ANALYSIS OF KEY CAUSES OF DELAY IMPACTING CONTRACTOR'S PROFIT IN ROAD CONSTRUCTION PROJECTS IN SRI LANKA

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Degree of Master of Science in Project Management

Department of Building Economics

University of Moratuwa

Sri Lanka

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Dissertation submitted in partial fulfillment of the requirements for the Masters of Science Degree Programmes

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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 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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The above candidate has carried out research for the Masters Dissertation under my supervision.

Name of the Supervisor: Senior Lecturer Ch. QS. P. A. P. V. D. S. Disaratna

……………………………… ……………………

Signature of the supervisor Date

Dedication

This research is adoringly dedicated to my loving family; my parents and my devoted wife, who have been my constant source of inspiration all through my life. They have given me the drive and the discipline to tackle this task with utter enthusiasm and determination. Without their love and support this project would not be a reality

Abstract

Construction Industry can be identified as the most important sector in Sri Lanka that drives the economic growth to its potential value. It is also one of the most important pillars in achieving the country's vision and ability to create direct and indirect job/ career opportunities. In Sri Lankan construction industry "delays" are treated as a common and regular phenomenon dating throughout the recent history. Nevertheless, these so-called delays can negatively affect all the parties involved in the project by causing mitigations, cost overruns, loss of productivity/ revenue, and termination of contract. One of the major negative effect of delay is loss of profit of the contractors. This study was aimed to safeguard Sri Lankan contractor's profit through the mitigation of key causes of delay impacting on contractor's profit.

To gain a more vivid perspective, questionnaire surveys were distributed among experts who were involved in the field of construction in Sri Lanka. Under the categorization of delay causes, six groups were identified as the most potential to affect the contractor's profit and was subjected to questionnaire survey one. To gain a better perspective sixty-three causes of delays were identified under these six categories. From the outcome of questionnaire survey one, twenty-one factors were identified as key delay causes by the risk matrix in road construction projects in Sri Lanka. Through the findings, Time and cost overrun were the common effects of delays in construction projects. Due to the magnitude and frequency of these overruns, these have come to pose a significant financial risk and negative impact to the contractor's profit. The identified twenty-one causes of delays, were subjected to questionnaire survey two. The professionals who responded in survey one, imparted on the survey two, by identifying major delay causes impact the contractor's profit.

The research identified most effective methods to mitigate causes of delays in Road construction projects as frequent coordination between the parties involved, Effective project planning and scheduling, site management and supervision, frequent progress meeting and Accurate initial cost estimates.

Key Words: Causes of delays, Road construction, Risk matrix, Questionnaire Survey, Contractor's Profit.

Acknowledgement

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Last but not least; my special thanks goes to my adoring wife for her encouragement on timely completion of this study, from start to conclusion she helped me in many ways to concentrate primarily on this study.

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List of Abbreviations

ADB	- Asian Development Bank
AHP	– Analytical Hierarchy Process
CBSL	– Central Bank of Sri Lanka
DPMM	- Department of Project Management and Monitoring
EOT	- Extension of Time
GDP	- Gross Domestic Product
RDA	- Road Development Authority
RII	- Relevant Importance Index
RMP	- Risk Management Process
SL	– Sri Lanka
WB	- World Bank

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CHAPTER ONE

1.0 INTRODUCTION

This chapter briefly discusses the importance of the growth of the construction industry and the negative impacts of delay and its past effects. Further, the study was carrying on discussing the problem statement, the scope of the research, the aim and objectives that are set on the study. Finally, the chapter discusses the methodology of carrying out the research and how the study is being organized.

1.1 Background

In the construction industry, the term “delay” is defined as a time overrun of the initial work plan from commencing to successful completion of the project. To discuss further, “delays” can disrupt the contractually obliged completion time to postponement owing to the behavior and practice of all parties involved on the project (Msafiri, 2015). Delays in construction projects seemingly be a common issue, the outcome can have inestimable cost impact to the society by incapacitating the involved parties (Ondari and Gakera, 2013). Furthermore, delays in construction projects can debilitate the successful project completion by negatively impacting in terms of time, cost, quality and safety (Knight, Hurst, Asnaashari and Farahani, 2009).

In recent times, construction industry has become a dominant factor of economy, by retaining a large percentile of the annual Gross Domestic Product (GDP). Thus, the growth of the construction industry directly capitalizes the growth of the economy of any given country. Construction industry holds the unique ability to stimulate the growth of other industrial sectors has become a milestone of dominance and undisputable remark of a country’s economic growth. Hence considering construction industry is an isolating factor of economic growth is misleading, since the companionship between the construction and the involved industrial sector are the factual causes of growth (Kwatsima, 2016). Thus, the economy of a country can be benefitted immensely by improving the efficiency of construction industry through effectively management and mitigation of any negative impacts.

Sri Lanka, with the resolution of the civil war that devastated the country for more than three decades, now heading towards improving the infrastructure of the country by initiating mega scale projects such as new and improved Port city, Express ways/ Roads, Megapolis development, Bridges, Commercial/ Residential buildings, Water supply, Telecommunication, and Airports etc.

With the progression of technology and the increasing population, the scale of these projects is being elevated rapidly comparing to the previous decades. According to Agarwal, A Gupta, and M.C. Gupta (2011) "Infrastructure projects are complex, capital intensive, having long gestation period and involve multiple risks to the project participants" In order to achieve the massive scopes in these projects, vast amounts of funds are required from either the government or a foreign body.

Under the infrastructure projects, one of the major issues every party involved in road construction faces, is the threat causes by delays. As stated by Pathiranage, and Halwatura (2010) there is a wide range of views on the causes of time delays for engineering and construction projects. Some are attributed to a single party, others can be ascribed to several quarters, and many relate more to systemic faults or deficiencies rather than to a group or groups.

Delay causes can occur in any manner of construction and the magnitude of these causes of delays can vary under the scope, cash-flow, estimate and client requirements of the project. In fact, the duration of construction projects from inception to successful completion will depend on these foreseen and unforeseen delays. To address the matter basing the study, which has been experienced by all parties involved, that the road construction in Sri Lanka almost always face greater delays than anticipated at the commencing of these projects (Ayudhya, 2011). To define this scientifically it is essential to understand the causes of the delays in order to mitigate their effect to the construction projects. It requires a comprehensive engineering know-how to execute and successfully carry out a construction project within the estimated budget/ initial cost and predefined schedule via a specific methodology (Al-Moumani, 2000).

Akinsiku and Akinsurile (2012) identified contractual mismanagement, change in constitutes & legislations, delays in decision making and approvals, miscommunication & lack of correspondence, contractual issues were the major factors that critically influenced delays in construction industry of Nigeria.

Pathiranage and Halwathura (2010) stated, causes of dispute a construction project faces in its life cycle, “Delay” is the most common dispute to cause losses to the parties involved in the project. In definition delay is, incapacity to maintain and operate current facilities and/or to be depending on excessively inefficient facilities on account of loss of revenue. In addition, increasing interest due to overwhelmingly escalation operations costs, delay of payment, and high cost of investment will succumb to critical cost overruns during construction.

Moreover, the contractors suffer consequences attributed to increment of overhead, material, machinery, equipment, and labour wages due to extension of construction period and fining of liquidate damages or penalty charges due to extensive delay (Marzouk, 2008).

In summary, when projects expose to delays, initial project period will suffer extensively due to inability to face deadlines, as a result of extended allocation of works. Sustaining to initial project cost and keeping quality of the works will not be tolerated under these circumstances. In addition, loss of return on investment, inability to maintain the cause of the project, and negligence will partake to litigation and total abandonment of the project. To conclude “delay” in construction will bring about distrust between the parties involved, contempt and cynicism on the industry.

1.2 Problem Statement

The importance of roads extends to all aspects of development of rural and urban communities, including demand for access to health, education, market and others.

Construction delays can be defined as an extension of time beyond the contractual time agreed during the tender and cost overrun as an extra cost beyond the contractual cost agreed during the tender process (Endut, Akintoye and Kelly 2011).

In a study carried out by Alaghbari (2007), in construction, delay is concurred as the most frequent, expensive, complex and hazardous conjecture encountered in the project lifecycle. Due to the mutual importance of the period of successful project completion for both the client and the contractor, it embraces as the frequent agent of disputes, claims and the common dominant of lawsuits and litigations.

Naturally, in many construction projects there will be request and award of Extension of Time (EOT) due to unavoidable circumstances, which will in result farther the completion of the project, increase of overhead, increase of escalation and contingencies, increase of cost due to inflation, termination of contract, mitigation/ court cases etc. or combinations of above stated factors, resulting in “delay damages” as known as loss of profit (Elimassi & Hillis ,2010).

Loss of profit and inefficiency often are not covered in the initial contract, leaving the contractor with little leverage. Clients believe that if overruns, change orders and undue delays are not addressed in the contract, then they are not liable for the results. Contractors have a better chance of recovering losses when job interruptions and change orders are addressed in the original contract, with appropriate compensation expectations clearly stated. The owner who signs the contract then agrees up front to pay for the extra labor or materials required to complete the job (Kohil, 2001).

The road construction projects in Sri Lanka often suffer from time overruns as a common quarrel. This issue is particularly addressed in most contract agreements with clauses of how to compensate if occurred. But the bitter fact that the contractor faces is the issue of justifying the overrun to be compensated, since the manner of being compensated for a time overrun often is in favor of the client rather than the contractor.

According to the progress reports of Department of Project Management and Monitoring (DPMM, 2011), in Sri Lanka when implementing the road infrastructure for a certain zone, it's not to completely avoid the issue of delay in construction under many conditions, and has pronounced that more than 50% of road construction projects were delayed in Sri Lanka. To reinforce the above statement, Pathiranage and Halwatura (2010), identifies that "56% to 88% of road projects in Sri Lanka faces the threat of time and cost overruns".

Furthermore, the issue of "delay" can be delegated as "cause and effect" where respectively, the cause is the act of deferment and effect is hindrance. Typically, all activities in construction may be delayed under certain circumstance yet not be disrupted by any means necessary. In example; duration of an activity can be protracted in the initiation and result in slowing down the progress in physical attribute, thus prolonging the completion in whole. Arditi and Pattanakitchamrron (2006) stated, that the following will convey how the delay causes expenses in construction. Compensation for the extended facilities such as, temporary offices, utilities and storage, liable cost for extended staff remunerations, supplementary travelling costs, additional extensions on insurance and bond premiums, prolongation costs for any sublet contracts, Safety and welfare measures, Lost opportunity due to overdraft facility, Head office overheads, and Loss of profit.

Accordingly, identifying the verified causes for delays in order to mitigate or avoid the damages instigated by delays and their corresponding expenses is an extreme importance and an essential necessity. These circumstances create a number of disputes in road construction project especially on those are carried out by using foreign funds, which may result in loss of diplomatic allegiances, loss of trust between countries and loss of future funds etc.

Furthermore, this research has been assimilated under the conclusion of lack research has been done or successfully completed on the subject of "safeguard Sri Lankan contractor's profit through the mitigation of key causes of delay impacting contractor's profit". Thus, the noticeable gap of knowledge regarding the subject is playing a critical role in contractor's dismay.

1.3 Aim and Objective of the Study

The aim of this research is to safeguard Sri Lankan contractor's profit through the mitigation of key causes of delay impacting contractor's profit in road construction projects.

- To identify the causes of delay in road construction projects in Sri Lanka.
- To develop a risk matrix to identify the key delay causes in road construction projects in Sri Lanka.
- To ranking the effects due to causes of delays in road construction projects.
- To identify the key delay causes impacting contractor's profit in road construction projects in Sri Lanka
- To identify the methods of mitigating key delay causes impacting the contractor's profit in road construction projects in Sri Lanka.

1.4 Methodology

The methodology used for this research contains three stages. The first stage contains literature survey to review and escalate on journals, books, conference proceedings and internet/ web. With the intellectual outcome of the literature review, causes of delay will be identified and grouped by depending on their nature and manner of occurrence. On the second stage the categorized groups were subjected on questionnaire survey and it was distributed amongst experts in the construction industry. And the results of the questionnaire survey will be enforced to a risk matrix which prescribes the delays on frequency over occurrence. On the third and final stage of the methodology the resulting factors of the risk matrix was subjectively on a secondary questionnaire survey which was distributed among the responded experts from the questionnaire survey one. The secondary questionnaire discloses which factors will majorly impact the contractor's profit in Sri Lankan road construction industry. Finally, the possible actions to mitigate delays that will negate the impact to the contractor's profit is discussed with the output revealed.

1.5 Scope and Limitations of the Research

The scope of this research is to identify the main causes of delays in road construction projects by developing a "risk matrix" and scientifically objectify the effect to contractor's profit via those delays.

Dissertation was focused on road construction aspect in Sri Lanka localizing the scope to be more practical for the contractors in Sri Lanka. The questionnaire surveys were designed based on the causes of road construction delays, effects of road construction delay causes, which are in effect to the profit of the contractor.

1.6 Research Organization

This research dissertation comprises of five chapters:

Chapter One -: Comprises a contextual to the study by discussing; Problem Statement aim, Objectives, Scope and Limitations of the study.

Chapter Two -: Contains the literature review comprehending previous researches, articles, and scientific data enclosed by other researches.

Chapter Three -: Comprehensive discussion of the scientific research methodology utilized for the research dissertation.

Chapter Four -: Navigate through the gathered data and produce findings.

Chapter Five -: Abbreviate the findings attained through the research along with analytical conclusion and recommendations for future researches.

1.7 Summary

The report is fundamentally initiated to identify and study the effects of key delays to the contractor's profit in road construction projects in Sri Lanka under the realization of lack of research done on the subject. This report proceeds to explain the effects of causes of delay that are directly causing damage to the final profit of the contractor, which has been a major issue that has not been recognized by any party who are involved in the industry. This chapter begins with a background survey of the industry and move on to identification of the knowledge gap, accrediting problem statement was and laying parameters under research aim & objectives as to classify the delay to identify and analyze the effects.

In conclusion this chapter will offer an introduction to the research, aim and objective of the research and the methodology that is being used for the research and finally deliberating the significance of the report under the Sri Lankan context.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter discussed the literature findings on causes of delays in road construction project and their influences on the profit and to the overall successful completion of the project. Cost and time overruns are common in both infrastructure and building construction projects. According to Ahmed (2000), throughout the history of the construction industry a notable number of projects were completed with a significant time and cost overruns.

2.2 Road Construction in Sri Lanka

After ending the 30 years civil war in Sri Lanka the government at the time realized that the much-needed infrastructure was to be constructed as fast as possible to up raise the country's plunging economic status. The country was at a point of hold due to not having a highway/ freeway connecting the major cities which were causing heavy delays of supply/ transport and was critically affecting the tourism industry which were at the time on the verge of being the most profited industry after seeing the end of the war. This sprouted the great up rise of mass infrastructure/ road construction projects Sri Lanka has ever seen after being liberated from the English Monarch.

When mass development and mass involvement take place the occurrence of risk is inevitable. Enshassi and Mosa, (2008) stated "construction industry is a risky business" due to its inclination towards risk as is in any other industry. Each construction project is unique and comes with its own set of challenges and opportunities. Identifying and managing risks can be tricky, but not impossible with careful planning and execution. When a risk turns into reality it can disrupt and derail a project. To avoid disaster, you need to be able to properly assess, control and monitor risks once they've been identified. Risks aren't always a negative. Being able to effectively identify and manage risks can lead to increased profits, establishing good relationships with clients that result in more projects and being able to expand your business into new markets and sectors.

2.3 Risk Assessment

The perception of risk varies according to viewpoint, attitude, and experience. In general, the risk is always announced as a term with a negative effect. Risk in a construction project is an uncertain event that if occurs result may come with a negative or positive affect on one or more elements of the project such as scope, schedule, cost, and quality (Assaf & Al- Hajji 2006). As argued by Aminbakhsh, Gunduz & Sonmez (2006), when identified, risk is assessed for its probability and the impact to the elements of the project. This preliminary assessment will provide an overall measure of the identified risks under the basis of frequency, severity, and the significance of the risk, as in higher or lower of its effect to the project. Here in the report identified risks are calculated under defined Risk Metrix.

A risk even after identified cannot be nullified under any circumstance but to be managed for less negative outcomes. This can be done through a proper and precise decision-making process. Risk Management Process (RMP) is the basic principle of understanding and managing risk in a construction project. According to Chapman (2001) RMP is a methodological course of action to endure through management policies, protocols, and practices to confront risk with communication, consultation, context establishment, via identifying, analyzing, evaluating, treating, monitoring and reviewing a risk.

As any other systematic procedure, RMP shall be applied throughout the project life cycle efficiently in a stepwise and iterative manner.

Mainly there are five phases in RMP such as;

Figure 2.1 Risk Management Process

(Source: https://www.google.com/search?q=Risk+Management+Process&source)

When dealing with risks RMP shall include all steps defined earlier in order to efficiently implement the process in the project. The methods analysis process assesses and evaluates characteristics of individually identified project risks and prioritizes risks based on agreed-upon characteristics. This method evaluates the probability that each risk will occur and the effect of each individual risk on the project objectives. Under the studies of Cooper, Grey, Raymond, & Walker, 2005 it was established that the combination of overall risks and potential interaction between the combinations effects the project objectives and can be mitigated by using quantitative risk analysis techniques.

2.4 Causes of Delay in Construction Industry

Rasid, Haq and Aslam (2013) define the delay in a construction project as an incident which causes to extend the completion of the particular project. They further state that the delay in a construction project is very critical since the causes of delay to increase especially the cost and time of a project which directly affects the loss profit, loss confidence and loss of opportunity to all parties involved. Menesi (2007) defined that; delay is inevitable regardless of the categorization of the project. Sambasivan and Soon (2006) argued that the delay in a construction project is a global phenomenon.

Rya, Lee and Ya (2005), have reinforced the above statement by affirming that no matter how the contractor schedule and manage the work to be competed under the allocated time for the contract, the project fails to achieve successful on time completion. They further proclaimed that in comparatively to other industries, delays are not uncommon in most construction projects due to the fact of construction is always and always will be facing indefinite extent of unforeseeable risks. However, in some rare cases the contractor will attain a successful project completion against all odds under the agreed time, earning the prerogative of calling himself fortunate.

To heighten the above statement, out of 1627 projects that were completed between the years 1974 to 1988 around the world, each and every project were badly affected by time overruns and the delay ratio varied between 50% to 80% (Francis, Brenan & D'Onofrio, 2014).

Arditi and Pattanakitchamro (2006) affirms that one, single delay of an isolated event can snow balled in to critical failure impended by delay of completion. The delays in construction projects are equally undesirable to the client and the contractor due to the fact that delay causes to change a profitable project to a loss.

Furthermore, with the findings of Kumange and Steeven (2013) due to delays, physical and financial progress of the project can be deteriorated while creating disputes among the involved parties. Sambasivan and Soon (2006) argued, that if a project is completed within the original time and cost, maintaining the standards, the project could be considered as a successful project. When a project is delayed it must be either accelerated to catch up the delay or completion date must be extended.

In both cases an extra cost is needed for completion of the project and its mainly affecting to the final profit through the project. Braimum (2013) sustained, that it is vital for both the contractor and the client to complete the project in due time. In order to recover the damages taken place due to the delay the party who is responsible for the delays must be identified accurately. Kumange and Stephen

(2013) composed that, failure to comply to the project schedule and successfully complete the project in due time will result in either in arbitration, tribunal or courts.

According to Ramanutan, Narayanan and Idrus (2012), a project is complied with major phases; Conception, Design and Construction. It has been related the majority of the delays are taken place during the construction stage.

Pandy (2012) stated that there are uncertainties on task duration and the resources availability at the planning stage of a project. At the construction stage delay could be taken place due to various reasons such as adverse weather, managerial action or inaction, and limitation of resources. Further he added that when the project is delayed due to various reasons, the payments due for the contractors are generally withheld and consequently the contractors suffer financially.

National Construction Association of Sri Lanka (NCASL, 2013) revealed that delay in payments to the contractor at the stage of construction intend to seed various problems/ issues which could cause even to abandon the project totally while well behind completion. In addition, Alhomidaa (2013) argued that the delay in projects caused not only the cost overrun but the mistrust be going to weaken the relationship between the parties and finally end up with litigation.

Ramanayan et al., (2012) mention that the delay of the project means a loss of revenue to the client and additional overhead to the client and to the contractor. They further added that successful completion of a project means an indicator of the efficiency of all parties involved.

2.5 Causes of Delay in Road Construction Projects

Identifying the causes for delay and taking appropriate action to mitigate them is important in a construction project. The causes for delay are comparable in most developing countries, studies have confirmed that consequently in Kenya more than 70% of road projects has been subjected to time overruns.

Through the findings of Seboru and Atiba (2006), it has been identified poor financial management, inadequate designing, poor construction management and client's unrealistic time allocation as main causes of time overruns.

In addition, Sambasivan et al., (2006) revealed that the main causes of delay in road projects in Malaysia were contractor's poor planning, inadequate experience, and payments shortage of materials and lack of communication.

According to a research carried out by Rashid, Ulhug and Aslam (2013) in Pakistan rarely a project had been completed within the original time and most of the delayed projects were significantly foreign funded projects. The main reasons according to them were poor project management, lack of material and labour as well as various issues between the clients and the contractors.

According to Kumange and Steeven (2013), more than 72 reasons were classified as delay causes in the Malawi road construction projects and the main reasons were; shortage of material, late payments, lack of construction professionals involved, and delay in mobilization. Alhomidan (2013) discovered that lack of material, war, late payments, and poor site management are the causes affecting road construction projects in Gaza Strip of Saudi Arabian.

As per the studies of Mahamid (2013), causes of delays in road construction projects in Palestine were due to, poor financial status of the contractor, late payments, adverse political situation, lack of material and poor project management. Finally, according to Alwi and Hampson (2003), the classified delay causes affected construction in Indonesia were, poor site management, inappropriate construction method, lack of equipment.

2.6 Type of Construction Delay Causes

Ahmed, Azher, Castillo and Kappagantula (2003) discovered that according to how delays operate contractually, "delay" can be grouped in to four broad categories. Several studies by numerous researchers like Majid and Caffer (1998), Reams (1990), and Rahman, Berawi, Mohamed, Othman, and Yahya (2006) grouped delays according to Ahmed et al., (2003) discovery as fallows;

1. Non-excusable
2. Excusable non-Compensable
3. Excusable Compensable

4. Concurrent

2.6.1 Compensable Delays

Alaghbari (2005), the delays that generally caused by the owner or a representative of the owner are classified as Compensable delays. Inadequate drawings and specifications, failure to respond in time are considered as the common candidates of compensable delays. Sudden change of design or approved materials and change project schedule by owner is entitled additional money and additional time resulting from compensable delays.

2.6.2 Non- Excusable Delays

According to Alaghbari (2005), delays caused due to contractors, sub-contractors, and suppliers through no instigation by the owner are classified as Non- excusable delays. The contractor can be compensated for the damages created by these delays by the responsible party yet the owner is not liable for any cause of action. Therefore, non-compensable delays usually result in no additional claim and/or no additional time being granted to the contractor by the owner.

2.6.3 Excusable Delays

Alaghbari (2005), also known as “Force Majeure” delays are considered as acts of god due to the responsibility for the delay is not claimed by any party involved. Due to the unforeseeable status of this delay type, the occurrence of the delay is particularly uncontrolled through contractor or sub-contractors. The owners usually allow and grant extension of time claims in such occurrences.

2.6.4 Concurrent Delays

Alaghbari (2005), claims when the delay is causes cascading effect and snowball in to simultaneous delays throughout the project life cycle it is called a concurrent delay. To elaborate, if a delay is caused by a singular factor mitigating and calculating the ultimate outcome of the delay is easier and can be managed, yet if the delay is caused by a series of factors interacting between each other it often severely affects outcome of the project resulting overruns in all directions.

2.7 Effects of Delay

Aibinu and Jagboro (2002) studied the effects of construction delays on project delivery in Nigerian construction industry. The six effects of delay identified were,

- Time overrun: - a project is said to encounter time overrun if the stipulated completion time is exceeded.
- Cost overrun: - a project is said to face a budget overrun if it is completed at a cost that is higher than that budgeted.
- Disputes : -
  - Bad public relations: - consultants, contractors and clients risk their public reputation if projects are delayed.
  - Poor project quality: - issues related to project quality may arise if there is inferior workmanship and/or use of inferior quality materials.
- Arbitration: - a project may incur additional cost and time following the engagement of professional arbitrators.
- Total abandonment (Contract Termination)
- Litigation: - courts may be used to resolve disputes, especially when severe penalties are at stake.
- Suspension of the work

Many studies have been conducted to identify the causes of cost overruns in construction projects. Assaf and Al-Hejji (2006), concluded that the top affecting factors that cause cost overruns in building construction projects in Gaza Strip as perceived by contractors were: strikes, Israeli attacks and border closures, lack of materials in markets, shortage of construction material, delay of material delivery to site, lack of cash/ financial issues during construction, and poor site management.

Koushki, Al-Rashid and Kartam (2005) conducted a study in Kuwait. They concluded that the main affecting causes of cost overruns are: changing orders, owners' financial constraints, and owners' lack of experience. Kaming, Olomolaiye, Holt, and Harris (2007) conducted a study to identify the main factors affecting cost overrun in Indonesian construction projects. They concluded that inflationary increases in material cost, inaccurate material estimating, and project complexity are the main causes of cost overrun.

Iyer, Chaphalkar and Joshi, (2008) concluded that the most factors mostly affecting the cost overruns of construction projects in India are: conflict among project participants, ignorance and lack of knowledge, presence of poor project specific attributes and non-existence of cooperation.

Enshassi, Al-Najjar, and Kumaraswamy (2010), concluded that the main factors affecting cost overrun in Gaza are: location of the project, segmentation of the Gaza strip and limitation of movements between areas, political situation, and financial status of the owner.

2.8 Cost Overruns in Construction Projects

Singh (2009) defines cost overrun as the difference between the initial budget of the project and the final cost of the project. The initial project cost also known as the estimated budget of the project, which are forecasted costs of the works specified on the contract. The budget of the project, even though should remain constant, will vary under planning and scheduling, project type, time and country, and current economy. This change to the estimated budget is summarized as the actual cost. Actual cost is defined as real, accounted cost determined at the time of completing a project.

Cost overrun is an incidence where the provision for services, goods, and/or procurement claimed requires extra financial resources than previously/ initially agreed upon the project contract. Cost overrun is defined as an increase of cost which is not expected (i.e. excess of a budgeted cost) during estimation of the initial budget.

2.9 Factors that Influence Construction Cost

A wide variety of factors can effectively increase the probability of causing cost overruns in a project. In a study conducted by Hegazy and Amrayed (1998), found and state that season, location, type of project, contract size and contract duration have a significant effect on individual contract costs. Moreover, direct factors related to construction organizations which are solely responsible for planning and managing the work, socio- cultural epitome, economy and financial status of the organization plays immense role in fluctuation of the initial project cost/ budget.

According to Molenaar (2005), cost overrun arises primarily because of three factors. Which are:

- External risk :- scope of a project, besides changes in the economic, legal, and technologic environments
- Technical complexity of the project :- size, duration, and technical difficulty
- Inadequate project management :- consists of poor control of internal resources, poor labour relations, unrealistic estimates and low productivity because of the uncertainties involved.

2.10 Cost and Delay Relationship

Abdullah, Abdul, and Abdul (2009), reveals that cost overrun has a positive and linear relationship with time overruns. Kaming, Olomolaiye, Holt and Harris (1997), exposed that, with regards to financial implications; all delays in construction projects undeniably cost money. Yogeswaran, Kumaraswamy, and Miller(1998), declares that delays, lead to losses and/or difficulties for all project participants, from being causes for claims and disputes. If and when a project is delayed due to justifiable causes, an extension of time will be awarded to the contractor. The EOT; extension of time may be awarded with or without covering the prolongation cost. If the EOT is granted with the prolongations costs the probability of impact to the contractor's profit can be mitigated. However, if the EOT is awarded without a prolongation cost the impact of additional payment for time related costs, such as overhead and profit. In addition to this, delays defer income, whereas interest and interest on interest, keep accumulating.

Flyvbjerg, Holm, and Buhl (2003), states that Extended delays might result in projects close up in the so-called 'interest trap', where a combination of overwhelmingly escalating construction costs, increasing interest due and payment delay will succumb to critical cost overrun. In addition, according to Ardit, Akan, and Gurdamar (1985), and supported by Sambasivan and Soon (2007), lengthy delay within inflationary environments increase cost overrun tremendously.

Delay causes cost overruns if the extra works, reworks, and variation of initial job scopes do not compensate by the budget of the project and the prolongation costs do not cover reworks and/or any mistakes carried out on the work. As stated by Sun and Meng (2009), the cost of rework could be as high as 10 to 15% of the initially estimated project cost. This indicates that cost overrun is the most frequent causes of delay in the construction industry.

As suggested by Sun and Meng (2009), time overrun and cost overrun are inter-related whereby delay will cause cost overrun in most cases. Moreover, delays will cost additional expenses under labour salaries, leasing/ hiring of equipment, machinery, and tools, and escalations due to the initial cost of the project was calculated based on the time of bidding of the project. Furthermore, rework due to mistakes and defective works require an additional disbursement of cash from the contractor's cashflow with no means of compensation.

In major constructions, event of delay either cause delay in overall project completion or escalate to disruption. Thomas (2001) argued that delays in construction projects are consistent to five decisive conditions. As in;

- Delays affect individual activities, forcing the contractor to retain resources for a prolonged period
- Delays affect individual activities forcing to change the sequence of effective resource schedule causing a domino effect of delays and/or mis conduct in scheduled activities.
- Delays affect individual activities to escalate interruption and disturbance to secondary activities.
- Delays affect activities causing idling of resources by rescheduling of program.
- Delays affect activities causing congestion in sections of the work zeroing out resources causing loss of productivity and progress of work.
- Delays affect activities causing loss of quality standards due to work carried out disjointedly

In addition to disruption, there are other factors that cause cost overruns in construction projects which are not directly associated with delay events such as change in legislation, price escalation and acceleration.

2.11 Categorization of factors causing delay

Chan and Kumaraswamy (1996), categorized the factors affecting delay into eight groups:

- **Project-related factors** include project characteristics, necessary variations, communication among the various parties, speed of decision making involving all project teams, and ground conditions;
- **Client-related factors** include those concerned with client characteristics, project financing, their variations and requirements, and interim payments to contractors;
- **Design team-related factors** include design team experience, project design complexity, and mistakes and delays in (producing) design documents;
- **Contractor-related factors** include contractor experience in planning and controlling the projects, site management and supervisions, degree of subcontracting, and their cash-flow;

- **Materials factors related** include shortages, material changes, procurement programming, and proportion of off-site prefabrication;
- **Labor factors related** include labor shortages, low skill levels, lack of motivation, and low productivity
- **Plant/Equipment related** factors include shortages, low efficiency, breakdowns, and wrong selection; and
- **External factors** include waiting time for approval of drawings and test samples of materials and environmental concerns and restrictions.

Majid and Caffer (1998), listed the causes of delay in the following categorizes

- **Material-related delays** factors include late delivery, unreliable supplier, damaged materials, poor quality, poor materials planning, poor monitoring and control, and inefficient communication;
- **Labor-related delays factors** includes low mobilization, unreliable subcontractor, poor labor planning, strikes, poor workmanship, low morale/motivation, absenteeism, poor monitoring and control, and inefficient communication.
- **Equipment-related delays** factors include poor equipment planning, late delivery, equipment breakdown, improper equipment, unreliable supplier, poor monitoring and control, and inefficient communication;
- **Improper planning** related factors include attitude, inappropriate practices/procedures, lack of facilities, and lack of experience;
- **Financial-related delays** factors include delay payment to supplier and/or subcontractor, inadequate fund allocation, poor monitoring and control, and poor financial planning;
- **Lack of control factors** include lack of experience, attitude, shortages of personnel, inappropriate practices/procedures, low morale/motivation, and deficient contract;
- **Subcontractor-related** delays factors include unreliable subcontractor, subcontractor bankruptcy, interferences with other trade, poor monitoring and control, absenteeism, poor quality, and slow mobilization;

- **Poor coordination factors** include inappropriate practices/procedures, shortages of personnel, and lack of experience;
- **Inadequate supervision factors** include too many responsibilities, shortages of personnel, shortages of personnel, absenteeism, inappropriate practices/procedures, poor quality, and poor labor planning;
- **Improper construction methods factors** include wrong methods statement, lack of experience, inadequate fund allocation, inappropriate practices/procedures, and unavailability of proper resources;
- **Technical personnel shortages factors** include strike, absenteeism, lack of experience, poor planning, and slow mobilization; and
- **Poor communication factors** include lack of facilities, lack of experience, and inappropriate practice/procedures.

Odeh and Battaineh (2002) studied, causes of construction delay in Jordan. They classified the causes of delays into the following eight major groups:

- **Client related factors include** finance and payments of completed work, owner interference, slow decision-making by owners, and unrealistic imposed contract duration;
- **Contractor related factor include** subcontractors, site management, construction methods, improper planning, mistakes during construction, and inadequate contractor experience;
- **Consultant related factor include** contract management, preparation and approval of drawings, quality assurance/control, and waiting time for approval of test and inspections;
- **Material related factor include** quality of material and shortage in material;
- **Labor and equipment related** factor include labor supply, labor productivity, and equipment availability and failure.
- **Contract related factor include** change orders, mistakes and discrepancies in contract documents, contractual relationship related factor include, major disputes and negotiations, inappropriate overall organizational structure

linking all parties to the project, and lack of communication between the parties; and

- **External factors include** weather condition, regulatory changes and building code, problems with neighbors, and unforeseen ground conditions.

Le-Hoaietal (2008) studied, causes of delay in Vietnam, the researcher showed that there are no differences in the viewpoints among three principal parties in the project. The factor analysis technique was applied to categorize the causes, these causes were categorized into the following six major respective groups:

- **Owner-related group** consists of financial difficulties of owner and slow payment of completed works.
- **Contractor-related group** involves poor site management and supervision, financial difficulties of contractor, obsolete or unsuitable construction methods, inaccurate estimates, incompetent subcontractor and mistakes during construction.
- **Consultants-related group** consists of poor project management assistance, poor contract management, slow inspection of completed works and mistakes in design.
- **Project-related group** comprises design changes, additional works and slow information flow between parties.
- **Material and labor group** involves shortages of materials and shortages of skilled workers.
- **External factors-related group** consists of unforeseen site conditions, price fluctuations, bad weather and obstacles from government.

Ogunlana, Promkuntong and Jearkjirm (1996) studied, the delays in building project in Thailand, as an example of developing economies. They concluded that the problems of the construction industry in developing economies can be nested in three layers: problem of shortages or inadequacies in industry infrastructure, mainly supply of resources; problems caused by clients and consultants; and problems caused by incompetence of contractors. They were classified source and causes of delays into six groups:

- **Owners related factors** include change orders and slow decision making,
- **Designers related factors** include incomplete drawings and low response,
- **inspector related factors** include deficiencies in organization, deficiencies in coordination; and uncompromising attitude,
- **Contractors related factors** include materials management problem, deficiencies in organization, coordination deficiencies, planning and scheduling problems, equipment allocation problems, financial difficulties, and inadequacy of site inspection,
- **Resources suppliers related factors** include shortage of construction materials, late delivery, price escalation, low quality of materials, shortage of site workers, shortage of technical personnel, insufficient numbers of equipment, and frequent equipment breakdown, and
- **Others factors** include confined site, problems with neighbors, and slow permits by Government agencies.

Sambasivan and Soon (2007), studied the Causes of delays in Malaysian. These causes were categorized into the following eight major groups:

- **Client related factors:** finance and payments of completed work, owner interference, slow decision making and unrealistic contract duration imposed by owners.
- **Contractor related factors:** delays caused by subcontractor, site management, improper construction methods, improper planning and errors during construction, and inadequate contractor experience.
- **Consultant related factors:** contract management, preparation and approval of drawings, quality assurance and waiting time for approval of test and inspection.
- **Material related factors:** quality of material and shortage in material.
- **Labor and equipment related factors:** labor supply, labor productivity and equipment availability and failure.

- **Contract related factors:** change orders and mistakes or discrepancies in contract document.
- **Contract relationship related factors:** major dispute sand negotiations, inappropriate overall organizational structure linking to the project and lack of communication between the parties.
- **External factors:** weather condition, regulatory changes, problem with neighbors and unforeseen site condition

2.12 Influences and Causes of Delay

Delay of projects often generates conflicts and disputes in the delivery of building and civil engineering projects Aibinu and Odeyinka (2002). If construction delay claims and conflicts can be avoided or mitigated, there could be substantial financial savings on projects. It was also discovered that the higher the level of pre-contract negotiation and pre-contract agreement on the rules for quantifying and assessing delays, the higher the contractor's perceived quality of the decision-making process for delay claims during the construction phase (Kwatslma, 2016).

Further, the higher the contractors perceived the quality of the decision-making process for delay claims, the lower the intensity of the conflict. At the time of entering into contracts, owners and their project management team need to pay more attention to pre-contract negotiation and agreement with their contractor to clarify and agree on the rules for quantifying and assessing the impact of anticipated delay and disruption.

According to Kwatslma (2016), that require pre-contract negotiation, agreement, and clarification include: the rules of evidence for claims, the record requirements for claims, and the procedure for keeping the records, form construction programs including the software for the preparation of the programs and the procedure updating the programs, the methodology for analysing delay claims, formula for quantifying unabsorbed head office overhead component of prolongation cost, the method for quantifying disruption cost, the handling of concurrent delays, profit whether claimable and the rate of profit to be paid, acceleration circumstances under which it will be compensated and basis of compensation, and the question of who owns the float (Odeh and Battaineh,2002). These are, typically, not adequately covered by most standard forms of contracts. The agreements on these matters may be incorporated as part of partnering agreement or as a supplement to the contract agreement. Pre-contract negotiation, clarity, and agreements could produce instrumental and no instrumental (social psychological) effects, which could facilitate delay and disruption claims assessment and their resolution. It could mitigate conflict even when the outcomes are unfavourable to a party.

2.13 Data Analysis

Data analysis, describes the techniques that are being used for this study and how the analysis to carried out to reach the set objectives. The Importance index will be used to calculate the frequency and severity indices of the delays and Relative Importance index (RII) will calculate the importance of delay's various causes and effects.

2.14 Mitigation of Delay in the Construction Projects.

An analysis is needed to identify the impact of delay on time and cost followed by taking the appropriate action to mitigate delay and minimize the cost required. It is important to improve the estimated activity duration according to the actual skill levels, unexpected events, efficiency of work time, and mistakes and misunderstandings. Mitigation efforts are necessary to minimize losses and this can be achieved by many procedures such as protection of uncompleted work, timely and reasonable re-procurement, and timely changing or cancellation of purchase orders. It is important to predict and identify the problems in the early stages of construction and diagnose the cause to find and implement the most appropriate and economical solutions (Abdul-Rahman et al., 2006).

In many cases, causes of delay can be mitigated to some extent by prompt remedial action initiated by the contractor, the contractor's degree of contractual liability for the delays being an important motivating factor (Yogeswaran et al, 1998). Construction projects involve more variables and uncertainties than in the product line. This factor increases the probability of delay causes occurrence in construction projects and makes effective management important to reduce the diversions from the original program. Planning is easily done in a homogeneous task environment under stable conditions such as found in production firms than in a construction project and this presents a challenge for managers involved in construction projects.

2.15 Types of Claims due to Causes of Delay

Different types of claims arising out of 'Time delay and extension' clause are as follows (Iyer etal., 2008).

- Levy of compensation by owner due to delay attributed to contractor.
- Claim for price escalation of resources by the contractor when the work is not completed in time and extensions are to be allowed because of client's default.
- Claim for idling of resources/overheads by the contractor due to delay by owner.
- Whenever, a contractor does not do the work with due diligence or his pace is slow, the running bill amount may be withheld leading to claim for interest on withheld payment.
- Sometimes the clause for 'reimbursement of price escalation' may not exist in the contract and the contractor claims for compensation, when the project gets delayed, as extra-contractual obligation.

2.16 Effects of Causes of Delay to the Contractor's Profit

In essence, the final form of any delay is a request of EOT from the contractor's party in any given project. This may sound fair and natural for that the contractor's party may claim for prolongation costs for the extended time via the EOT claim. Yet the reality may differ in drastic measures. In a project mainly a road construction project the contractor after receiving of the award letter shall proceed with the contract schedule of mobilizing the mass of staff, machinery, and labour to accomplish the course in due time. Even with the profound knowledge of pre identified risks and causes of delay at initiation of the project the contractor may fall in to unforeseeable risks which causes of delay on scheduled work which effects the cash flow of the project (Akinradewo and Aigbavboa, 2019).

The cash flow of the project is divided in to two sectors,

- Cost for the work done
- Profit/ Cost overhead

With a delay featuring as a time overrun the contractor has to fund the project either until a prolongation cost gets approved or as a liquidated damage. In either case it comes as loss of profit to the contractor (Ayudhya, 2011). To deliberate, if the delay cause was seen as unforeseeable and directly offend the critical path of the project the contractor may get an approval for prolongation cost claim, but the contractor already has overdriven scheduled time for the subjected project which cuts out the profitability of finishing the project on time which directly affect the overhead cost of his company (Fugar and Agyakwah 2010),. In contrast a prolongation cost claim may cover the cost of idling, extra work, and the preliminary/ mobilization cost, yet it will not address any measure of cost of the overhead facilities provided for the project to run properly. In effect of this scenario usually the contractor may cut down his profit to provide for the overhead facilities which may affect as loss of profit under claim. To explicate a contractor mobilizes to the project site under one direct initiation/ goal, a successful completion of the project and get out. And this will be affected and ruined under EOTs and the damage of loss profit from losing opportunity to get in to other project shall not be claimed easily. The loss opportunity claim is a hard appeal with less than 10% chance of winning in a litigation and a direction a contractor rarely convene too (Kohil ,2001).

So, in conclusion the fact remains that no matter the contractor is awarded an EOT with prolongation cost or the contractor is fined under Liquidated Damage (LD) the contractor is facing loss of profit. Yet the fact remains if the delays are identified beforehand and the effect of delay may be reduced then of course the contractor can sweep away with a better profit than not.

2.17 Deterrents to Delays

2.17.1 Breach of Contract due to Delay

If and when one party void the contractual agreement by breaching specifications, party suffered the consequences are contractually obliged to recover the damages in essence of money or otherwise. However, the recovery should be confined to the nature of the losses suffered from the breach and should be contemplation to the parties involved. the measure of recoverable is identified as the difference between the cost to successfully complete the project and the cost of additional works due to the breach (Kawatsima, 2016).

2.17.2 Damages due to Delay

Under the contact agreement, in an event of a breach, the party caused breaches are liable to pay the damages. Contractually the payment of the damages is called “liquidated damages”. These obligations are manufactured on contract agreements to save time, trouble and additional expenses caused by litigations. Even though, the total sum of “liquidated damages” is fixed and agreed on the contract it may not cover the total damages suffered by the initial breach. However, if damages are to be assessed by the contract itself, it is essential to estimate precisely with a monetary effect of any possible breach may caused under quality standards (Kawatsima, 2016).

2.17.3 Conceptual Framework

According to Kothari (2006), Conceptual frameworks are set of pre-structured form of initiatives to theories any problem that a researcher looks in to, form quarries, and find respective literature. Often most academics use Conceptual frameworks as wireframe due to its guidance and clarity prepare aims and objectives by ease and to form data collection methods and finally for data analysis.

Haralambos and Holborn (2008), a conceptual framework let the researcher to create and obtain links between existing literature and his own research objectives.

2.18 Minimizing the Causes of Delay in the Construction Project

Kang (2010), In the face of a matter of delay in a construction project, there is no argument that the contractor may suffer the consequences of the delay, financially.

The mere question on the matter would be that the extent of the loss and how the contractor can recover from the issue. The only concern here shall be, is how to minimize the risk of delay occurrence and how to avoid risk of facing financial loss under the contract agreement. Based on multiple case studies of successful project completions, a base line factors were identified for rectification of loss via delays in construction projects. A total of 15 methods that have been identified are as follows,

Table 2.1: Methods of Minimizing Construction Delay

No	**Proposed Method**
1	Frequent progress meeting (Majid, 2006)
2	Use up-to-date technology utilization (Majid, 2006)
3	Use proper and modern construction equipment (Majid, 2006)
4	Use appropriate construction methods (Majid, 2006)
5	Effective strategic planning (Majid,2006)
6	Proper material procurement (Majid, 2006)
7	Accurate initial cost estimates (Majid, 2006)
8	Clear information and communication channels Majid, 2006)
9	Frequent coordination between the parties involved (Majid, 2006)
10	Proper emphasis on past experience (Majid, 2006)
11	Proper project planning and scheduling (Majid, 2006)
12	Complete and proper design at the right time (Assaf, 2006)
13	Site management and supervision (long, 2008)
14	Collaborative working in construction (Kumaraswamy,1997)
15	Compressing construction durations (long, 2008)

2.19 Chapter Summary

The purpose of this chapter was to identify the causes of delay in road construction projects in Sri Lanka. To identify these causes of delay was made possible through an intensive and comprehensive review of past articles and scholarly notes that were written on the subject matter. This literature review subsequently generated substantial amount of evidence to develop a conceptual frame work for the research method design.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Introduction

This chapter conversed on the methodology adopted for this dissertation. By comprehensively evaluating the scope of the research, and the corresponding aim and the objectives, outlining the frame work of the adopting methodology to pursue the subjects of the research was identified and discussed here. In addition the research philosophy and strategic approach to fundamentally support the methodology are conversed on this chapter.

The questionnaire was the man avenue to gather data and the outlook of the professional respondents. The motive of any dissertation is to cultivate data and evaluate the objectives through prominence of scientific methodologies. In pursue of that and as stated in chapter one, the main purpose of this dissertation was to investigate the effects of key delay causes to the contractor’s profit in road construction projects. In addition, the research developed a matrix showing the best representation of delay causes.

3.2 Research Process

Research process consists of the steps that to be carried out by the researcher to successfully complete and achieve the aim of the research. With a proper and precise research process, there is a higher possibility to minimize the errors during the research and can reduce the mistakes done by the researcher. The research process includes research approach, research technique, data collection techniques and the data analysis strategy that are to be used for the research study. The important steps of the process are illustrated in following Figure 3.1.

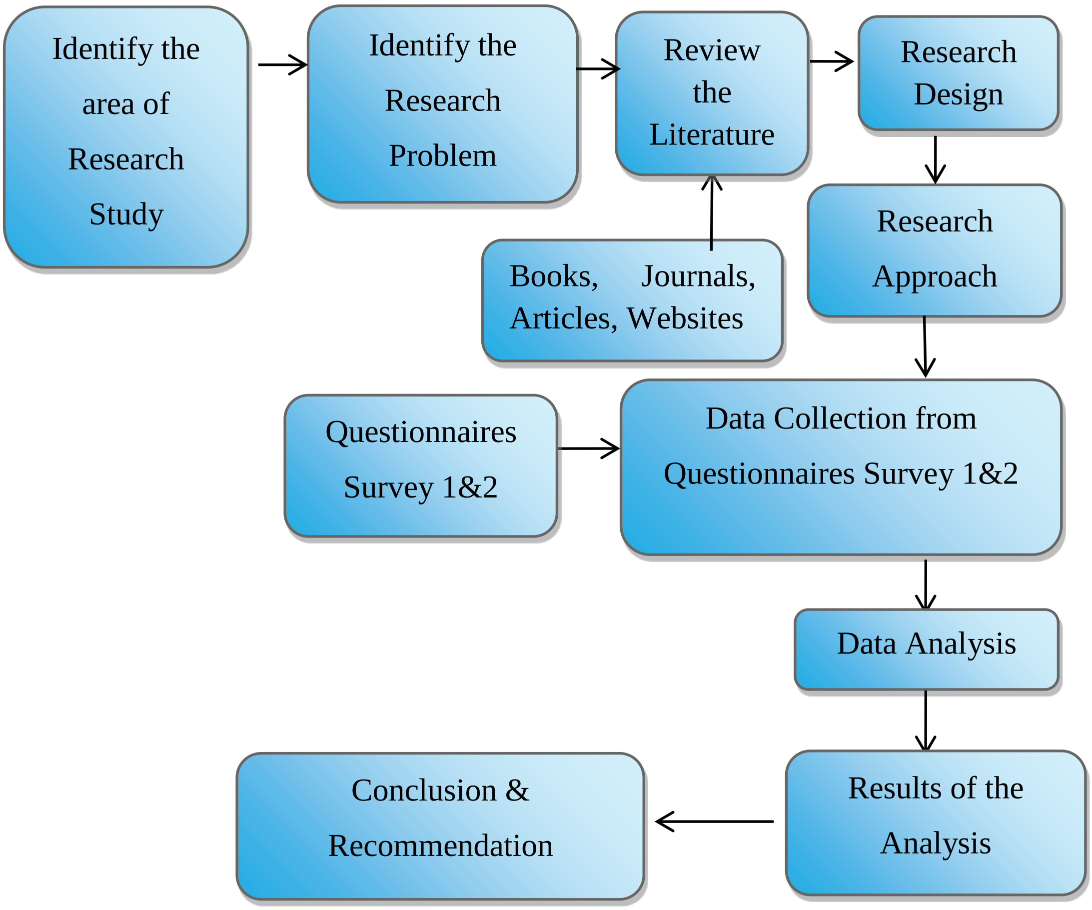

Figure 3.1 Research Process

3.3 Research Strategy and Design

The research strategy and the design shall be focused on finding a tactical approach to explore the major causes of delay and how they affect to the profit of the contractors in road construction projects. The outcome of a successful research will ultimately depend on the research design and the fundamental strategies that are used to data collect and analysis (Senarathne, 2005).

At the most primitive level Research Design is considered as the catalyst of planning and executing a research from conception to conclusion, developing the formation and structure to stabilize the grounds of the objectives. Basically, a research design is a protocol for achieving the objective of the research in a scientific manner.

"In order to do a better scientific investigation, any research design was should consist with three steps called research philosophy, research approach, and research techniques" (Kagioglou, Cooper, Aouad, Hinks, Sheath and Sexton, (1998).

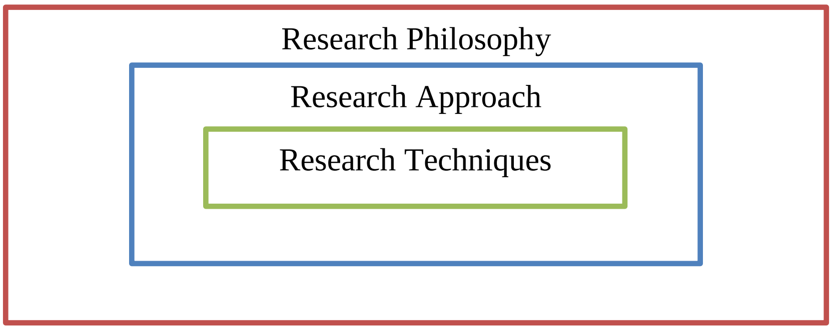

Figure 3.2: Nested research approach (*Kagioglou et al, 1998)*

3.4 Research Philosophy

Philosophy of the research can be approached as a comprehensive study of the source, nature and development of knowledge that allows assumptions and beliefs which take part on the research. Research philosophy plays a major role on any research due to enabling the researcher to build up on assumptions and accumulate on objectives. In prospection there are four concepts in research as, Pragmatism, Positivism, Realism and Interpretivism (Saunders, Lewis, & Thornhill, 2012).

Table 3.1. Research philosophies and data collection methods

Concept	Pragmatism	Positivism	Realism	Interpretivism
Popular data collection method	Mixed or multiple method designs, quantitative and qualitative	Highly structured, large samples, measurement, quantitative, but can use qualitative	Methods chosen must fit the subject matter, quantitative or qualitative	Small samples, in-depth investigations, qualitative

Here the study use positivism which allows the researcher to use highly structured large samples and quantitative measurement to build a better mechanism to case and prove the findings.

> *Flowers, (2009) In order to do an in-depth research, the researcher should have a clearly specified set of objectives.*
>
> *Holden & Lynch, (2004) The study of the behavior in their natural environment is key to the interpretivist philosophy, together with the acknowledgment that scientists cannot avoid effecting those phenomena they study.*

In relation to these definitions research will approach to study the causes of delay and how it affects the contractor's profit.

3.5 Research Approach

For the study quantitative research approach was used in order to gain the required information thus the gathered data had pragmatic and a mixed perspective.

Although Ellis (2006) argued that combined research approach provides sincerely accurate outcomes since qualitative method can be used to improve the finding of the quantitative method. Nevertheless, to comprehensively analyze the objectives of the study through the perspective of the professionals of the industry, quantitative research approach was utilized here.

In broad aspiration, quantitative approach corresponds with factual and analytical data that supports the theoretical indices and the actual prospective of the current field. Whereas, qualitative approach attempt to gain insight to the people's perception on the subject as individually or group status. (Fellows and Liu, 2003). The combination of quantitative and qualitative approaches is mixed approach. Naoum (1998) states mixed approach favors to gather realistic data for study relationships with cases and compare the findings of any previous researches.

The research strategy adapted for this research is quantitative research method, since quantitative research produce more applicably analytical data and generalizable conclusions in regards of the larger sample sizes. Moreover, for circumstances where, scientific and standardized comparisons are made the data should be reliable and appropriate for the subject, and should be gathered through a statistically applicable method. Ultimately, using the quantitative method will benefit the study to obtain a more accurate image of risk in road construction project due to the delay.

3.6 Research Technique

Once the appropriate research approach is selected, suitable research techniques should be identified to operatize the research. Research techniques conceivably discussed under two extensive categories as data collection techniques and data analysis techniques. Selecting proper data collection techniques and data analysis techniques will directly affect the quality of the outcome of the research.

3.6.1 Data Collection Technique

The point is made by Field (2009) to obtain precise data for the subject, the researcher must convey and stick to accurate procedures. Panas and Pantouvakis (2010) argued that the validity of the gathered data, will solely rely upon the procedures taken to obtain the data.

By trading on these findings, the study disclosed that there are two types of data surveys that are currently being used. The study briefly discuss the survey types, correlation or cross-sectional, and experimental followingly, Cross-sectional data is collected on relevant variables and provides a very natural view of the answers being searched for, but there is some influence over what happens and it is possible for the researcher to be biased in the measurement of the variables, so the researcher must be careful to be completely impartial.

For this dissertation the technique shall be comprised as collecting the cross-sectional data obtained from the questionnaires and literature review.

3.7 Literature Review

An analytical literature was carried out effectively evaluating the research scope with the existing knowledge on the subject and past researches, to hinder repetition and secure the viability of the current research aim and objectives, to strategically approach a methodology, to find suitable routs for cultivate knowledge, and to support the modeled objectives and research questions (Fellows and Liu, 2003). According to the literature review this study helped to comprehend the parameters, necessities, hindsight and the issues associated with research aim; “delay”. The literature review was carried out by surveying; textbooks, specialist journals, newspaper publications, and electronic sources, and the secondary data.

3.7.1 Categorization Group of Delays

Through the finding accompanied by the literature review and according to the studies carried out by Chan and Kumaraswamy (1996), Majid and Caffer (1998), Odeh and Battaineh (2002), Le-Hoaietal (2008), Ogunlana et al.,(1996), and Sambasivan et al., (2007) on various cases, six groups of delay causes were identified to cover the findings.

The groups are,

- Logic and Environment,
- Managerial,
- Monitoring and Controlling Group,
- Financial Group,
- Material, Plant & Equipment,
- Human Resources.

These groups are composed with the frequent delay causes that occur in road construction projects. Furthermore, the outcome of the delays subjected in these groups has most potential of affecting the contractor’s profit. To gain a better perspective of these groups and the outcome of the delay causes, these groups were used as the contingent for the questionnaire survey one.

Additionally, to gain an enhanced insight of the effects of these delay groups, 63 numbers of delay causes were divided under the six categories. Under the findings of the literature survey, these divided delay causes have more potential to affect contractor's profit throughout the projects carried out in Sri Lanka.

The classifications of six groups are discussed further below;

Table 3.2 Classification of Causes of Delays

No	Factors
	Logic and Environment
1	Weather condition
2	Natural disaster
3	Rework from poor material quality
4	Rework from poor workmanship
5	Disturbance from public activities
6	Poor soil suitability
7	Lack of detail in surveys
8	Lack ground condition details
9	Limited area for the Site
10	Rework due to mistakes in construction

No	Factors
	Managerial
11	Delays in decision making
12	Late issuing of approval documents
13	Postponement of project
14	Late submission of nominated materials
15	Late land hand-over
16	Poor communication between construction parties
17	Unreasonable project time frame
18	Poor resource management

19	Changes in management ways
20	Design changes
21	Internal administrative problems
22	Undefined scope of working
23	Late documentation
24	Delay in commencement
25	Improper construction method
26	Inaccurate planning and scheduling
27	Ineffective time management
28	Poor site management and supervision
29	Impact of Low liquidity
30	Delay in mobilization

No	Factors
	Monitoring and Controlling
31	Insufficient controlling and monitoring
32	Failure to give expedient solutions to problems
33	Political influences
34	Delay in quality assurance/control
35	Long waiting time for approval of tests and inspection
36	Slow decision making
37	Inadequate staff
38	Late design works
39	Mistake in design
40	Inappropriate design
41	Late inspection
42	Late approval
43	Insufficient inspectors
44	Incapable inspectors
45	Poor coordination with parties

No	Factors
	Financial Group
46	Delay in approving payments
47	Delay in approving extra work and variations
48	Rate fluctuation
49	Conflict with contractors
50	Monopoly
51	Changing of banker's policy for loans
52	Nonpayment of mobilization advance
53	Ineffective delay penalties

No	Factors
	Material, plant & Equipment
54	Low productivity and efficiency of equipment
55	Low quality of material
56	Shortage of material in the market
57	Changes in material types and specifications during the construction
58	Delay in material delivery
59	Damages to the material in transport and storages

No	Factors
	Human Resources
60	Unavailability of experienced technical staff
61	Scarcity of skill labours
62	Shortage of labours
63	Low productivity level of labours

3.8 Questionnaire Survey

The main technique of data collection used on this study was the questionnaire surveys. According to Kothari (2004), use of questionnaire surveys is one of the most reliable and consistent data collection methods in research works. Furthermore, Questionnaire surveys substantially obtain data on contemporary contexts, practices, perceptions, and insight in specific and productive manner (Orodho, 2008).

3.8.1 Questionnaire Design

In a research a constructive questionnaire design is a key to obtaining good survey results and warranting a high rate of return (Zikmund, 2000). Data was primarily gathered by providing two questionnaires to the professionals in the industry. The questionnaires were classified in to two main parts;

On the questionnaire Survey 01, "Section A" of the questionnaire, was to form general information of the company, experience of the professional and the history of revenue of the company currently working on. On section B of the questionnaire the professionals were required to place their opinion to identify the frequency of the causes of delay by filling the boxes on a scale of rarely to constantly through their understanding on the field of construction.

The scales were broken down in to six (6) major factors in order to classify the effects of delay causes to the contractor's profit. These groups were predefined at the categorization of the factors causing delays on the literature review and were incorporated to the questionnaire surveys here after to suit the study. The group factors are, Logic & Environment Group, Managerial Group, Monitoring & Controlling Group, Financial Group, Material, Plant & Equipment Group and Human Resources Group. Using these groups of delay causes the professionals were required to fill the boxes on a Likert scale of 1– Very Low to 5– Very High to stipulate the frequency of contribution to the delay causes, under the section B. And to find out the severity of these delay causes all the professionals were required to fill the boxes under the same delay causes identified above on Likert scale of Very Low to Very High.

Under section C the professionals were to sort through a list of effects on a scale of never to always defining the effects of delays to the construction and on Section D the professionals were required to sort the effectiveness of the methods that were taken to minimize the delays on past and current construction projects.

The Questionnaire Survey two indicts how the selected factors from the questionnaire survey 01 effect the profit of the contractor. The professionals were requested to categorize the factors under personal experience, on a scale of rarely contributing to constantly contributing to affirm finding on the questionnaire survey one.

In conclusion, the professionals were asked whether any propositions were taken to minimize the delay causes. In addition, with the gathered and analyzed data, the research shall develop a matrix showing the best representation of delay causes. As Quantitative method was the primal data collective method, it breads data for analysis and shall be documented in two stages as follows:

- An assessment of the literature review to establish and fill the knowledge gap.
- In creation of questionnaire under the findings of the literature review and disburse among various stakeholders who are engaged professionally in the construction industry.

Kallet (2004), clarified that the methodology should define the procedure carried out to answer the problem statement, describe the protocol and limitations, justify the preliminary prototype, and comprehensively define the method of analyzing the data. Moreover, the assembled method section must prescribe the resources applied to the study, clarify how the resources were organized for the study, outline the research procedure, explain how the finding were analyzed *and calculated, and finally state what are the carried out statistical assessments to analyze the gathered data.*

As described earlier, the questionnaire method was adopted as a quantitative approach to gain factually analytical data to understand people's perception concerning the cause of delays in the construction projects. The personal chosen for the survey were people who have experienced practical extents on road projects such as engineers, project managers, designer quantity surveyors etc.

Rowley (2014) stated, that adopting the questionnaire approach is justifiable under the following circumstances,

- The research objectives center on surveying and outlining a condition, to develop conclusive patterns.
- Sufficient is already known about the situation under study that it is possible to formulate meaningful questions to include in the questionnaire.
- Willing respondents can be identified, who are in a position to provide meaningful data about a topic. Questionnaires should not only suit the research and the researcher, but also the respondents.

Hence, in this research, questionnaire is mainly considered as the necessary structure to collect the required data.

3.9 Selection of the Sample

To select a sample from a broad frame of samples can be observed under probability or non-probability sampling methods. A probability sample method proposes that every candidate in the overall research population has an equal and proportionate chance of being selected. Whereas, in non-probability sample method the researcher holds bases in selecting the criteria of comprehension of the individual/ group, the accessibility to information, the professionalism of the individual/ group to make and ideal case (Knight et al., 2009). In this study, the researcher used a non-probability sampling frame.

3.9.1 Non-Probability Samples

As they are not truly representative, non-probability samples are less desirable than probability samples. However, a researcher may not be able to obtain a random or stratified sample, or it may be too expensive. A researcher may not care about generalizing to a larger population. The validity of non-probability samples can be increased by trying to approximate random selection, and by eliminating as many sources of bias as possible (Doherty, 1994).

Non-Probability Sampling was used for the study due to following properties it brings to the study;

- Non-Probability Sampling shall be used when demonstrating that particular trait exists in mass community.
- If the researcher is keen on pilot or exploratory study using a non-probability sampling can have high effect on results.
- It can be used when the test group is limitless and randomly picking candidates is impractical and impossible.

Before choosing Non-Probability Sampling advantages and disadvantages of using the sampling method was reviewed.

3.9.2 Advantages of Non-Probability Sampling

Non-Probability Sampling is more beneficial and practical when the researcher is deploying the quantitative survey with real world elements. If the sampling method used in a correct manner Non-Probability Sampling shall yield statistically analyzable quality data.

Receiving/ finding data from Non-Probability Sampling is comparably faster and is way more cost effective than Probability Sampling as a result of the sample demography is known to the researcher hence, they are motivated and keen to quick respond rather than a group chosen randomly (Doherty, 1994).

3.9.3 Disadvantages of Non-Probability Sampling

Although, when using Non-Probability Sampling the researcher must think through potential reasons for individual perspective/ biases and the researcher should get the sample that closely represent the mass community.

When Non-Probability Sampling have been chosen the researcher must be careful of distortion of the data by the recruits because at the end of the day researcher must suffice significant insights and useful data for proper analysis of the objectives (Doherty, 1994).

3.10 Data Analysis

Under the sector of data analysis, the researcher must institute ground rules of data analysis, establish methods to present data, and how-to breakdown and describe the analyzed data without being bias or extorting the facts. Similarly, the researcher should present the findings in such a way where the reader is induced by the provided information. Furthermore, presenting sheets of data with mere relationship to the subject and/or presenting inconceivable data should be avoided in any costs, unless the presented data has a concurrent relationship to reveal other finding by comparison or further analysis.

> *Panas and Pantouvakis, (2010) note the need to continually evaluate and re-evaluate results and to be sensitive in data analysis in order to gain an in-depth perspective of a study's implications.*

Since the research data collection was quantitative, it provides comprehensible and calculable results and therefore shall be very helpful in evaluation. These results can be analyzed using Relative Importance Index – RII or Analytical Hierarchy Process – AHP, and in this case it was focused on Relevant Importance Index – RII.

3.10.1 Data Analysis Method

The gathered data was studied based on the following statistical analysis techniques to direct the Metrix of frequency and the severity of delays before using RII to identify the Causes of delays. These equations are described as follows (Assaf and Hejji, 2006).

Frequency Index: A formula was used to rank causes of delay based on frequency of occurrence as identified by the survey participants.

Frequency Index = *(F.I)(%)= Σa(n/N)*100/5 …………………. (1)*

Where "a" is the constant expressing weight given to each response (ranges from 1 for rarely up to 5 for constantly), "n" is the frequency of the responses, and "N" is total number of responses.

Severity Index: A formula was used to rank causes of delay based on severity as indicated by the participants.

Severity Index = *(S.I)(%)= Σa(n/N)*100/5……………………… (2)*

Where "a" is the constant expressing weighting given to each response (ranges from I for slightly to 5 for extremely), "n" is the frequency of the responses, and "N" is total number of responses.

Both frequency index of occurrence and severity index were categorized according to Table 3.3 and rendered via risk matrix as shown in Figure 3.3 (Mahamid, 2011).

Table 3.3 Risk Metrix

Scale used to identify factor's severity and frequency of occurrence scale	**Severity Index**	**Frequency of occurrence**
< 20%	very low (VL)	very low (VL)
20% - 40%	low (L)	low (L)
40% - 60%	moderate (M)	moderate (M)
60% - 80%	high (H)	high (H)
80% - 100%	very high (VH)	very high (VH)

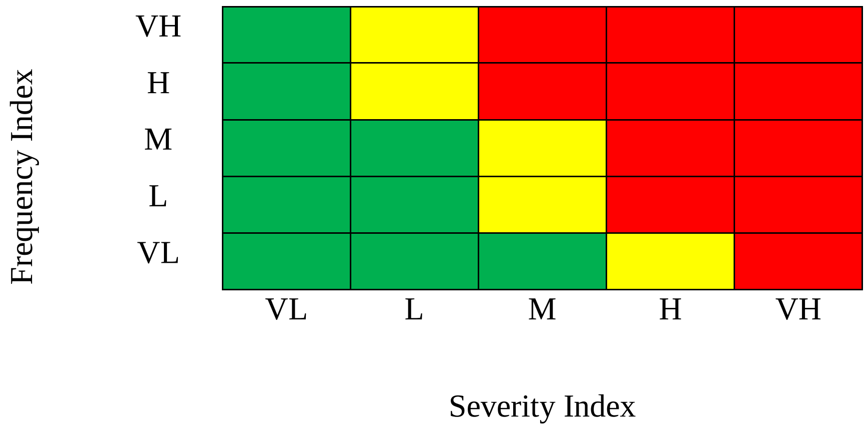

Figure 3.3 Risk Matrix

The map is classified into three zones:

- Green zone**:** risks in these zones are low level.
- Yellow zone: risks in these zones are of moderate importance.
- Red zone: risks in these zones are of critical importance.

Relative Important Index (RII): As mention in the literature review, Relative Importance Index (RII) was used to determine the relative importance of the various causes and effects of delays. The method was adopted in this study within various groups (i.e. clients, consultants or contractors). The five-point Likert scale ranged from 1 (not important) to 5 (extremely important) was adopted and was figured in to relative importance indices (RII) for ranked the effect of delay causes, method to minimizing causes of delay and causes of key delays effect to the contractor's profit.

3.11 Chapter Summary

This chapter strategically presents the methodology adopted and how the methodology was used for its potential for this dissertation. This was carried out by discussing the theoretical foundations of the methodology, and the actual practicalities when conducting the study.

Quantitative approach is used to gather factual data and to study relationships between facts and how such facts and relationships accord with indexes and ultimately rendered through risk matrix to classify the key causes of delays.

Through the findings of the risk matrix, a second questionnaire was prepared a distributed among industry professionals, elongating the qualitative attribute of the study.

The questionnaires were developed to quantify the impact of the major causes of delay and how it affects the contractor's profit in road construction industry of Sri Lanka. Then the data was analyzed using Relevant Importance Index in validating the aim and objective of the research.

CHAPTER FOUR

4.0 DATA ANALYSIS AND DISCUSSIONS

4. 1 Introduction

This chapter presents the data collection and analysis based on two questionnaire surveys. Questionnaire one includes Section A which represent the respondent's present company and profile. Section B of Questionnaire One was prepared to achieve the first and the second objectives of this study. These objectives intend to classify the delay causes in road construction projects and recognize the frequency & severity indexes of the causes of the classified/identified delays to form a risk matrix. Section C, of the questionnaire was designated to obtain data for the third objective of this study. The third objective was intended to classify the effects of delay in road construction projects in Sri Lanka. Finally, the section D of the questionnaire was designated to obtain data attributable to fifth objective of the study, classify the methods of mitigating delays in road construction projects in Sri Lanka. Further to questionnaire one, a second questionnaire was cumulated to identify key delay causes impacting to contractor's profit in road construction projects. Both of these questionnaires were circulated among seasoned professionals in the construction field to get the maximum outcome. The collected data was then analyzed by using the method as stated on Chapter Three.

4.2 Data Collection

For data collection via questionnaire survey, non-probability sampling method was implemented. Since non-probability method produce significant insights and useful data for proper analysis of the objectives when used with proper recruits to submit their expertise.

To gather a competent volume of data from the questionnaire survey one, a collective sum of 52 nos of questionnaires were distributed among the group of professionals and 37 nos, which was 71.2% of professionals responded with their expertise on the matter. Secondly a questionnaire two was designed and disbursed amidst the same group of professionals who were involved in the first questionnaire process. As a result, 37 nos of questionnaires were distributed among the professionals and the respond was 31 nos, which was 83.8% for the questionnaire survey two as shown in Table 4,1.

Table 4.1 Responding percentages to questionnaire surveys

	Questionnaire Survey One	**Questionnaire Survey two**
Distributed	52	37
Responded	37	31
Response Percentage	**71.2%**	**83.8%**

A total of thirty-seven (37) sets of questionnaires were collected after distribution from the designated respondents in order to gain data to identify the significant factors that causes delays, the common effect of delay causes, and methods of mitigating road construction delay causes.

The questionnaires were distributed to a group of industry professionals contained with Contractors, Consultants, and Designers who have taken part and well experienced in the Road construction projects.

4.2.1 Respondents According to Their Dedicated Field

In order gain a better perspective the professional experts in the field of construction were requested to contribute their expertise regarding delay causes. Furthermore, the professional experts were selected through a tough censoring procedure to represent all categories of the construction industry such as; Client, Contractor, Consultant, Others, as in; Sub-contractor/ Suppliers.

Contractors were the dominant portion of the respondents counting up with 57 % of the total responds and consultants who were working with specialized firms in consulting road construction projects came in second with 24 % of the total. Clients came in as third portion with a count of 14 % of the respondents where 5 % counted as others as in suppliers/ sub-contractors. The numbers of respondents based on organization type are shown in Figure 4.1.

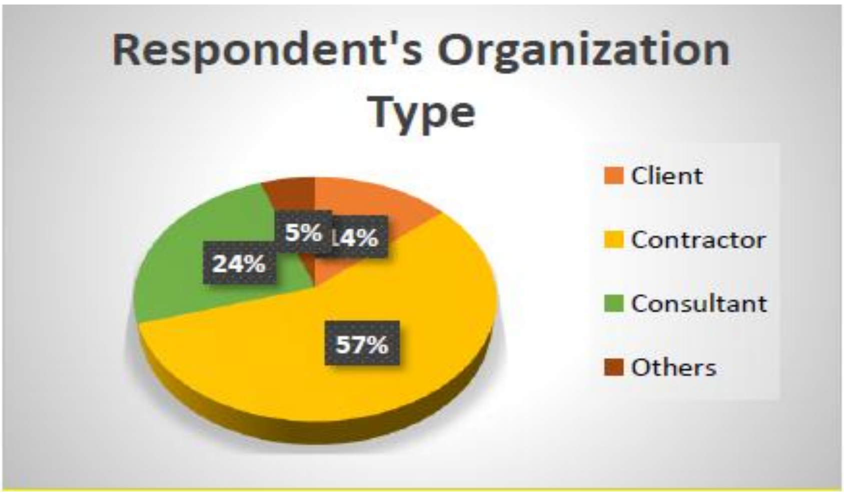

Figure 4.1: Respondents Organization type

4.2.2 Position of Respondents

Figure 4.2 shows that 51% from the respondents were site managers / engineers, 14 % were project managers, 11 % were designers, and 24% were others such as: Technical offices, Safety officers, quantity surveyors, etc.

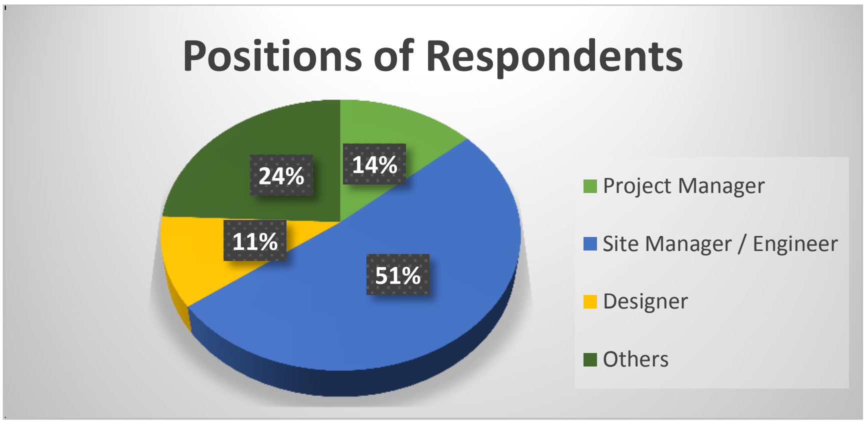

Figure 4.2: Position of Respondents

4.2.3 Years of Experience for the Organization

Figure 4.3 observed that 46% of the surveyed samples have experience more than 15 years, while 3% of the surveyed samples have experience less than 5 years for their organizations.

The survey presents that, the it occupied to reflect better indicators since the results were concentrated and conclusive to add depth for the study. The findings further acknowledged that long years of experience, on hand knowledge and practice in management these organizations obtained. Moreover, the variations of the experiences of the subjects in each group (less than 5 years, from 5-10 years from 10-15 years and more than 15 years) will improve the study via providing diverse knowledge and information levels.

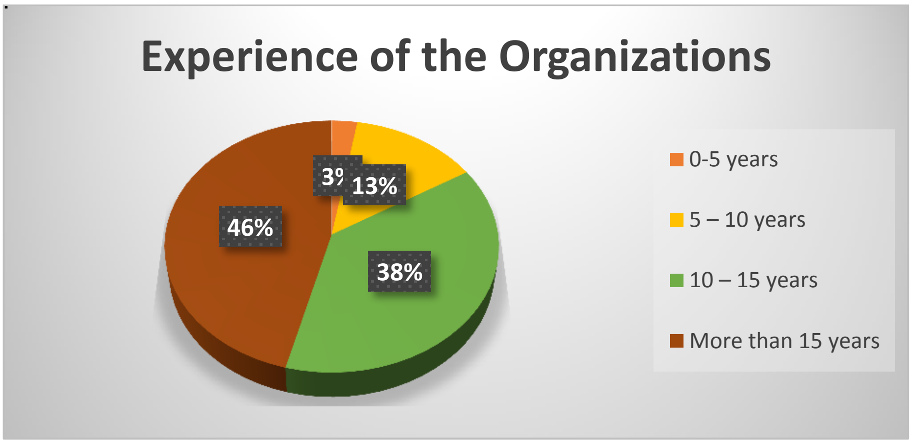

Figure 4.3: Years of Experience for the Organizations

4.2.4 Number of Projects Implementations in the Last Five Years

As shown in Figure 4.4, 60 % of the companies' (the companies mentioned here are the ones that the group of professionals are working in.) have undertaken 21 to 30 projects within the period of 5 years. This means in an average of five projects per year. Also 5% of the companies have a volume of work from 1-10 projects in the last five years. This indicates that the companies which implement more projects per year have a better capacity, experience, competency and potential with handling projects and a better understanding of delay causes, rather than the companies which implements a smaller number of projects per year.

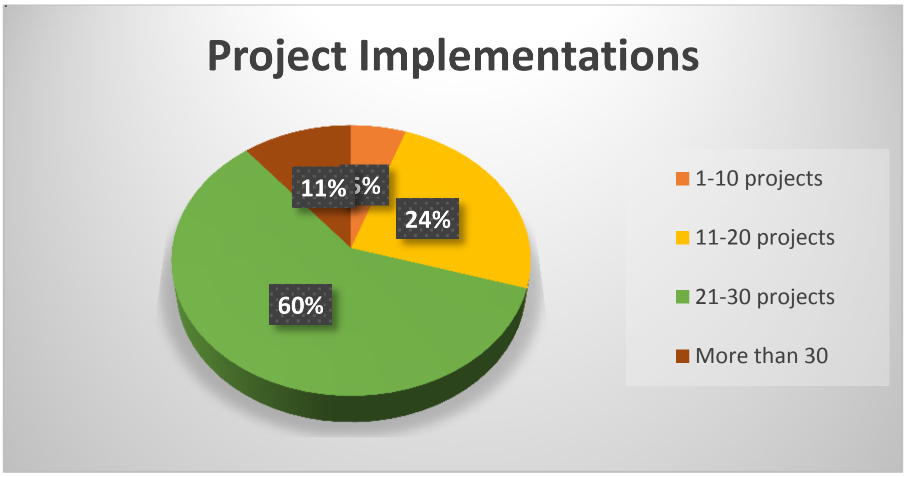

Figure 4.4: Number of Projects Implementations in the Last Five Years

4.2.5 Respondent's Years of Experience

Figure 4.5 shows that 5% from the respondent have between 1-3 years of experience, 11 % have between 4-5 years of experience. 65% have between 6-10 years of experience, and 19% have more than 10 years of experience. These results provide a sufficient satisfaction on the obtained data since it reflects the prominence of its design. Furthermore, it is a fact and a valuable asset to maintain a good relationship between the researcher and the respondents to gain a better outcome of satisfactory inputs, facts and information.

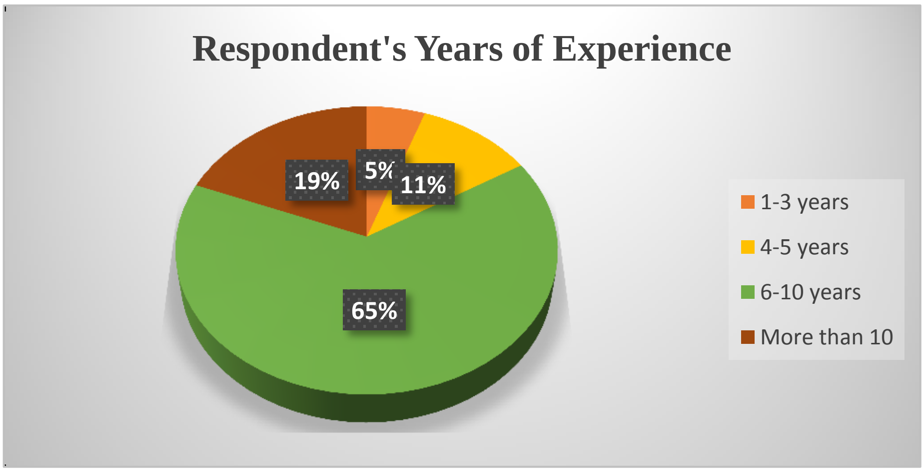

Figure 4.5: Years of Experience in the Organization

4.3 Development of Risk Matrix for the Causes of Delay

A risk matrix is a graph where one axis is divided to designate categories of probability and the other axis is designated to categorize the consequences. Probability may be expressed as frequency and consequences may defined as severity of the causes for research purposes.

Risk matrixes are used to assess the risk element in any given scenario. Potential undesirable events and occurrences can be identified via a proper Risk Matrix. To gain a sincere outcome, each event is documented and assigned to a probability and consequence category (see Table 4.2). The probability category indicates the extreme chances of an event may occur and the consequences category indicates the severity of the cause by the occurrence of the event. For any pre identified event the Risk Matrix will assign a priority level. The organization's risk management protocols uses these priority levels provide by the risk matrix to specify acceptability, urgency, priority, required level of management attention, etc.

Index	Scale	Categorization	Notation
Frequency	(5)	Very High	VH
	(4)	High	H
	(3)	Moderate	M
	(2)	Low	L
	(1)	Very Low	VL
Severity	(5)	Very High	VH
	(4)	High	H
	(3)	Moderate	M
	(2)	Low	L
	(1)	Very Low	VL

Table 4.2: Likert scale notation of indexes

NOTE: The notation shown in the Table 4.2 was used in categorization of the contributions on the questionnaire surveys and will be used on the report here forth.

4.3.1 Logic and Environment Group

The Table 4.3 and Figure 4.6 illustrate the risk matrix for causes of delays under Logic and Environmental group; ten causes of delays were considered under this group. The results indicate that four delay causes are located in the red zone, five delay causes are located in the yellow zone and one delay cause is located in the green zone.

Table 4.3: Risk matrix for delay causes under logic and environment group

	Logic and Environment					
No	**Causes of delays**	**Severity index(SI)**	**Level**	**Frequency Index(FI)**	**Level**	**Matrix Zone**
1	Weather condition	75.7	H	72.4	H	RED
2	Natural disaster	42.7	L	39.5	L	YELLOW
3	Rework from poor material quality	56.8	L	39.5	L	YELLOW
4	Rework from poor workmanship	49.7	M	45.9	M	YELLOW
5	Disturbance from public activities	77.3	VH	84.9	VH	RED
6	Poor soil suitability	62.2	H	79.5	H	RED
7	Poor terrain condition	41.6	L	38.9	L	YELLOW
8	Poor ground condition	58.9	M	58.9	M	YELLOW
9	Limited construction area	74.6	VH	82.2	VH	RED
10	Rework due to mistakes in construction	38.4	M	48.1	M	GREEN

As identified on the Logic and Environment group Figure 4.6, the delay causes are categorized under the Matrix Zone as below, where the Red Zone has the highest capacity in occurrence of delay causes and the Green Zone effects minimal.

✓ Rework due to mistakes in construction	✓ Natural disaster ✓ Rework from poor material quality ✓ Rework from poor workmanship ✓ Poor terrain condition ✓ Poor ground condition	✓ Weather condition ✓ Disturbance from public activities ✓ Poor soil suitability ✓ Limited construction area

Figure 4.6: Risk zones for delay causes under logic and environment group

4.3.2 Managerial Group

The Table 4.4 illustrates the risk matrix for causes of delays under managerial group; twenty delay causes were considered under this group. The results indicate that six delay causes were located in the red zone, ten delay causes are located in the yellow zone and four delay causes are located in the green zone.

Table 4.4: Risk matrix for delay causes under Managerial Group

	Managerial					
No	**Causes of delays**	**Severity index(SI)**	**Level**	**Frequency Index(FI)**	**Level**	**Matrix Zone**
11	Delays in decision making	61.7	H	65.9	H	RED
12	Late issuing of approval documents	38.9	M	42.2	M	YELLOW
13	Postponement of project	36.8	M	43.2	M	GREEN
14	Late submission of nominated materials	43.2	L	37.8	L	YELLOW
15	Late land hand-over	53.5	M	49.7	M	YELLOW
16	Poor communication	76.2	H	68.6	H	RED

	between construction parties					
17	Unreasonable project time frame	52.4	M	55.1	M	YELLOW
18	Poor resource management	79.5	H	77.3	H	RED
19	Changes in management ways	36.8	L	33.5	L	GREEN
20	Design changes	47.0	L	28.6	L	YELLOW
21	Internal administrative problems	42.7	L	33.0	L	YELLOW
22	Undefined scope of working	49.2	L	29.7	L	YELLOW
23	Late documentation	36.8	L	36.8	L	GREEN
24	Delay in commencement	40.0	L	25.4	L	YELLOW
25	Improper construction method	43.8	M	41.1	M	YELLOW
26	Inaccurate planning and scheduling	75.7	VH	94.6	VH	RED
27	Ineffective time management	81.1	VH	84.3	VH	RED
28	Poor site management and supervision	75.1	VH	90.8	VH	RED
29	Poor liquidity	36.8	L	33.5	L	GREEN
30	Delay in mobilization	42.7	L	31.9	L	YELLOW

As identified on the Managerial Group Figure 4.7, the causes of delays are categorized under the Matrix Zone as below, where the Red Zone has the highest capacity in occurrence of delay causes and the Green Zone effects minimal.

✓ Postponement of project ✓ Changes in management ways	✓ Late issuing of approval documents ✓ Late submission of nominated materials	✓ Delays in decision making ✓ Poor communication between construction parties

✓ Late documentation ✓ Poor liquidity	✓ Late land hand-over ✓ Unreasonable project time frame ✓ Design changes ✓ Internal administrative problems ✓ Undefined scope of working ✓ Delay in commencement ✓ Improper construction method ✓ Delay in mobilization	✓ Poor resource management ✓ Inaccurate planning and scheduling ✓ Ineffective time management ✓ Poor site management and supervision

Figure 4.7: Risk zones for delay causes under Managerial Group

4.3.3 Monitoring and Controlling Group

The Table 4.5 illustrates the risk matrix for causes of delays under monitoring and controlling group; 15 delay causes were considered under this group. The results indicate that four delay causes are located in the red zone, nine delay causes are located in the yellow zone and two delay causes are located in the green zone.

Table 4.5: Risk matrix for delay causes under Monitoring and Controlling

No	Causes of delays	Severity index(SI)	Level	Frequency Index(FI)	Level	Matrix Zone
	Monitoring and Controlling					
31	Insufficient controlling and monitoring	75.7	VH	84.9	VH	RED
32	Failure to give expedient solutions to problems	48.1	H	37.3	L	YELLOW
33	Political influences	77.3	H	76.2	H	RED
34	Delay in quality assurance/control	40.0	L	29.7	L	YELLOW
35	Long waiting time for approval of tests and inspection	40.0	L	37.3	L	YELLOW
36	Slow decision making	74.6	M	58.9	M	RED
37	Inadequate staff	42.7	L	29.7	L	YELLOW
38	Late design works	42.2	M	41.7	M	YELLOW
39	Mistake in design	40.5	L	34.7	L	YELLOW
40	Inappropriate design	43.8	L	38.9	L	YELLOW
41	Late inspection	42.7	L	37.8	L	YELLOW
42	Late approval	44.3	M	44.3	M	YELLOW
43	Insufficient inspectors	37.3	L	31.9	L	GREEN
44	Incapable inspectors	39.5	L	34.6	L	GREEN
45	Poor coordination with parties	72.4	H	62.2	H	RED

As identified on the Monitoring and Controlling Group Figure 4.8, the causes of delays are categorized under the Matrix Zone as below, where the Red Zone has the highest capacity in occurrence of delay causes and the Green Zone effects minimal.

✓ Insufficient inspectors	✓ Failure to give expedient solutions to problems	✓ Insufficient controlling and monitoring

✓ Incapable inspectors	✓ Delay in quality assurance/control	✓ Political influences
	✓ Long waiting time for approval of tests and inspection	✓ Slow decision making
		✓ Poor coordination with parties
	✓ Inadequate staff	
	✓ Late design works	
	✓ Mistake in design	
	✓ Inappropriate design	
	✓ Late inspection	
	✓ Late approval	

Figure 4.8: Risk zones for delay causes under Monitoring and Controlling

4.3.4 Financial Group

The Table 4.6 illustrates the risk matrix for causes of delays under financial group; 8 causes of delays were considered under this group. The results indicate that three delay causes are located in the red zone, two delay causes are located in the yellow zone and three delay causes are located in the green zone.

Table 4.6: Risk matrix for delay causes under Financial Group

	Financial Group					
No	**Causes of delays**	**Severity index(SI)**	**Level**	**Frequency Index(FI)**	**Level**	**Matrix Zone**
46	Delay in approving bill and payments for the bill	74.6	VH	88.1	VH	RED

47	Delay in approving extra work and variations	77.8	H	75.7	H	RED
48	Rate fluctuation	37.3	L	30.3	L	GREEN
49	Conflict with Sub contractors	77.8	VH	84.3	VH	RED
50	Monopoly	38.9	L	25.9	L	GREEN
51	Changing of bankers policy for loans	40.0	L	33.0	L	YELLOW
52	Nonpayment of mobilization advance	36.2	M	40.5	M	GREEN
53	Ineffective delay penalties	46.5	M	51.4	M	YELLOW

As identified on the Financial Group the delay causes Figure 4.9, Causes of delays are categorized under the Matrix Zone as below, where the Red Zone has the highest capacity in occurrence of delay causes and the Green Zone effects minimal.

✓ Rate fluctuation ✓ Monopoly ✓ Nonpayment of mobilization advance	✓ Changing of bankers policy for loans ✓ Ineffective delay penalties	✓ Delay in approving bill and payments for the bill ✓ Delay in approving extra work and variations ✓ Conflict with Sub contractors

Figure 4.9: Risk zones for delay causes under Financial Group

4.3.5 Material, Plant, & Equipment Group

The Table 4.7 illustrates the risk matrix for causes of delays under Material, Plant, & Equipment group; 6 delay causes were considered under this group. The results indicate that one delay cause is located in the red zone, five causes of delays are located in the yellow zone and zero causes of delays are located in the green zone.

Table 4.7: Risk matrix for causes of delays under Materia, plant & Equipment

	Material, Plant & Equipment					
No	**Causes of delays**	**Severity index(SI)**	**Level**	**Frequency Index(FI)**	**Level**	**Matrix Zone**
54	Low productivity and efficiency of equipment	74.1	M	58.9	M	RED
55	Low quality of material	37.8	H	68.1	H	YELLOW
56	Shortage of material in the market	42.2	L	37.3	L	YELLOW
57	Changes in material types and specifications during the construction	39.5	H	60.0	H	YELLOW
58	Delay in material delivery	40.5	M	40.5	M	YELLOW
59	Damages to the material in transport and storages	39.5	L	37.3	L	YELLOW

As identified on the Material, Plant, & Equipment Group Figure 4.10, the causes of delays are categorized under the Matrix Zone as below, where the Red Zone has the highest capacity in occurrence of delay causes and the Green Zone effects minimal.

	✓ Low quality of material ✓ Shortage of material in the market ✓ Changes in material types and specifications during the construction ✓ Delay in material delivery ✓ Damages to the material in transport and storages	✓ Low productivity and efficiency of equipment

Figure 4.10: Risk zones for causes of delays under Financial Group

4.3.6 Human Resources

The Table 4.8 illustrates the risk matrix for causes of delays under Human Resources group; 4 causes of delays were considered under this group. The results indicate that three causes of delays are located in the red zone, one causes of delay is located in the yellow zone and zero delay causes are located in the green zone.

Table 4.8: Risk matrix for causes of delays under Human Resources

	Human Resources					
No	**Causes of delays**	**Severity index(SI)**	**Level**	**Frequency Index(FI)**	**Level**	**Matrix Zone**
60	Unavailability of experienced technical staff	59.5	M	57.8	M	YELLOW
61	Scarcity of skill labours	78.9	H	76.2	H	RED
62	Shortage of labours	76.2	VH	83.8	VH	RED
63	Low productivity level of labours	75.1	H	76.2	H	RED

As identified on the Human Resources Group Figure 4.11, the causes of delays are categorized under the Matrix Zone as below, where the Red Zone has the highest capacity in occurrence of delay causes and the Green Zone effects minimal.

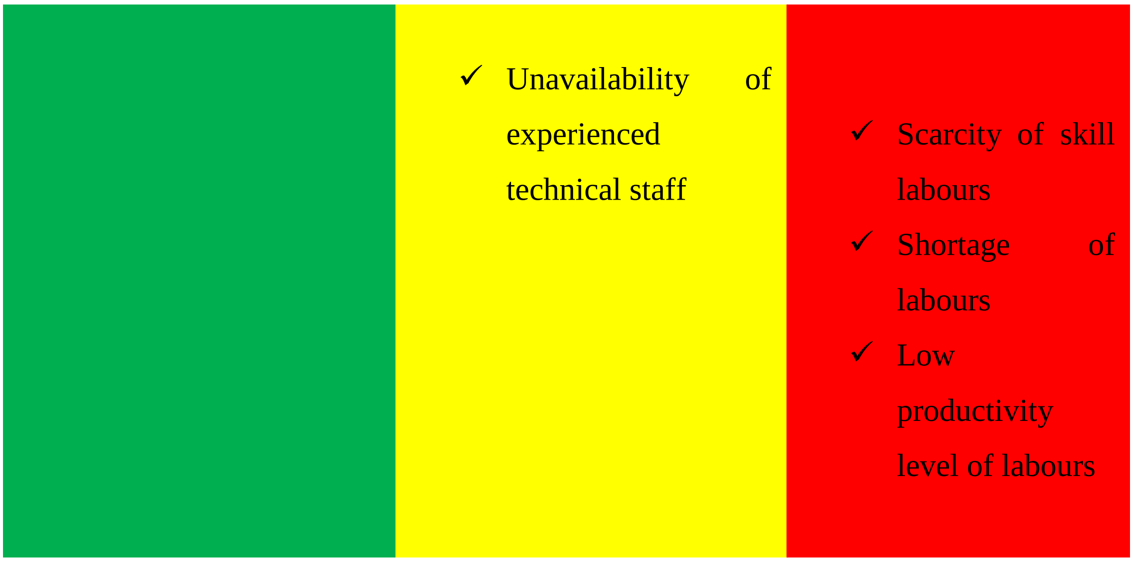

Figure 4.11: Risk zones for causes of delays under Human Resources

Here the delay causes indicted on the red box via the risk matrix are the major causes of delays that effects the construction the most.

4.4. Effects of Construction Delays

Based on the findings of the literature review, under the preliminary investigations of constructions, and by the limitations of this research, it was possible to identify certain major effects of delay causes on project delivery. To elaborate on the subject, seven major effects were identified as followings; time overrun, cost overrun, dispute, arbitration, total abandonment, litigation, and Suspension of the work as shown in Table 4.9. The questionnaire survey was designed and distributed among targeted respondents in order to obtain information about the effects of delay causes in construction project.

The factors that have definitive effects on delay causes were identified and ranked based on the Relative Important Index (RII) which calculates, as presented on Table 4.9.

Table 4.9. Effects of Construction Delay causes in construction project

No	Effect	RII %	Rank
1	Time Overrun	74.05	1
2	Cost Overrun	70.81	2
3	Dispute	60.54	3
4	Arbitration	55.14	5
5	Total abandonment (Contract Termination)	47.03	7
6	Litigation.	52.97	6
7	Suspension of the work	56.22	4

Here it shows time overrun and cost overrun were the two most common effects of delay causes in construction project.

4.5. Affected by “Loss of Profit” due to Major Causes of Delay in Company

Using the data gathered from Questionnaire One, a Second Questionnaire was built to indict how the selected causes of delays from the questionnaire survey one effect the profit of the contractor. To gain a precise perspective, the second questionnaires were distributed among the same professionals that were involved on the first questionnaire. The responders were requested to categorize the delay causes under previous experience, on a Likert scale of rarely contributing to constantly contributing.

The questionnaire commenced as the responders were required to direct the initiation by answering whether the “company has effected from loss of profit due to major delay causes”. This was used as the threshold to determine the actual effect of the major delays in construction. Figure 4.12 shows, 89 % of the responders answered yes to the question optimizing the fact effect of major delay causes to loss of profit. And 11 % of the responders answered that there has not been a loss of profit by commenting “no” on the question. The survey carried out with the data gathered from the 89 percentile which conceded that there was a loss of profit or risk of loss of profit due to delays causes.

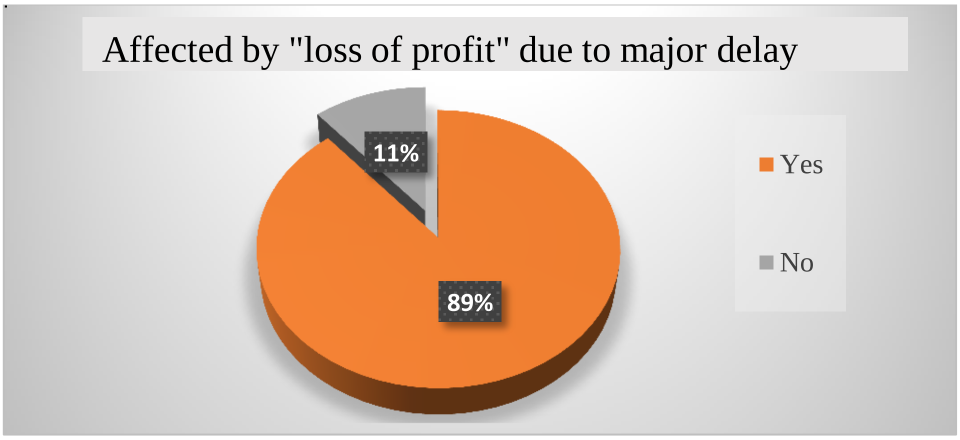

Figure 4.12. Affected by “loss of profit” due to major delay causes

4.6 Effect of Delay Causes to the Profit

Based on the questionnaire 01, precisely 21 nos of delay causes were identified as the major causes of delays. To find which delay causes were heavily contribute to effect the contractor’s profit these isolated delay causes were comprised under six groups,

- Logic and Environment Group
- Managerial Group
- Monitoring and Controlling Group
- Financial Group

- ➢ Material, Plant & Equipment Group
- ➢ Human Resources Group

The key causes of delays under the allocated groups were then ranked using the RII to find which causes of delays has the most effect to the contractor's profit. The results are shown in the Table 4.10.

Table 4.10: Ranking of key delay causes affect Contractor's Profit

No	Causes of delays	RII %	Rank
	Logic and Environment		
1	Weather condition	39.3	17
2	Disturbance from public activities	46.7	12
3	Poor soil suitability	34.1	19
4	Limited construction area	28.1	21
No	**Causes of delays**	**RII%**	**Rank**
	Managerial		
5	Delays in decision making	61.5	4
6	Poor communication between construction parties	45.9	13
7	Poor resource management	59.3	9
8	Inaccurate planning and scheduling	60.7	8
9	Ineffective time management	61.5	4
10	Poor site management and supervision	42.2	16
No	**Causes of delays**	**RII%**	**Rank**
	Monitoring and Controlling		
11	Insufficient controlling and monitoring	63.0	3
12	Political influences	43.0	15
13	Slow decision making	34.8	18
14	Poor coordination with parties	32.6	20
No	**Causes of delays**	**RII %**	**Rank**
	Financial Group		
15	Delay in approving bill and payments for the bill	60.7	6
16	Delay in approving extra work and variations	45.2	14
17	Conflict with Sub contractors	57.0	10
No	**Causes of delays**	**RII %**	**Rank**
	Material, Plant & Equipment		
18	Low productivity and efficiency of equipment	60.7	5
No	**Causes of delays**	**RII %**	**Rank**
	Human Resources		
19	Scarcity of skill labours	64.4	2
20	Shortage of labours	54.8	11
21	Low productivity level of labours	65.2	1

From the 21 number of identified factors which causes major delays in construction

The delay causes that are ranked with heights number were selected as the major candidate and will be discussed further on chapter 5.

4.7 Precaution for Minimizing the Causes of Delays

Figure 4.13 shows that 96% from the respondents were taken to precautions to minimizing the causes of delay, 4 % were not taken to actions to minimizing the delay causes.

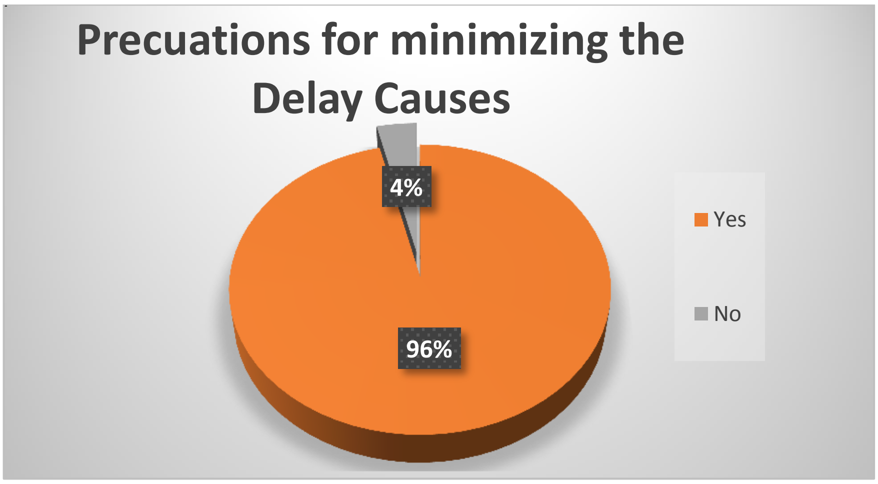

Figure 4.13. Precautions taken to minimizing the delay causes

4.8 The Methods of Minimizing Construction Delays

In Table 4.11 shows the results of methods of minimizing construction delay causes from the experience and the knowledge of the respondents. These methods of minimizing the construction delay causes were ranked based on the RII to identify the key methods that were used in the field to safeguard the contractor's profit.

Table 4.11 Methods of minimizing construction delay causes

No	**Proposed Method**	**RII %**	**Rank**
1	Frequent progress meeting	68.65	4
2	Use up-to-date technology utilization	44.86	11

3	Use proper and modern construction equipment	43.78	13
4	Use appropriate construction methods	47.03	8
5	Effective strategic planning	42.70	15
6	Proper material procurement	49.73	6
7	Accurate initial cost estimates	51.89	5
8	Clear information and communication channels	45.95	9
9	Frequent coordination between the parties involved	78.38	1
10	Proper emphasis on past experience	43.78	13
11	Effective project planning and scheduling	72.97	2
12	Complete and proper design at the right time	43.78	12
13	Site management and supervision	69.73	3
14	Collaborative working in construction	45.95	9
15	Compressing construction durations	47.57	7

The results of research revealed that;

- Frequent coordination and liaison between the main involved parties
- Effective project planning and scheduling
- Site management and supervision
- Frequent progress meetings
- Accurate initial cost estimates

Were the top five and most effective methods of minimalizing the delaying candidates of a road construction projects.

4.9 Chapter Summary

This chapter summarizes the adaptation of the methods and the scientific analysis of the gathered data for the study. The delay causes identified through the literature review were subjected to the questionnaire survey one and two and with the use risk matrix these delays were rendered down to find the key delay causes that effect the contractor’s profit. Furthermore, the questionnaire survey two used to identify the methods taken to minimize the effects of delay causes which cause of delays damage to the contractor’s profit.

The study disclosed that from a total of 15 methods, Frequent coordination and liaison between the main parties involved, Effective project planning and scheduling, Site management and supervision, Frequent progress meetings, Accurate initial cost estimates are the most reliable methods to safeguard the contractor’s profit in the road construction projects.

CHAPTER FIVE

5.0. CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the final outcome of the study carried out on “safeguard Sri Lankan contractor’s profit through the mitigation of key causes of delay impacting contractor’s profit” in relation of the objectives stated on chapter one. In relationship to the stated objectives a literature survey was carried out to identify the key variables and to unearth the knowledge gap on the issue. Studies and research carried out on the matter on “effect of delay causes to the contractor’s profit” were minimal and lacking in depth to discuss the relativity of the issue yet the current volume of ongoing constructions in Sri Lanka begs on the issue that delay causes do effect the contractor’s profit. Since the availability of existing articles and documents are zero to none and reaching the knowledge gap and closing it was also considered as a subliminal objective of the study. With a thorough literature survey key categories of delay causes were recognized and was subjected to questionnaire survey one to determine the severity and frequency indexes of the delays. A risk matrix was developed from these indexes and finally identified the key delay causes that directly affect the road construction projects in Sri Lanka. With the finding of key delay causes, questionnaire survey two to was formed and distributed among the respondents to identify which of these key delay causes that effect the contractor’s profit. Finally, the study discuss the coordination taken to minimize the effect caused by the classified delay causes and provide recommendations on the issue of “effects of key delays to the contractor’s profit in road construction projects in Sri Lanka.

5.2 Conclusions

Construction Industry is a vital component of Sri Lanka’s financial growth and development. Sri Lanka is heading towards to being a developed country from being a developing country for massive period of time due to the civil wars that devastated the country for almost three decades. Since it’s ascending to higher economical development Sri Lanka has identified that infrastructure development plays a massive role and developing the nations road structure condones massively to the benefit of the economy. Under this assumption the government started initiating massive road construction projects with both local and international contractors.

The requirement of this study originated due to, the effect of major delay causes to the contractors and that delay causes were immensely affecting the local contractors and massive construction cooperation and/or international contractors. Under the expectation of carrying out a thorough study on the subject using scientifically means to gather data and analyze the raw findings using a matrix to reach the pre-set goals and providing a proper recommendation was successfully completed with this chapter.

To brief the finding, the set objectives were;

- To identify the causes of delay in road construction projects in Sri Lanka.
- To develop a risk matrix to identify the key delay causes in road construction projects in Sri Lanka.
- To ranking the effects due to causes of delays in road construction projects.
- To identify the key delay causes impacting contractor’s profit in road construction projects in Sri Lanka
- To identify the methods of mitigating key delay causes impacting the contractor’s profit in road construction projects in Sri Lanka.

The achievement of these objectives are discussed in section 5.1.1 to 5.1.5

5.2.1 Identify the Causes of Delay in Road Construction projects in Sri Lanka

The first objective of the study; to identify the causes of delay in road construction projects in Sri Lanka, was achieved under the literature review by gathering data from articles and scholarly notes that were written on the subject matter. With a thorough research through pre- written documents, data was gathered to identify the causes of delay in road construction projects in Sri Lanka. From this exercise 63 numbers of causes of delay were classified to six numbers of groups.

5.2.2 Develop a Risk Matrix to Identify the Key Delay Causes in Road Construction Projects in Sri Lanka

The second objective of the study was; to develop a risk matrix to identify the key delay causes in road construction projects in Sri Lanka. This was achieved by forming the questionnaire survey one using the classified causes of delays and determining the severity and frequency indexes of the delay causes. The outcome was then subjected to a risk matrix to render the key delay causes (21) that effect the road construction projects.

5.2.3 To Ranking the Effects due to Causes of Delays in Road Construction Projects

To identify the key delay causes impacting contractor's profit in road construction projects in Sri Lanka, based on the data gathered from the literature survey seven (07) nos of effects were set on the questionnaire survey one. The seven effects are Time overrun, Cost Overrun, Dispute, Arbitration, Total Abandonment, Litigation, and Suspension of Work. And professionals were asked to respond on scale from 1 "never"- 5 "always" Likert psychometric scale. The result of analysis shown time overrun and cost overrun were the ones that have the most effect of delay causes in road construction projects.

5.2.4 To Identify the Key Delay Causes Impacting Contractor's Profit in Road Construction Projects in Sri Lanka

The delay causes impacting contractor's profit which identified through the literature review and classified through the questionnaire survey one was subjected on the questionnaire survey two to identify the key causes of delays that ranking influences the contractor's profit. The professionals were requested to respond on Likert scale of 1 – 5 where 1 = rarely contributing and 5 = constantly contributing. The results of the analysis showed that, Low productivity level of labors, Scarcity of skill labours, Insufficient controlling and monitoring, Delays in decision making, Ineffective time management, Low productivity and efficiency of equipment and Delay in approving bill and payments for the bill are the most influencing key delay causes to the contractor's profit.

5.2.5 To identify the Methods of Mitigating Key Delay Causes Impacting the Contractor’s Profit in Road Construction Projects in Sri Lanka

Finally, To identify the methods of mitigating key delay causes impacting the contractor’s profit in road construction projects in Sri Lanka was achieved through questionnaire survey one and two by asking the professionals to respond on 15 no of methods which were identified on the literature review on scale of 1-5 where 1 = very low effective and 5= very high effective Likert psychometric scale. Through this exercise the most effective methods were ranked and identified and on questionnaire survey two the professionals were requested to respond whether they have taken precaution methods to minimize delay. The results showed that the key methods taken to minimize the delays are,

- Frequent coordination and liaison between the major parties,
- Effective project planning and scheduling,
- Site management and supervision,
- Frequent progress meetings,
- Accurate initial cost estimates.

With the analysis of the respondents voting results, proper and precise correspondence between all parties regarding design matters, ongoing financial and physical progress, and critical path of the project schedule will minimize delay occurrences or damage to be occurring. Under the aspect of the contractor proper site management and supervision can minimize most delay causes and critical analysis of the cost factors at the initiation of the project would make much effort in minimizing the effects of delay causes.

5.3 Recommendations

In this research, a significant attempt was made to identify the key delay causes impacting contractor’s profit in road construction projects in Sri Lanka and to recommend methods of mitigating key delay causes impacting the contractor’s profit in road construction projects in Sri Lanka. Based on the findings of the study recommendations were formed with the gathered and analyzed data, as follows:

5.3.1 Poor Labour Productivity

The study revealed that causes of delay in construction primarily occur during the phase of construction and majorly due to the poor labour productivity and the scarcity of skilled labour. This will affect the project time period and impact the contractors profit margin due to idling and time extensions.

- **Hiring Manpower companies:** Scarcity of skilled labour issue can be minimized or nullified by assorting a potential labour carder for the scheduled work by recruiting a proper manpower company. Highly recommended manpower companies supply well skilled labour for construction and maintaining a good relationship with these companies will solve the unease of finding productive labour. (History of the company)
- **Training and workshops:** Enforcing in house training sessions and workshops to the labour carder will help to build a skillful set of workers who are dedicated to the company. And will form good relationship between supervisory staff and the workers.
- **Motivation:** Motivating the labour carder by promoting unskilled labours to semi/ skilled laboures with wage increments with a proper evaluation of the laborer will also condone to the company as an asset to minimize delays due labour inefficiency.

5.3.2 Monitoring and Controlling Issue

Monitoring and controlling the approved budget plays a major role in construction projects. The contractor must appoint an experienced team for the process of monitoring and controlling of on-going project budget to cut or minimize extra costs and maintain the company overhead and profit.

- **Maintaining work/ cost record:** the monitoring controlling team of the project must keep clear and well documented work/ cost record for the project work carried out in the project. This will help the management to prepare cost norms which helps to cut back any extra cost on works and helps to maintain a proper flow of finance to the project.

- **Mismanagement and corruption control:** the monitoring and controlling team can make profit by cutting down any means of mismanagement and corruption by properly analyzing and comparison for the lowest bid of work/ supply. Further the team will carry out value engineering principals at all stages of the project allowing the contractor to stay on the initial budget and ensuring the profit overhead to stay intact.
- **Cash flow and costing:** the monitoring and controlling team can maintain a precise cash flow by proper costing of the project work. This will enable the contractor to prepare required funds to execute work at scheduled time. This in turn helps the contractor to maintain the initial work program excluding the requirement of extensions.

5.3.3 Decision Making

One of the major issues surfaced through the study was delay in decision making may promote severe damage through delaying scheduled work, new design implements, and extra/ variation works.

- **Improve Designs:** When carrying out project works the contractor must prepare workable drawings, which improve the chance to get the drawing approved and ready commence. This will lead the project team to carry out the scheduled work on time without dragging time on re drawing or modifying the drawings.
- **Improve Work Program:** the contractor must initiate a proper and precise work program when implementing the project so that the project team can schedule work beforehand. Further, having a precise work program the contractor can maintain the critical path even if some work gets delayed, which ultimately help the contractor to complete the project in due time.
- **Improve Decision Making:** the contractor can arrange daily/ weekly toolbox meetings with both executive and supervising staff to maintain a flow of knowledge regarding day-to-day works which helps the managing staff to make quicker and detail-oriented decisions.

- **Method of action:** in the case of unavoidable delay the method of action is to notify the client regarding the unavoidable delay with the means of proving that it was an unforeseeable and unavoidable occurrence. On the notification the contractor must pronounce the intention to claim for the time overrun on top of the request of time extension via prolongation cost. Whether the client approves the total sum of the prolongation cost is up to debate but the contractor can cut back some of his loses by sticking in to the "critical path" time bar with adding modifications to the actual program schedule. Furthermore, any given construction project is always being abide by the work schedule prepared at the inception of the project. When delay causes are identified, the contractor can reschedule construction programme by considering lag tasks also, where delay may occur and the resulting consequence will affect the critical path to stay on the actual time bar. If this was achieved, where the critical path time bar was not disrupted by any delay, the contractor's profit will not be impacted by the means of the delay.

5.3.4 Coordination among the professionals

In construction, we need to ensure the coordination among the various professionals regarding the maintaining of construction quality and standard with compliance to guarantee the contractors will meet the specified timetables.

5.3.5 Maintaining Quality Standards:

The professionals must carry out the project work without attempting to take shortcuts or deviate from budgetary restraints. Furthermore, the project manager needs to ensure that the material used for work is those agreed on the contract and that they meet the standards.

- **Maintaining Resources:** The professionals involved on the project must maintain a precise resource plan by coordinating under each stage of the project. This may decrease the idling of labour, machinery and excessive purchasing of material.

Ultimately coordinating among the professionals will negate any additional work arise from miscommunication and will help to maintain a proper resource procurement thus producing a proper cashflow which in the end benefit the contractor's profit.

5.3.6 Strategic Planning

Moreover, the strategic planning/ scheduling is important for Construction Company as it will give you the direction and measurements you need to be competitive in the industry.

- **Planning in Advance:** the contractor must implement a precise planning sequence covering all stages of the project to gain effective advantages throughout the project life cycle. In addition, this allows the contractor to ensure the required resources when needed. Planning in advance will cut the cost on excess material procurement and over recruiting labour for project work which ultimately benefits the contractor's final profit.

5.3.7 Clear Information and Communication Channels

The clear communication is essential when managing activities. Clear stream of information shall be achieved under yielding to frequent coordination with all parties' involved, frequent meetings and proper site supervision and management to communicate and pass ideas and information engaged from the project itself via supervisory staff.

Finally, from the inception to the successful completion of any project corresponding with the initial cost plan is essential. If not bound to the financial plan throughout the project life cycle even the contractor may complete all tasks in given time period may forfeit the set profit margin due to budget over runs and unnecessary expenditure.

5.4 Further Research to be Carried out on the Subject

- Focus area of the research can be broaden to "Effects of key delays to the contractor's profit in Building, Tunnel, Bridge, and Special construction projects In Sri Lanka"
- Focus on case studies to prove and justify the causes of delay and its impact to the contractor's profit.
- Focus on a different methodology such as structural equation model to examine the effect of various causes of delay against massive construction projects, which will enhance many constructs that will show causes of delays with a contrast to large scale construction projects.
- Further, a develop time overrun model(software) for construction Industry can be developed with the comprehensive investigation of such trends

REFERENCE

1. Abd Majid, M.Z., & McCaffer, R. (1998). *Factors on non-excusable delays that influence contractors' performance*. Journal of Management in Engineering, Vol. 14 No.3, pp.42-9.
2. Abd Majid, M.Z.; McCaffer, R. (1998). *Factors on non-excusable delays that influence contractors' performance.* Journal of Management in Engineering, Vol. 14 No.3, pp.42-9.
3. Abdullah, M.R, Abdul, A.A and Abdul, R. (2009). *Causes of delay and its effects in large MARA construction project.* International journal of Integrated Engineering, Vol 1.
4. Abdul-Rahman, H., Berawi, A., Mohamed, O., Othman, M., & Yahya, I. (2006). *Delay mitigation in the Malaysian construction industry*, Journal of Construction Engineering and Management, Vol. 132, No. 2, pp. 125-33
5. Ahmed, S., Azhar, S., Kappagantula, P., & Gollapudi, D. (2003). *Delays in: A brief study of the Florida construction industry*. Proceeding of the 39th Annual Conference of the Associated Schools of Construction. Clemson, South Carolina: Clemson University, Miami, USA.
6. Ahmed, S.M. (2000). *Construction Delays in Florida.* An Empirical Study. International Journal of Project Management
7. Aibinu, A. A., & Jagboro, G.O. (2002). *The Effects of construction delays on project delivery in Nigerian construction industry*. International Journal of Project Management, Volume 20, Issue 8, November 2002, Pages 593-599
8. Aibinu, A.A. ; and Jagboro, G. O. (2002). *The effects of construction delays on project delivery in Nigerian construction industry*. International Journal of Project Management, Vol. 20, pp 593–599
9. Akinsiku, O. E., & Akinsulire, A. (2012). *Stakeholders' Perception of the Causes and Effects of Construction Delays on Project Delivery*. Journal of Construction Engineering and Project Management, 2(4), 25-31.
10. Alaghbari, W. (2007). *The Significant Factors Causing Delay of Building Construction Project in Malaysia*
11. Al-Momani, A.H. (2000). *Construction delay: A quantitative analysis*. Elsevier science Ltd and IPMA.

12. Alwei, S.K. (2010). *Causes effect and method of minimizing delays in construction projects.* University of technology, Malaysia.
13. Alwi, S., & Hampson, K. (2003). *Identifying the important causes of delays in building construction projects.* In Proceedings The 9th East Asia-Pacific Conference on Structural Engineering and Construction, Bali, Indonesia.
14. Aminbakhsh S., Gunduz M., & Sonmez R. (2006) *Safty risk assessment using analytic hierarchy process(AHP) during planning and budgeting of construction projects*. J. Saf. Res. 46(2013) 99-105.
15. Ardit, D., Akan, G.T., and Gurdamar, S. (1985). *Reasons for Delays in Public Projects in Turkey, Construction Management and Economics, 3*(2): 171-181
16. Arditi, D. and Pattanakitchamroon, T. (2006). Selecting a Delays Analysis Method in Resolving Construction Claims. International Journal of Project Management, Elsevier. 21 : 145-155
17. Arditi, D., & Pattanakitchamroon, T. (2006). *Selecting a delays analysis method in resolving construction claims*. International Journal of Project Management, Elsevier. 21 : 145-155.
18. Assaf, S.A., & Al-Heiji. (2006). *Causes of delays in large construction projects.* International Journal of Project Management, Volume24, 349 -357.
19. Ayudhya, B. I. N. (2011). *Evaluation of Common Delay Causes of Construction Projects in Singapore.* Journal of Civil Engineering and Architecture, 5(11), 1027-1034.
20. Bassioni, H.A., & El-Razak. (2008). *Causes of delays in building construction Projects in Egypt.* Journal of Construction Engineering and Management.
21. Chan, D.M.W., & Kumaraswamy, M.M. (1996). *Comparative Study of causes of Time Overruns in Hong Kong Construction Projects*. International Journal of Project Management, Vol. 15 (1). pp.55-63.
22. Chapman, R.J. (2001). *The controlling influences on effective risk identification and assessment for construction design management,* Int. Project Manag. 147-160.

23. Cooper D.F., Grey S., Raymond G. & Walker P. (2005). *Project risk management guidelines: managing risk in large projects and complex procurements.* John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England.
24. Doherty, M. (1994). *Probability versus Non-Probability Sampling in Sample Surveys.* The New Zealand Statistics Review March 1994 issue, pp 21-28
25. Elimassi A.D. & Hillis S.R. (2010). *Delay Management in Construction Projects in the Gaza Strip -Clients perspectives.* The Islamic University-Gaza. Faculty of Engineering. Construction Management, Gaza.
26. Enshassi, A., & Abu Mosa J. (2008). *Risk management in building projects: Owners' perspective.* Islamic Univ., J., 16(1): 95-123.
27. Enshassi, A., Kumaraswamy, M., & Al-Najjar, J (2010). *Factors influencing time and cost overruns in construction projects in the Gaza Strip Consultant's view.* International Journal of Construction Project Management, 2(1): 73-89.
28. Flanagan, R., & Norman, G. (1993). *Risk management and construction*. Oxford: Blackweel science Ltd.
29. Flyvbjerg, B., Holm, M.K.S. and Buhl, S.L (2003). *How common and how large are cost overruns in Transport infrastructure projects?* Transport Reviews, 23: 7188.
30. Fugar, F. D. K., & Agyakwah, B. A. B. (2010). Delays in Building Construction Projects in Ghana, Australasian Journal of Construction Economics and Building, 10(1), 103- 116.
31. Hegazy, T. and AmrAyed (1998). *Neural network model for parametric cost estimation of highway projects.* Journal of Construction Engineering and Management, ASCE 124(3): 210-218
32. Iyer, K.C., Chaphalkar, N.B., & Joshi, G.A. (2008). *Understanding time delay disputes in construction contracts*. International Journal of Project Management, Vol.26, pp. 174–184.

33. Kagioglou, M., Cooper, R., Aouad, G., Hinks, J., Sexton, M.G. & Sheath, D.M. (1998). *A generic guide to the design and construction process protocol*. University of Salford, Salford.

34. Kaming, P., Olomolaiye, P., Holt, G, and Harris, F., (1997). *Factors influencing construction time and cost overruns on high-rise projects in Indonesia*. Construct Manage Economics, 15: 83–94

35. Kaming, P.F. ; Olomolaiye, P.O. ; Holt, G.D., and Harris, F.C. (1997). *Factors influencing construction time and cost overruns on high rise projects in Indonesia.* Construction Management and Economics, Vol. 15, No. 1, pp 83-94.

36. Kang S. W. (2010). *Causes, effects and methods of minimizing delays in construction projects*. Faculty of Civil Engineering Malaysia: University of Technology.

37. Knight, A., Asnaashari, E., Hurst, A. and Farahani, S.S. (2009). *Causes of construction delays in Iran:* Project management, logistics, technology and environment. In Dainty, A. (Ed) Procs 25th Annual ARCOM Conference, 7-9 September 2009, Nottingham, UK, Association of Researchers in Construction Management, 897-906.

38. Kohli U. (2001). *How to Minimize Time and Cost Over-Runs of Projects*. Available at: Http://www.shilpabichitra.com/shilpa2001/v083.htm(Cited 13-August-04)

39. Koushk, A. P.; Al-Rashid ,K. ; and Kartam ,N. (2005). *Delays and cost increases in the construction of private residential projects in Kuwait*. journal of Construction Management and Economics, Volume http://www.informaworld.com/smpp/title~db=all~content=t713664979~tab =issueslist ~branches=23 - v2323, pp. 285-294.

40. Kwatsima, S.A (2016). *An investigation into the causes of delay in large construction projects in Kenya.* Kenyatta University of Agriculture and Technology.

41. Le-Hoai, L. ; Lee, D.Y. ; and Yong Lee, J. (2008). *Delay and Cost Overruns in Vietnam Large Construction Project.* A Comparison with Other Selected Countries" Journal of Civil Engineering", Vol.12(6), pp. 367-377.
42. Le-Hoai, L., Lee, D.Y., & Yong Lee, J. (2008*). Delay and cost overruns in Vietnam large construction projects: A comparison with other selected countries.* Journal of Civil Engineering", Vol.12(6), pp. 367-377.
43. Mahamid, I (2013). *Common risks affecting time overrun in road construction projects in Palestine: Contractors's Perspective*. Australasian Journal of Construction Economics and Building, vol. 13, no. 2, pp. 45–53, 2013.
44. Mahamid, I.(2011). *Risk matrix for factors affecting time delay in road construction projects: Owners' perspective*. Eng. Construct. Architectural Manage., 18(6): 609-617..
45. Molenaar, K.R. (2005). *Programmatic Cost Risk Analysis for Highway MegaProjects.* Journal of Construction Engineering and Management. 131(3): 343-353
46. Msafiri, A. S. (2015). *An Investigation into Factors Causing Delays in Road Construction Projects in Kenya.* American Journal of Civil Engineering, Vol. 3(3), 51-63.
47. Odeh, A. M. ; and Battaineh, H.T. (2002). *Causes of Construction Delay: Traditional Contracts.* International Journal of Project management, Vol. 20, pp.67-73.
48. Odeh, A. M. and Battaineh, H.T. (2002). *Causes of Construction Delay: Traditional Contracts.* International Journal of Project management, Vol. 20, pp.67-73.
49. Odeh, A. M., & Battaineh, H.T. (2002). *Causes of construction delay: Traditional Contracts*. International Journal of Project management, Vol. 20, pp.67-73
50. Ogunlana, S.O. ; Promkuntong, K. and Jearkjirm, V. (1996). *Construction Delays in a Fast-Growing Economy: Comparing Thailand with Other Economies.* International Journal of Project Management, Elsevier. Vol.14(1), pp. 37-45.

51. Ondari, P. O. & Gekara, J. M. (2013). *Factors influencing successful completion of roads projects in Kenya.* International Journal of Social Sciences and Entrepreneurship, 1(6), 26-48
52. Pathiranage, Y.L., Halwathura, R.U (2010). *Factors influencing the duration of road construction projects in Sri Lanka*. Engineer journal of Institution of Engineers Sri Lanka, XXXXIII (04).
53. Perera , K.B.D. (2006). *Simulation methodology for time and cost overrun in read construction rehabilitation projects in Sri Lanka*.
54. Rashid, Y., Ulhug, S., & Aslam,S.M., (2013). *Causes of delay in construction project of Punjab.Pakistan.* An Empirical study. Journal of basic and applied scientific research. 3(10), 87-96.
55. Reams, J.S. (1990). *Substantiation and use of the planned schedule in a delay analysis*. Journal of Cost Engineering, Vol.32, No.2, pp.12-16
56. Sambasivan M., & Soon Y.W. (2007). *Causes and effects of delays in Malaysian construction industry.* International Journal of Project Management, 25(5): 517-526.
57. Singh, R. (2009). Delays and Cost Overruns in Infrastructure Projects: An Enquiry into Extents, Causes and Remedies. Department of Economics Delhi School of Economics University of Delhi.
58. Sun, M. and Meng, X. (2009). *Taxonomy for change causes and effects in construction projects*, International Journal of Project Management, 27: 560-572.
59. Theodore J., & Trauner J. (2009). *Types of construction delays.* Construction Delays (Second Edition), 2009, Pages 25-36.
60. Thomas, R. (2001). *Construction Contract Claims,* Second Edition, Palgrave Publishers Ltd. United kingdom.
61. Yogeswaran K., Kumaraswamy M. M., and Miller Douglas R.A. (1998), *Claims for Extensions of Time in Civil Engineering Projects,* Construction Management and Economics, 16(3): 283–293.
62. Zikmund, W.G. (2000). *Business research methods*. 6th ed. Orlando, US: Dryden Press

Appendix 01

Questionnaire Survey 01

<u>DETAIL OF QUESTIONNAIRE</u>

ANALYSIS OF KEY CAUSES OF DELAY IMPACTING CONTRACTOR'S PROFIT IN ROAD CONSTRUCTION PROJECTS IN SRI LANKA

Dear Sir/Madam;

<u>Request for filling the Questionnaire</u>

I am D.D.D.T. Stephen, fallowing the MSc in Project Management program conducted by the department of Building Economics, University of Moratuwa. To conclude the MSc program, I have chosen my dissertation on the topic of **"Analysis of Key Causes of Delay Impacting Contractor's Profit in Road Construction Projects in Sri Lanka".**

I would be grateful if you could read and complete the attached questionnaire within your busy work schedule. The information furnished herewith will only be used to complete my research program and all of your information will be treated confidentially. Your early responses would be highly appreciated since I have to undergo with a tight –time schedule.

Thank You,

Yours Faithfully

D.D.D.T.Stephen

Civil Engineer

Annex A

QUESTIONNAIRE FOR ANALYSIS OF KEY CAUSES OF DELAY IMPACTING CONTRACTOR’S PROFIT IN ROAD CONSTRUCTION PROJECTS IN SRI LANKA.

<u>SECTION A</u>

COMPANY RESPONDENT PROFILE AND PROJECT DESCRIPTION

Please, tick one box and fill in the blanks if you select others.

1. Project Name/Organization -
   …………………………………………………...

2. State respondent organization/company type.

   Client ☐ Contractor ☐ Consultant ☐ Others ☐
   Please specify: ______________

3. State respondent position in the organization/company.

   Project Manager ☐ Site Manager / Engineer ☐ Designer ☐

   Other (Mention here…………………………. …..) ☐

4. State the number of years the organization/company has experience in construction industry.

   0– 5 years ☐ 5 – 10 years ☐ 10 – 15 years ☐ More than 15 years ☐

5. No of project implementations during the last 5 years

   1-10 projects ☐ 11-20 projects ☐ 21-30 projects ☐ More than 30 Projects ☐

6. Average revenue from the projects executed in the last 5 years (SLRs):

   Less than 2 billion ☐ 2-5 billion ☐ 6-10 billion ☐
   More than 11 billion ☐

7. Respondent's years of experience in the construction industry.

1-3 years ☐ 4-5 year ☐ 6-10 years ☐ More Than 10 ☐

SECTION B

CAUSES OF DELAYS IN ROAD CONSTRUCTION PROJECTS IN SRI LANKA.

Objective of the Study: To identify the major causes of delays in construction projects please, tick and fill the boxes on your opinion.

In getting a frequency measurement through the survey the respondents are asked to tick the boxes on their opinion how the factors may cause delay on certain projects.

To attain a precise measurement, a 1 to 5 point scale has been introduced here with a relation escalating from very law to very high.

Each scale represents the following rating:

(5) = Very High (VH) (4) = High (H) (3) = Moderate (M)

(2) = Low (L) (1) = Very Low (VL)

No	Factors	5	4	3	2	1
	Logic and Environment					
1	Weather condition					
2	Natural disaster					
3	Rework from poor material quality					
4	Rework from poor workmanship					
5	Disturbance from public activities					
6	Poor soil suitability					
7	Lack of detail in surveys					
8	Lack ground condition details					

9	Limited area for the Site					
10	Rework due to mistakes in construction					

No	Factors	5	4	3	2	1
	Managerial					
11	Delays in decision making					
12	Late issuing of approval documents					
13	Postponement of project					
14	Late submission of nominated materials					
15	Late land hand-over					
16	Poor communication between construction parties					
17	Unreasonable project time frame					
18	Poor resource management					
19	Changes in management ways					
20	Design changes					
21	Internal administrative problems					
22	Undefined scope of working					
23	Late documentation					
24	Delay in commencement					
25	Improper construction method					
26	Inaccurate planning and scheduling					
27	Ineffective time management					
28	Poor site management and supervision					
29	Impact of Low liquidity					
30	Delay in mobilization					

No	Factors	5	4	3	2	1
	Monitoring and Controlling					
31	Insufficient controlling and monitoring					
32	Failure to give expedient solutions to problems					
33	Political influences					
34	Delay in quality assurance/control					
35	Long waiting time for approval of tests and inspection					
36	Slow decision making					
37	Inadequate staff					
38	Late design works					
39	Mistake in design					
40	Inappropriate design					
41	Late inspection					
42	Late approval					
43	Insufficient inspectors					
44	Incapable inspectors					
45	Poor coordination with parties					

No	Factors	5	4	3	2	1
	Financial Group					
46	Delay in approving payments					
47	Delay in approving extra work and variations					
48	Rate fluctuation					
49	Conflict with contractors					
50	Monopoly					
51	Changing of banker’s policy for loans					

52	Nonpayment of mobilization advance					
53	Ineffective delay penalties					

No	Factors	5	4	3	2	1
	Material , Plant & Equipment					
54	Low productivity and efficiency of equipment					
55	Low quality of material					
56	Shortage of material in the market					
57	Changes in material types and specifications during the construction					
58	Delay in material delivery					
59	Damages to the material in transport and storages					

No	Factors	5	4	3	2	1
	Human Resources					
60	Unavailability of experienced technical staff					
61	Scarcity of skill labours					
62	Shortage of labours					
63	Low productivity level of labours					

In getting a severity measurement through the survey the respondents are asked to tick the boxes on their opinion how the factors may cause delay on certain projects.

To attain a precise measurement, a 1 to 5 point scale has been introduced here with a relation escalating from Very low to Very High.

Each scale represents the following rating:

(5) = Very High (VH) (4) = High (H) (3) = Moderate (M)

(2) = Low (L) (1) = Very Low (VL)

No	Factors	5	4	3	2	1
	Logic and Environment					
1	Weather condition					
2	Natural disaster					
3	Rework from poor material quality					
4	Rework from poor workmanship					
5	Disturbance from public activities					
6	Poor soil suitability					
7	Lack of detail in surveys					
8	Lack ground condition details					
9	Limited area for the Site					
10	Rework due to mistakes in construction					

No	Factors	5	4	3	2	1
	Managerial					
11	Delays in decision making					
12	Late issuing of approval documents					
13	Postponement of project					
14	Late submission of nominated materials					
15	Late land hand-over					
16	Poor communication between construction parties					
17	Unreasonable project time frame					
18	Poor resource management					
19	Changes in management ways					
20	Design changes					
21	Internal administrative problems					

22	Undefined scope of working					
23	Late documentation					
24	Delay in commencement					
25	Improper construction method					
26	Inaccurate planning and scheduling					
27	Ineffective time management					
28	Poor site management and supervision					
29	Impact of Low liquidity					
30	Delay in mobilization					

No	Factors	5	4	3	2	1
	Monitoring and Controlling					
31	Insufficient controlling and monitoring					
32	Failure to give expedient solutions to problems					
33	Political influences					
34	Delay in quality assurance/control					
35	Long waiting time for approval of tests and inspection					
36	Slow decision making					
37	Inadequate staff					
38	Late design works					
39	Mistake in design					
40	Inappropriate design					
41	Late inspection					
42	Late approval					
43	Insufficient inspectors					
44	Incapable inspectors					

45	Poor coordination with parties					

No	Factors	5	4	3	2	1
	Financial Group					
46	Delay in approving payments					
47	Delay in approving extra work and variations					
48	Rate fluctuation					
49	Conflict with contractors					
50	Monopoly					
51	Changing of banker's policy for loans					
52	Nonpayment of mobilization advance					
53	Ineffective delay penalties					

No	Factors	5	4	3	2	1
	Material , Plant & Equipment					
54	Low productivity and efficiency of equipment					
55	Low quality of material					
56	Shortage of material in the market					
57	Changes in material types and specifications during the construction					
58	Delay in material delivery					
59	Damages to the material in transport and storages					

No	Factors	5	4	3	2	1
	Human Resources					

60	Unavailability of experienced technical staff					
61	Scarcity of skill labours					
62	Shortage of labours					
63	Low productivity level of labours					

SECTION C

EFFECT OF DELAYS

Objective of the Study: To identify the effects of delays in construction project

Please, tick and fill the boxes on your experience.

Each scale represents the following rating:

(5) = Always (4) = Mostly (3) = Sometimes (2) = Seldom (1) = Never.

No	Effect	5	4	3	2	1
1	Time Overrun					
2	Cost Overrun					
3	Dispute					
4	Arbitration					
5	Total abandonment (Contract Termination)					
6	Litigation.					
7	Suspension of the work					

SECTION D

METHODS TO MINIMIZING CONSTRUCTION DELAYS

Objective of the study: To identify the methods of minimizing construction delay in Road Construction Projects in Sri Lanka

Please, tick and fill the boxes on your opinion.

Each scale represents the following rating:

(1) Very low effective (2) Low effective (3) Medium effective

(4) High effective (5) Very high effective

No	Proposed Method	1	2	3	4	5
1	Frequent progress meeting					
2	Use up-to-date technology utilization					
3	Use proper and modern construction equipment					
4	Use appropriate construction methods					
5	Effective strategic planning					
6	Proper material procurement					
7	Accurate initial cost estimates					
8	Clear information and communication channels					
9	Frequent coordination between the parties involved					
10	Proper emphasis on past experience					
11	Proper project planning and scheduling					
12	Complete and proper design at the right time					
13	Site management and supervision					
14	Collaborative working in construction					
15	Compressing construction durations					

Please state out your comment for any recommendations

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Appendix 02

Questionnaire Survey 02

Under the questionnaire Survey 01, 21 numbers of critical delay factors that severely affect the construction were identified, analyzed and shortlisted. The objective of this questionnaire is to identify how the analyzed and shortlisted delay factors may effect on the loss of profit to the construction projects in Sri Lanka.

To achieve a precise measurement of how these selected factors affect the profit of the contractor, a 1 to 5 point scale has been introduced here with a relation escalating from Very Low (VL) contributing to Very High (VH) contributing.

Each scale represents the following rating:
(5) = Very High (VH) contributing (4) = High (H) contributing (3) = Moderate (M) contributing
(2) = Low (L) contributing (1) = Very Low (VL) contributing

Your company has affected from a loss of profit due to major delays?

Yes ☐ No ☐

If the frequency of the contributing factor affects the contractor's profit, then please tick the contributed factor/ factors of the delay:

No	Factors	5	4	3	2	1
	Logic and Environment					
1	Weather condition					
2	Disturbance from public activities					
3	Poor soil suitability					
4	Limited area for the Site					

If the frequency of the contributing factor affects the contractor's profit, then please tick the contributed factor/ factors of the delay:

No	Factors	5	4	3	2	1
	Managerial					
5	Delays in decision making					
6	Poor communication between construction parties					
7	Poor resource management					
8	Inaccurate planning and scheduling					
9	Ineffective time management					
10	Poor site management and supervision					

If the frequency of the contributing factor affects the contractor's profit, then please tick the contributed factor/ factors of the delay:

No	Factors	5	4	3	2	1
	Monitoring and Controlling					
11	Insufficient controlling and monitoring					
12	Political influences					
13	Slow decision making					
14	Poor coordination with parties					

If the frequency of the contributing factor affects the contractor's profit, then please tick the contributed factor/ factors of the delay:

No	Factors	5	4	3	2	1
	Financial Group					
15	Delay in approving bill and payments for the bill					
16	Delay in approving extra work and variations					

17	Conflict with Sub contractors					

If the frequency of the contributing factor affects the contractor's profit, then please tick the contributed factor/ factors of the delay:

No	**Factors**	5	4	3	2	1
	Material , Plant & Equipment					
18	Low productivity and efficiency of equipment					

If the frequency of the contributing factor affects the contractor's profit, then please tick the contributed factor/ factors of the delay:

No	**Factors**	5	4	3	2	1
	Human Resources					
19	Scarcity of skill labours					
20	Shortage of labours					
21	Low productivity level of labours					

Have you taken precaution for minimizing the delays?

Yes ☐ No ☐