God" because no one responsible for occurrence of them. (Alaghbari, 2005). According to Armando (2002), following causes are mainly resulting excusable and non - compensable delays;

- Unusually severe or unanticipated weather conditions
- Strike and labour problems beyond the contractor's control
- War
- Subcontractor or supplier delays if the contractor was compelled by the owner or owner's representative to use that subcontractor or material supplier

2.5.2. Excusable and Compensable delays

Delays caused by the owner are generally compensable delays. The most common form of compensable delay is inadequate drawings and specifications. It can also arise from the delay in response by the owner to requests for information or shop drawings, owner's changes in design or materials, and owner's disruption and/or change in the sequence of the work. The contractor is entitled to both additional money and additional time resulting from compensable delays (Alaghbari et al, 2007). According to Armando (2002), following causes are mainly resulting excusable and compensable delays;

- Lack of timely access or restriction of access to the site
- Delay in approval of shop drawings or in giving requested instructions or directions
- Late, defective or improper owner -furnished materials or supplies
- Inadequate or defective shop drawings or specifications
- Failure of the owner to make required payments
- Changes or changed conditions in the work
- Owner's interference with the work forces of the contractor or creation by the owner of labour problems which disrupt the contractor's work

2.5.3. Non-Excusable and Non-Compensable delays

Basically, these delays are caused by contractors or his subcontractors or his materials suppliers and those are not due to fault of the owner. For those delays the contractor is not entitled to compensation from the owner, but he might get compensation from the delaying subcontractor or supplier. (Alaghbari et al, 2007). Contractor will not be entitled to a time extension for these delays and contractor may not recover against the owner. Also contractor may be subjected to a claim by the owner for liquidated or un liquidated delay damages (Armando, 2002).

2.5.4. Concurrent delays

Situations where more than one factor delays the project at the same time or in overlapping periods of time, those delays are called concurrent delays (Alaghbari, 2005). Mainly for excusable and compensable delays, it is necessary to determine whether the contractor is independently delaying the work. When the owner and the contractor simultaneously delay the works and the responsibility for the delay cannot be apportioned the contractor is not entitled for liquidated damages (Cushman et al, 2001). The 'concurrent delays' is described in detail in the literature review as the main area of this study.

2.6. Concurrent Delays

2.6.1. What is "Concurrent Delay"?

Baduge and Jayasena (2012) identified that concurrency in delays is a special aspect in claims management as both Contractors and Employers can use concurrency when defending delay claims. Contractor may use concurrency to defend delay damages, while Employer may use it to avoid paying compensation for the prolongation to the Contractor.

The term "Concurrent Delay" has many definitions in construction industry.

Columnist (2012) defined the Concurrent delays as *"delays which occur when two or more independent critical delays by the employer and the contractor, each having the ability to delay the time for completion, occur at the same time period."* He further mentioned that there are three key factors which are necessary for concurrent delays:

- They should critically impact the time for completion, and not simply absorb float;
- They should be independent and not caused indirectly by the other parties delay; and
- They should occur approximately at the same time period and their impact should be concurrent but not necessary identical.

Peters and Thomas (2013) identified the lack of consistency in meaning of concurrent delay which creates the systemic confusion within the industry and they deliberated the concept of concurrent delay is merely an observance that at least two parties defaulted on an obligation to perform.

Tiggeman and Toscano (2010) argued that true or real concurrent delay can only occur when there are two events occurring at the same time and those affect the time for completion of whole work.

The Society of Construction Law (2002) refers to "true concurrent delay" and defines it as *"the occurrence of two or more delay events at the same time, one an Employer risk event the other a Contractor risk event and the effects of which are felt at the same time".*

The Association for the Advancement of Cost Engineering (AACE) provides definition for Concurrent Delay as follows:

1) *Two or more delays that take place or overlap during the same period, either of which occurring alone would have affected the ultimate completion date.*

2) *Concurrent delays occur when there are two or more independent causes of delay during the same time period. The "same" time period from which concurrency is measured, however, is not always literally within the exact period of time. For delays to be considered concurrent, most courts do not require that the period of concurrent delay precisely match. The period of "concurrency" of the delays can be related by circumstances, even though the circumstances may not have occurred during exactly the same time period.*

3) *True concurrent delay is the occurrence of two or more delay events at the same time, one an employer (owner) risk event, the other a contractor risk event and the effects of which are felt at the same time. The term concurrent delay is often used to describe the situation where two or more delay events*

arise at different times, but the effects of them are felt (in whole or in part) at the same time.

4) *Concurrent delay occurs when both the owner and contractor delay the project or when either party delays the project during an excusable but non-compensable delay (e.g. abnormal weather). The delays need not occur simultaneously but can be on two parallel critical path chains.*

Mohan and Al-Gahtani (as cited in Menesi, 2007) specified three major difficulties in calculating concurrent delays as follows:

- When concurrent delay events occur in two or more concurrent activities which have different start and finish dates, it is difficult to agree on the concurrency period, because only part of these activities is concurrent.
- New critical paths could be formed because of consuming the total floats for non-critical activities.
- If the concurrent delays are on critical paths, and if the owner delays the critical path, the contractor can slow down his work on the parallel critical paths in order to be critical.

Related to Sri Lankan construction industry, Baduge and Jayasena (2012) carried out a research exploring instrumental causes in discouraging the application concurrency in Sri Lankan construction industry. Accordingly, they have found that the significant causes that affect the consideration of concurrency in delay claims slightly varied among Employers, Engineers and Contractors where acceptable quality of documents became the most significant cause for all three groups. Further, following causes are second significant causes Employers, Engineers and Contractors respectively

- Awareness of concurrent delays
- Satisfaction on current delay management practice
- Disfavour for negotiated solution.

2.6.2. Case Law in respect of Concurrent delays

Claims in concurrent delays are argued as both a sword and shield in fighting delay claims. There have been many cases which have covered the aspects of concurrency. Some of them are summarised in Table 2.1 highlighting facts of the case and held by the Judge.

Table 2.1: Analysis of Case Law related to Concurrent Delays

Case	Fact of the Case	Held by the Judge
Peak Construction v McKinney Foundations [1970] 1 BLR 111	• Peak Construction entered into a bespoke contract with Liverpool Corporation for the construction of a multi-storey block of flats. • McKinney Foundations was the nominated subcontractor for foundation piling. • A pile was gravely defective and it was suspended while the problem was investigated. • Employer delayed the investigation. • Similarly McKinney delayed to commence remedial work.	*"If the failure to complete on time is due to the fault of both the employer and the contractor, in my view the clause does not bite. I cannot see how, in the ordinary course, the employer can insist on compliance with a condition if it is partly his own fault that it cannot be fulfilled…"*

Case	Fact of the Case	Held by the Judge
Trollope & Colls v North West Metropolitan Reginioal Hospital Board [1973] 9 BLR 60	• Hospital was to be built in 3 phases. Phase 3 had fixed completion date. • Phase 1 was completed late and granted EOT. • Contractor argued that there shoul be obvious term in the Contract that completion date of phase 3 should be similarly extended.	*If an employer causes a delay then it cannot insist upon strict adherence to the time for completion.*
Percy Bilton v Greater London Council [1982] 20 BLR 1 (HL)	• Bilton entered into a Contract to construct dwellings for the GLC. • Lowdells were nominated sub-contractor for Mechanical services and went into liquidation. • Bilton argued that failure of sub-contractor was Employer's fault.	*Unless a contract provides otherwise, an employer cannot rely upon a liquidated damages clause if it has prevented the contractor from completing.* *It would have to claim general damages from whenever the contractor should have completed, after allowing a reasonable time for completion.* *However, in order to be entitled to an extension of time a contractor must still demonstrate a causal link between the relevant event and the delay to completion.*

Case	Fact of the Case	Held by the Judge
SMK Cabinets v Hili Modern Electric Pvt Ltd [1984] VR 391	• S M K Cabinets ('SMK'), the contractor, contracted with Hili Modern Electric Pvt Ltd ('Hili'), the proprietor, to supply and install cupboards at premises in Fawkner. • There was no extension of time clause. • The contract was delayed and Hili sought to claim liquidated damages. • SMK submitted that 'prevention principle applied and the liquidated damages clause was unenforceable'	*It does not matter if the contractor would not have been able to complete in time anyway, if the employer caused delay then it prevented the contractor from completing.*
H Fairweather v Borough of Wandsworth [1987] 39 BLR 106	• Fairweather entered into contract to erect 478 dwelling for Wandsworth • Long delay culminated in the architect giving an EOT for strikes. • Contractor claimed few weeks designated as on account of architect's late instructions. • The Arbitrator decided use dominant cause for granting EOT	*Disapproved the use of the dominant cause test when dealing with concurrent delays for claims for an extension of time.*

Case	Fact of the Case	Held by the Judge
Balfour Beatty Building v Chestermount Properties [1993] 62 BLR 1	• Balfour contracted with Chestermount for the construction of the shell and core of an office Block. • The works were not completed by the contractual completion date and the architect issued a certificate of non-completion. • The architect then instructed instructions for fit-out works as variations.	"*the contractor was entitled to an extension of time attributable to a (post-completion) variation/instruction, but that the period of the extension should only be 'dotted-on' to the original or extended completion date."* *"It is not enough that a relevant event occurred; a causal link between cause and effect must still be established."*
Henry Boot Construction (UK) Limited v Malmaison Hotel (Manchester) Limited [1999] 70 Con LR 32.	• Henry Boot contracted with Malmaison for the construction of a hotel in Piccadilly, Manchester. • The contractor claimed EOT due to variations and late information. • The employer argued – it is due to contractor-risk events.	*"It is agreed that if there are two concurrent causes of delay, one of which is a relevant and the other is not, then the contractor is entitled to an extension of time for the period of delay caused by the relevant event notwithstanding the concurrent effect of the other event."*

Case	Fact of the Case	Held by the Judge
Multiplex v Honeywell [2007] BLR 195	• Honeywell successfully argued before the adjudicator that time was at large due to Multiplex's delay under subcontract. • However Honeywell failed to issue a notice of delays.	*An employer cannot hold a contractor to a completion date if the employer has caused the contractor to miss that date.*
City Inn Ltd v Shepherd Construction Ltd [2008] 8 BLR 269 (CSOH); [2010] BLR 473 (CSIH)	• The parties had contracted for the construction of a hotel in Bristol. • The works completed after the contractual completion date. • The employer claimed LD • The contractor claimed an EOT and to loss and expenses.	*"Where there is true concurrency between a relevant event and a contractor default, in the sense that both existed simultaneously, regardless of which started first, it may be appropriate to apportion delay between the two causes"*

Case	Fact of the Case	Held by the Judge
De Beers UK v Atos ATOS Origin IT Services UK Limited [2010] EWHC 3276	• De Beers UK (DB) agreed to move a major part of its diamond business to Botswana and engaged Atos to develop a software system to support DB's diamond supply chain management and upgrade its existing systems. • The project was significantly delayed, and the timetable was revised. • DB failed to pay one of ATOS's invoices. • ATOS also complained about material increases in the scope of the work. Eventually ATOS suspended work. • Each party asserted that the other was in breach of contract.	*Followed the Malmaison approach, that is where there is concurrent delay then a contractor should get time but not its costs.*
Walter Lilly & Company Ltd v MacKay [2012] BLR 503	• Walter Lilly & Company Ltd ("WLC") was employed by DMW Developments Ltd ("DMW") to build a house for Mr Mackay. • WLC made claims for extensions of time and related loss and expense as there were delay. • Mr Mackay later taken Knowles Ltd as claims consultants to provide "contractual and adjudication advice.	*Contractor is entitled to an extension of time by following Henry Boot v. Malmaison. But here, the judge confirmed that the 'apportionment approach' was not applicable in England.*

2.6.2.1. Discussion

The case ***Peak Construction v McKinney Foundations*** paved the way over 40 years. The underlying principle of the decision was that it is not reasonable for an Employer to retain the benefit of liquidated damages if the delay is caused by his own act. This referred to as the "prevention principle". As per the prevention principle, the Contractor will normally be entitled an EOT to a delay caused by the owner regardless of any concurrent delay for which the contractor might be responsible. Simply a party cannot benefit from its own wrong under prevention principle.

In ***Percy Bilton v Greater London Council*** the Judge upheld the prevention principle, but, recognised that it could be displaced by an express term of the Contract. In ***SMK Cabinets v Hili,*** Judge considered prevention principle in some depth. The case ***Multiplex v Honeywell*** followed the prevention principle as in ***Peak Construction v McKinney Foundations.***

The application of the prevention principle was considered again in the case ***Balfour Beatty Building v Chestermount Properties***, where an employer's risk event occurs after the time that the works have to be completed and when the contractor was in culpable delay. However the judge commented that;

"In some circumstances it may not be 'fair' to grant a contractor an extension of time if the relevant event was 'caused' by the contractor's own delay".

In ***H Fairweather v Borough of Wandsworth*** case the judge expressly disapproved the use of the dominant cause test when dealing with concurrent delays for claims for an extension of time.

The case ***Henry Boot Construction (UK) Limited v Malmaison Hotel (Manchester) Limited*** became a famous case as its decision provides some indication on the acceptable principles for dealing the issue of concurrent delay and continued applying for many later cases such as ***De Beers UK v ATOS Origin IT Services UK Limited*** and ***Walter Lilly & Company Ltd v MacKay***. The "Malmaison" approach (test) established as a method for analyzing concurrent delays after the case.

In the case ***City Inn Ltd v Shepherd Construction Ltd,*** the Judge was found that the delay to completion was the result of concurrent causes and any of the causes of delay could not be regarded as a "dominant" cause. So, the Judge concluded that *where there is true concurrency of effect between contractor risk events and employer risk events, it may be appropriate to make an apportionment that is to allocate the time and money effects of the delay based on the relative contributory strength or significance of the competing causes of delay.*

The Judge proceeded to set out the basis for apportionment. He considered that two main elements were important:

1. The degree of culpability involved in each of the causes of the delay (likely to be the less important element).
2. The significance of each of the factors in causing the delay, based on:
   a. The length of the delay caused by each of the causative events; and
   b. The significance of each of the causative events for the works as a whole.

However the approach of apportioning such risks has not received much support in England which could be seen in decision of ***Walter Lilly v MacKay*** case where the judge confirmed that the 'apportionment approach' was not applicable in England.

Multiplex v Honeywell and ***Trollope & Colls v North West*** cases considered prevention principle but the key question in these cases was whether time was set at large under the contracts.

2.7. Analysing Delays

Analysing and apportioning delays accurately is essential to allocate liability for time-related costs (Lee and Diekmann, 2011). Delay analysis is the task for investigating the delay events of a project delay to determine the financial responsibilities of the contracting parties due to the delay (Ndekugri, Braimah and Gameson, 2008). Menesi (2007) stated that the purpose of the delay analysis is to calculate the contribution of each party to the total project delay. Braimah (2013) also mentioned that the objective

of delay analysis is to calculate the project delay and identify how much of it is attributable to each party (contractor, owner, or neither).

Yang and Kao (2009) pointed out that at least four types of schedule network are used in various delay analysis methods. Those are as-planned, as-built, adjusted and entitlement schedules. Further Menesi (2007) identified the as-planned and as-built schedules are the basic sources of data generally used for delay analysis.

An as-planned schedule is an initial approved schedule submitted by the contractor to the owner for a project and it is considered as a baseline schedule or a target schedule use for managing a project (Yang and Kao, 2009). On the other hand Menesi (2007) recognized the as-planned schedule as a graphical representation of the contractor's original target for the completion of the project which shows different critical paths, planned activities and their sequence.

According to Yang and Kao (2009) as-built schedule is the final schedule for a project and it is usually prepared once the project is completed. So that it contains all the actual start and finish dates, and the delays of the project. Further as-built schedule shows the actual sequence and progress of the activities of the project including the slowdowns, work stoppages, and accelerations and provides evidence to substantiate an assessment of liability for any delays (Menesi, 2007).

An adjusted schedule is prepared by modifying the as-planned or as-built schedule along with the chosen delay analysis technique. Entitlement schedules are used to show the original contractual completion dates, how these completion dates have been impacted due to excusable delays and the projected completion dates given for the remaining works. The final entitlement schedule shows the original, adjusted and actual completion dates which can be used to find the total time that the contractor or the owner is entitled to for compensation (Yang and Kao, 2009).

For analysing delays, daily records of the actions performed by all parties on a construction site are required. Those site events include a large amount of data related to staffing, resource use, work accomplished, inspections, accidents, weather, delivery

of materials, and change orders. Delay analysis requires recorded site data such as start and finishes times, work completed, resources used, idle times and work disruption periods.

Several researchers have proposed various processes for delay analysis as guidance to delay analysts. However, according to Yang and Kao (2009) processes for delay analysis can be split into the five phases as Figure 2.3.

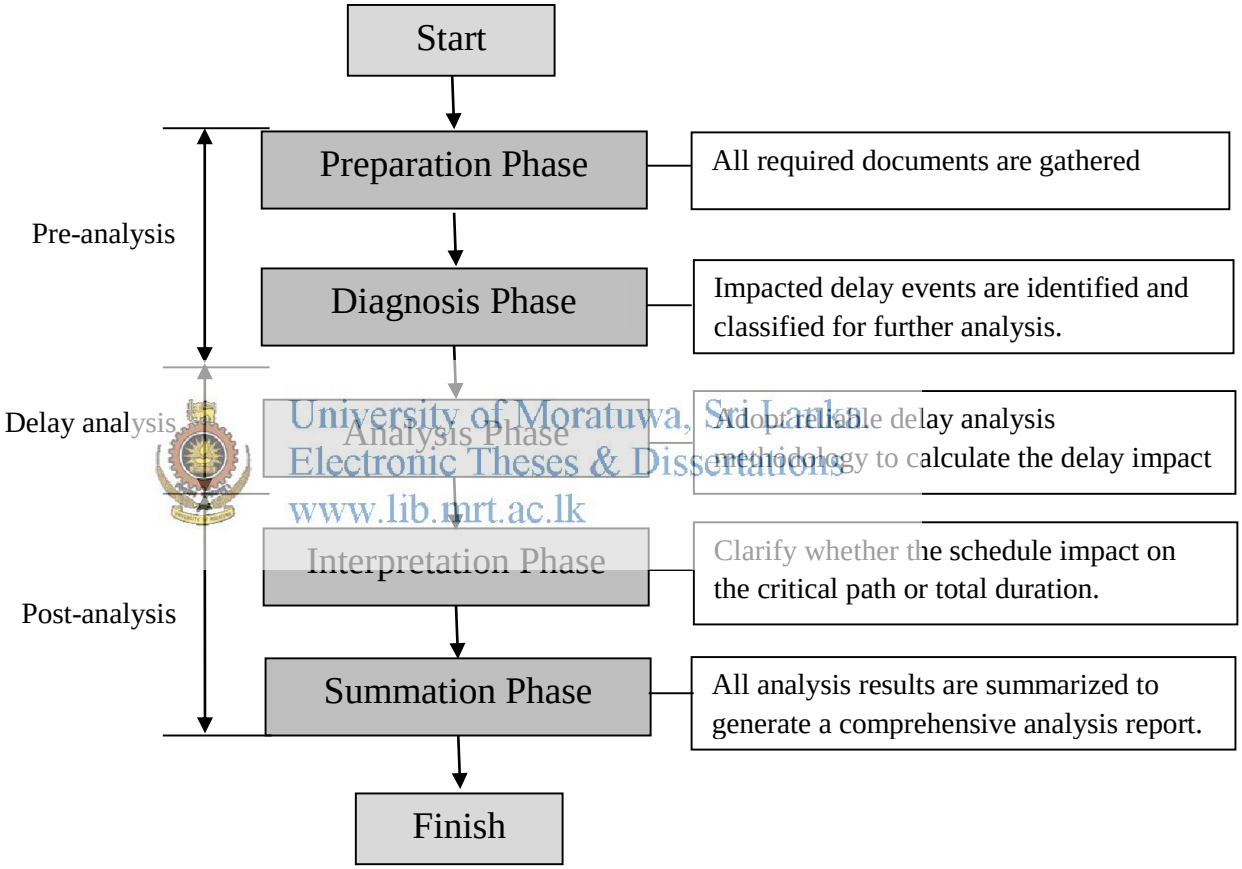

Figure 2.3: General delay analysis process

(Source: Yang and Kao, 2009)

The Availability and accuracy of project records is one of the factors to be considered when selecting DAT since the various techniques take up different programming information sources. The time of performing delay analysis is also an important factor, because some techniques are suitable for performing as forward assessment, while

others are used for retrospective assessment. In addition the type of delay claims in dispute and the availability of resources for the analysis are also relevant issues of consideration when selecting suitable DAT (Braimah, 2013).

Similarly Arditi and Pattanakitchamroon (as cited in Yang and Kao, 2009) found that the most suitable delay analysis method depends on the available information, time of analysis and capabilities of the method and funds and effort allocated to the analysis.

2.7.1. Delay analysis techniques

Many delay analysis techniques have been present in the literature. Some researchers identified several delay analysis methods and developed a new method by addressing weaknesses of the existing methods. Some researchers have discussed the improvement needs of existing delay analysis methods and some other proposed approaches to select suitable delay analysis methodology. (Refer Appendix A).

According to the Bordoli and Baldwin (1998), the `as-built' techniques are the most widely recognized methods for assessing delays. They developed a clear, straight-forward, step-by-step technique based on the critical path planning method which takes into account the progress of the project at the time the delay occurred, the changing nature of the critical path and the effects of action taken to minimize potential delays.

Singh and Trivedi (2012) developed a schedule delay assessment model using Fuzzy Logic Toolbox of MATLAB Program which provides a simple way to get a definite conclusion based upon vague, imprecise or missing input information.

Alkass, Mazerolle and Harris (1996) assessed different delay analysis techniques and identified their advantages and weaknesses and they have introduced a new delay analysis technique called Isolated Delay Type (IDT). Delays to be analysed during the analysis process are allowed in this method, reducing the time required for the delay analysis considerably and thus reducing the analysis cost.

Lee and Diekmann (2011) identified need for a delay analysis method that incorporates the varying rate of production for the delayed activities. So that they introduced a delay analysis method that can reasonably apportion the concurrent delays with consideration of the nonlinear production rates of activities in construction projects. That method called Delay Analysis considering Production rate (DAP).This technique gives more realistic and reasonable results on large construction projects.

Kim (2009) explored the Contemporaneous Period Analysis (CPA) and the "but-for" delay analysis methods based on Resource Constrained Schedules (RCS) and found that these delay analysis techniques are not properly operated with RCS techniques. So that he introduced Resource-constrained Critical Path Method (RCPM) and shows how the RCPM can be utilized for those delay analysis.

Menesi (2007) studied commonly used delay analysis methods and proposed a ne method called Modified Daily Windows Analysis (MDWA) and developed prototype computer software for MDWA. This model consider multiple baseline updates and accurately allocates delays and accelerations among the project parties.

Yang and Kao (2009) identified 18 existing delay analysis techniques and compared three process-based dynamic analysis methods namely Snapshot analysis method, Windows analysis method and Isolated delay type methodin detail.

Moreover, researchers such as Bubshait and Cunningham (1998), Braimah (2013), Barry (2009), Hegazy (2012), Ng, Skitmore, Deng and Nadeem (2004), Dayi (2010), Salunkhe and Patil (2013), Harris and Scott (2001), Carmichael and Murray (2006), Kim, Soibelman and Grobler (2008) and Ndekugri, Braimah and Gameson (2008) studied about delay analysis techniques in their studies and discussed key issues regarding those techniques.

2.7.2. Common delay analysis techniques

By reviewing previous studies done by several researchers following five delay analysis techniques can be identified as common techniques of delay analysis.

- As-planned vs. As-built
- Impacted as-planned
- Window analysis/ Snapshot analysis method/Contemporaneous Period Analysis (CPA)
- Time impact analysis
- Collapsed as-built or 'but-for' analysis method

According to Lee and Diekmann (2011), as-planned versus as-built method basically compares the activities of the original CPM baseline schedule with those of the as-built schedule for assessing the delays in detail. Further Barry (2009) indicated that as-planned versus as-built method functions on the principle that actual delay to completion must by definition be found on the actual critical path of the project.

Impacted as-planned method is also called as the "what-if" or "adjusted-baseline" method. Simply this method measures the impact of the delays on the contractor's as-planned CPM schedule. The amount of delay is equal to the difference in completion dates between the schedules before and after the impacts and it can be used to analyse delays during and after project completion (Braimah, 2013). Yang and Kao (2009) summarise that this method starts with the as-planned schedule and adds delay one by one to an activity to display why the project was behind the planned schedule.

Dayi (2010) identified that Window analysis method is also called the contemporaneous period analysis and snapshot method. According to Alkass et al (1996),the snapshot window analysis technique is used to determine the amount of delay, time of the delay and the cause(s) of the delay and it is based upon the as-planned, as-built and any revised schedules that have been implemented during the execution of the project. This method offers a very effective approach to analyse delays

and it divides a complicated network into a manageable parts and also it takes into account the dynamic nature of the critical path. The more the snapshots or windows used the accuracy of the results is more (Braimah, 2013).

The time impact technique is similar to the snapshot technique some extent where both techniques examine the effects of delays or delaying events at different times in the project. But the difference is that the time impact technique concentrates on a specific delay or delaying event and it does not consider the time period containing delays or delaying events (Alkass et al, 1996). According to Braimah (2013) a stop-action picture of the project is developed each time it experiences a major delay situation and then the schedule is updated at this delay period.

Collapsed as-built method first creates an as-built CPM schedule including all the delays came across. Delays are then removed from the schedule to create a "collapsed" as-built schedule. This shows how the project would have progressed excluding those delays (Lee and Diekmann, 2011). In the same way, according to Braimah (2013) it removes the delays of each party from the as-built network so that the resulting schedule will give the completion date of the project but for the delays of the other party. Finally the difference between the as-built and the revised project completion dates is the delays that were beyond the control of the claimant party (Alkass et al, 1996).

Above techniques could be used for assessing concurrent delays mainly when granting EOT, after analysing under following methods which are used to analyse concurrency in construction delay claims. Further those techniques could be used for identifying concurrency in delay claims, its effect, periods and reasons.

2.7.3. Methods for Analysing Concurrent Delays

According to Williams (2003), whenever Employer and Contractor concurrently delay the work, responsibility for the delay cannot be identified and shared properly. Therefore concurrent delays are known to be complex to analyse and difficult to prove. However, impact of concurrency in construction delay claims cannot be ignored when analysing the contractual liability for delays accurately.

There are quite a few methods for trying to analyse concurrency in delay claims. These approaches are having varying degrees of success in the courts. According to Baduge and Jayasena (2012), apportioning method for analysing concurrent delays should be selected depending on the circumstances and other common methods in practice are But for Test, Dominant Case Approach, and use of common sense.

The more common approaches are;

- Apportionment
- The 'but for' test
- The dominant cause approach
- 'Malmaison' approach
- First-in-line approach

2.7.3.1. Apportionment

Where you have two completing causes of delay of equal or relative causative potency a natural response would be to suggest that the overrun and its consequences should be 'apportioned' between the contractor and employer on the basis to their relative causative potency (Jayalath, 2013).

As this approach reveal to be reasonable, it promotes little support to common law jurisdictions where there is a tendency to apply principles of causation in an 'all or nothing' way. Consequently the courts tend to seek a single event to a cause and the claimant would either win or lose. Therefore it can be said that the apportionment

approach is dependent on the court's interpretation of the facts and the application of difficult concepts of causative potency.

2.7.3.2. The 'but for' test

This method tends to attract the most support from the contracting fraternity as it trends to support the claimant. It is based on a simple concept that the overrun would not have occurred 'but for' the event complained. That is the claimant may seek to argue that delay is 'but for' the other parties delay.

However, when there are concurrent events independently push back the project schedule applying this approach will give stupid answer like neither of the events caused the delay, as for each case the delay would have occurred in any event. As a result courts avoid this approach where two or more concurrent events independently sufficient to cause the delay in question. This method can therefore generally be discounted.

2.7.3.3. The Dominant Cause approach

Under the dominant cause approach, where there are two causes of delay, one of the contractual responsibilities of the defendant and the other contractual responsibilities of the claimant, the claimant will succeed if it can be established that the cause for which the defendant is responsible is the effective dominant cause.

The dominant cause rationale is based on the parties having intended that in the event of a delay one of them must be responsible. Where you have competing delays and with the absence of apportionment one claim either for an extension of time or a cross claim for liquidated damages must succeed.

It anticipates for the engineer to consider the cause or reasons for the delays and choose a 'dominant' one, which is perfect and reasonable. However, in practice it often creates considerable difficulties and it could be impossible or impractical to apply when the two causes have equal potency or you cannot simply determine the difference.

2.7.3.4. The Malmaison approach

The case Henry Boot Construction (UK) Ltd v. Malmaison Hotel (Manchester) Ltd (1999) 70 Con LR 32, Dyson J in ratifying an agreement reached between the parties on the issue of responsibility where there are concurrent delays, said:

"If there are two concurrent delays, one which is a relevant event and the other not, then the contractor is entitled to an extension of time for the period of delay caused by the relevant delay notwithstanding the concurrent effect of the other event."

Dyson J cited the following example by way of explanation of the above view:
"If the contractor suffered a delay of a week because of exceptional weather, a relevant event and the same period of delay because of the shortage of labour, not a relevant event. Then, if the engineer feels it fair and reasonable to do so, he could grant an extension of time and he cannot refuse to grant one on the grounds that the delay would have occurred anyway because of the shortage of labour."

The decision of "Malmaison" provide some indication on the acceptable principles for dealing the issue of concurrent delay.

2.7.3.5. First-in-line approach

This approach is applied upon the basis that, where there are two events causing a delay, the event which took place first in time either by the contractor or by the employer, is the cause of the whole delay.

In this approach it is failed to take into account the circumstances where a party was largely responsible for the delay. Consequently the liability is decided merely on the point of order in time.

2.7.4. Information used for assessing concurrent delay

According to Baduge and Jayasena (2012), the main requisites for successful concurrent delay claim practice are,

- Parties' awareness on contractual entitlement for EOT for completion and Delay Damages.
- Parties' awareness on concurrent delay and its analysis methods
- Parties' proper documentation or record keeping

In the circumstances, the maintenance of properly updated programme and contemporaneous records become particularly pertinent to dealing with the consequences and resolution of concurrent delays disputes within a construction contract (Doyle, 2014).

The study of Baduge and Jayasena (2012), examined 24 numbers of organizations in Sri Lankan construction industry to identify whether they are at appropriate standard to be used in a concurrent delay analysis and they have checked the availability, completeness and timeliness of the documents used for delay claims. Baduge and Jayasena (2012), concluded that the lapses in the documents specially notice of claim, daily site records, construction programme and method statement are the primary reasons for low consideration of concurrency in delay claims in Sri Lankan construction industry.

2.8. Summary

Delays have become a universal phenomenon in construction projects which creates unbearable effects to the project stakeholders. It is typical that the construction projects are delayed due to several reasons. There are many causes of delays identified by several researchers and most of them have categorized the causes into several groups. There are several types of delays which can be classified based on responsible party for the delay, compensability of delay and timing of delay. According to the literature

many methods have been developed and adopted to analyse and measure construction delays, but one method cannot be accepted for all project participants and not suitable for all delay situations.

Concurrent delay is a particularly vexed and difficult concept which has been confused both employer and contractor. But at the present time there is little coherent guidance from the courts as to the accepted principles for dealing with this matter. Inference can be drawn from the judicial statements which are helpful in ascertaining and guiding in the decision of concurrent delay claims. Each specific case of concurrent delay should be viewed on their own merits and the appropriate procedure to be adopted.

3. RESEARCH METHODOLOGY

3.1. Introduction

The aim of this chapter is to discuss the research methodology adopted in this study. To begin with, it discusses the Research Design including Research approach and Research Technique. Further this chapter explains identification of data collection techniques and the selection of sample respondents for questionnaire survey. Lastly, statistical tool used for data analysis is described.

3.2. Research Process

According to Blankenship (2010) research process contains Identifying the research problem, Review the Literature, Identify the purpose of the study, define the terms and concepts, Research Design, Data Collection and Discussion and Conclusion and Recommendation. Figure 3.1 illustrates the research process which was adopted in this study.

3.3. Research Design

As per Welman and Kruger (2001) research design is the plan according to which one obtains research subjects and collects information. Kobus (2007) states that a research design is a plan or strategy which moves from the underling philosophical assumptions to specifying the selection of respondents, the data collecting techniques to be used, and the data analysis.

Kagioglouet al. (1998) describe that research design to be done through research methodology which consists main three key factors, **research philosophy** (on which the research will be premised), **research approach** (theory of testing) and **research techniques** (data collection and data analysis).

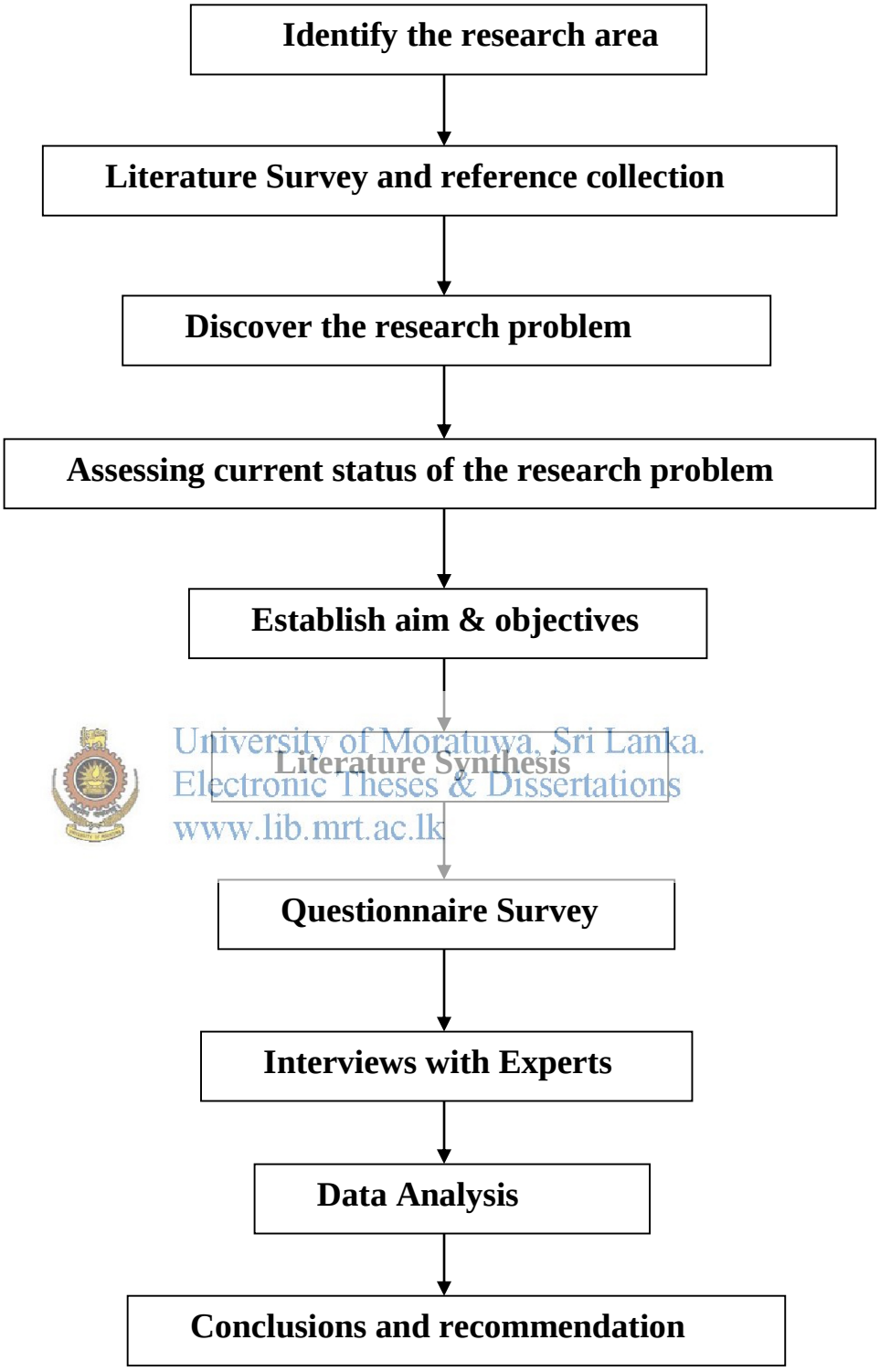

Figure 3.1: Research Process

3.4. Preliminary Study

3.4.1. Research problem statement

The research problems emerged through literature survey and preliminary expert interviews as "what are the compatible approach/es for analysing concurrency in construction delays Sri Lankan Construction Industry?" and "What are the barriers for applying those approaches in Sri Lankan construction industry?"

Through the literature review, the construction delays, causes of delays, delay analysis methods, the concept of concurrent delays, case laws with respect to concurrent delays and ways of analysing concurrent delayswere identified. The research problem was supposed to discover with empirical factors by using proposed research methodology.

3.4.2. Literature review

The comprehensive literature review focused on the first objective of the research and developing questionnaire. The literature review was conducted by referring books, journals, articles and other publications related to the research field specially emphasising the importance of carrying out a research on that field.

3.5. Research Approach

Research approaches are classified under four categories by Alzheimer (2009), namely; Qualitative Research, Quantitative Research, Pragmatic Research Approach (mixed methods)and Advocacy/participatory approach to research (emancipatory). Panneerselvam (2004) stated that type of study to be conducted will be depended on the aim and objectives of the research of the study. Further, selecting appropriate research approach, help to achieve the success of the research.

3.5.1. Choice of the research approach

Creswell (1994) had given a very concise definition of quantitative research as a type of research, that explains the phenomena by collecting numerical data that are analysed using mathematically based methods (in particular statistics). Sukamolson

(2005) identified six research questions where quantitative research is particularly suited as research approach as; when quantitative answer is needed, accurately study a numerical change, useful for conducting audience segmentation, useful to quantify opinions, attitudes and behaviours and find out how the whole population feels about a certain issue. Survey researches and experimental researches basically proceed under quantitative approaches.

Moreover, this research covers the evaluation of approaches for analysing concurrent delays in Sri Lankan construction industry and identification of the barriers due to which the concurrent delay analysing approaches are not practicing in Sri Lankan construction industry. In order to achieve objectives of the research it is required to find out the opinion of construction professionals towards concurrent delays and to identify awareness, usage level, success level and applicability of the concurrent delay analysing methods. Thus, this research required to get quantitative answer and to quantify opinions as mentioned in above paragraph which direct the researcher to use the quantitative approach. Besides awareness, usage level, success level and applicability of the concurrent delay analysing methods to be investigated through experience of construction professionals rather from case studies or experiments. Furthermore due to the less popularity of concurrent delays in Sri Lankan Construction Industry carrying out case study or experimental research would be impossible. So, the Survey research is the best approach for achieving aim and objectives of this research.

However, at the beginning of the research preliminary survey was done and collected the opinion of claims experts regarding research problem, aim and objectives. At the end of the research structured interviews were carried out with two claims experts to verify the research findings. Therefore this research consists of smaller portion of qualitative research method. Accordingly this research followed mixed research method.

3.6. Data Collection Techniques

Data collection is essential as evidence to the study conducted. Panneerselvam (2004) categorised data collection techniques as primary and secondary where primary data collection techniques are observation method, personal interview, telephone interview, mail survey and secondary data collection techniques are internal sources and external sources.

3.6.1. Preliminary survey and informal interviews

Kothari (2004) preliminary survey guide the researcher to put for the problem in general terms and it is then the researcher to narrow it down and phrase the problem in operational terms. The researcher has conducted a preliminary survey to verify research problems and to get help to develop questionnaire for detailed survey via informal interviews with the four construction professionals who are identified as claim experts in the Sri Lanakan construction industry.

3.6.2. Detailed questionnaire survey

The questionnaire is a most common instrument used for collecting survey information which is being able to manage without the presence of the researcher and often being comparatively straightforward to analyse (Wilson and McLean 1994).

The questionnaire was designed for the purpose of identifying awareness, usage level, success level and applicability of the concurrent delay analysing methods and it is comprised close-ended questions constructed using the Likert scale. The Likert scale was easy to construct and could be easily understood by the respondents.

3.6.3. Sample selection

There are two major categories of sampling techniques; Probability sampling where the researcher has a significant measure of control over who is selected and selection method, and Non probability sampling where the researcher has a less control over selection of participants to the sample (Kothari, 2004).

The selection of construction professionals for the survey was based on non - probability sampling technique, due to the absence of a specific sampling frame of construction professionals with experience of concurrent delay claims. However, consistent with the preliminary survey and researcher's experience, it was limited to quantity surveyors, engineers and project managers who is having more than 5 years of experience. According to Janes (2001), number of respondents could enough to carry out statistical analysis because central limit theorem holds true when the sample size is more than or equal to 30 which is a generally accepted rule.

3.6.4. Structured interview

Saunders and Lewis (2003) define an interview which is a purposeful discussion between two or more people. Simply, a structured interview involves one person asking another person a list of predetermined questions about a selected topic.

Two claims experts (Refer Table 3.1 for details) were interviewed using structured interview questions (refer Appendix C) which were prepared based on the result of detailed questionnaire survey.

Table 3.1: Details of Experts

Claims Expert	Profession	Qualifications	Years of Experience
Expert A	Cost & Claims Consultant	LL.M., AIQS SL, MAIQS, FQSi, FCIArb	40 years
Expert B	Contracts Management Specialist	BSc QS (Hons), MBA(PM), PG Dip (CPM), Dip in Com, Arb., AIQSSL	20 years

3.7. Data Analysis Method

The most of the responses to the questionnaire were ratings measured on the Likert scale so the data obtained from the survey were ordinal in nature. Therefore these types of data can only be analysed by using non parametric methods including descriptive statistical analysis and Relative Important Index (RII) method were used to determine the relative significance of awareness, usage, success, applicability and barriers of concurrent delay analysing methods. Statistical software package Microsoft Excel used as data analysis tools of this research.

3.7.1. Statistical analysis methods

3.7.1.1. Descriptive statistical analysis

This includes the use of means, averages and percentages to present data related to characteristics of the respondent and theirType equation here. organization.

3.7.1.2. Relative Importance Index (RII)

The equation to calculate RII is shown in figure 3.2.

$$RII = \frac{\Sigma W}{A \times N}$$

Figure 3.2: Equation of Relative Importance Index

Where,

W – Rank given to each factor by the respondents (ranging 1 to 5)

A – Highest Rank (here A=5)

N – Total number of respondents

RII value has a range from 0 to 1. Higher value of RII gives higher significance of the awareness, usage, success, applicability and barriers of concurrent delay analysing methods.

3.8. Summary

The research methodology of this study was discussed in this chapter. Research approach for this study was a Survey research Method and rationale behind the selection of that method was discussed. Quantitative data were collected mainly through questionnaires distributed among construction professionals namely engineers and quantity surveyors. Subsequently, the statistical tools used for data analysis were highlighted in this chapter and statistical results obtained from the raw data are discussed in Chapter 4.

4. RESEARCH FINDINGS AND DATA ANALYSIS

4.1. Introduction

This chapter presents the findings of this research study together with the data analysis and interpretation. Research findings and data analysis chapter is explored mainly in two sections namely; preliminary survey and detailed survey. Preliminary survey illustrates its aim and results and the detailed survey demonstrates the data analysis and interpretation of results of questionnaire survey. Collected data from detailed questionnaire survey are analysed mainly using five point Likert scale under three main sections namely respondents' opinion towards concurrent delays, perceptions of respondents on concurrent delay analysing methods and barriers for using concurrent delay analysing methods. Results from the detailed questionnaire survey are further clarified with the expert opinions. Finally this chapter proposes most suitable method for analysing concurrency in construction delay claims in Sri Lankan construction industry.

4.2. Preliminary Survey

The Preliminary Survey was undertaken via informal telephone interviews with the four construction professionals who are identified as claim experts in the Sri Lanakan construction industry.

The aim of the preliminary survey was to verify research problems and to get an idea for developing a detailed questionnaire for detailed survey. Lack of the literature regarding concurrent delays in Sri Lankan construction industry led the researcher to go for a preliminary survey and find out details to aid developing detailed questionnaire. Consequently it was clarified the researcher's observation regarding concurrent delays that is "consideration of cocurrent delay in Sri Lankan construction industry is substantially low". The survey also helped to get general view and issues of the concurrent delays. Additionally, the barriers behind the low consideration of concurrent delay analysing methods were asked and listed out as follows and their level of restriction was found through detailed questionnaire survey.

- Lack of awareness of concurrent delays
- Lack of familiarity with the approaches
- Difficulty in using approaches
- High time consumption in using the approaches
- Lack of skill for using approaches
- Lack of adequate project information
- Absence in acceptable quality in documentation
- Lack of knowledge in Case Laws
- Absence of potential impacts of delays
- Lapses and omissions in documents
- Lack of suitable programming software
- Poorly updated programmes

4.3. Detailed Survey

4.3.1. Rate of Response

Figure 4.1 shows the rate of response to the detailed questionnaire survey. A total of 40 questionnaires were distributed among 20 Quantity Surveyors, 15 Engineers and 5 Project Managers in Sri Lankan construction industry. However out of 40 questionnaires only 32 questionnaires were returned from 19 Quantity Surveyors, 10 Engineers and 3 Project Managers (refer Figure 4.2). This represents a response rate of 80%.

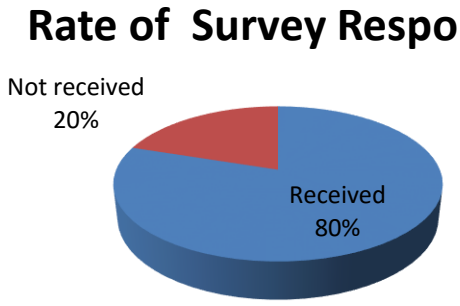

Figure 4.1: Rate of Survey Response

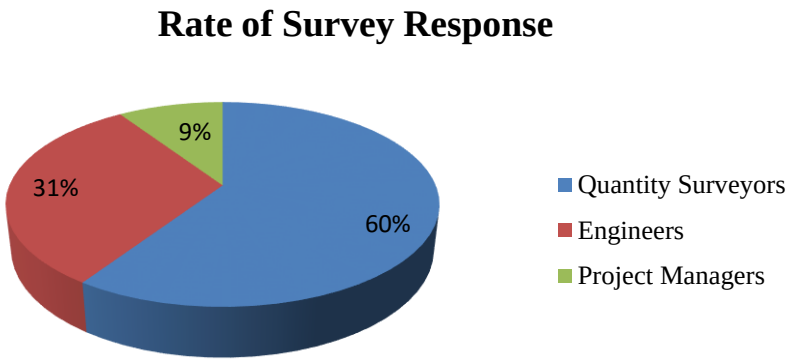

Figure 4.2: Rate of Survey Response– Respondents' Designation

4.3.2. Details of the respondents

Section A of the Questionnaire (Refer Appendix B) was designed to obtain general information about the respondents which was considered in terms of the Respondent's Current working organization, years of experience and experience in handling delay claims.

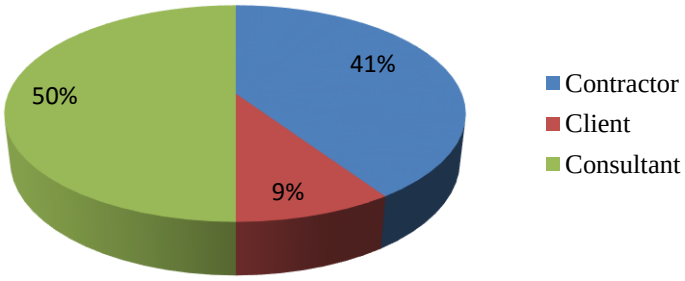

Figure 4.3: Respondents' Current Working Organization

At the time of distributing questionnaires, respondent's type of organization was not considered, as the researcher was seeking opinion of the construction professionals namely Quantity Surveyors, Engineers and Project Managers regarding concurrency in construction delays which is mainly influenced by their experience. However under

general information the respondent's current working organization was analyzed as shown in Figure 4.3.

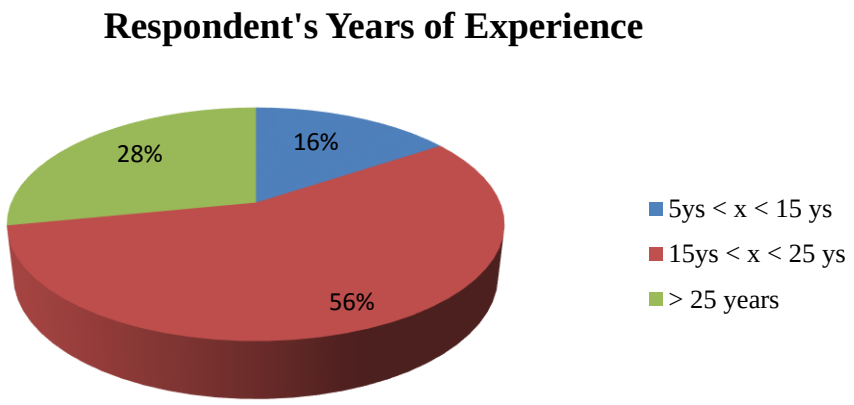

Figure 4.4: Respondents' Years of Experience

Figure 4.4 shows 56% of the respondents have experience between 15 – 25 years and 28% of respondents have more than 25 years of experience. Only 16 % of the respondents have between 5 – 15 years of work experience. Hence it is noted that 84% of construction professionals involved in detailed survey are having more than 15 years of working experience.

Further according to Figure 4.5 it is eminent that majority of the respondents that is 94% have the experience in handling delay claims. Having further observation it was noted that two respondents who are not having experience in handling delay claims are Engineers.

Consequently the above details indicate that the detailed survey was successfully carried out with the well experienced construction professionals. The success of the questionnaire survey regarding concurrency in construction delays was also influenced by the respondent's experience in handling delay claims.

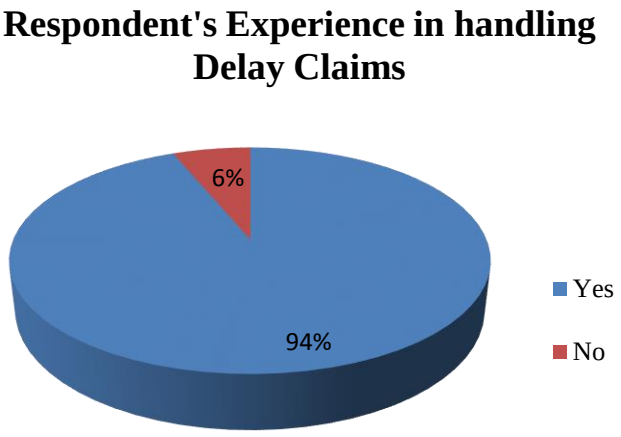

Figure 4.5: Respondents' Experience in Handling Delay Claims

4.4. Results of the Detailed Survey

4.4.1. Respondents' opinion towards concurrent delays

The Questionnaire was developed based on literature survey, researcher's experience and the preliminary survey to achieve the 2nd, 3rd, 4th and 5th objectives of the study (Refer Appendix B). Section B of the questionnaire was to find out the respondents' opinion towards Concurrent Delays. Ten statements related to concurrent delays were provided for the respondents and their agreement level towards those statements were analyzed as shown in Table 4.1. A five point Likert scale as used in the some of the previous literatures was adopted as follows;

- Strongly Disagree 1
- Disagree 2
- Neutral 3
- Agree 4
- Strongly Agree 5

Presenting analyzed data in all the above 5 agreement levels created problems such as too many numbers and information was not interpretable. Thus the agreement levels are further calculated as Disagree, Neutral and Agree as shown in Table 4.1.

Disagreement percentage was calculated by adding strongly disagree % and disagree %, whereas the agreement percentage was calculated by adding strongly agree % and agree %.

Table 4.1: Respondents' Agreement towards the statements related to Concurrent Delays

Statement	Disagreement %	Neutral %	Agreement %
Concurrency is the most complex and problematic element in construction delay claims	0%	0%	100%
A Contractor can use concurrency to defend against a liquidated damages claim.	13%	56%	31%
Contractor will be generally entitled to an extension of time where there are concurrent delays.	0%	19%	81%
Many concurrent delays cause disputes among parties	0%	9%	91%
Many Standard forms of contract are silent as far as concurrent delays concerned.	0%	0%	100%
Case law regarding concurrent delays gives assistance to avoid criticism when handling concurrent delays.	25%	63%	13%
Clear guidance on the most suitable approaches for dealing with concurrent delays is very important to avoid complexity and disputes	0%	0%	100%
When assessing concurrent delays, knowledge regarding case law is essential.	0%	56%	44%
SCL "Delay and Disruption Protocol" in 2002, gives clear guidance to parties when dealing with concurrent delays	0%	19%	81%
A way of handling concurrent delay should be included in all the construction contracts	0%	6%	94%

Elsewhere researchers such as Baduge and Jayasena (2012), Doyle (2014), Long (2014), McNair and Linke (2013), Peters (2013) and Owen and Hasofer (2012) have mentioned that concurrency is the most complex and problematic element in construction delay claims. According to Table 4.1, this study is also proven that above statement is in fact true as the agreement percentage to that statement is 100%.

On one hand all the respondents that is 100% were agreed to the statements that "many Standard forms of contract are silent as far as concurrent delays concerned" and "Clear guidance on the most suitable approaches for dealing with concurrent delays is very important to avoid complexity and disputes". On the other hand most of them (81%) agreed to the statement that "SCL "Delay and Disruption Protocol" in 2002, gives clear guidance to parties when dealing with concurrent delays". This could be further clarified by the both claims experts who were interviewed after the detailed questionnaire survey, stating that even though the SCL "Delay and Disruption Protocol" in 2002 gives a clear guidance to parties it is not mentioned or referred in the most of the Contracts. So that when dealing with concurrent delays, most of the professionals are not tend to refer SCL "Delay and Disruption Protocol" in 2002 align with the particular Contract.

More than 50% of respondents were impersonal to the statement of "a contractor can use concurrency to defend against a liquidated damages claim" and Expert A stated that contractors can use concurrency to defend against a liquidated damages claims as long as they could prove it whereas Expert B mentioned that as concurrent delay is aroused due to contractor's fault as well as due to employer's fault, normally contractors can get EOT so that they do not pay LD for the delay due to concurrency. However both of experts highlighted that this could be changed if suitable method for analyzing concurrent delays is used by the construction professionals.

Also more than 50% respondents were neutral for the statements "Case law regarding concurrent delays gives assistance to avoid criticism when handling concurrent delays" and "When assessing concurrent delays, knowledge regarding case law is essential". The idea of the Expert A regarding the case law relating to concurrent

delays was "*As the concurrency in construction delays is most problematic area earlier judgments for similar situations will be very useful in making decisions so that knowledge of case law is very important"* . Expert B pointed out "*As most of the concurrent delay analysis methods are based on case law it is essential to aware case law related to concurrent delays"*

In achieving 2nd objective of identifying the occurrence and degree of consideration of concurrent delays in Sri Lankan Construction Industry, the results in the Table 4.2 can be interpreted as follows.

Most of the respondents, 91% have noted that in Sri Lankan construction industry concurrent delays are occurring often. However 88% of respondents mentioned that professionals of contractors in Sri Lankan construction industry sometimes highlight concurrency when defending delay claims and similarly 63% of professionals of clients in Sri Lankan construction industry sometimes highlight concurrency when defending delay claims.

Table 4.2: Respondents' opinion towards the Concurrent Delays in Sri Lankan Construction Industry

Statement	Never	Rarely	Sometimes	often	Always
According to your experience to which extent concurrent delays are occurring in Sri Lankan construction projects	0%	0%	9%	91%	0%
To which extent the professionals of contractors in Sri Lankan construction industry highlight concurrency when defending delay claims.	0%	9%	88%	3%	0%
To which extent the professionals of clients in Sri Lankan construction industry highlight concurrency when defending delay claims.	0%	34%	63%	3%	0%

Both the experts clarified the above result by pointing out few lapses in Sri Lankan construction industry as; poor quality of documents, weaknesses in programmes and less awareness in concurrency which are also identified as barriers for using concurrent delay analyzing methods in latter part of the questionnaire.

4.4.2. Methods for analysing concurrent delays

Baduge and Jayasena (2012) highlighted that concurrent delays are known to be complex to analyze and difficult to prove. However concurrency in construction delays cannot be avoided. Thus analyzing the liability accurately for the delay in concurrency is important to avoid many disputes in the construction projects. Nevertheless Baduge and Jayasena (2012) further emphasized that consideration of concurrency in delay claims in Sri Lankan construction industry is significantly low.

Therefore the section C of the questionnaire mainly focused to the fulfillment of 4th and 5th objectives of the study and explored towards four concerns namely awareness, usage, success and applicability of concurrent delay analyzing methods in Sri Lankan construction industry.

Through the literature survey five methods for analyzing concurrent delays were identified and if any respondent aware or use any other method/s, it was expected to be stated in the questionnaire. It is interesting to note that 9 respondents were identified other method for analyzing concurrent delays and all of them have stated the other methods as “Use of common sense”. This was asked from the experts and both the experts stated that use of common sense is not commonly recognized method and it may depend on the personal view of the professionals which may lead disagreements between parties. However, Expert A further added that not only the use of common sense but also the power of negotiation will have the impact when dealing with concurrent delays.

4.4.3. Perceptions of respondents on concurrent delay analysing methods

Level of awareness

Level of awareness affects the use or implementation of any concurrent delay analysis method. Further awareness can also be aroused through the education, knowledge and observation. Respondents were asked to state their level of awareness of the concurrent delay analysis methods on a 5 point Likert scale where 1 denotes "Very low awareness" and 5 denotes "Very high awareness". To make the results interpretable, percentages of only low awareness, middle awareness and high awareness were calculated as shown in Table 4.3.

Table 4.3: Awareness Percentages for Concurrent Delays Analyzing Methods

Method	Low awareness	Middle awareness	High awareness
The 'Malmaison' approach	0%	56%	44%
Apportionment	13%	38%	50%
Dominant cause approach	22%	78%	0%
But for test	56%	41%	3%
First in line approach	78%	22%	0%
Other methods	0%	3%	25%

Table 4.4: Awareness RII for Concurrent Delays Analyzing Methods

Method	Awareness RII	Rank
The 'Malmaison' approach	0.700	1
Apportionment	0.669	2
Dominant cause approach	0.556	3
But for test	0.456	4
First in line approach	0.381	5
Other methods (Use of common sense)	0.219	6

Among the all analysis methods, the 'Malmaison' approach received the highest level of awareness RII that is 0.700. It owns 56% of middle awareness and 44% of high awareness. Apportionment method was ranked for second having 0.669 RII, 38% of middle awareness.

Even though other approaches (Use of common sense) got the lowest awareness level, only 9 professionals were responded to the other approaches by stating their level of awareness.

In view of that we can say the method with the lowest level of awareness was the First in line approach followed by the But- for test.

The overall ranking tabulated in Table 4.4 shows that the level of awareness of concurrent delay analysis methods among industry practitioners was more towards the fair and reasonable methods.

Level of Usage

The practical application of concurrent delay analysis methods in construction industry was investigated by having a part in the questionnaire of Level of Usage where the respondents were asked to rank the extent of use of the methods identified through the literature review. Degree of usage was ranged using a 5 point Likert scale where 1 denotes "Very low usage" and 5 denotes "Very high usage". To make the results interpretable, percentages of only low usage, middle usage and high usage were calculated as shown in Table 4.5.

Table 4.5: Usage Percentages for Concurrent Delays Analyzing Methods

Method	Low Usage	Middle usage	High usage
The 'Malmaison' approach	78%	3%	6%
Apportionment	84%	6%	0%
Dominant cause approach	75%	9%	3%
Other methods	0%	0%	28%
But for test	53%	3%	0%
First in line approach	56%	0%	0%

Table 4.6: Usage RII for Concurrent Delays Analyzing Methods

Method	Usage RII	Rank
The 'Malmaison' approach	0.294	1
Apportionment	0.281	2
Dominant cause approach	0.275	3
Other methods	0.225	4
But for test	0.131	5
First in line approach	0.125	6

According to the survey results, the 'Malmaison' approach was ranked first by the industry professionals followed by Apportionment method with the RII of 0.294 and 0.281 respectively. However, both the methods are having more percentages for low usage according to Table 4.5. It perhaps decided that upon the awareness level industry practitioners would use the concurrent delay analyzing methods. Auxiliary, more "low usage" percentage may due to less consideration of concurrent delays in Sri Lankan construction industry as per the survey findings in Table 4.2.

Similar to the awareness, first in line approach obtained the lowest rank for degree of usage followed by but-for test.

Concerning "other approaches" ranked 4th for usage level in Table 4.6, is having only 28% for usage on "high usage" category as per Table 4.5. It means to that the industry professionals who responded to the usage level of other approaches (Use of common sense) were used their common sense for most of the concurrent delay claims handled by them. According to the final expert survey, use of common sense to be tag along with power of negotiation of the professionals who is handling concurrent delay claims to be success.

Level of Success

Level of success of the approaches mainly associated with the extent of usage of those approaches. However, it was understood that respondents' experience and knowledge regarding concurrent delays, construction case laws…etc have also affected on their decision regarding success rate of concurrent delay analysis approaches.

Respondents were rated the level of success of the concurrent delay analysis methods on a 5 point Likert scale where 1 denotes "Very low success" and 5 denotes "Very high success". To make the results interpretable, percentages of only low success, middle success and high success were calculated as shown in Table 4.7.

Table 4.7: Success Percentages for Concurrent Delays Analyzing Methods

Method	Low Success	Middle Success	High Success
The 'Malmaison' approach	13%	72%	16%
Apportionment	56%	31%	3%
Dominant cause approach	88%	3%	0%
But for test	53%	3%	0%
Other methods	6%	0%	0%
First in line approach	44%	0%	0%

Table 4.8: Success RII for Concurrent Delays Analyzing Methods

Method	Success RII	Rank
The 'Malmaison' approach	0.613	1
Apportionment	0.363	2
Dominant cause approach	0.256	3
But for test	0.131	4
Other methods	0.100	5
First in line approach	0.088	6

The summary of results is shown in Table 4.7 and Table 4.8 related to success level of approaches for analyzing concurrent delays. Although the 'Malmaison' approach was ranked as the most effective approach of ensuring success of concurrent delay claims in Table 4.7, its success level is in the middle range according to the Table 4.8. The Apportionment approach got second rank and its success level is in middle and low success range. The possible explanation for this result may be due to the low range of

usage level of those approaches where the industry practitioners could decide only for limited extent, the success level of any approach without using it.

It is noteworthy to say that use of common sense is having low success as specified by the professionals who have used it. Experts were mentioned that use of common sense is not a recognized method and it is depend on the knowledge and attitude of the professionals.

On the contrary first in line approach denotes the least success approach in analyzing concurrent delays with the RII of 0.088.

Level of Applicability

As Braimah (2013) stated, the general view amongst practitioners regarding use of DATs is that there is no single technique is suitable for all delay claims situations and the most appropriate DAT for any claim situation is depend on several factors. But when considering concurrent delay analysis, some approaches can be applied for most of the situations. Not like other DATs, approaches used for analysing concurrency in construction delay claims were started to apply after a decision of Courts. Therefore it is possible to decide the most suitable technique for analysing concurrency in construction delay claims applicable to Sri Lankan Construction Industry.

Industry practitioners having more than 5 years experience were rated the level of applicability of the concurrent delay analysis methods on a 5 point Likert scale where 1 denotes “Very low applicability” and 5 denotes “Very high applicability”. To make the results interpretable, percentages of only low applicability, middle applicability and high applicability were calculated as shown in Table 4.9.

Table 4.9: Applicability Percentages for Concurrent Delays Analyzing Methods

Method	Low Applicability	Middle Applicability	High Applicability
The 'Malmaison' approach	0%	50%	50%
Apportionment	31%	66%	3%
Dominant cause approach	66%	34%	0%
But for test	59%	6%	0%
First in line approach	44%	0%	0%
Other methods (Use of common sense)	19%	0%	0%

Table 4.10: Applicability RII for Concurrent Delays Analyzing Methods

Method	Applicability RII	Rank
The 'Malmaison' approach	0.750	1
Apportionment	0.538	2
Dominant cause approach	0.413	3
But for test	0.181	4
First in line approach	0.094	5
Other methods (Use of common sense)	0.075	6

Table 4.10 represents the ranking of methods for analyzing concurrent delays using RII. "Malmaison" approach ranked first and 50% of its respondents are in high applicability range and other 50% are in middle applicability range according to Table 4.9. RII of Apportionment method got second place and most of the respondents (66%) are in middle applicability range and only very few (3%) are in high applicability range.

With regards to other methods it seems that only 19% respondents were graded the applicability which is in low applicability range.

Discussion

It is interesting to note that "Malmaison" Approach stemming from Dyson J's decision in Henry Boot Construction (UK) Limited v Malmaison Hotel (Manchester) Ltd was the most successful and applicable method for analyzing concurrency in construction delay claims according to the survey results mentioned above.

As stated by Smith (2015), "Malmaison" Approach is the most preferred method to treat concurrent delays under English Law and it has been described as the "English law benchmark" and "the general principle of English law on concurrent delay".

As said by expert A "the Malmaison Approach is go in line with "Prevention Principle" which is a long established English common law doctrine well established by the case of *Peak Construction v. McKinney Foundations[1970] 1 BLR 111*. As per the prevention principle, the contractor will normally be entitled an EOT to a delay caused by the owner regardless of any concurrent delay for which the contractor might be responsible. So that this approach is commonly used in many countries."

Moreover Experts highlighted that SCL Protocol (2002) is also followed "Malmaison" Approach and the protocol does not appear to favour an apportionment approach. Concurrency delay is dealt with by the SCL protocol and the recommendation is made as "Where Contractor delay to completion occurs concurrently with Employer delay to completion the Contractor's concurrent delay should not reduce any time due." Apparently the Contractor could succeed with relief from delay damages and entitlement of EOT. As a result success of the project could be achieved without unnecessary disputes.

By interpretation of this, Experts were emphasized difficulties in adopting other methods as follows;

- The apportionment approach appears reasonable but there are practical problems and difficulties over the basis for the apportionment. Further, whilst an apportionment approach seems like a "common sense" approach, it creates a great deal of uncertainty among parties. With the apportionment approach, definitely the culpable party tries to identify some form of concurrent delay to get some of the delay apportioned between himself and his contracting partner. This will lead to more disputes.
- The one of the difficulty with the dominant cause approach is to select the cause which is to be characterized as a dominant cause. Deciding which cause is dominant is a question of fact. It would be decided by point of order in time and applying common sense standards.

Unsurprisingly, the First in line approach was ranked last in applicability level and success level which assumes that the first event from the two concurrent delay events is the cause of whole delay.

4.4.4 Barriers for using concurrent delay analysing methods

Through the preliminary survey researcher was identified 12 barriers which may restrict the effective use of concurrent delay analyzing methods and those were included in the detailed questionnaire to identify their level of restriction. Respondents to detailed questionnaire were asked to rank the level of restriction by the identified barriers on a 5 point Likert scale where 1 denotes "Very low restriction" and 5 denotes "Very high restriction". To make the results interpretable, percentages of only low level restriction, middle level restriction and high level restriction were calculated as shown in Table 4.11.

Table 4.12 shows the ranking of the barriers according to their level of restriction RII obtained from data analysis of collected data through questionnaire survey. It is required to mention that no respondent was stated any additional barrier.

"Poorly updated programmes" was ranked first in Table 4.12 by the respondents which possesses 100% of high level restriction for effective use of concurrent delay analyzing

methods. Programme of a project has to be maintained properly with periodical updates to identify any concurrency in delays and to determine the effect of delays at the time that they occur. Updated programme gives important information for analyzing any type of delays including concurrent delays such as changes in the critical path, completed percentages of each activity, work sequence actually carried out, timely effect of delays and reviewed activity durations. However most of the professional's opinion was that in Sri Lankan construction industry project programmes are not properly updating and consequently evaluating concurrency in delay claims become complicated, and thus disregard. Expert A and B both highlighted *"Programme is submitted by the contractor at the beginning of the project generally because of the contractual requirement. But, every programme should be included several details like clearly identified critical path, milestones and key days, dates of Engineer's submissions and approvals, Engineer required dates, activities and their start dates…etc for using the programme effectively in analyzing concurrent delays."*

Table 4.11: Percentages of level of restriction for Usage of Concurrent Delays Analyzing Methods

Barrier	Low Level of Restriction	Middle Level of Restriction	High Level of Restriction
Poorly updated programmes	0%	0%	100%
Lapses and omissions in documents	0%	3%	97%
Absence in acceptable quality in documentation	0%	9%	91%
Absence of potential impacts of delays	0%	6%	94%
Lack of knowledge in Case Laws	3%	22%	75%
Lack of familiarity with the approaches	0%	16%	84%
Lack of adequate project information	0%	22%	78%
Lack of awareness of concurrent delays	3%	19%	78%
Difficulty in using approaches	13%	47%	41%

Lack of skill for using approaches	38%	34%	28%
Lack of suitable programming software	81%	19%	0%
High time consumption in using the approaches	81%	19%	0%

Table 4.12: RII for Level of restriction for usage of Concurrent Delays Analyzing Methods

Barrier	RII for Level of Restriction	Rank
Poorly updated programmes	0.888	1
Lapses and omissions in documents	0.863	2
Absence in acceptable quality in documentation	0.844	3
Absence of potential impacts of delays	0.838	4
Lack of knowledge in Case Laws	0.825	5
Lack of familiarity with the approaches	0.825	5
Lack of adequate project information	0.819	7
Lack of awareness of concurrent delays	0.806	8
Difficulty in using approaches	0.656	9
Lack of skill for using approaches	0.581	10
Lack of suitable programming software	0.394	11
High time consumption in using the approaches	0.381	12

"Lapses and omissions in documents" and "Absence in acceptable quality in documentation" were ranked 2nd and 3rd in level of restrictions and got 97% and 91% high level of restriction respectively. As concluded by Baduge and Jayasena (2012), concurrent delay analysis became difficult and often impractical due to number of lapses found in documents like as planned programme, method statement and notice of claim. It can be also identified that most of the documents are not in acceptable quality and not including required details which lead to low consideration of concurrent delays in Sri Lankan construction industry.

"Absence of potential impacts of delays" which took 4th place of restriction RII as per Table 4.12, is mainly the result of above three reasons and poor record keeping. "Lack of knowledge in Case Laws" and "Lack of familiarity with the approaches" both barriers got 5th place. Knowledge regarding case laws is very important for dealing with concurrency in delay claims as most of the concurrent delay analysis methods were adopted after a decision of a court case.

"Difficulty in using approaches", "Lack of skill for using approaches", "Lack of suitable programming software" and "High time consumption in using the approaches" reasons got 9th, 10th, 11th and 12th (last) ranks respectively in Table 4.12. It is conveyed that those factors are not much influenced the low consideration of concurrent delay analyzing methods. Expert A and B stated that most of the professionals, dealing with claims including delay claims are well qualified and experienced persons. Hence, the lack of skill could not be accepted as a barrier. They also mentioned *"There are many advanced softwares in Sri Lanka but most of the contractors are using simple methods just to fulfill the contract requirement"*. Expert A underlined that if quality, accurate and adequate information and documents are available there would not be any difficulty in using concurrent delay analyzing approaches.

Summing up, it can be noted that following factors are restricting use of concurrent delay analyzing methods in Sri Lankan construction industry in more than 75% of high level restriction according to the questionnaire survey (Table 4.11).

- Poorly updated programmes
- Lapses and omissions in documents
- Absence in acceptable quality in documentation
- Absence of potential impacts of delays
- Lack of knowledge in Case Laws
- Lack of familiarity with the approaches
- Lack of adequate project information
- Lack of awareness of concurrent delays

4.5. Summary

Detailed analysis of collected data was done by applying appropriate statistical method. All the respondents were highlighted that Concurrency is the most complex and problematic element in construction delay claims. The ultimate objective of finding compatible method for analyzing concurrent delays was achieved under this chapter. "Malmaison" Approach is identified as the most suitable method for analyzing concurrent delays which was further verified with reasons by two claims experts through structured interviews. Finally barriers for low consideration of concurrency in delay claims were identified with their level of restriction.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

This study was aimed to identify the most appropriate method/s for analysing concurrency in construction delay claims in Sri Lankan Construction Industry. To achieve the aim and objectives of the research comprehensive literature reviewed, data were collected through preliminary survey and detailed survey. Subsequently collected data were analysed and discussed the findings in previous chapter "Research Findings and Data Analysis". However this chapter attempts to take out conclusions and recommendations from the analysis and discussion performed in the previous chapter.

5.2. Conclusions

Construction delay claims are inevitable in most projects in the construction industry. It is rarely seen that a project completed without any adjustment on the completion time. Concurrent delay claims are the most disputed issue in the industry. It has implications concerning the awarding of liquidated damages and the granting of extensions of time. As such this research was carried out to explore the way of handling concurrency in construction delay claims in Sri Lankan construction industry.

At the beginning of the study a background study was conducted to establish the research problem, aim and objectives of the study. It was further verified through preliminary survey and identified that the research problem of the study was common among most of the professionals who deal with construction delay claims. Under literature survey concurrency in construction delay claims was streamed out through causes of delays, effects of delays, types of delays and analyzing delays. Further literature review was contributed in achieving first objective of the research of analyzing case laws and identifying existing concurrent delay analysis methods namely Apportionment, the 'but for' test, the dominant cause approach, 'Malmaison' approach and first-in-line approach.

The second and third objectives of this research were to identify the occurrence and degree of consideration of concurrent delays in Sri Lankan Construction Industry and Identify the Sri Lankan professionals' opinion towards concurrent delays respectively. These were achieved through the detailed questionnaire survey and interviews with experts. To get the opinion towards concurrent delays respondents were asked to rank 10 statements about concurrent delays ranging 1(strongly disagree) to 5 (strongly agree). Agreement levels were further calculated as Disagree, Neutral and Agree as shown in Table 4.1 for the purpose of interpreting. It is prevalent that concurrency is the most complex and problematic element in construction delay claims which is also proven through the survey with the agreement percentage of 100%. Moreover, all the respondents that is 100% were agreed to the statements that "many Standard forms of contract are silent as far as concurrent delays concerned" and "Clear guidance on the most suitable approaches for dealing with concurrent delays is very important to avoid complexity and disputes". In contrast respondents also agreed with the statement of "SCL "Delay and Disruption Protocol" in 2002, gives clear guidance to parties when dealing with concurrent delays". The reason behind the contrary as per the experts is not referring SCL protocol in most of the contracts. Most of the respondents have identified that in Sri Lankan construction industry concurrent delays are occurring frequently but professionals of contractors and consultants in Sri Lankan construction industry are highlighting it occasionally when defending delay claims.

In attaining 4th objective the detailed questionnaire survey helped in finding out awareness, usage, success and applicability of above mentioned methods related to the Sri Lankan context. The RII was used as a tool to rank the significance and importance level of methods in each category. It is interesting to note that according to the results of survey "Malmaison" approach got first rank in all the categories of awareness, usage, success and applicability whereas "First in line" approach got least. It is also necessary to mention that only 9 respondents were revealed other method for analyzing concurrent delays and "use of common sense" is the method stated by all of them.

Similar to the result of detailed questionnaire survey, both the experts (Expert A and B) also recommended "Malmaison" approach as most suitable method of analyzing

concurrent delays in Sri Lankan construction industry accomplishing 5th objective. Further the experts explained the merits of the "Malmaison" approach highlighting;

- The "Malmaison" Approach is the most preferred method to treat concurrent delays under English Law.
- The "Malmaison" Approach is go in line with "Prevention Principle" which is a long established English common law doctrine.
- SCL Protocol (2002) is also followed "Malmaison" Approach
- Reduced unnecessary disputes

To complete the accomplishment of final objective, barriers for application of concurrent delay analysis were identified through preliminary survey and their restriction level investigated through detailed questionnaire survey. When analyzing any type of delay updated programme, quality, accuracy and adequacy of documents, potential impact of delay and familiarity with approaches are vital. Hence following were identified as barriers with high restriction level for using concurrent delay analysis methods.

- Poorly updated programmes
- Lapses and omissions in documents
- Absence in acceptable quality in documentation
- Absence of potential impacts of delays
- Lack of knowledge in Case Laws
- Lack of familiarity with the approaches
- Lack of adequate project information
- Lack of awareness of concurrent delays

To conclude, it is expected that the findings of this research will assist the Sri Lankan construction industry professionals for consideration of concurrency in construction delay claims and employ most appropriate method to analyse concurrent delays. Following recommendations are also necessary to establish a good concurrent delay claim practice in Sri Lanka Construction Industry.

5.3. Recommendations

The analysis of questionnaire survey and final expert survey derived recommendations for establishing a good concurrent delay claim practice in Sri Lanka Construction Industry.

- Professionals who handle construction delay claims are advised to enhance knowledge of case law for successful evaluation of concurrent delay by avoiding criticisms.
- As "SCL "Delay and Disruption Protocol" in 2002 gives guidance to parties when dealing with concurrent delays. So, i
- t is suggested to refer the protocol in the Contracts and it is necessary to be familiar with the protocol by construction professionals as a guideline.
- As most of the present Contracts only require a programme to be submitted for the consent of the Engineer, there is no specific reference or method of preparing the programme. As a result most of the programmes submitted by the contractors are not included essential information and not in proper quality. Therefore, it is recommended to include a specification describing the method of preparing the work programme in the Contracts.
- It is paramount important to have a proper updated work programme at any given of time to evaluate the concurrency. It is necessary to guide construction practitioners to keep updating the programme periodically.
- Claim documentation is also very important in analyzing concurrent delays. So it is recommended to ensure the completeness and timeliness of those documents specially claim notice.
- Educate project team in keeping all the daily site records accurately.

5.4. Further Research

This research was carried out to find out suitable method for assessing concurrency in construction delay claims. While carrying out the research, researcher came across following areas to be required further research.

- A study on investigating applicability of Malmaison approach in assessing concurrency in construction delay claims in practical nature in the perspective of Contractor and Consultant separately.
- Suitability of the SCL Protocol's proposed method for dealing with concurrency, for adoption and use on Sri Lankan construction projects.

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Case Law

1. Balfour Beatty Building v Chestermount Properties [1993] 62 BLR 1
2. City Inn Ltd v Shepherd Construction Ltd [2008] 8 BLR 269 (CSOH); [2010] BLR 473 (CSIH)
3. De Beers UK v Atos Origin IT Services UK Limited [2010] EWHC 3276
4. Henry Boot Construction (UK) Ltd v Malmaison Hotel (Manchester) Ltd [1999] 70 Con LR 32.
5. H Fairweather v Borough of Wandsworth[1987] 39 BLR 106
6. Multiplex v Honeywell [2007] BLR 195
7. Peak Construction v McKinney Foundations [1970] 1 BLR 111
8. Percy Bilton v GLC [1982] 20 BLR 1 (HL)
9. SMK Cabinets v Hili Modern Electric (pvt) Ltd [1984]VR 391
10. Trollope & Colls v North West Metropolitan Regional Hospital [1973] 9 BLR 60
11. Walter Lilly v MacKay [2012] BLR 503

APPENDIX A

Summary of previous studies on Delay Analysis Techniques

Reference	Methods identified through the Literature survey	Methods developed/considered for the survey	Remarks
Alkass, Mazerolle and Harris (1996)	• Global impact technique • Net impact technique • Adjusted as-built CPM technique • `but for' or collapsing technique • Snapshot technique • Time impact technique	Isolated Delay Type (IDT)	This system could assist in improving the process of delay analysis, thus reducing the cost of claims preparation.
Bordoli and Baldwin (1998)	**Basic methods** : entropy method, as-built bar chart method and scatter diagram **Critical path analysis methods** : as-built network method, as-built subtracting impacts method, baseline adding impacts method, window analysis method and isolated delay type	Developed a technique based on the critical path planning method	This method is a clear, straightforward step-by-step approach to calculate the expected delay in the completion of the project.

Reference	Methods identified through the Literature survey	Methods developed/considered for the survey	Remarks
Bubshait and Cunningham (1998)	• As Planned Method • As-Built Method • Modified As- Built Method • Float Allocation Method • Concurrent Delay Method	Considered only • As Planned Method • As-Built Method • Modified As- Built Method	The result of the study reveals that outcome of the delay analysis is not predictable and one method may not be used over another in all Situations.
Singh and Trivedi (2012)		Developed a schedule delay assessment model using Fuzzy Logic Toolbox of MATLAB Program	It provides a simple way to get a definite conclusion based upon vague, imprecise or missing input information.
Kim (2009)	• Contemporaneous Period Analysis (CPA) • "But-for" Method	Resource-constrained Critical Path Method (RCPM)	This method analyzes the problems arise when CPA and but-for methods are performed on the basis of the resource constrained scheduling techniques and shows how the RCPM can be utilized for those delay analysis.

Reference	Methods identified through the Literature survey	Methods developed/considered for the survey	Remarks
Barry (2009)	• Impacted as-planned method • Time impact analysis method • Collapsed as-built or 'but-for' analysis method • Snapshot/windows/time slice analysis method • As-planned versus as-built windows analysis method.	• Impacted as-planned method • Time impact analysis method • Collapsed as-built or 'but-for' analysis method • Snapshot/windows/time slice analysis method • As-planned versus as-built windows analysis method.	This paper provides some general clarity to those commonly used delay analysis techniques, what they do, what they do not do, and when they may appropriately be applied
Lee and Diekmann (2011)	• As-planned versus as-built • Impacted as-planned • Collapsed as-built or but-for • Windows analysis	Developed a modified method for delay analysis; DAP (Delay Analysis considering Production rate)	This method is a feasible choice for delay calculation in case of production changes over activity progress because it calculates the sub- phase productivity and the learning effects very objectively.

Reference	Methods identified through the Literature survey	Methods developed/considered for the survey	Remarks
Braimah (2013)	• As-planned vs. As-built • Impacted as-planned • As-planned but for • Collapsed as-built • Window analysis • Time impact analysis	Considered the most common techniques: • As-planned vs. As-built • Impacted as-planned • As-planned but for • Collapsed as-built • Window analysis • Time impact analysis	The study discussed the key relevant issues often not addressed by the techniques and their improvement needs.
Ng, Skitmore, Deng and Nadeem (2004)	• Global impact technique • Net impact technique • 'but for' or collapsing technique • Apportionment delay technique • Snapshot technique • Isolated delay technique • Time impact technique	• Global impact technique • Net impact technique • 'but for' or collapsing technique • Apportionment delay technique • Snapshot technique • Isolated delay technique • Time impact technique	Two improvements are proposed to make seven existing techniques suitable for use in schedule compression: • to incorporate the scrutiny of delay types • to apply Excusable Delays

Reference	Methods identified through the Literature survey	Methods developed/considered for the survey	Remarks
Menesi (2007)	• As-Planned Versus As-Built Comparison • Impacted As-Planned Method (What-If approach) • Collapsed As-Built Method (but-for method) • Contemporaneous Period Analysis Method (window analysis)	Modified Daily Windows Analysis (MDWA) and prototype computer software for a Modified Daily Windows Analysis (MDWA)	This model takes into consideration multiple baseline updates and accurately apportions delays and accelerations among the project parties.
Hegazy (2012)	• As-planned vs. as-built schedule analysis method • Impacted as-planned schedule analysis method • Collapsed as-built schedule analysis method • Time impact analysis method (Windows Analysis)		The research discussed the delay claims in the construction industry in UAE and the approach for choosing delay analysis methodology.
Dayi (2010)	Non-CPM Based Techniques: S-curve Global impact technique and Net impact CPM Based Techniques: As-planned versus as-built, Impacted as- planned, Collapsed as-built, Window analysis and Time impact analysis.	Impacts of construction schedule delays on the duration of the case study project were analyzed using Time Impact Analysis method	This method is the best technique for determining amount of time extension caused by construction schedule delays and clearly present the situation of construction on the updated dates.

Reference	Methods identified through the Literature survey	Methods developed/considered for the survey	Remarks
Yang and Kao (2009)	• Reams' systematic approach • Global impact technique • Net impact technique • Snapshot technique • Isolated delay type • After-the-fact and modified CPM schedule • Dollar-to-time relationship • Bar chart analysis • CPM update review • As-planned versus as- built analysis • Linear schedule analysis • B&B's delay analysis method • Impacted as-planned method • But-for • Modified but-for • Apportionment delay method • Windows analysis • Total float management	Compares in detail three process-based dynamic analysis methods; • Snapshot analysis method • Windows analysis method • Isolated delay type method Proposed six suggestions to develop an ideal delay analysis method.	An ideal delay analysis method contributes to a fair and accurate delay analysis It fixes several defects suffered by available delay analysis methods

APPENDIX B

Sample Questionnaire

Dear Sir / Madam,

Dissertation – MSc in Construction Law and Dispute Resolution post graduate degree programme.

I am a Post graduate student of Department of Building Economics, University of Moratuwa, undertaking the Master of Science in Construction Law and Dispute Resolution. A Research under the supervision of Dr. Gayani Karunasena on "**Methods for Analysing Concurrent Delays in Sri Lankan Construction Industry**" is carrying out for the fulfilment of my Master of Science Degree.

Objectives of the study

1. Analysing case law regarding concurrent delays and investigate methods for analysing concurrent delays.
2. Identify the occurrence and degree of consideration of concurrent delays in Sri Lankan Construction Industry.
3. Identify the Sri Lankan professionals' opinion towards concurrent delays.
4. Identify the methods for analysing concurrent delays and their applicability to Sri Lankan Construction Industry.
5. Identify compatible method/s for analysing concurrency in construction delay claims in Sri Lankan construction industry and barriers for their application.

The information from this questionnaire survey will only be used for fulfilling the above requirement and I would like to thank for the information given and time you have dedicated to my research. If you are interested to know the outcome of this research, it would be my pleasure to share it with you.

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METHODS FOR ANALYSING CONCURRENT DELAYS

IN SRI LANKAN CONSTRUCTION INDUSTRY

QUESTIONNAIRE SURVEY

Definition of 'Concurrent Delays':-"The occurrence of two or more delay events at the same time, one is an employer risk event, other is a contractor risk event and the effects of which are felt at the same time"

Section A: General Information about the Respondent

Name (optional)						
Organization (optional)						
Type of organization	Contractor		Client		Consultant	
Profession						
Years of experience in Construction Industry						
Having experience in handling Delay Claims		Yes			No	
If yes, No of Delay Claims Handled (approximately)						

Section B: Respondent's opinion towards Concurrent Delays

1	**Please indicate your level of agreement towards the following statements related to the concurrent delays**					
	Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	Concurrency is the most complex and problematic element in construction delay claims	1	2	3	4	5
2	A Contractor can use concurrency to defend against a liquidated damages claim.	1	2	3	4	5
3	Contractor will be generally entitled to an extension of time where there are concurrent delays	1	2	3	4	5
4	Many concurrent delays cause disputes among parties	1	2	3	4	5
5	Many Standard forms of contract are silent as far as concurrent delays concerned.	1	2	3	4	5
6	Case law regarding concurrent delays gives assistance to avoid criticism when handling concurrent delays.	1	2	3	4	5
7	Clear guidance on the most suitable approaches for dealing with concurrent delays is very important to avoid complexity and disputes	1	2	3	4	5
8	When assessing concurrent delays, knowledge regarding case law is essential.	1	2	3	4	5

9	SCL “Delay and Disruption Protocol” in 2002, gives clear guidance to parties when dealing with concurrent delays	1	2	3	4	5
10	The way of handling concurrent delays should be included in all the construction contracts	1	2	3	4	5

2	**Your opinion towards Concurrent Delays in Sri Lankan construction industry**					
Statement		**Never**	**Rarely**	**Sometimes**	**often**	**Always**
1	According to your experience to which extent concurrent delays are occurring in Sri Lankan construction projects	1	2	3	4	5
2	To which extent the professionals of contractors in Sri Lankan construction industry highlight concurrency when defending delay claims.	1	2	3	4	5
3	To which extent the professionals of clients in Sri Lankan construction industry highlight concurrency when defending delay claims.	1	2	3	4	5

Section C: Methods for dealing with concurrent delays

1	**Please indicate your level of awareness of each of the following methods for analysing concurrent delays**				
Methods for dealing with concurrent delays	**Very Low 1**	**2**	**3**	**4**	**Very high 5**
But for test It is based on a simple concept that the overrun would not have occurred 'but for' the event complained.(Here the claimant may seek to argue that delay is 'but for' the other parties delay)	1	2	3	4	5
First in line approach The basis of this method is that where there are two events causing a delay, the event which took place first in time either by the contractor or by the employer is the cause of the whole delay.	1	2	3	4	5
Dominant cause approach Under this approach, where there are two causes of delay, one is by the defendant and the other is by the claimant, the claimant will succeed if it can be established that the cause for which the defendant is responsible is the effective dominant cause.	1	2	3	4	5
Apportionment Here, when you have two completing causes of delays, it is suggested that the overrun and its consequences should be 'apportioned' between the contractor and the employer on the basis to their relative causative potency.	1	2	3	4	5

The 'Malmaison' approach If there are two concurrent delays, one which is a relevant event and the other not, then the contractor is entitled to an extension of time for the period of delay caused by the relevant delay without considering the concurrent effect of the other event	1	2	3	4	5
Any other method (Please specify)	1	2	3	4	5

2	**Please indicate the extent to which you use each of the following methods for analysing concurrent delays**				
Methods for dealing with concurrent delays	**Very low 1**	**2**	**3**	**4**	**Very high 5**
But for test	1	2	3	4	5
First in line approach	1	2	3	4	5
Dominant cause approach	1	2	3	4	5
Apportionment	1	2	3	4	5
The 'Malmaison' approach	1	2	3	4	5
Any other method (Please specify)	1	2	3	4	5

3	**Please indicate the level of success of claims analysed by using each of the following methods for analysing concurrent delays**

Methods for dealing with concurrent delays	**Very Low 1**	**2**	**3**	**4**	**Very high 5**
But for test	1	2	3	4	5
First in line approach	1	2	3	4	5
Dominant cause approach	1	2	3	4	5
Apportionment	1	2	3	4	5
The 'Malmaison' approach	1	2	3	4	5
Any other method (Please specify)	1	2	3	4	5

4	**Please specify the level of applicability of following methods to Sri Lankan construction industry**

Methods for dealing with concurrent delays	**Level of applicability**				
	1	**2**	**3**	**4**	**5**
But for test	1	2	3	4	5
First in line approach	1	2	3	4	5
Dominant cause approach	1	2	3	4	5
Apportionment	1	2	3	4	5
The 'Malmaison' approach	1	2	3	4	5
Any other method (Please specify)	1	2	3	4	5

Section D: Barriers to use of concurrent delay analysing methods

1	**Please indicate the extent to which the following factors restrict the use of concurrent delay analysing methods in Sri Lankan Construction industry**				
Factors	**Very Low 1**	**2**	**3**	**4**	**Very high 5**
Lack of awareness of concurrent delays	1	2	3	4	5
Lack of familiarity with the approaches	1	2	3	4	5
Difficulty in using approaches	1	2	3	4	5
High time consumption in using the approaches	1	2	3	4	5
Lack of skill for using approaches	1	2	3	4	5
Lack of adequate project information	1	2	3	4	5
Absence in acceptable quality in documentation	1	2	3	4	5
Lack of knowledge in Case Laws	1	2	3	4	5
absence of potential impacts of delays	1	2	3	4	5
lapses and omissions in documents	1	2	3	4	5
Lack of suitable programming software	1	2	3	4	5
Poorly updated programmes	1	2	3	4	5
Other (Please specify)					

"THANK YOU FOR YOUR SUPPORT AND COOPERATION"

APPENDIX C

METHODS FOR ANALYSING CONCURRENT DELAYS IN SRI LANKAN CONSTRUCTION INDUSTRY

STRUCTURED INTERVIEW QUESTIONS

1. 100% respondents were agreed to the statements that "many Standard forms of contract are silent as far as concurrent delays concerned" and "Clear guidance on the most suitable method for dealing with concurrent delays is very important to avoid complexity and disputes". Also most of them agreed to the statement that "SCL "Delay and Disruption Protocol" in 2002, gives clear guidance to parties when dealing with concurrent delays".
    a. What is your idea regarding the mismatch of result of above statements?
    b. What could be the precautions for that?

2. Can contractors use concurrency to defend against a liquidated damages claim?

3. More than 50% of respondents were impersonal to the statement of "a contractor can use concurrency to defend against a liquidated damages claim" and 81% agreed for the statement "Contractor will be generally entitled to an extension of time where there are concurrent delays". What is your opinion regarding this result?

4. Is the knowledge regarding case law is essential when handling concurrent delays?

5. "According to the survey results, though the concurrent delays are occurring often in Sri Lankan construction industry, most of the professionals in both consultant and contractor are sometimes highlighting the concurrency in defending delay claims" What is your opinion regarding this?

6. Every professional who responded to the other methods in the questionnaire have mentioned it as “Use of common sense”. What is your opinion regarding this?

7. Most of the professionals were identified that the “Malmaison” approach is the most successful and applicable method for analyzing concurrent delays. What would be the reasons behind this?

8. Which method do you think is the most suitable method for analysing concurrent delays in Sri Lankan Construction industry and What are the reasons for not recommending other methods?

9. Followings are the barriers for low usage of concurrent delay analyzing methods identified through the preliminary survey along with the ranks given according to their restriction level. What is your opinion regarding given ranks?

Barrier	Rank
Poorly updated programmes	1
Lapses and omissions in documents	2
Absence in acceptable quality in documentation	3
Absence of potential impacts of delays	4
Lack of knowledge in Case Laws	5
Lack of familiarity with the approaches	5
Lack of adequate project information	7
Lack of awareness of concurrent delays	8
Difficulty in using approaches	9
Lack of skill for using approaches	10
Lack of suitable programming software	11
High time consumption in using the approaches	12

10. What are the precautions we can have to establish a good concurrent delay claim practice in Sri Lanka Construction Industry?