RISK MANAGEMENT FOR DISPUTE AVOIDANCE IN DIFFERENT PROCUREMENT SYSTEMS USED IN HIGH RISE BUILDINGS IN SRI LANKA

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Degree of Master of Science in Construction Law and Dispute Resolution

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DECLARATION

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

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Ch.QS. Prof. (Mrs.) B.A.K.S. Perera Date

Dissertation Supervisor

Risk management for dispute avoidance in different procurement systems used in high rise buildings in Sri Lanka

ABSTRACT

Disputes drive endemic problem in construction industry particularly in high rise buildings as most important part of the construction in Sri Lanka where it is required to avoid disputes for successful project completion. Consequently, risks, as a root causes of the disputes, should be managed systematically. Even though there are several researches on risk management on individual procurement systems, systematic risk management process is not applied in either. Hence, this research is aimed to develop systematic risk management frameworks for different procurement systems commonly used in high rise building in Sri Lanka which will be ultimately help to avoid disputes. The collected data from preliminary survey and two phase of questionnaire surveys were analyzed using content analysis, severity index, average method and relative importance index.

There are three procurement methods named separated with measure & pay, separated with lump sum & design & build with sump sum are used in high rise buildings in Sri Lanka. 128 risk factors are identified as applicable to the high rise building in Sri Lanka and all risk factors lead to disputes. There are 22 significant risk factors to the high rise buildings in Sri Lanka. Among them 16, 15 and 18 risk factors are significant to Separated with LumpSum (LS) systems, Separated with Measure and Pay(M&P) systems and Design and Build (D&B) with LS systems respectively. "Lack of skilled labours" and "unable to finish work on time" are the most significant risk factors for all procurement systems". Third highest risk factor is "need innovative construction methods" which is significant to only D&B with lump sum system.Risk shall be allocated to the best party who can tolerate and manage the risk. 15 Risk response methods appropriate in high rise building projects in Sri Lanka were identified. Risk Response methods are common to all procurement systems. Education and training has been highly recommended as the best response method for most of the risk factors. It is recommended to use standard conditions of contract for subcontracts and consultant contracts. Finally systematic risk management frameworks for each procurement methods were developed which can be used as a tool for procurement selection and as a guidance for risk management where ultimately help to avoid disputes of the high rise projects in Sri Lanka.

Keywords*:* *Risk management frameworks; Severe risk factors for dispute avoidance; Procurement systems; High rise buildings*

DEDICATION

To my beloved parents, husband and sons,

With special thanks to support and love,

Any credit of accuracy belongs to you,

Any blames for mistakes is mine.

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My special thanks go to all the leading professionals in the construction industry who gave me an immense support and cooperation to complete the data collection successfully by sharing their valuable knowledge and experience with me.

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CMC	-	Colombo Municipal Council
D&B	-	Design and Build
LS	-	Lump Sum
M&P	-	Measure and Pay
NEDO	-	National Education Development Office
RF	-	Risk Factors
RR	-	Risk Response
UDA	-	Urban Development Authority

Chapter 1

1. INTRODUCTION TO RESEARCH

1.1. Background

As a result of different views, talents and level of knowledge of construction process of the participants work together, the construction industry has become very complex and high risk. Consequently, disputes have become inevitable in each and every construction (Sinha, M & Wayal, A.S., 2007; Cakmak, E. & Cakmak, P.I., 2014). Disputes incur additional cost and time, damage the reputation of the company, result to depression in socio economy in country and spoil the stake holder relationship, which means disputes are the main factors which prevent the successful completion of the construction project (Cakmak, E. & Cakmak, P.I., 2014). Therefore, disputes drive endemic problem in the construction industry and it is essential to avoid or manage disputes. In order to avoid disputes prior to arise, it is vital to identify the causes of disputes. Kumaraswamy (1997) has identified unfair risk allocation and unclear risk allocation as root causes of disputes. Sensible risk allocation is one of the six factors critical to minimization and avoidance of disputes and risk management is under the check list of dispute avoidance (Cooperative Research Centre for Construction Innovation, 2009). Davis (2007) has highlighted that effective risk management avoid causes of disputes. This reveals that the proper risk management is required to avoid any disputes.

The construction industry is more prone to risk and uncertainty compared to other industries (Flanagan & Norman, 1993; Kim & Bajaj, 2000; Tah & Carr, 2000) which will be ultimately impacted to cost, time, quality and sustainability of project delivery. Therefore, risk management in order to avoid risks, is an important tool to cope with construction risk (Dey, 2002; Edwards and Bowen, 1998). Effective management of risk is critical to the success of any construction project (Banaitiene et al., 2011). However, risk management should be carried out in systematic way, where it makes the risks clear, formally describing them and ultimately help to manage easily (Mills, 2001). Moreover following systematic risk management will help to identify, assess, rank risks, making the risks explicit and focus on major risks (Godfrey, 1996). Among

several systematic risk management processes, Raftery (2003) has proposed Risk Identification, Risk Analysis and Risk Response where the same has been applied by Jaafari, et al. (1995), Dey (1999/2002), Wang S.Q. et al. (2004), Turnbaugh (2005), Kayis and Amornsawadwatana (2007), and Othman (2008) in their studies. Perera, et al. (2009) identify that Risk Allocation also shall be a part of systematic risk management process.

Risk management is massively influenced by three procurement variables project delivery method, form of payment, and use of collaboration or partnering arrangements (Osipova & Erikson, 2011). There is a strong link between risk management and the choice of procurement system in the construction industry. According to Jayasuriya and Rameezdeen (2011), many researchers have identified risk management as significant procurement selection parameter (PSP). According to Younis, et al. (2008), the literature clearly reflects the interrelationship between risks and procurement systems which will be ultimately lead to disputes. The amount of risk that each party will bear is largely attributed to the procurement method (CUP, 1993). The chosen procurement method plays a major role in ensuring that the project requirements are achieved in terms of how much risk the client wishes to accept (Chege and Rwelamila, 2000). On the other hand, the selection of appropriate procurement systems is one of the techniques for risk allocation and response (NEDO, 1985; Love et al., 1998; Erikson & Westerberg, 2011). Unfortunately, there is incorrect choice of procurement system in many instances and this increases the probability of risk events occurring within the project. Therefore, it is important to study on risk management against each procurement variables.

As construction projects become more complex and dynamic, they have resorted to the use of alternative procurement systems. This has added to the complex nature of the construction industry forcing organizations to rethink the manner in which they treat project risks (Tah & Carr, 2000; Dey & Ogunlana, 2004). NEDO (1983), Masterman (1992), Franks (1998) and many other authors on procurement have endeavored categorizing procurement systems in many ways. Procurement systems are categorized into four broader classifications as Separated systems, Integrated systems, Management oriented systems and Collaborative systems in Sri Lanka

(Rameezdeen & Silva, 2002). Further they have observed that due to government influence, the dominance of separated (Traditional) procurement systems in Sri Lanka from year 1977-2000 while Design and Build has been developed mainly due to the industrial growth of the country. With the post war development of the construction industry in Sri Lanka, it seems that there is a trend of employing Management Contracting (MC) and Construction Management (CM) procurement systems for fast track and large scale projects. Each of those involves different type of contracts, contractual relationships, information flows, roles and responsibilities within a planning team (Cooke & Williams, 2004).

Even though growth in the construction sector slowed down in 2015 after the new government of Sri Lanka halted some big infrastructure projects, pending reviews of their costs and environmental impact, huge number of commercial and residential high rise projects are still continuing since 2012 which were started as post war development. It is expected "a booming construction sector over next 2-3 years in Sri Lankan supported by rising affordability for housing and demand for skyscrapers (Mathew et al., 2016). The risk involved in high rise buildings rates higher in the construction industry as it is estimated that the high-rise buildings are the most significant part of the construction for the grander development (Sakthiniveditha and Pradeep, 2015).

1.2. Research Problem

There are extensive research works on the interrelationship between risk and procurement systems. For example, Chege and Rwelamila (2000) reviewed the relationship between risk management and the choice of procurement systems. In a study carried out in Swedish construction projects by Osipova (2008) also investigated the impact of the selection of procurement method on risk management and found that there is a clear connection between the procurement option and risk management in construction projects.

Oztas and Okmen (2003) have only analyzed the risk factors for fixed price design and build projects. Bing, Akintoye, Edward, and Hardcastle, (2005) have only allocated risks for PPP/PPI projects. However, systematic risk management approach was not

applied in either. Osipova and Eriksson (2011) showed how procurement options influence risk management which proves the requirement of developing a systematic framework of risk management for each procurement systems.

Cheung (2016) emphasized that the selection of a dispute resolution mechanism depends on the characteristics of the transaction, which is the type of a contract in construction projects. Therefore, given the variety of dispute resolution mechanisms available, Cheung (2016) showed the importance of investigating on how these mechanisms are to be selected with due consideration of the characteristics of the transaction. This demonstrates the necessity of developing a systematic framework of risk management for procurement systems to avoid disputes.

The Skyscraper Center, the global tall building database of the Council on Tall Buildings and Urban Habitat - CTBUH (2017) showed the hugely upcoming of tallest building in Sri Lanka. With the less experienced on skyscrapers and since the risk is inherent in every construction project, especially complex projects like high rise buildings (Santoso et al., 2003), this research is focused on high rise buildings in Sri Lanka. For most purposes, the cut-off point for high-rise buildings is around seven stories (Hall, 2005). However the City of Colombo Development plan of UDA (2018) and "Access Requirements to be Included in Proposed Building Plans" of fire service department of CMC, have classified high rise projects above twenty stories separately as a one category and all their rules and regulations are depend on this category. Therefore high rise buildings above 20 floors were selected to for this study to have a realistic outcome since the risk is drastically deviates based on the complexity of projects. All above reveal the need of carrying out research to develop systematic frameworks of risk management for different procurement systems commonly used in high rise building projects in Sri Lanka which will ultimately help to avoid disputes.

1.3. Aim and Objectives

This research aims to develop systematic frameworks of risk management for different procurement systems commonly used in high rise building projects in Sri Lanka which will be ultimately help to avoid disputes. Then the results can be used

as a tool for procurement selection as well as a guidance for risk management. In order to achieve this, it is necessary to;

1. Identify commonly used procurement systems in high rise building projects in Sri Lanka.
2. Evaluate the significant risk factors which lead to disputes of above identified procurement systems.
3. Determine the allocation of significant risk factors which lead to disputes among the stakeholders (Employer, Contractor and Consultant) of above identified procurement systems.
4. Determine the risk response methods for above identified significant risk factors

1.4. Methodology

Below mentioned methodological approaches were adopted for this study:

1. An extensive literature survey on disputes, construction disputes, risk, risk management, construction risk management, procurement systems and research methods. Risk factors related to high rise buildings and risk response methods were specifically identified in the research.
2. Preliminary survey to identify the procurement systems used for high rise building projects in Sri Lanka and to identify the applicability of various types of risk factors and risk response methods observed from the literature review to the Sri Lankan high rise building projects.
3. Two phases of structured questionnaire survey to identify significant risk factors which leads to disputes and allocation of risk among project stake holders for identified procurement systems of high rise building projects in Sri Lanka.

1.5. Scope and Limitations

Procurement systems can be classified in different ways based on project delivery methods, costs, rewards, etc…However, This research is limited to commonly used procurement systems for high rise projects in Sri Lanka.

Further only risk factors which leads to disputes were focused under this research.

Definition of the Consultant for this study purpose is party who appointed by the client but not the in house consultants appointed by the D&B contractor.
Definition of the subcontractor for this study purpose is only domestic subcontractors but not nominated subcontractors.

1.6. Dissertation outline

Chapter 1 discusses the background, research problem/rationale, aim and objectives, research methodology, scope and limitations and dissertation outline.

Chapter 2 gives a comprehensive literature survey on construction disputes, risk management and procurement systems in the construction industry. It introduces the concepts of disputes, disputes in construction, concept of risk, risk management, different procurement systems commonly used in high rise building of Sri Lanka. It gives risk factors relevant to high rise projects which ultimately leads to disputes.

Chapter 3 sets out the research framework used to guide this research in order to achieve its aims and objectives. The chapter outlines the research philosophy, methodology and methods adopted and the modes of data analysis used for the study.

Chapter 4 evaluates the allocation of significant risk factors which leads to disputes among the stakeholders against each procurement systems. Further it will be analyzed to ascertain the risk response methods for significant risk factors which leads to disputes of commonly used procurement systems in high rise projects of Sri Lanka.

Chapter 5 summarizes the research process and presents the key research findings. It mentions the conclusions derived from the research findings and recommendations to improve risk management in commonly used procurement systems in high rise building projects in Sri Lanka. It also provides limitations and suggestions for further development.

Chapter 2

2. LITERATURE REVIEW ON RISK MANAGEMENT AND PROCUREMENT SYSTEMS.

2.1. Introduction

This chapter describes the overall of Construction disputes, risk management and procurement systems as discussed in the literature.

This chapter starts explaining that how risk management will affect to avoid disputes. Then it explains the concept of risk, risk in construction and systematic risk management process. Then it elaborates how risk management is influenced by procurement systems while describing each procurement systems in detail. Then it enlightens the requirement of systematic risk management for high rise projects in Sri Lanka against procurement systems. Finally, it includes the risk factors applicable to high rise buildings derived from literature and risk response methods adopted by previous researches.

2.2. Disputes in Construction

2.2.1. Concept of Disputes

In accordance with the Cambridge dictionary, "disputes is an argument or disagreement, especially an official one between, for example, workers and employers or two countries with a common border". "The legal definition of dispute is an assertion of opposing views or claims, or disagreement as to rights" (Merriam-Webster's Dictionary of law, 1996). Collins (as cited in Karthikeyan & Manikandan, 2017) has defined Conflict as "a serious difference between two or more beliefs, ideas or interests". According to Reid and Ellis (2007), "a dispute does not exist until a claim has been submitted and rejected, a claim which is for compensation for damages incurred by any party to the contract". Therefore, a dispute arises as a problem or disagreement between the parties when it cannot be resolved by on-site project managers (Mashwama et al., 2016). Disputes are occurred due to prolonged dis-agreements on unsettled claims and protracted unresolved/destructive conflict.

2.2.2. Disputes in Construction

Due to the nature of the construction industry, being complex, high risk, competitive, and in which various stakeholders and professionals work together, there is a great deal of disputes exist within the construction industry (Cakmak. & Cakmak, 2014). Conflict, which leads to disputes is 'inevitable in human relationships' (Rhys Jones as cited in Karthikeyan & Manikandan, 2017), where ultimately disputes are inevitable in construction projects due to involvement of various humans with various perceptions. Construction disputes materialize if construction claims are not settled in an effective, economical and timely manner (Mashwama et al., 2016). A claim is an assentation of a right to money, property or remedy; for example in construction, one party think that they deserve monetary or extension of time or compensation, and submit a claim (Sinha and Wayal, 2008).

Disputes are the main factors causing delays disrupting construction schedule, increased projects cost and adverse influence on relationships between project participants leading to the prevention of the successful completion of construction projects (Cakmak. & Cakmak, 2014). The research conducted by Ojo (2010) reflected the event of risk occurrence that was not well analyzed or integrated by either clients, contractors, or consultants as one of the main causes of claims and disputes in the construction projects. In order to avoid disputes, it is vital to develop systematic risk management system against each procumbent method as described by Younis et al. (2008) which elaborate in the figure 2.1.

Even though it has been identified that risk lead to disputes in the literature, but it is not clear whether all risk factors will lead to disputes or not. Therefore, risk factors which leads to disputes will be identified during this study.

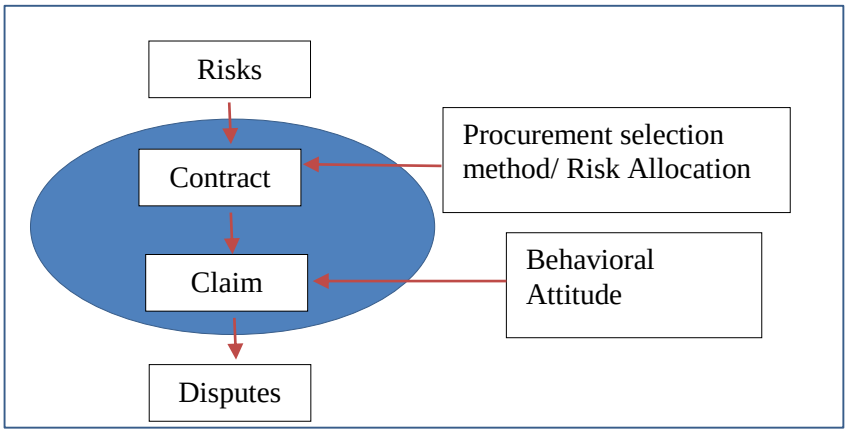

Figure 2.1: Conceptual flow chart of Dispute Evolution

Source: Younis *et al*. (2008)

2.3. Risk Management in construction

2.3.1. Introduction to Risk

The word "risk" is used in many different meanings with many different words such as hazard or uncertainty (Walke & Kabiraj, 2010; Lifson and Shaifer 1982; Hertz and Thomas 1984). Since the existing literature often uses the terms risk and uncertainty interchangeably, literature for these terms is discussed first.

In decision making environment on probability of occurrence, if the event is definitely occurring or non-occur, then it is certain, otherwise it is a Risk or Uncertain as described in figure 2.2. Raftery (2003) defines the Risk and uncertainty together as the situations where the actual outcome for a particular event or activity is likely to deviate from the estimate and forecast value, where it lies in between 1 or 0.

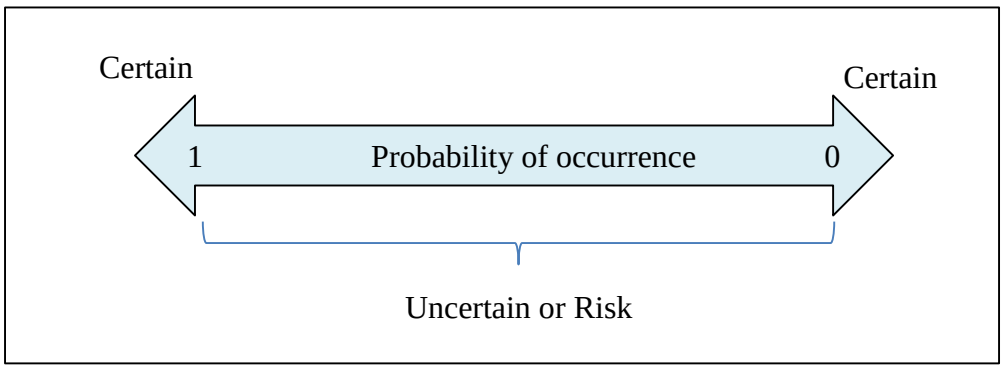

Figure 2.2 : Behaviour of Certain, Uncertain and Risk

Hillson (2013) defines risk as the uncertainty that can be measured, and uncertainty is a risk that cannot be measured. According to Flanagan and Norman (1993) "uncertainty" can be used to describe situations for which there is no historical data while "risk" can be used for situations where the success or failure of a project is predicated in probabilistic quantities on the basis of previous data. As further explained by them, uncertain situations can be converted to risky situations by the assignation of subjective probabilities. Raftery (2003) defines Risk is insurable as its nature of possibility of statistical assessment of the probability occurrence and uncertainty as uninsurable due to its vice versa nature. Therefore, according to literature these terms cannot be distinguished, where only the term Risk is considered for this research purpose as its more assessable.

2.3.2. Definition of general Risk

The meaning of risk changes when time goes on and the meanings differ when they are at the specific socio-cultural and historical contexts which we are located in (Lupton, 1999). Risk is a pervasive thing but its definition is elusive and its measurement is controversial (Lifson and Shaifer 1982). Risk has different meanings to different people, therefore the concept of risk varies according to viewpoint, attitudes and experience.

According to Kedar, (1970), the origin of the word risk is thought to be either the Arabic word Risq (anything given to you by god from which you draw profit) or the Latin word Riscum (challenge that a barrier reef presents to a sailor). The Oxford Advanced Learner's Dictionary—1995 ed. defines risk as "the chance of failure or the possibility of meeting danger or of suffering harm or loss". According to Macquarie dictionary, Risk is defined as "the chance of an adverse event depending on the circumstances". "Risk is exposure to the possibility of economic or financial loss or gain, physical damage or injury, or delay, as a consequence of the uncertainty associated with pursuing a particular course of action" (Cooper et al., 1987). Any definition of risk is likely to carry an element of subjectivity, depending upon the nature of the risk and to what it is applied.

Several formulas can be found in the literature for Risks which elaborate its definition as mentioned below;

- Risk = Probability of event x Magnitude of Loss/ Gain (Raftery, 2003)
- Risk Impact = Likelihood of a specific unwanted event x Its unwanted consequence (Mills, 2001)
- Risk = *f* (Uncertainty of event, Potential loss/gain from event) (Al-Bahar and Crandall, 1990)
- RE = POJO) * L(U0)

  Where RE is the risk exposure, P(U0) is the probability of an unsatisfactory outcome and L(U0) is the loss to the parties affected if the outcome is unsatisfactory (Boehm, 1991)
- Risk = Hazard x Exposure

  Where defining hazard as "the way in which a thing or situation can cause harm," and exposure as "the extent to which the likely recipient of the harm can be influenced by the hazard". Harm is taken to imply injury, damage, loss of performance and finances, whilst exposure imbues the notions of frequency and probability. It can be argued that hazard is not the "way in which" rather it is the 'thing' itself.

Rowe (1977) defines risk as the potential for unwanted negative consequences of an event and Rescher (1983) defines the risk as the chancing of a negative outcome. Most of the definitions on risk have been concentrated only on the downside related with risks such as losses or damages, and neglected the up side or opportunity such as profit or gains. But the fact that most risks usually have negative outcomes has led individuals to consider only their negative side (Baloi and Price, 2003).

2.3.3. Risk in construction project

The Construction industry can be identified as one of the most dynamic, risky, and challenging business (Mills, 2001). Construction projects are normally executed in uncertain and risky environment. Risk is inherent in all most all construction projects which is adversely affect to achieve their time, quality, and budget goals (Al-Bahar & Crandall, 1990; Baloi & Price, 2003). According to Hayes et al. (1986) risk and

uncertainty are fragment of all construction work irrespective of the size of the project. The construction industry is more complex and diverse risks, exposing to uncertainties cannot be avoided. Risk is unavoidable in both building construction and civil engineering construction (Thompson & Perry, 1992).

Even in construction industry, there are different definitions on risk. Risk may be defined as the probability of a harmful event occurring to the project (Baloi, 2003). Adeleke et al. (2017) define it as the likelihood of occurrence of any unforeseen or neglected event that can delay the achievement of project objectives. According to Ward and Chapman (2003), "risk is considered as threats but not opportunities and when it occurs it affects the project performance". Edwards (1999) identifies that in the most of the time, risks have an undesirable impact on the project's cost, quality and time. There is a common feature in most of the above definitions where they define risk in terms of uncertain events and may have positive or negative impact on a project's objectives. Therefore, the construction Risk can be defined as probability of loss or gain associated with the physical (construction) phase of a construction project where the endeavor action is unknown, unexpected, undesirable and unpredictable. This loss or gain may be an economic and financial loss or gain, physical damage, delays or quality wise.

Thompson and Perry (1992) and Mills (2001) have shown, these risks are not addressed properly in the construction industry. Most of the time risks are either disregarded or dealt with in illogical way by simply adding contingency on cost estimate (Mills, 2001), According to Al-Bahar and Crandall (1990), most contractors use a series of rules of thumb based on their experience and judgment to deal and very rarely they quantify uncertainty and systematically measure the risks involved in a project. Even though they assess these risks, the consequences associated with these risks is not considered at all. Contractors usually use high mark-ups to cover risk, however their profit margins become smaller. Therefore this approach is no longer effective and the construction industry has witnessed significant changes particularly in procurement systems with clients allocating greater risks to contractors (Baloi and Price, 2003). According to Mills (2001) the way of dealing with risk inadequate in complex business like construction which resulting expensive delays, litigation and

even bankruptcy (Hayes et al., 1986). Carr and Tah (2001) mention that inadequate dealing with risk, frequently resulting in poor performance, high cost and delays of the construction project.

Therefore, it is necessary to manage risks related to construction project properly for the project success. There is a direct relationship between effective risk management and project success since risks are assessed by their potential effect on the objectives of the project (Baloi and Price, 2003). Risks are inevitable throughout the life cycle of the construction project, therefore organization should manage them proactively (Goh et al., 2013; Zhao et al., 2013).

2.3.4. Risk Management in construction project

Akintoye and MacLeod (1997) found that in order to minimize losses and to increase the profit, risk management is essential to construction activities. With the complexity and high competition, risk management is very critical for the project success (Baloi and Price, 2001; Goh et. al., 2013). Risk management, is an essential part of project management and it is a positive and proactive process intended to reduce the probability of inacceptable consequences to the project in its different stages, such as design, construction and operation (Mills, 2001; Rohaninejad & Bagherpour, 2013). The purpose of risk management is to identify risky situations and to develop approaches to decrease the likelihood of occurrence and/or the negative impact (Fan et al., 2008).

Committee of Sponsoring Organizations of the Treadway Commission - COSO (2004) defines "risk management as a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives". According to Akintoye and MacLeod (1997), formal risk management techniques are hardly used by the construction practitioners due to a lack of knowledge and to uncertainties on the appropriateness of these techniques for construction industry activities. Further they identify that risk analysis and management in construction is applied instinctively mainly depends on perception,

judgment and experience, but it should be systematic then only risk will be clear, formally describing and making them easier to manage (Mills, 2001) which elaborating further by Serpella et al. (2014) mentioning that to make risk management an effective and efficient function, it is required to have a proper and systematic methodology and, specially, knowledge and experience of various types of risks.

2.3.5. Systematic Risk Management process in construction project

There are several benefits can be obtained by following risk management process as elaborated by Zikmund et al. (2009) which include identifying and analyzing risk and improvement of construction project management processes with the effective use of resources. Godfrey (1996) has identified the several benefits of systematic risk management as mentioned below,

- Identify, asses and rank risks making the risks explicit
- Focus on the major risks of the project
- Make informed decision on the provision for adversity such as mitigation measures
- Minimize potential damage should the worst happen
- Control the uncertain aspects of construction projects
- Clarify and formalize the company's role and the roles of others in the risk management process
- Identify the opportunities to enhance project performance

Mills (2001) has identified bellow advantages of following systematic risk management;

- Questioning of the assumptions that most affect the success of your project
- Concentrates attention on actions to best control risks and
- Assesses the cost benefit of such actions.

Different researchers have proposed different models of systematic risk management process in the literature and different bodies of knowledge (Goh et. al., 2013). However according to Rohaninejad and Bagherpour (2013), the anticipated output of risk management is to identify, evaluate and manage risks using methods to lessen them to an acceptable level and finally to have the successful project.

Edwards and Bowen (1998) explain risk management as a systematic approach which creating the context of setting goals and objectives, recognizing and examining risk, influencing decision-making, and monitoring and reviewing risk responses. According to Boehm (1991) systematic risk management process involves two primary steps. There are two main steps in risk management i.e. risk assessment which is consisted of risk identification, risk analysis and risk prioritization. And the second step is risk control which consisted of risk management planning, risk resolution, and risk monitoring. However, Taylor (2005) describes that there are five steps in systematic risk management process such as risk management planning, risk identification, qualitative and quantitative risk analysis, risk response planning, and risk monitoring and control.

According to Baloi, and Price (2003) systematic Risk management is a process comprising risk management planning, risk identification, risk assessment, risk analysis, risk response, risk monitoring and risk communication. Al-Bahar (1988) describes Risk identification, Risk analysis and evaluation, Response management and System administration as the construction risk management system. Chapman (1997) defines the risk management is consisted nine steps as define, focus, identify, structure, ownership, estimate, evaluate, plan and manage. Kululanga and Kuotcha (2010) also describes nine phases such as risk identification, risk analysis, systematic risk approach, risk exposure, risk prioritization, risk response, risk contingency planning, risk monitoring and risk continuous assessment. Kahkonen defines with fewer steps as Project Risk Management Handbook (2004) defines risk management as "the systematic process of planning for, identifying, analyzing, responding to, and monitoring project risk" (p.2) while Flanagan and Norman (1993) look risk management as a process of risk identification, classification, analysis, attitude and risk response.

Raftery (2003) divides systematic risk management process into three stages as Risk Identification, Risk Analysis and Risk Response. Baker, Ponniah, and Smith (1999b) also have established on three processes as identification, analysis and response in risk management which they suggest to implement in fifteen steps. According to Kayis and Amornsawadwatana (2007), the risk management process comprises three stages as

same above with different terminology as risk identification, risk assessment and risk treatment. Further this three step of systematic risk management process has been followed by Al-Bahar and Crandall (1990), Jaafari et al. (1995), Dey (1999, 2002), Wang et al. (2004), Turnbaugh (2005) and Othman (2008). Even though there are three steps systematic risk management process is identified in the above described scenarios, they tend to cover all most all scope described in other lengthy processes which tend to apply three step systematic process for this study.

However, Bunni (1997) has recognized another layer to this process called risk allocation to various parties in addition to identification, assessment and analyzing, in order to keep it either under control or to avoid the occurrence of destructive consequences and, thereby, to lessen the risk. Construction risks cannot be eliminated rather be transferred or shared from one party to another through contract clauses (Hartman, 1996; Andi, 2006). This is further discovered by Mak and Picken (2000) where it is required by the contractors to accept the risk up to some extend due to unexpected costs they incur during construction which is on the other hand a matter for the clients as well. According to Perera et al. (2009) risk allocation shall be a part of systematic risk management process. Therefore, it tends to extend the above identified three step systematic process including risk allocation before risk response as shown in the figure 2.3 for this study.

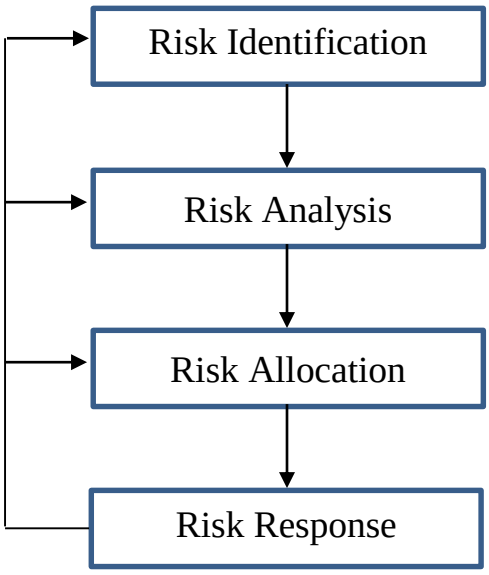

Figure 2.3 : Systematic Risk management process

2.3.5.1. Risk Identification

Risk identification can be identified as a procedure of discovering, recognizing and describing the risks which is diagnosis of the risks. Al-Bahar and Crandall (1990); Williams (1995); Andi (2006); Ling and Hoi (2006); Kayis and Amornsawadwatana (2007) found that risk identification as the initial stage of risk management and is possibly the most difficult. Risk analysis and response management cannot be performed without identifying potential risks. Therefore, all possible potential sources of project risks and their potential consequences shall be investigated. Risk identification is carried out to determine the probable risks (Osipova and Erikson, 2011). The risk shall be identified in order to categorize negatively affected risks and to document these risks. The outcome of risk identification is a list of risks. These outcomes should be very detailed and comprehensive (Bajaj et al., 1997). Purpose of this list of risks depends on the nature of the risks and the project.

After identifying a risk it should be a management problem rather than a risk (Flanagan and Norman, 1993). Further they noted that a bad definition of a risk may precipitate other risks, where it is most important to obtain a clear opinion on the risk event before focusing on the sources of risk and their potential effects.

Unavailability of a professionals with knowledge on major risks of projects and their importance could be a source of threats for projects in any context (Maslow 1943; Al-Bahar & Crandall 1990). The identification process depends on the nature of the project and the risk management skills of the project team, but most identification processes begin with a scrutiny of matters and concerns created by the team.

According to Smith, Merna, and Jobbling (2006), four techniques are commonly used to identify risks in construction projects. There are number of other risk identification tools and techniques can be found in the literature. Table 2.1 provides an example of project-specific documents, programmatic documents, and techniques available for risk identification. These only help the team in the risk assessment process and never prevent the engineering decision required for a comprehensive risk identification process.

Table 2.1 : Risk identification tools and techniques

Risk identification tools and techniques	
Project Specific Documents	Project description, Listing of team's issues and concerns, Work breakdown structure, Design and construction schedule, Cost estimate, Procurement plan
Programmatic Documents	Historic data, Academic studies, Checklists, Final project reports, Published commercial databases, Risk response plans, Organized lessons learned
Techniques	Brainstorming, Influence or risk diagramming, Scenario planning, Crawford slip methods, Expert interviews, Delphi methods, Nominal group methods

Al-Bahar and Crandall (1990) has defined Risk identification as "the process of systematically and continuously identifying, categorizing, and assessing the initial significance of risks associated with a construction projects" which consisted of six steps shown in the figure 2.3 which further elaborated in the table 2.2.

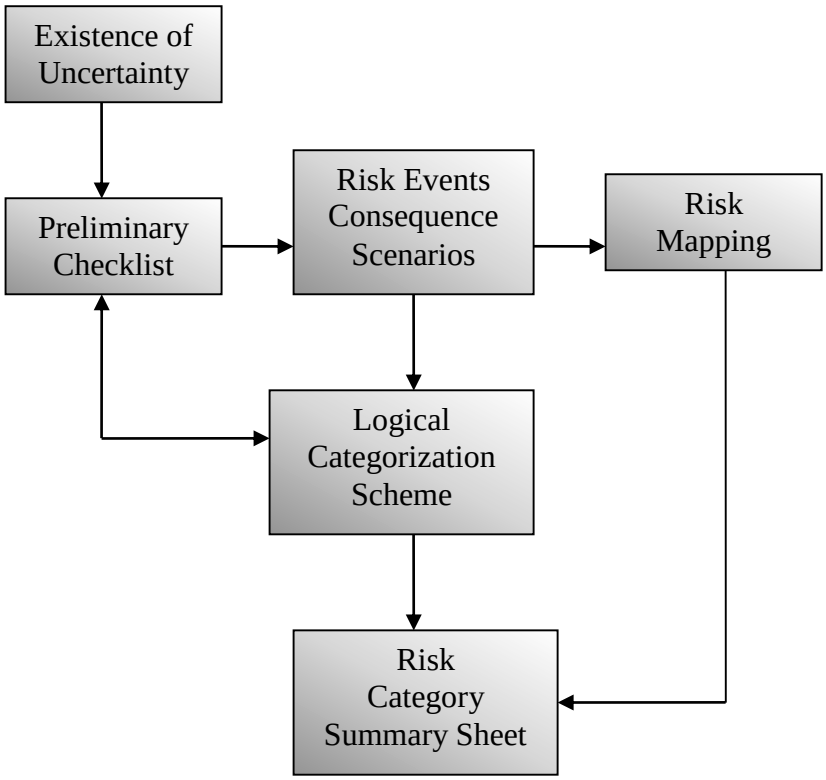

Figure 2.4 : Risk identification process framework

Source: Al-Bahar and Crandall (1990)

Table 2.2 : Explanation on Risk identification process framework

Risk identification step	**Description**
Step 1: Preliminary Checklist	This is the starting point for identifying risk. Documents and techniques mentioned in the table 2.1 can be used to prepare the check list. There should be an effort of listing all types of risk sources without any failure. The preliminary checklists used during the risk identification process are usually developed based on historical information and previous project team experience (Heldman, 2005). Thus, in the case of the present research, the preliminary check list was prepared using previous research findings.

Risk identification step	**Description**
Step 2: Risk Events/ Consequence Scenarios	This set represents all reasonable possibilities associated with the realization of each primary source of risk included in the preliminary checklist while the consequences can include economic gain or loss, personal injury, physical damage, time and cost savings or overrun. Since most risks that evolve in construction projects are financially related, the emphasis is on the financial consequence criterion as a uniform basis of assessment. Any other criteria can be valued in terms of financial gain or loss.
Step 3: Risk Mapping	In event risk mapping, a graph of two dimensions or scales is proposed to construct the risk map. In the first dimension, uncertainty will be assessed with regard to the probability of occurrence. In the second dimension, risk will be assessed with regard to its potential severity. Such a two-dimensional graph is considered an important graphical representation, and will enable the project manager to assess the relative importance of an exposure to a potential risk in an early stage.
Step 4: Logical Categorization Scheme (Taxonomy)	The purpose of forming a taxonomy or classification of risks is to 1. Expand the awareness of risk and 2. As the strategies adopts to mitigate risks will vary according to their nature (Al-Bahar and Crandall, 1990) 3. As it attempts to structure the diverse risks affecting a construction project (Tah and Carr, 2000) 4. As it is useful way to manage them (Wong and Hui, 2006) 5. As one may not be interested in the analysis of all risks but only in a particular category for various reasons (Walke et al., 2011). The classification of risks consists of a number of steps such as the identification of the consequences, types and impacts of the risk (B.A.K.S. Perera et al., 2009). In order to manage Risks

Risk identification step	Description
	effectively, many approaches have been suggested in the literature for classifying risks as summarised in the table 2.3.
Step 5: Risk Category Summary Sheet	This is the final step in risk identification process. The summary sheet will integrate the participation of all personnel involved in the project management team. Such participation is considered very important in risk identification process, since judging the significance of any risk cannot be delegated to a single person. As information changes or different risk exposure develops, the summary sheet is updated and it becomes a living picture of management's understanding of the project risks.

Source: Al-Bahar and Crandall (1990)

Table 2.3 : Risk Taxonomy abstracted from literature

Reference	Risk Taxonomy
Perry and Hayes (1985)	Risks retainable by parties i.e. contractors, consultants and clients
Edwards and Bowen (1998)	Natural and Human risks.
Chapman (2001)	Environment, industry, client and project.
Shen, Wu and Ng (2001)	Financial, legal, management, market, policy and political, technical risks.
Wiguna and Scott (2006)	External and site condition risks, economic and financial risks, technical and contractual risks, and managerial risks.
Thompson and Perry (1992); Flanagan (1993)	Technical, construction, legal, natural, logistic, social, economic, financial, commercial and political
Wang et al. (2004)	Political risks, financial risks, intellectual property risks, social risk
Tah and Carr (2000)	Internal and external

Reference	Risk Taxonomy
Adams (2006)	Objective (identified via the actual observation/ calculation of their occurrence and impact on a project) or subjective (assessed based on people's perceptions)
Baloi and Price (2003)	Dynamic/static, corporate/individual, Negative effect (risks) and positive effect (opportunities), acceptable/unacceptable and insurable/non-insurable
Zhi (1995)	Quality risks, personnel risks, cost risks, deadline risk, risk of strategic decision and external risks
Santoso, et al. (2003)	Physical, Personal, Technical, Safety, Design, Political, Financial, Contractual, Environmental. This risk taxonomy was used for the current study, because it is a comprehensive categorization which cover the construction stages and parties to the contract. Further the same has been used for the risk assessment of high rise buildings in Jakarta.

2.3.5.2. Risks Analysis

The risk analysis process can be identified as the important link between systematic identification of risks and management of the significant risks where it short list the highest impact risks on the project. Risk Analysis supports to predict and evaluate the consequences of the probable risks for the projects (McClelland 1961). Basically there are two risk analysis methods called qualitative and quantitative (Flanagan and Norman, 1993). Figure 2.4 elaborates these both methods. The quantitative methods are mostly used to determine the likelihood and effect of the identified risks which is based on numeric estimates. The qualitative methods are used when risks can be positioned on a descriptive scale from high to low level. (Winch, 2002). Majority tend to use a qualitative approach in the construction risk analysis (Zhi, 1995) as it is more convenient to describe the risks than quantifying. However, there is another method called semi-quantitative analysis, which is a combination of numerical values from

quantitative analysis and description of risk factors, the qualitative method Cooper et al., 2005) this was used for this study.

There are some systematic models for use in the risk evaluation process (Dey, 2001) such as classical and conceptual (Kangari and Riggs, 1989). However, (Tah et al., 1996; Akintoye & Macleod, 1997; Uher & Toakley, 1999) have found that these techniques are rarely used in the industry as they don't serve the purpose.

It is important to select the most appropriate risk analysis model for a specific project against quantitative and qualitative categories. It should be based on the type of risk, project scope and the specific methods requirements and criteria. However the anticipated outcome of such assessment should be trustworthy. According to Perry (1986), the selection of the correct technique normally depends on past experience, expertise, and/ or availability of computer software.

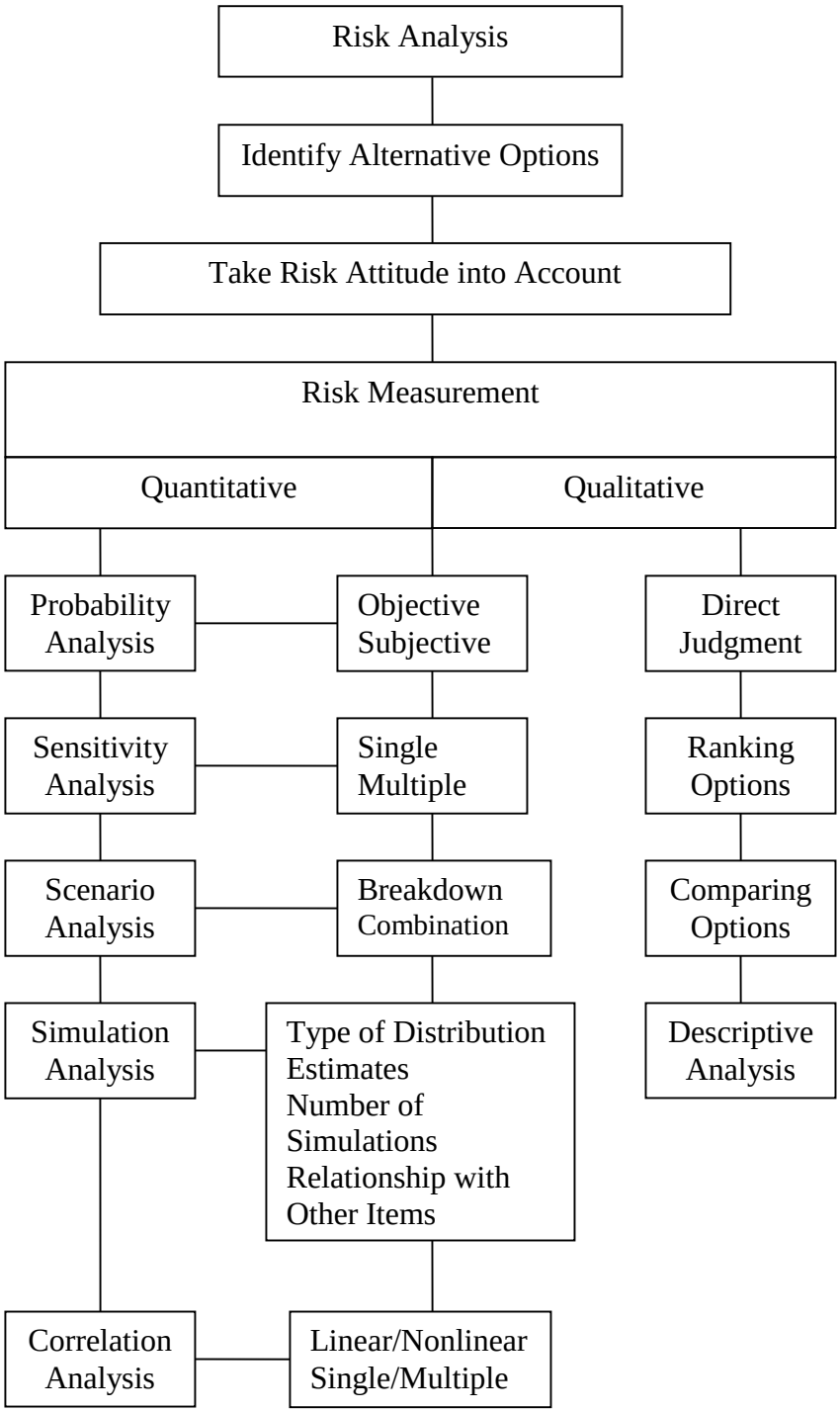

Figure 2.5 : Risk analysis process

Source: Flanagan and Norman (1993)

2.3.5.3. Risks Allocation

Risk must be must be allocated to various parties after identifying, assessing and analyzing in order to keep risk under control or to prevent the occurrence of negative consequences and to reduce the risk (Bunni, 1997). This has been further explained by Perera et al. (2009) and conclude that Allocation of risk becomes part of the risk management process.

The varied interests of project stakeholders in a construction project further worsen the unpredictability and complexity of the risks (Zou et al., 2006). It is important to effectively and frequently involve by all stakeholders of the project in all stages of risk management process which will help to identify most of the risks and to protect their promise of managing them (Loosemore et al., 2006). Consequently, the risk should be attached to all parties involved rather than one party and problems may be divested from one party to another by contract agreement. Even though Hartman (1996) has mentioned that only client and the contractor must have similar understanding of risks, Bunni (1986) identified risks in a project comes to affect the all stake holders of the project such as owner, the professionals, which includes consultants, and the contractor. Thompson and Perry (1992) have argued that the client is the person who identifies a risk and the other parties identify the risk only if it defends their own benefits. According to Ward et al. (1991), clients may be more eager to take on a risk if they are expertise in the industry and often construct. Usually consultants bear very little risk as they just consult, even though the harm incurred due to bad consultancy may be very significant (Flanagan & Norman, 1993). While risks are oriented towards all project stake-holders, project success depends on the way of managing the risks (Zou et al., 2007). Ahmed et al. (1999) argue that risk can either be shared with or totally shifted to the employer, contractor, or any other third party. Therefore the current study aims to evaluate the risk allocation among client, contractor and consultant before moving to risk response of the process.

Carefully drawn up contract will ensure the right allocation of responsibilities in the same way as the procedure which determines the type of contract and the tendering

procedure for a project (Thomsan and Perry, 1992). Risk allocation is determined in the each constituent of the contract, such as the contract agreement, conditions of contract, specifications, preamble notes, bills of quantities and drawings, etc.(Prerera et al., 2009). The party to whom the risk is allocated should have both capability and expertise to fairly evaluate the risk and to manage the risk (Godfrey, 1996; Hartman, 1996; Fisk, 1997; Perry & Hayes, 1985).

2.3.5.4. Risks Response

Final stage of the risk management directs the action should be taken towards the recognized risks. Purpose of risk response is to remove as much as possible the potential impact and to increase control of risk (Al-Bahar and Crandall, 1990). The response strategy and approach chosen depend on the nature and potential consequences of the risk. It is required to have a supervisor to monitor the development of the response, which will be agreed by the parties involved in this risk management process (PMI, 2004). Winch (2002) has mentioned that if the risk has minor effect, then it can be managed well.

Most common approaches for risk response are Avoidance, Reduction, Transfer and Retention (Raftery, 2003: Mills, 2001; Al-Bahar and Crandall, 1990) as further explained in the table 2.5. According to Mills (2001), these risk response methods may be used individually or in blend.

Table 2.4 Risk response strategy

Response Strategy	Explanation on strategy
Risk Avoidance	If the risk brings negative consequences to the whole project, the best solution is to avoid it by changing the scope of the project or cancel it (Baker et al., 1999a). There are many potential risks that a project can be exposed to, and which effect to the project failure (Potts, 2008) which required risk management instead of dealing with injury after risk occurrence. The avoidance means that by looking at alternatives in the project, many risks can be excluded. According to Carter and Doherty (1974) there are several

Response Strategy	Explanation on strategy
	ways of avoiding risks i.e. pre-contract negotiations, tendering a very high bid, placing conditions on the bid, and not bidding on the high portion of the contract.
Risk Reduction/Mitigation	According to Baker et al. (1999a) the risk reduction technique is the one more oftenly utilized in the construction industry but mostly difficult (Perera and Rameezdeen, 2008). This is consisted of two methods, reducing the likelihood of a risk; and reducing the financial severity of risk if it does occur (Al-Bahar and Crandall, 1990). According to Flanagan and Norman (1993) this can be done by giving education and training the staff on potential risks; providing physical protection to reduce the likelihood of loss; putting systems in place to ensure consistency and to make people ask the 'what if' questions; and providing physical protection devices and mechanisms to protect people and property.
Risk Transfer	Risk should be transferred to the party who can best manage it (PMI, 2004). According to Thompson and Perry (1992), risk transfer has two basic forms as transferring the property or activity responsible for the risk and retaining the property or activity transferring the financial risk, for instance insurance. Risks such as political issues or labour strikes (Darnall & Preston, 2010) and catastrophes (Winch, 2002) which beyond the management's control can be transferred through insurance policies.
Risk Retention	If a risk cannot be reduced, transferred or avoided, then it should be retained. Then risk must be controlled, in order to reduce the negative impact (Potts, 2008). Retention can be chosen when other solutions are inefficient (Thomas, 2009).

Response Strategy	Explanation on strategy
	Two retention methods have been identified by Carter and Doherty (1974) as active (deliberate retention after evaluating the consequences of risk) and passive (risks incurred due to negligence, ignorance or absence of decision).

It has been identified that the risk management as a procurement selection factor by Bennett and Flanagan (1983), Skitmore and Marsden (1988), Love et al. (1998), Luu, Kim, Tuan and Ogunlana (2003), NEDO (1985), Cheung et al. (2001), A.P.C. Chan, Wong, E.H.W. Chan, and Ho (2000), Ng et al. (2002), Singh (1990), Bennett and Grice (1990), Kumaraswamy and Dissanayaka (1998).

General principles of risk management can be utilized in design of procurement system. The client's choice of procurement option implies different ranges of responsibilities and liabilities for the various actors, as well as different degrees of their collaboration in the project (Love et al., 1998; Eriksson and Westerberg, 2011) and may thereby influence risk management. Before proceeding with a project, a client has to choose an appropriate procurement option that facilitates an effective project organization in general and a thorough risk management process in particular (Osipova and Eriksso, 2011). Further he identified that three procurement variables (project delivery method, form of payment and use of collaboration or partnering arrangements) have a major influence on risk management. Therefore, it is vital to discuss the systematic risk management against each procurement systems and variables. This study is focused both of project delivery method and form of payment.

2.4. Procurement systems

2.4.1. Concept of procurement system in construction

The concept of procurement in the construction can be defined in several manner (McDermott, 1999; Love et al., 1998). Dewage (2009) simply describes the procurement method of any construction project as the procedure adopted to procure construction work. According to Masrom (2012) definition of the Procurement is the

process of obtaining goods and services from another for some consideration. Further he defines the term procurement is used in the context of construction as the processes of acquiring construction project. According to Masterman (1992) a construction procurement system to be "the organizational structure adopted by the client for the management of design and construction of a building project". A procurement system "is an organizational system that assigns specific responsibilities and authorities to people and organizations, and defines the various elements in the construction of a project" (Love et al., 1998). CIB (1991) defined procurement systems as "the framework within which construction is brought about acquired or obtained". Construction procurement has been subject to considerable transformation from lowest cost to best value procurement and a revised agenda for delivering broader policy goals related to social and environmental sustainability (Oyegoke et al., 2009). Tookey et al. (2001) stated that procurement is, therefore, a succession of 'calculated risks' and further stated that reducing procurement risk can be done through better procurement-system.

For this research purpose the word of procurement system is used rather than procurement methods because it is consisted of all properties which system has. System is s a set of interacting or interdependent elements forming an integrated whole. System is an organized, purposeful structure regarded as a whole and consisting of interrelated and interdependent elements. These elements continually influence one another (directly or indirectly) to maintain their activity and the existence of the system, in order to achieve the goal of the system. All systems have following properties;

- Inputs, outputs, and feedback mechanisms
- Maintain an internal steady-state (called homeostasis) despite a changing external environment.
- Display properties that are peculiar to the whole (called emergent properties) but are not possessed by any of the individual elements
- Have boundaries that are usually defined by the system observer.

In procurement system we talk about;

- Parties involved (elements) and selection of parties
- Relationship between parties (interaction)
- Features of the system (emergent properties)
- Effectiveness under volatile environment (homeostasis)
- is something we design
- in fact is the project strategy we develop

NEDO (1983), Masterman (1992), Franks (1998) and many other authors in procurement have attempted in categorizing procurement systems in many ways.

2.4.2. Procurement systems based on project delivery methods

Procurement systems are categorized into four broader types as Separated systems, Integrated systems, Management oriented systems and Collaborative systems (Rameezdeen and Silva, 2002) based on project delivery methods as shown in Figure 2.5 with most common arrangements belonging to each category.

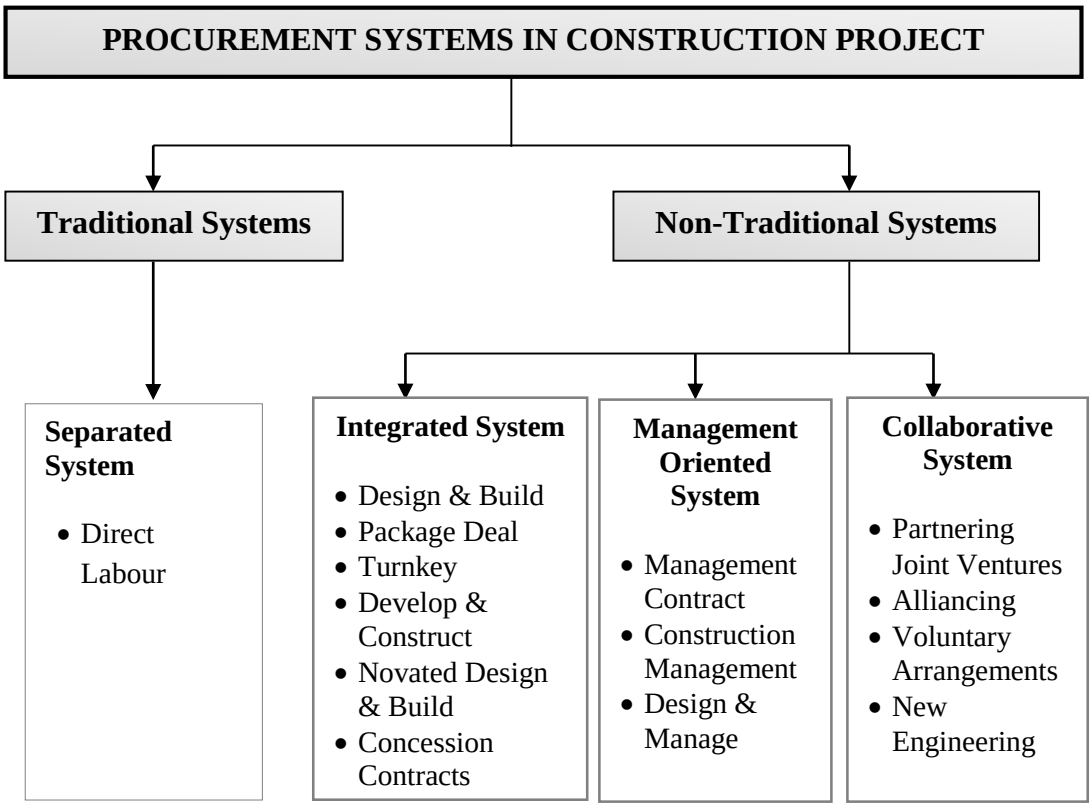

Figure 2.6 : Categorization of Construction Project Procurement Systems

Source: Rameezdeen and Silva (2002)

2.4.2.1. Separated systems

Seperated system is the most widely used project delivery method in many countries (Eriksson and Laan, 2007). There are key features of separated systems such as the rigid separation of design and the construction process and lack of integration across this boundary (Cox and Townsend, 1998). Normally in this method construction started after the design is completed. Client first appoint a consultant to do the design and after completing designing in fully, tendering procedure is being held and a contractor is selected thereafter to carry out the project (Ashworth, 1996). The selected contractor enters into a direct contract with the client and carries out the work under the supervision of the consultants, which offer insignificant contribution of contractors to the design process (Rowlinson, & McDermott, 1999).

This is the most popular procurement system and most owners and contractors would have experience of it. It is also thought that this method offers some price certainty since the design is fully completed before starting construction even though this is

often not the case. This system gives the client greater control of the design as he controls the design team. This is advantage to the client of having a self-governing professional in the role of the contract administrator monitoring the project. The main drawbacks of this method is splitting responsibility between construction and design which can lead to disputes whether defects are really due to design or workmanship.

2.4.2.2. Integrated systems (Design and Build)

There are severe forms of Design and Build, however it is characterized as the contractor taking both design and construction responsibility. It has been widely accepted that closer integration of design and construction is a benefit of the system (McDermott, 1999). In integrated D&B contracting the contractor develops the design and constructs the building based on a set of requirements provided by the employer. Although, the contractor assumes the overall responsibility for project delivery, the client may appoint an independent adviser to monitor quality and cost (Cox and Townsend, 1998). This method is very popular when a competitive design wanted (Ashworth, 1996).

There are several variants to the integrated procurement system, which have been introduced to bring more competition into the process and to allocate the riskin balance (Valance and Akintoye, 1996). The range of services offered by the contractor varies greatly with these variants (Franks, 1998). With some variants contractors find sites, arrange mortgages, sales and finance. Some even operate the constructed facility in addition to design and construction. In novated D&B contracting is slightly closer to the traditional system where the client's design team develops the design but is then novated to the contractor who takes the design responsibility and then constructs the building. "Turnkey" or EPC contracts are a type of D&B contract but Turnkey and D&B are not synonymous. The fundamental characteristic of Turnkey contracts is that contractor should simply "hands over the keys" to the employer at completion. Turnkey contracts are typically associated with process or power plants or works with a heavy engineering element and tend to be associated with performance based contracts. They typically place most of the risk on the contractor. The main advantages of this method of procurement are single point responsibility by the contractor for both design and construction and the ability to fast track the project. In a turnkey project

contractor provides all the necessary resources required to carry out the project, including the design, construction as well as the finance (Bagnall, 1999). Package deal system is used only in special type of design build project where the client chooses a suitable design from a given catalogue (Ashworth, 1996). In Develop & Construct system, Consultants appointed to design the building to a certain stage and then constructors complete and guarantee the design and competition, either using client's consultants or their own designers (Seeley, 1997). Private Finance Initiative (PFI) is a system whereby the private sector (usually as a consortium) undertakes to finance the total procurement process on behalf of the public sector, payment being delayed until the project is complete and ready for occupation at handover (Bagnall, 1999).

D&B lends itself more readily to allowing contractors to start on site before the design is completely finished. This can be important, particularly to government bodies who sometimes need to spend their budget for the project within allocated periods. This procurement method is increasingly common and shares the advantage that most employers and contractors would have experience of it. The disadvantages of D&B include the loss of design control by the employer. Experience suggests that in an effort to bring projects in on budget D&B contractors can often compromise on design and this can be a problem for employers. It places a greater responsibility on employers to carefully detail their requirements without being over prescriptive to the point where they are effectively providing a design themselves. The client also faces the absence of the contract administrator as his eyes and ears for the project.

2.4.2.3. Management oriented systems

In addition to client, consultant and contractor, specialized contractors become as participant in this method. Finance and operation carried out by client. This method will be chosen if there are possibilities to identify projects in packages. The major difference of this system is the separation of management function from design and construction by adding new separate management layer to the design and construction. Contractor (external organization) acts as a manager who responsible for management and coordination of design and construction of the work and specialized contractors undertake real build aspect on their specialized field.

The common variants to these systems are Management Contracting and Construction Management. In Management Contracting, an expert builder is appointed on a fee basis well before work starts on the site to advise the design team and in Construction Management, a construction exert is appointed early on, for a fee, to manage the construction process (Potter, 1995).

The overall design and construction time is generally shorter with these systems (Turner, 1990). Varying ideas on cost reliability of the arrangements are reported by many researchers (Chan, et al., 1994). Technologically complex buildings and large projects are recommended for these systems. In Sri Lanka, only few projects have been procured through this method and all of them are very complex and large-scale building projects and this is a good improvement of the separated model (Rameezdeen and De Silva, 2002).

2.4.2.4. Collaborative systems

The common variants to the Collaborative systems are Partnering, Join ventures, Alliancing and Voluntary Arrangements. The basic principle of these systems is the collaboration between two or more parties to achieve successful project objectives through fair dealings, commitment, and shared investment. Various forms of joint ventures through combine investment of capital and expertise to undertake the works are also considered as collaborative procurement systems (Valence and Huon, 1999). Public/private partnership (PPP) is the first form of collaborative system where first launched in 1992, in the form of the Private Finance Initiative (PFI), the UK Government appeared to view them primarily as a way of getting infrastructure costs off the public balance sheet, keeping investment levels up, cutting public spending and avoiding the constraints of public sector borrowing limits (Bing et al., 2005). Crowly and Karim (1995) stated that partnering is a decentralized organizational structure that allows better flexibility in meeting specific project needs through increased organizational competence.

The key attributes associated with partnering are trust, shared vision and long term commitment of the parties involved. Some of the advantages of partnering according to Franks (1998) and Matthews (1999) are reduced exposure to litigation, low risk of cost and time overruns, non-adversarial win-win attitudes, better quality products,

quicker start and improved efficiency of human and other resources. Nevertheless, the lack of commitment by all parties, cultural issues, higher risks involved and loss of control over dishonesty may be seen as common disadvantages of partnering (Matthews, 1999). CIB (1997) believes that this is the most suitable approach for high-value high-risk construction projects. In Sri Lanka, Collaborative systems have just started to emerge as international contractors form joint venture arrangements with local counterparts or existing international contractors when entering the Sri Lankan market.

2.4.3. Procurement systems based on payment methods

Form of payment has a significant impact on risk allocation and influences the behaviour of the project actors (Osipova and Eriksson, 2011). Procurement systems can be mainly categorized as Lump Sum, Measure and Pay and Prime Cost (Rameezdeen and Silva, 2002) based on their form of payment as described below.

2.4.3.1. Lump sum

In lump sum arrangements, contract sum is agreed before the construction starts and risk is very high to the contractor. These contracts render maximum price certainty before the start, provided that client's requirements are fully specified (Turner, 1990). This system is becoming increasingly popular among private sector clients in Sri Lanka (Rameezdeen and Rathnasabapathy, 2006). In this fixed price, shift most risk and responsibility to the contractor and do not underpin possibilities for joint performance improvement (Floricel and Miller, 2001).

2.4.3.2. Measure and pay

Measure and pay contracts are generally used where the work has been substantially designed but final details have not been completed. The tender is based on drawings, specifications and approximate bill of quantities. The contractor is paid according to the amount of work done as measured after the physical completion. Even though, the overall time is shorter with this method, lack of price certainty at the contract stage remains a main disadvantage. In Sri Lanka, majority of public works are procured using this method (Rameezdeen and Rathnasabapathy 2006; Wijewardana et al.,

2013). Transparency and accountability are the main driving forces for favouring this method over others in the public sector.

2.4.3.3. Prime cost

Prime cost contracts include three main approaches such as cost plus contracts, target cost contracts and fee contracts (Rameezdeen and Silva, 2002). In contrast, cost-reimbursement forms of payment imply that the contractors are compensated for their actual costs and an agreed amount to cover profits. Target cost contracts further identified as incentive-based contracts where both client and contractor share the risks and rewards (Floricel and Miller, 2001). These methods are used where there is an inadequate definition of work at the time of tender, during high inflation and the project is extremely complex or unquantifiable risks are involved. The absence of tender sum at the beginning and no contractual commitment of the contractors to reduce the final cost are considered as the major disadvantages of these systems. Prime cost arrangements are the most popular method in the informal sector of the Sri Lankan construction industry. Informal sector accounts for a considerable amount of workload in the country mainly from the housing sub-sector.

2.4.4. Risk management of each procurement systems

Each procurement systems carry different levels of risks to each party. Securing an optimum level of risk transfer between the client and the contractor is one of the major objectives of any procurement system and this led to the divergence of procurement systems in construction from traditional model to alternative procurement systems by transferring risk to the party that is best able to deal with it (Chege and Rwelamila, 2000). Procurement systems have different characteristics which are suitable to varying situations and therefore they are important tools for risk management in the area of risk response development (Chege and Rwelamila, 2000).

Therefore there are few researches have focused on risk management on individual procurement systems. Oztas and Okmen (2003) have only analyzed risks for the projects following design and build delivery method and fixed price-lump sum payment method. There are 14 risks have been explored through examining the project's documents, contract clauses, and conversations arranged with design and build firms

and these risks factors have been analyzed and find out the cost and time impact of each. Complete risk management process in not applied here. Bing et al. (2005) have identified risks factors for PFI projects and risk management process has been carried out till risk allocation. Ogunsanmi et al. (2011) have developed a model for risk classification for design and build projects. No researches can be found which follow systematic risk management process in either sole procurement systems or as combined.

2.4.5. Procurement systems used in high rise Projects of Sri Lanka

2.4.5.1. High rise projects in Sri Lanka

A tall building is a multi-story structure in which most occupants depend on elevators to reach their destinations. The most prominent tall buildings are called high-rise buildings in most countries and tower blocks in Britain and some European countries. The terms do not have internationally agreed definitions (Challinger, 2008). According to Hall, 2005, for most purposes, the cut-off point for high-rise buildings is around seven stories. Sometimes, seven stories or higher define a high-rise, and sometimes the definition is more than seven stories. Sometimes, the definition is stated in terms of linear height (feet or meters) rather than stories. According to City of Colombo Development plan of UDA (2018), high rise buildings are defined as more that 13 floors and high rise also further classified 13, 14, 15-20 and 21 and above where UDA rules depend on this classification. Moreover, in accordance with the "Mandatory Structural Fire Protection and Access Requirements to be Included in Proposed Building Plans" of fire service department of CMC, 30m-60m height buildings are defined as high rise and above 60m height (20 floors) is defined as super high rise where fire regulations are categorized accordingly Therefore, for this study high rise buildings with 20 floors and above is considered, as above evident that complexity of the high rise buildings in Sri Lanka can be changed if the number of floors are above 20 floors.

As the ever-changing skylines of cities all over the world show, tall buildings are in increasingly important solution to accommodate a countries growth more sustainably in urban areas with increase in demand of higher life quality. Whether it is residential,

commercial or mixed use, the tower of the functionality is both a statement of intent and the defining image for the new emerging cities and skylines.

It is estimated that the High-rise or multi story buildings are the most important part of the construction for the greater development (Sakthiniveditha & Pradeep, 2015). According to population and Housing Census of Sri Lanka in 2012, population of western province is 29% and among that urban area population is 39%. It's no wonder that an increasing number of tall buildings are being planned and constructed to cope with this demand in Sri Lanka. High rise allow space to be maximized in densely populated areas, minimize urban sprawl, reinvent the city skyline, and satisfy human fascination with tall buildings.

The tall building typology has witnessed more rapid growth in the past decades than in the preceding hundred years. The boom in construction of tall buildings is so unprecedented in the history mankind. The globe has virtually reached its intense period of tall building construction between 1990's to 2000's whereas Sri Lanka unfortunately suffered the consequences of war therefore prevented us from reaching the mile stones of tall building construction. Before 20th century only six number of tall building as mentioned in the Table 2.6 with maximum 43 floors have been constructed in Sri Lanka. With the post war development, more than twenty number of high rise buildings have been already constructed and there about more than thirty number of high rise building are being constructing, with spreading range of 20 to 70 floors. Further there are proposed structure such as Al-Aman World Capital Centre with 110 floors and Altitude with 96 floors yet to be come.

Table 2.5 : High rise building in Sri Lanka before 20th century

Sr Nr	Building	Completion year	Nr of Floors
1	Ocean View Tower	1980	22
2	Bank of Ceylon headquarters	1985	32
3	Hilton Hotel	1987	21
4	World Trade Centre	1996	43
5	Hilton Residencies	1997	34
6	Crescat Residencies	1997	25

According to Fernando (2016) almost all cities globally have been developing their urban habitat skyward. At the same time, many characteristics of high rise construction have changed fundamentally from what they were for the most of 20th century in terms technical aspect and constructability. Therefore risk is inherent on high rise projects of Sri Lanka considering its complexity and in experience.

2.4.5.2. Procurement systems used in Sri Lanka

By summarizing past researches in Sri Lanka, Jayasena et al. (2008) shows that the traditional procurement system is dominating delivery method from 1977 to 2003 and Design and Build procurement system use as next alternative option among alternative procurement systems. Further it shows that Measure and pay as the most dominant payment method and Lump sum method is used as the next alternative option.

However, as described above the trend on high rise buildings starts with the post war construction which is after 2005. Therefore, above researches finding available up to year 2003 may not applicable for the current scenario, as it doesn't imply on high rise building in Sri Lanka. Consequently, preliminary survey is required to find out the commonly used procurement systems, both in delivery method wise and payment method wise for high rise projects in Sri Lanka.

2.5. Approach to the Research Problem

There are massive number of researches on risk management in the construction industry (Williams, 1995; Wang et al., 2004). A great deal of research has been carried out on various aspects of risk management worldwide (Wiguna & Scott, 2006) with many country-specific models too on how to identify, analyze and manage severe risks. These studies have contributed much adequately covering the perception of contracting parties on risk and risk management (Kangari, 1995; Cheung, 1997; Ahmed et al., 1999; Kartam & Kartam, 2001; Rahman & Kumaraswamy, 2002) while orienting both researchers and practitioners towards effective risk management.

There are numerous country-specific studies on risk management in the construction industry and these studies are of immense value to those who wish to study the principles and practices of risk management in the Sri Lankan construction industry. Since the perception of risk is subjective while also being affected by the unique

political, economic, environmental and cultural conditions of a country (Han & Diekmann, 2001; Andi, 2006; El-sayegh, 2008; Li, 2009), researchers have argued for paying attention to the manner in which these differences in thinking, value systems and living conditions affect the construction industry, especially the management of risks. Hastak and Shaked (2000) also expose this argument because they identify how the analysis of the project risk is impacted by the country's socio-economic and market environment. Thus, in the case of the Sri Lankan construction industry, the conditions affecting the industry have to be understood as particular to the country's environment. However, the most said surveys and case studies were typically based on one group of project participants. More often than not, only the perspective of the contractor was considered in identifying risk factors (Kangari, 1995; Ahmed et al., 1999; Bing et al., 1999; Kim & Bajaj, 2000; Kartam & Kartam, 2001; Wang & Chou, 2003; Fang, Fong, & Shen, 2004; Wiguna & Scott, 2006). But risk management aims at minimizing risks to all parties irrespective of who bears the risk (ASCE, 1979). Therefore, the risks of a project should not be determined on the basis of the perceptions of one party. Risk management moreover considers the total project cost due to the perceived risks of the different parties and not just the costs borne by individual parties separately (Rahman & Kumaraswamy, 2002). Therefore, it is important to understand the combined effort of contracting parties towards risk management.

There are many complex and iconic high rise buildings are being constructing and many have been proposed to be constructed in Sri Lanka. Therefore, there is an urgent need to study issues to do with risk management in the Sri Lankan construction industry which has to cater to this current demand for high rise building. However, to date, there are no studies have been found in the case of high rise building projects of Sri Lanka. Han and Diekmann (2001) have pointed out that risks could be the result of the unique political, economic, environmental and cultural conditions of a country. Hence, it is important to arrive at country-specific studies of critical risk factors and their management. However, according to Osipova and Erikson (2011) and Serprel risk management is massively influenced by procurement systems. Therefore, the present study addresses this gap by studying risk management in each procurement systems commonly used in high rise projects in Sri Lanka.

As risk involved in high rise projects are higher (Sakthiniveditha & Pradeep, 2015), risk factors should be higher in high rise projects. Only few studies which identify risks factors in high rise building projects can be found even though there are a number of studies which identify risk factors in building projects for other countries. However, studies can be found in Sri Lankan context in neither cases. Since, as discussed above, risk factors are affected by the culture, politics, values, etc., of a country, these lists may be not applicable for Sri Lanka. Perera and Rameezdeen (2008) have identified list of risk factors in Sri Lanka but for road projects where it is obvious that risks associate with infrastructure projects is differed from building projects especially high rise projects.

Santoso et al. (2003) has developed risk factors which generally suits to high rise projects in Jakarta by filtering and modifying risk factors derived from various researches. But it emphasis risk factors only important to contractors. Therefore, risk factors for this study purpose is listed out by filtering the risk factors used by Santoso et al. (2003). Only risk factors appropriate to high rise projects of Sri Lanka were filtered from preliminary survey and adopting the experience in high rise buildings of the author. This risk factors adopted for this research is give in table 2.6 below under the risk taxonomy used by Santoso et al. (2003) since it is benefited to classify the risks as explained in the Table 2.2.

Table 2.6 : Risk factors of high rise buildings

Risk Taxonomy	Sub Category	Risk Factor
01. Physical risk		01. Fire 02. Lightning 03. Heavy rain 04. Flood 05. Extraordinary wind 06. Pestilence
02. Personal risk	2.1 Technician and labour	01. Frequent job change by skilled labour 02. Lack of skilled labour 03. Lack of unskilled labour 04. Strikes and labour disputes 05. Low productivity 06. Poor workmanship 07. Brawls and fighting 08. Use of illegal foreign labour 09. Gambling on site 10. Absenteeism 11. Unable to understand drawings 12. Communication problems
	2.2 Subcontractor	01. Lack of funds to proceed with work (Insolvency) 02. Lack of required technical skill 03. Unable to finish work on time 04. Low quality of work 05. Unable to find qualified subcontractor 06. Low productivity 07. Coordination problems 08. Subcontractor unable to afford adequate labour 09. Subcontractor takes jobs in several projects 10. Subcontractor abandons project
	2.3 Contractor	01. Incompetence and lack of responsibility 02. Absenteeism 03. Brawls 04. Lack of experienced staff
	2.4 Engineer	01. Incompetence and lack of responsibility 02. Absenteeism 03. Brawls

Risk Taxonomy	Sub Category	Risk Factor
		04. Lack of experienced staff
	2.5 Consultants	01. Does not understand his role/duty 02. Poor construction method 03. Delays in materials and shop drawings approval 04. Communication and coordination problem 05. Dishonesty 06. Unaccountability of work
	2.6 Client	01. Interference 02. Change orders 03. Client lacks managerial capability 04. Quality expected beyond standard and specification
03. Technical risk	3.1 Materials	01. Affordable material is more expensive than presented in BOQ 02. Proposed materials are not approved 03. Material shortage 04. Late in material delivery 05. Quality of material below standard 06. Marital damage during storage 07. Marital damage during transportation
	3.2 Equipment	01. Low productivity and efficiency 02. Frequently out of order or damaged 03. Inappropriate equipment causes problems 04. Unavailability of spare parts or cost is high 05. No reserve equipment 06. Need to import from other countries 07. High maintenance cost
	3.3 Technique	01. New technique is required 02. Quality criteria are difficult to achieve
	3.4 Construction process	01. Failure to construct as planned 02. Coordination problems 03. Delay on procession of site after LOA 04. Communication problems

Risk Taxonomy	Sub Category	Risk Factor
		05. Red tape in liaisons with public service consumes too much time 06. Irregularity of work load 07. Severe climate causes low productivity 08. Errors or omissions in BOQ 09. Insufficient time to prepare bids 10. Delay of information from designers
	3.5 Construction Site	01. Access problem 02. Construction site is adjacent 03. Work hours are limited 04. Traffic congestion 05. Local regulations 06. Theft 07. Project is threatened by hooligans
	3.6 Ground condition	01. No site investigation or boring log 02. Inadequate site investigation 03. Errors in information of site investigation 04. Unforeseen problems
04. Safety-accident risk		01. Severe accidents occur 02. Inappropriate machine induces accident 03. Machine is not checked before operating 04. There is no fence or protection net 05. There is no fire protection system at site
05. Construction Design causes risk		01. Inadequate od ambiguous specification 02. Errors in drawings 03. Incomplete design scope 04. Need innovative construction methods 05. Need new materials and equipment 06. Non-standard details of drawing induces low quality of work and error in estimate 07. Likelihood of change 08. Incompatibility between drawings and method
06. Political and regulation risk		01. Frequent changes in law 02. War, revolution and civil disorder 03. Requirement to use local labour

Risk Taxonomy	Sub Category	Risk Factor
		04. Customs and import restrictions 05. Unstable politics 06. Embargo 07. Long procedure for approval and permits 08. Cost for corrupt government officials
07. Financial risk		01. Payment risk of completed work 02. Slow payment by clients due to disputes 03. Retention is not returned 04. Liquidated damages for delay 05. Adequate payment for variations 06. Financial problems due to errors in estimating 07. Loss due to default of contractor, subcontractor, supplier or client 08. Inflation 09. Exchange rate fluctuation 10. Local and national taxes are high 11. Bid and performance bond are unfairly called 12. Insufficient insurance 13. Labour cost is higher than predicted 14. Material cost is higher than predicted
08. Contractual risk		01. Unfair and unreasonable stipulation 02. Ambiguous clauses that have several meanings 03. Work conditions differ from contract 04. Misinterpretation 05. Extent of work differs from contract 06. Red tape in litigation
09. Governmental regulations cause risk		01. Construction process causes pollution 02. Waste treatment required by law 03. Preserving historical finds 04. Local environment regulations obstruct construction process

Source: Santoso *et al., 2003*

2.6. Summary

Disputes are the main factors causing delaying the construction projects, increased projects cost and adverse influence on relationships which affects the successful completion of construction projects. Risks lead to disputes. Most construction projects are consistently exposed to different types of risks due to their increasing complexity, size and client requirements. Therefore it is required to manage these risks following systematic risk management approach as those adversely affect the projects in terms of cost, time, quality and safety which ultimately end up with disputes. Systematic risk management process is consisted of risk identification, risk analysis, risk allocation and risk response.

Risk management is influenced by procurement system applied i.e. project delivery method and payment methods. There are four delivery methods as Separated systems, Integrated systems, Management oriented systems and Collaborative systems and there are three payment methods Lump Sum, Measure and Pay and Prime Cost.

It is expected "a booming construction sector over next 2-3 years in Sri Lankan supported by rising affordability for housing and demand for skyscrapers. Risk of high rise building are higher due to its complexity and inexperience and there are many risk factors relevant to high rise buildings are identified through literature review. It shows the requirement of finding the relevancy of above risk factors to the Sri Lankan context and applying systematic risk management against each procurement systems used in high rise projects in Sri Lanka.

Chapter 3

3. RESEARCH METHODOLOGY

3.1. Introduction

The research methodology and research methods adopted for the study is outlined under this chapter. Research design is explained in generally and simultaneously its applicability to the study is discussed. The process adopted for this particular research is explained in detail here. It consists of overall three stages. The first stage involved a detailed literature review and in addition to the general knowledge obtained on risk management to avoid disputes and different procurement systems, risk factors and risk response methods related to high rise projects is specifically identified here in order to apply for the current study. In the second stage preliminary survey was held to identify the applicability of these identified risk factors and risk response methods to Sri Lankan context. Moreover, commonly used procurement systems in high rise projects of Sri Lanka is identified here. Finally, as the Third stage structured questionnaire survey was held in two phases. First phase was focused to evaluate the significant risk factors leads to disputes among each procurement systems identified in the second stage. Risk allocation and response methods among each stake holders is determined in the second phase of the third stage. Chapter three discusses these stages in detail, including the methods of data analysis employed for the study and validation methods.

3.2. Research Design

Tan (2002) defines research design as converting a research problem to a conclusion. According to Brian (2009) "The research design is the overall plan for connecting the conceptual research problems to the pertinent (and achievable) empirical research". Maxwell (2012) defines research design as the combination of research approach and research technique in a collaborative manner to achieve the aim and objectives of the research successfully where Haron (2013) also describes research design as an overall strategy carry out in scientific study that comprises factors of philosophy, approach and techniques. Kagioglou, Cooper, Aouad, & Sexton (2000) described the same but in descriptive way which consisted of three key steps sequentially: identification of the

research philosophy, research approach and research technique. According to them the selection of research techniques for data collection and data analysis is based on the research approach, the selection of the research approach is based on the research philosophy.

Saunders, Lewis and Thornhill (2016) have introduced research onion approach as research design by linking six layers commencing from research philosophy until data collection and analysis approaches as shown in figure 3.1 According to them philosophy is the outer layer which directs and invigorates the inner procedures. Choosing a proper research methodology is important as it determines the research methods to be used in the study (Liyanage, 2006). Therefore research design of this study is described under research onion introduced by Saunders et al. (2016).

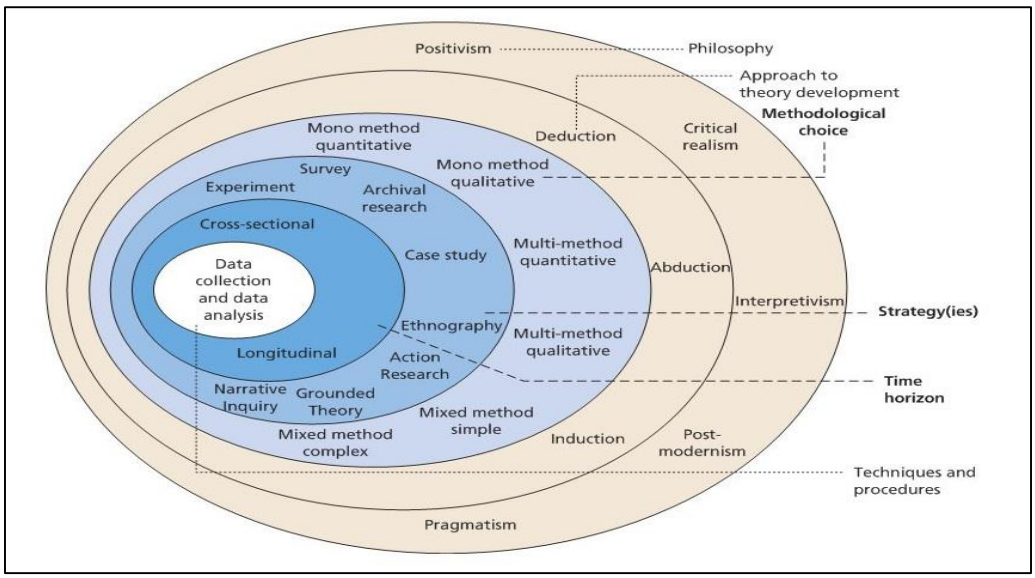

Figure 3.1 : Research Onion

Source: *Saunders et al., 2016*

3.2.1. Research philosophy

Selection of a research philosophy is the initial step in a research design and its determination is dependent on the researcher's attitude towards the development of knowledge (Kagioglou et al., 2000). According to Saunders et al. (2016) research philosophy directs and invigorates all other procedures and it consisted of positivism, interpretivism, critical realism, post-modernism and pragmatism.

3.2.1.1. Positivism

Positivism is a stance often adopted by natural science researchers in positivism researchers' work with an observable social actuality and the finished product of the research can be generalized (Remenyi et al., 1998) for instance, experiments and statistics, to reveal a true nature of how society operates.

3.2.1.2. Interpretivism

Interpretivism involves researchers to interpret elements of the study, thus interpretivism integrates human interest into a study. Accordingly, "interpretive researchers assume that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings, and instruments" (Myers, 2008). Researchers who adopted this approach tried to discover the details of the situation in order to understand the reality or perhaps the reality that is working behind them (Remenyi et al., 1998).

3.2.1.3. Critical Realism

Researchers subscribing to this school of thought believe that reality is subjective and interior to the people and shares the views of both positivism and interpretivism to describe an interface between the natural and social worlds.

3.2.1.4. Post-modernism:

An `introduction' typically offers an overview narrative of a work and directs the reader's attention to the key issues, creating a semblance of a coherence that progresses through a story or argument. Different postmodern "approaches" to qualitative nursing research derived from other disciplines are being rooted in nursing as epistemology.

3.2.1.5. Pragamatism

Pragmatism is a deconstructive paradigm that advocates the use of mixed methods in research, "sidesteps the contentious issues of truth and reality" (Feilzer 2010, p. 8), and "focuses instead on 'what works' as the truth regarding the research questions under investigation" (Tashakkori & Teddlie 2003b, p. 713).

Current study requires watchful observation and identification of construction project risks for the purpose of managing the project risks for the construction parties for high

rise buildings against different procurement systems where 'critical interpretivism' was selected as the research philosophy.

3.2.2. Research approach to theory development

The research approach describes the organization of research activities, especially the collection of data from the population in a way that meets the aims and objectives of the research. The researcher must therefore settle on an appropriate research approach to deal with the research question in accordance with the research philosophy. According to Saunders et al. (2016) there are three research approaches as deduction, induction and abduction as explained below.

3.2.2.1. Deductive approach

In deductive approach, the researcher first develops a theory and hypothesis and then designs a research strategy to test the hypothesis. Whereas, in the application of deductive approach, develop of a hypothesis or theory is executed by referring the relevant literature review for the relative subject matter. Afterwards most suitable research strategy is designed to test the developed hypothesis. This approach is based on positivism

3.2.2.2. Inductive approach

In inductive approach, the researcher first collects the data and develops a theory based on the results of the data analysis. This approach is based on interpretivism.

3.2.2.3. Abduction approach

Combination of induction and deduction approaches which successively can be used in an advantageous way to the research. This approach is most suitable if an area is wealthier by literature and other area is poor with literature.

According to Saunders et al. (2016), deductive approach is most suitable if there is ability to create the hypothesis correlated to the research topic and if substantial literature is available for the relevant topic. As well, if the research is based on a fresh topic and if literature is inaccessible, inductive approach is suitable. Further they depict, if an area is wealthier by literature and other area is poor with literature, as a remedy abductive approach can be make use of. Therefore, the present study employs

abduction approach as it requires to identify the risk factors applicable to high rise buildings through literature synthesis and then identify the significance of them and risk management against procurement systems commonly used in Sri Lanka through preliminary survey.

3.2.3. Research methodological choice

Research onion defines three types of research methodological choices as quantitative, qualitative and mixed methods and Creswell (2013) has defined each methodology as mentioned below.

3.2.3.1. Quantitative method

Quantitative method is used to examine the relationship among variables which are measured so that numbered data can be analyzed using statistical procedures. Saunders et al. (2016) define quantitative is every so often making use of as an alternative expression for any data collection technique or data analysis procedure which produces or make use of numeric data. Quantitative approach concerns on questions as "how much" and "how many", and strive to support the facts submissively (Bell, 2005, cited in Haron, 2013). Quantitative data are worthwhile in evaluating the established theories and hypothesis.

3.2.3.2. Qualitative method

Qualitative method involves collecting data through emerging questions and procedures inclusive of researcher making interpretations of the data. Saunders et al. (2016) defined qualitative every so often making use of as an alternative expression for any data collection technique or data analysis procedure that produces or make use of non- numeric data. Mixed method approach comprises of quantitative and qualitative data collection techniques and analytical procedures. Also mixed method can be applied for deductive, inductive or abductive approaches.

Qualitative research is bringing into play to figure out the discernments of individuals with regard to world rests on wide-ranging knowledgeable study and analysis (Haron, 2013; Bell, 2010). According to Haron (2013) to foster a theory, if the researcher is thorough with reference to the phenomenon and the aims of the study, qualitative is

most suitable in an attempt to discover the factors' persuading phenomenon and settings.

3.2.3.3. Mixed method

Mixed method approach comprises of quantitative and qualitative data collection techniques and analytical procedures. Also mixed method can be applied for deductive, inductive or abductive approaches.

Table 3.1 depicts the characteristics of each above methods for better understanding. Present study requires characteristics mentioned in the mixed method in order to identify the risk factors applicable to high rise buildings through literature synthesis and then to evaluate the significance of them and risk management against procurement systems commonly used in Sri Lanka through preliminary surveys. Hence, this research tends to use a mixed method as it comprises of both quantitative and qualitative research methods.

Table 3.1 : Characteristics of quantitative, qualitative and mixed method approaches

Quantitative	Qualitative	Mixed
Pre-determined	Emerging methods	Both pre-determined and emerging methods
Instrument based questions	Open-ended questions	Both open and closed- ended questions
Performance data, attitude data, observational data and census data	Interview data, observation data, document data and audio visual data	Multiple forms of data drawing on all possibilities
Statistical analysis	Text and image analysis	Statistical and text analysis
Statistical Interpretation	Themes, patterns interpretation	Across database interpretations

Source: Creswell (2013)

3.2.4. Research strategies

According to Kagioglou et al. (2000), there are several research strategies such as experiments-laboratory, quasi-experiments, surveys, case study research, ethnography, action research and grounded theory. Narrative inquiry and archival

researches have been further shown as research strategies in the research onion. The present study adopted the survey as the most appropriate research strategy since it was necessary to elicit the perceptions and opinions of building construction practitioners.

3.2.4.1. Survey strategy

Survey is a systematic method of collecting primary data based on a sample (Tan, 2002). Survey strategy is one of the most common research strategies which have main characteristics of obtaining information from a sample and asking questions from the respondents (Pinsonneault and Kraemer, 2002). After developing a feasible research question, it is necessary to design the research from a macro to a micro perspective. Among many research strategies, surveys, Archrivals and Case studies are being commonly used. For the purposes of this research, the survey approach is selected over the case-study and archival strategies, because it offers a bird's eye view of the whole industry and thus a broader perspective rather than an in-depth analysis. This is benefitted as outcomes obtained can be made known to entire population with less cost. Drawback is consuming considerable time to confirm the sample is archetypal, planning and steering data collection method and attempt to validate satisfactory rate of response. Noteworthy consumption of time is noticed while formulation of data and analyzing them.

However, in identifying risk factors and how they are managed, the survey approach provides better access to information through a concise and precisely designed questionnaire (Kartam & Kartam, 2001). Since, according to Akintoye and MacLeod (1997), the analysis and management of construction risk depend mainly on intuition, judgment and experience, it is clear that the research can be implemented through a questionnaire survey for the purpose of obtaining the relevant data under the research topic.

It is also a fact that there is a need to generalize the result to some extent. Hence, by resorting to a survey, the research obtains the following advantages (Saunders et al., 2004):

- Surveys are relatively inexpensive (especially self-administered surveys);

- Surveys are useful in describing the characteristics of a large population. No other method of observation can provide this generalizing capability;
- Surveys make very large samples feasible, thus making the results statistically significant even when analyzing multiple variables;
- Many questions can be asked of a given topic which gives considerable flexibility to the analysis;
- There is flexibility at the creation phase in deciding how the questions will be administered: as face-to-face interviews, via telephone, as a group-administered written or oral survey, or via electronic mail;
- Standardized questions make measurement more precise by enforcing uniform definitions upon the participants;
- Standardization ensures that similar data can be collected from groups and then interpreted comparatively (i.e. between-group study).

Selection of sample is vital in a survey. Sampling can be defined as methods of selection from a population (Tan 2002). Naoum (2013) point out sample is a case in point or segment of a population and that describe how the remnants is like. The most important factor is wide-awake sampling of participants' and data sources in any research. In qualitative research the selection of samples will give rise to a considerable influence on the eventual quality of the research (Naoum, 2013). In quantitative designs one main objective is to produce substantial results that can make a generalizing statement to large population.

3.2.5. Time Horizon

As explained by Saunders et al. (2016), time horizons are needed for the research design independent of the research methodology used. There are two types of time horizons namely Longitudinal and Cross-sectional. Longitudinal studies are repeated over an extended period. Cross sectional studies are limited to a specific time frame. This research is also limited to a specific time frame, hence the cross sectional time horizon is used.

3.2.6. Research techniques and procedures

Research techniques comprise of data collection and data analysis (Kagioglou et al., 2000; MacDonald & Headlam, 2011) which elaborates hereinafter.

3.2.6.1. Data collection techniques

- **Literature review**

It is important to find out what have been said and done before pertaining to the research matter in order to widen the collective knowledge of the researcher. The literature review gives details about the chronicle of the subject matter and the important sources of literature, demonstrating main issues and improving the sense of purpose of research in a way that can produce one or more research queries (Gray (2014). The researcher himself has to search around for the preceding researches carried out on the subject of the relevant research area. This review of literature delivers a profound guide regarding the relevant topic to the person who reads and findings and analysis of the preceding researches.

A comprehensive literature survey was carried out by using peer reviewed journal articles, text books and periodicals in both printed and electronic version, thesis and dissertations, reports, web pages, other online works, and unpublished materials. The literature survey helped to obtain overall knowledge on disputes in construction, risk management, procurement systems and high rise buildings in Sri Lanka. Systematic risk management process and Procurement systems applied for this study was identified through literature synthesis. Moreover, comprehensive risk factors applicable for high rise buildings were summarized through the literature review. Further to the systematic risk management process, Risk response methods used for the second phase of questionnaire were identified.

- **Preliminary Survey**

Preliminary survey was carried out for this study to validate the data collected through literature synthesis, towards this research and to find out the commonly used procurement systems in high rise projects in Sri Lanka. Among different types of sampling methods, purposive sampling was selected for the preliminary survey. Purposive sampling is a non-probability sample that is selected based on

characteristics of a population and the objective of the study. Construction professionals of 35 ongoing high rise building projects over 20 floors in Sri Lanka were selected as the survey sample. This is covered almost all super high rise building projects in Sri Lanka. Preliminary survey was consisted of three (03) questions as attached in the Appendix 1.

Objective of the first question was to find out the applicability of identified risk factors through literature review to the Sri Lankan high rise building. Respondents were asked to mark "YES" or "NO" by considering applicability of each identified risk factors to the Sri Lankan high rise building projects. Accordingly, 128 risk factors were identified as appropriate to Sri Lankan high rise projects. From second question applicability of risk response methods identified through literature review to the high rise buildings of Sri Lanka were observed. In this question also respondents were asked to mark "YES" or "NO" by considering the applicability of given risk response methods and accordingly, 15 response methods were identified which is applicable to the high rise building projects in Sri Lanka.

Project details such as project name, number of floors of the building and the procurement system applied by each projects in terms of both delivery method and payment method of each projects were collected from the third question in order to identify the commonly used procurement systems in high rise projects of Sri Lanka.

- **Two phases of Structured Questionnaire Survey**

A questionnaire survey allows gathering large amounts of data within a shorter time period covering a large geographical area. Questionnaire is a research tool that comprise of a sequence of questions in order to obtain responses from the respondents. Here, predetermined uniform set of questions were asked from all the respondents and the advantage is that this can be supervised individually and can be distributed among the respondents. In addition, time consumption is less when collecting data by means of questionnaires. And also by sending same set of questions for each respondents to answer, it gives an effective method to collect data from a sizeable section prior to the quantitative analysis. In a situation where there is time constraint, the questionnaire helps to save time as well as to collect data quickly. Questionnaires are suitable for descriptive or explanatory types of researches but aren't suitable for fact-finding and

other researches that have need of large number of open-ended questions. (Saunders et al., 2016).

The drawback in questionnaires is the low rate of responses due to busy schedules of the respondents; few actions were taken to reduce the drawbacks of the online questionnaire survey such as, all the questions were developed in the way of closed-end (forced choice questions / closed questions) which accommodate a number of substitute answers and the respondent are instructed to pick out of them. This method increases the response rate compare to open-ended questions. When analyzing open-ended questions, time consumption in coding can be minimized by the use of close-ended questions (Saunders et al., 2016). Moreover, with the aim of increasing the response rate, every so often communicated with the locators through phone calls and it assisted to increase their motivation towards the survey. Before going with the main questionnaire survey, a pilot questionnaire survey was executed involving few staff members and this facilitated to identify the chances of survey results becoming contaminated. For a good study design, pilot studies are a vital building block. Performing a pilot study will not assurance the success of the main study however, it sees to increase the chances of success.

Aside from many sampling approaches purposive sampling was selected for each phases. Purposive sample is necessary where people are selected not on the basis of their representativeness of the general population but on their expert ability to answer the research questions (Fink & Kosecoff, as cited in Skulmoski et al., 2007). Therefore, questionnaire was held among Engineers, Quantity Surveyors and Architect with high rise experience were selected for this study.

Two phases of structured questionnaire were carried out for this study. It was impossible to use free web tool for the questionnaire surveys for both phases as number of rows and columns exceed the allowable limit of those web tools. Therefore, Microsoft excel sheets with drop down list were used for both phases where considerable control was offered as it was managed by emails because many users read and answer back to their personal mails using their own computers.

Purpose of undertaking first phase of questionnaire survey is to obtain general opinions, views on the significance of risk factors which lead to disputes of different procurement systems from expertise in high rise buildings in Sri Lankan industry. The survey duration was four weeks and questionnaires were emailed among 100 professionals who has experience in high rise building projects in Sri Lanka. Among them 34 respondents had effectively completed and send back the filled questionnaires where the response rate was 34%. In this questionnaire (Appendix 2), identified and filtered risk factors (128) relevant to high rise buildings through literature review were listed and the respondents were asked to indicate "YES" or "NO" as the response of leading to disputes. Further it indicated the levels of frequency of risk occurrence and the significance of risk impact on the project objectives, against each procurement systems in order to estimate the severe risk factors. The level of frequency of risk occurrence (α) and significance of risk impact (β) were presented for each risk factor according to a 5 point scale denoting 1=Very Low, 2=Low, 3=Medium, 4=High, 5=Very High.

The second phase was held to obtain the opinion on the risk allocation among the stakeholders (client, contractor and consultant) and on the risk response methods of significant risk factors which leads to disputes against each procurement systems used in high rise buildings in Sri Lanka. The survey duration was three weeks and the survey questionnaires were emailed among 100 professionals who has experience in high rise building projects in Sri Lanka. Among them 30 respondents had effectively completed and send back the filled questionnaires where the response rate was 30%. In this questionnaire (Appendix 3), only significant risk factors which lead to disputes as identified in the first phase against each procurement systems were considered. It was consisted of three questions and in the first question, the respondents were asked to indicate the risk allocation percentage among client, contractor and consultant against each of risk factors for all three procurement systems maintaining the total percentage as hundred (100%). In the second question, it was asked to select the most recommended first five risk detailed response methods among the given list against each given risk factors for three procurement systems. Respondents were free to list out any more suitable methods as well.

3.2.6.2. Data analysis techniques

- **Content analysis**

Content analysis is a data analysis technique used to make replicable and valid inferences by interpreting and coding textual material. By systematically evaluating texts (e.g., documents, oral communication, and graphics), qualitative data can be converted into quantitative data. Content Analysis is a research tool used to determine the presence of certain words or concepts within texts or sets of texts (Weber, 1990; Holsti, 1969). Therefore content analysis was used for this study to analysis the data collected through preliminary interview and questionnaire surveys.

- **Severity index (To analyze risk factors)**

In order to analyze the survey results of the first phase of questionnaire to identify the severe risk factors Severity index was calculated for each risk factors. This method had been used in similar studies previously of Fang et al. (2004), Zou et al. (2006) and Sun, Fang, Wang, Dai, & Ly (2008). The Severity Index calculation was used to rank the risk factors according to their criticality. The following formulas (1) and (2) show the calculation of the Severity Index for risk factors:

$$S_j^j = \alpha_j^j \beta_j^j \qquad (1)$$

$$RS^i = \frac{\sum_{j=1}^{n} S_j^i}{n} \qquad (2)$$

Where

n = Number of responses

$S^i{}_j$ = Evaluation of risk severity of i^{th} risk factor by j^{th} respondent

$\alpha_j{}^j$ = Evaluation of frequency level of risk occurrence by j^{th} respondent

$\beta_j{}^j$ = Evaluation of significance of risk occurrence by j^{th} respondent and

RS^i = Risk Severity Index for the i^{th} risk factor.

- **Average (To analyze risk allocation)**

In order to analyze the survey results of the second phase of questionnaire to evaluate the risk allocation of significant risk factors Average method was used as shown below.

$$\mathbf{A^i} = \frac{\sum_{j=1}^{n} \boldsymbol{P}_j^{\mathbf{i}}}{\mathbf{n}}$$

Where,

$\mathbf{A^i}$ = *Average Percentage of Risk allocation of* i^{th} *party*

P = *Rating (percentage) of each Factor given by* j^{th} *respondent*

n = Number of responses

- **The Relative Importance Index (To analyze risk response methods)**

In order to analyze the survey results of the second phase of questionnaire to evaluate the risk response of significant risk factors Relative Importance Index (RII) was used. RII facilitates evaluation of nonparametric sample by giving a RII value for each factor. Relative Importance Index (RII) is one of the most commonly used measures to determine the relative significance of the attributes (Doloi, 2008).

$$RII = \frac{\sum(Wn)}{NxA}$$

Where,

W = *Rating of each Factor given by respondent*

n = *Frequency of Responses*

N = *Total number of responses*

A = *Highest Weight*

3.3. Research Process

This research aims to develop systematic frameworks of risk management for different procurement systems commonly used in high rise building projects in Sri Lanka which will be ultimately help to avoid disputes. In order to achieve the aims and objectives of the research following steps have been adopted. The details of each steps has been described in detail under above research design and below given process summarized the methodology applied to achieve the aim and objectives of the study.

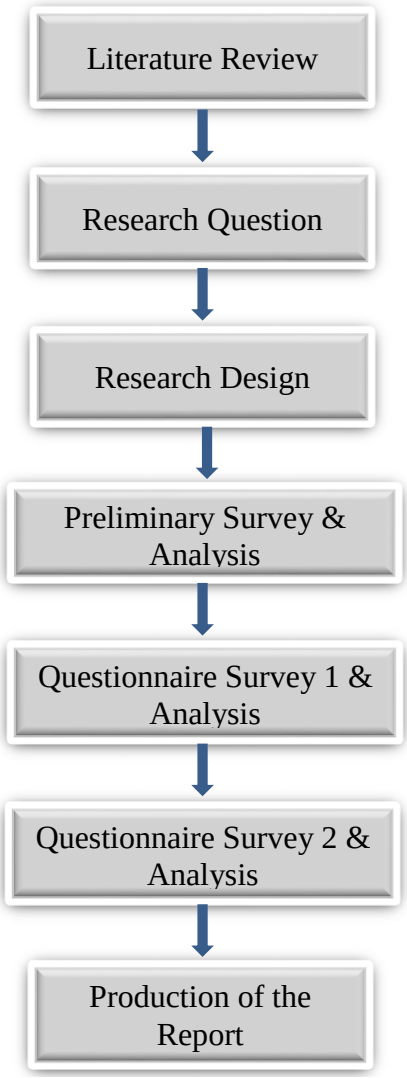

Figure 3.2 : Research process

3.4. Summary

This chapter has described and justified the research process and the methodology adopted for the purpose of the research. Literature review were used specifically to identify the risk factors and risk response methods relevant to high rise buildings in Sri Lanka in addition of having thorough knowledge on the subject. Preliminary Survey was held to identify the procurement systems commonly used in high rise buildings of Sri Lanka and to identify the applicability of identified risk factors and risk response methods in the literature review to the Sri Lankan high rise buildings. Two phases of questionnaire surveys was held and first phase was held to identify the significance of risk factors which lead to disputes of different procurement systems in high rise buildings in Sri Lankan. Second phase was held to determine the risk allocation and risk response methods of severe risk factors against each procurement systems which leads to dispute. Severity Index was used to evaluate the severity of the risk factors of each procurement systems commonly used in high rise projects in Sri Lanka. Average methods and relative important index were used to determine the risk allocation and response methods of these significant risk factors respectively. The next chapter will analyze and discuss the results obtained through the research methodology discussed in this chapter.

Chapter 4

4. DATA ANALYSIS AND RESULTS

4.1. Introduction

In the previous chapter, the research process and methodology were discussed. This chapter discuss in detail the analysis and results of preliminary survey and two phases of structured questionnaire surveys in accordance with the aforesaid methodology. The chapter aims at presenting the research findings of the empirical investigation. Since the study aims at identifying the severe risks leads to dispute against each procurement systems used in high rise buildings in Sri Lanka and determining the allocation and risk response of them, the discussion of results below is carried out focusing the same. Finally it developed systematic risk management frameworks for three procurement systems commonly used in high rise buildings in Sri Lanka to avoid disputes.

4.2. Respondent to the survey

Survey samples used for both preliminary survey and questionnaire surveys have been summarized in table 4.1. Managing Directors, Project Directors, Project Managers, Construction Managers, Contracts Managers and Quantity Surveyors who has more than 5 years of high rise buildings were selected for all samples.

As the sample of preliminary survey, 35 ongoing high rise building projects which consisted of more than 20 floors were selected. This is covered almost all high rise building projects over 20 floors in Sri Lanka. One respondent from each projects who has 5 years of high rise experience was selected for the sample and it was able to fill the questionnaire for all projects where the respond rate was 100%.

First phase of the questionnaire survey was held to obtain general opinions, views on the significance of risk factors which lead to disputes of different procurement systems. Questionnaires were emailed among 100 professionals who has experience in high rise building projects in Sri Lanka. Among them 34 respondents had effectively completed and send back the filled questionnaires where the response rate was 34% as shown in the table 4.1.

The second phase was held to obtain the opinion on the risk allocation among the stakeholders (client, contractor and consultant) and on the risk response methods of significant risk factors which leads to disputes against each procurement systems used in high rise buildings in Sri Lanka. The survey questionnaires were emailed among 100 professionals who has experience in high rise building projects in Sri Lanka. Among them 30 respondents had effectively completed and send back the filled questionnaires where the response rate was 30% as given in the table 4.1.

Table 4.1 : Survey samples of preliminary survey and questionnaire survey phase 1 &2

Designation	Nr of years with high rise experience	Preliminary Survey	Questionnaire Survey – P1	Questionnaire Survey – P2
Managing Director	30+	0	4	3
Managing Director	15+	2	2	2
Project Director	30+	8	8	6
Project Manager	20+	5	5	5
Construction Manager	15+	4	4	4
Contracts Manager	10+	7	6	6
Quantity Surveyor	5+	9	5	4
Total responses		35	34	30
Percentage of response		100%	34%	30%

4.3. Results of preliminary survey

Preliminary survey was carried out to validate the data collected through literature synthesis, towards this research and to find out the commonly used procurement systems in high rise building projects in Sri Lanka. Data was collected from 35 construction professionals who are working in different high rise projects in Sri Lanka as summarized in the table 4.1. Experience mentioned is total high rise experience but not solely in Sri Lanka. Preliminary survey was consisted of three questions as explained herein after.

4.3.1. Risk factors appropriate in high rise building projects in Sri Lanka

Objective of the first question was to find out the applicability of identified risk factors through literature review to the Sri Lankan high rise building. Accordingly, 128 risk factors were identified as appropriate to Sri Lankan high rise projects as listed in the Appendix 2. Among identified other risk factors through literature, earthquakes and landslide/ subsidence were identified as not appropriate to high rise buildings of Sri Lanka. These two risk factors got less than 15% as appropriate while all others are getting more than 65%. Reason for this may be the probability of landslide in Colombo is very lesser than the other provinces of Sri Lanka where survey samples of this research were based on Colombo as majority of high rise buildings are located around Colombo.

4.3.2. Risk response methods appropriate in high rise building projects in Sri Lanka

In second question of the preliminary survey, applicability of risk response methods identified through literature review to the high rise buildings of Sri Lanka were observed. In this question respondents were asked to mark "YES" or "NO" by considering the applicability of given risk response methods and accordingly, all identified 14 response methods were identified as applicable to the high rise building projects in Sri Lanka by getting more than 60%. Moreover, only one risk response method has been suggested as "Retaining risk with the client" by 7 respondents among 35. Therefore all these 15 risk response methods as given below were used for this study as elaborated in table 4.2 below.

L = Risk response methods derived from literature

S = Risk response methods derived from preliminary survey

Table 4.2 : Risk response methods used for the study

Tag	Risk response methods	L	S
RR1	Tendering a high bid	91%	
RR2	Including conditions on the bid	86%	
RR3	Pre contract negotiations as to which party takes certain risks	71%	
RR4	Transferring risk to subcontractor	80%	
RR5	Transferring risk to insurance company	86%	
RR6	Transferring risk to main contractor	80%	
RR7	Retaining risk with the client		17%
RR8	Claiming for the damages	77%	
RR9	Allocation of contingency plan	86%	
RR10	Education and Training	60%	
RR11	Encourage team work culture	80%	
RR12	Using suitable standard conditions of contract	60%	
RR13	Physical protection to reduce the likelihood of risk	83%	
RR14	Physical protection for people and property	89%	
RR15	Brainstorming to identify new risks	77%	

4.3.3. Commonly used procurement systems in high rise building projects in Sri Lanka (Objective 01)

Under the third question of preliminary survey, the procurement systems applied by each 35 projects in terms of both delivery method and payment method in high rise building projects in Sri Lanka which consisted of more than 20 floors were identified. 20 floors cut off level was decided based on the information derived from the literature and this was confirmed by the respondents through the preliminary interviews. According to the survey results there are four procurement systems combining the project delivery method and payment methods are used as separated with measure & pay, separated with lump sum, design & build with measure & pay, design & build with sump sum as shown in table 4.3, 4.4 and figure 4.1.

Table 4.3 : Procurement systems commonly used in high rise building projects in Si Lanka

Sr Nr	Project	Nr of floors	Procurement system					
			Delivery Method			Payment Method		
			Separated	D&B	Other	Lump Sum	M&P	Other
1	Project 1	63/68	X				X	
2	Project 2	47	X				X	
3	Project 3	47	X			X		
4	Project 4	80/73/60		X		X		
5	Project 5	54/31	X				X	
6	Project 6	54/54	X			X		
7	Project 7	50/50	X				X	
8	Project 8	50/50		X		X		
9	Project 9	40/55	X				X	
10	Project 10	47-50		X		X		
11	Project 11	46	X			X		
12	Project 12	39/45	X			X		
13	Project 13	45	X				X	
14	Project 14	40		X		X		
15	Project 15	40/40/40	X				X	
16	Project 16	30	X			X		
17	Project 17	24	X				X	
18	Project 18	29		X			X	
19	Project 19	30	X			X		
20	Project 20	29	X				X	
21	Project 21 –Tower 1	24 S		X		X		
	Project 21 –Tower 2	24-26 S		X			X	
22	Project 22	16/23	X				X	
23	Project 23	29	X				X	
24	Project 24	21		X			X	

Sr Nr	Project	Nr of floors	Procurement system					
			Delivery Method			Payment Method		
			Separated	D&B	Other	Lump Sum	M&P	Other
25	Project 25	42		X		X		
26	Project 26	63/50	X				X	
27	Project 27	35		X		X		
28	Project 28	31	X			X		
29	Project 29	22/24		X		X		
30	Project 30	40	X				X	
31	Project 31	32		X		X		
32	Project 32	47	X				X	
33	Project 33	31/36	X			X		
34	Project 34	21		X		X		
35	Project 35	34	X				X	

Table 4.4 : Summary of procurement systems used in high rise buildings in Sri Lanka

Procurement System	No. of projects
Separated with M&P	15
Separated with LS	8
D&B with LS	10
D&B with M&P	2
Total	**35**

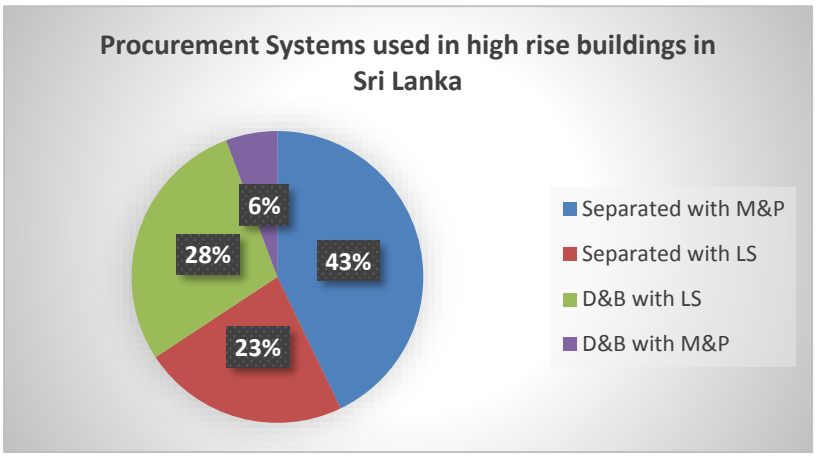

Figure 4.1 : Procurement Systems used in high rise buildings in Sri Lanka

According to the above shown results, only 6% is used Design & Build with Measure & Pay system and on the other hand this is not a correct practice. Therefore, it is concluded that only three procurement systems as Separated with Measure & Pay, separated with Lump Sum and Design & Build with Lump are used in high rise buildings in Sri Lanka and these systems were considered for further study.

4.4. Analysis and Results of phase one of structured questionnaire survey

4.4.1. The significant risk factors which lead to disputes of commonly used procurement systems in high rise buildings (objective 02)

The aim of the first phase of structured questionnaire was to evaluate the significant risk factors which lead to disputes of above identified procurement systems. In this phase 100 questionnaires were distributed among industry practitioners who have more than 5 years of experience in high rise buildings both in overseas and Sri Lanka. However only 34 (34%) were responded as given in table 4.1.

128 risk factors against 9 risk taxonomy were used for the questionnaire by filtering as applicable to the high rise building in Sri Lanka through preliminary survey. It has been identified that all risk factors are lead to disputes by 25 respondents among 34 which is as a percentage 71%. Hence it can be concluded that all risk factors are lead to disputes consequently all risk factors were considered for further study.

Risk severity of each risk factors were calculated as explained in the research methodology chapter and only risk factors which exceed 50% of risk severity (>12.5)

were identified as significant risks factors against each procurement systems as shown in the table 4.5.

Table 4.5 : Severity Index of significant risk factors against each Procurement Systems used in high rise buildings in Sri Lanka

Risk Taxonomy	Risk Sub Taxonomy	Risk Factors	Tag	Severity Index		
				Separated with Lump Sum	Separated with Measure & pay	D&B with Lump Sum
01. Personal risk	1.1 Technician and labour	01. Frequent job change by skilled labour	R1	14.94	14.85	14.76
		02. Lack of skilled labour	R2	20.41	20.68	20.44
		03. Lack of unskilled labour	R3	14.76	15.00	14.88
		04. Poor workmanship	R4	13.91	14.03	14.12
	1.2 Subcontractor	01. Lack of required technical skill	R5	15.12	15.12	15.35
		02. Unable to finish work on time	R6	19.44	19.71	19.85
		03. Subcontractor unable to afford required labour	R7	13.06	12.97	12.94
		04. Subcontractor takes jobs in several projects	R8	14.09	13.97	13.74
	1.3 Contractor	01. Lack of experienced staff	R9	N/A (12.29)	N/A (12.29)	16.29
	1.4 Consultants	01. Does not understand his role/duty	R10	15.50	16.09	N/A (2.44)
		02. Delays in materials and shop drawings approval	R11	16.82	16.35	N/A (3.06)
		03. Communication and coordination problem	R12	16.15	16.32	N/A (2.68)
	1.5 Client	01. Interference	R13	15.94	15.88	15.79
		02. Change orders	R14	15.06	15.29	15.56
02. Technical risk	2.1 Technique	01. New technique is required	R15	N/A (8.62)	N/A (8.38)	13.44
	2.2 Construction process	01. Insufficient time to prepare bids	R16	16.94	N/A (9.74)	16.59
		02. Delay of information from designers	R17	14.94	15.32	N/A (5.59)
03. Construction Design causes risk		01. Need innovative construction methods	R18	N/A (11.41)	N/A (11.41)	17.91
		02. Need new materials and equipment	R19	N/A (11.44)	N/A (11.44)	13.97
04. Political and regulation risk		01. Frequent changes in law	R20	N/A (11.74)	N/A (11.91)	14.88
		02. Requirement to use local labour	R21	13.06	13.06	13.15
05. Financial risk		01. Labour cost is higher than predicted	R22	N/A (11.74)	N/A (11.35)	14.76

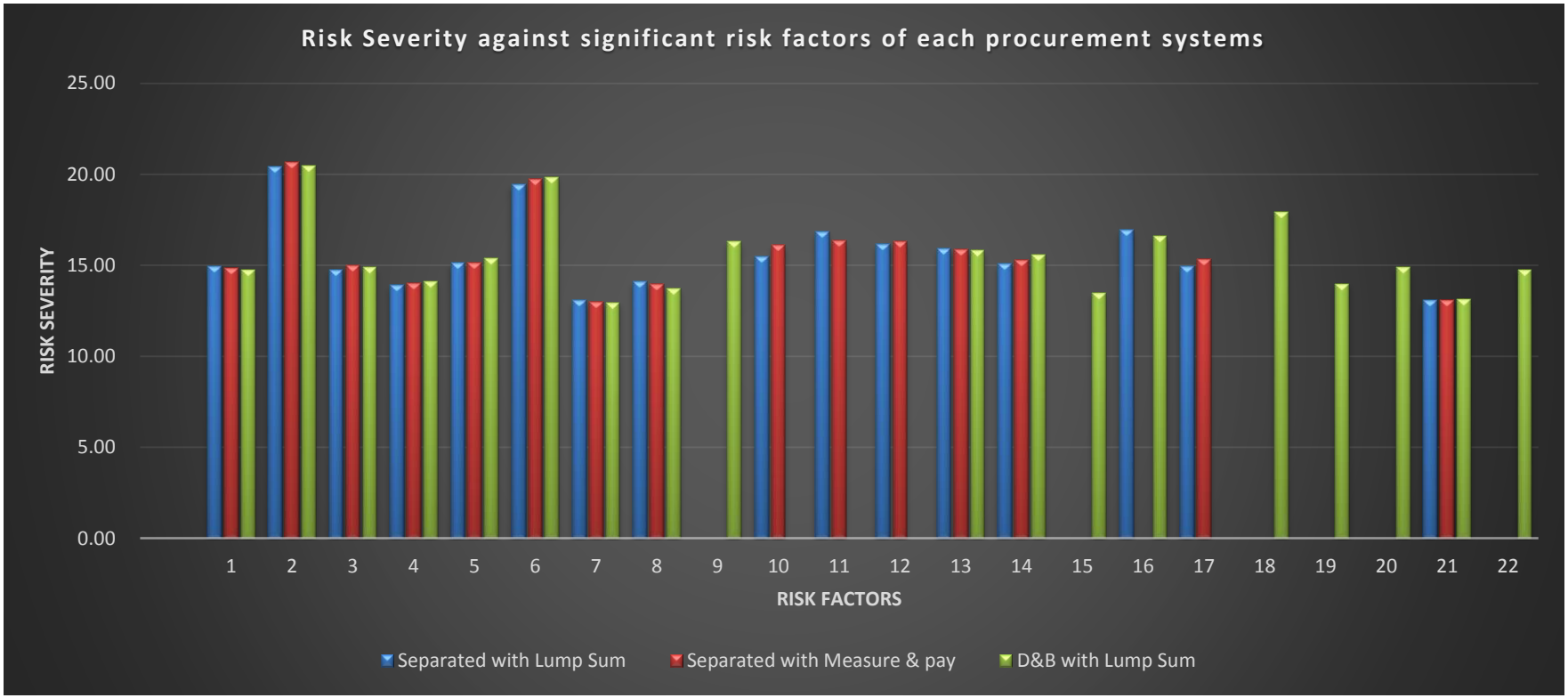

Figure 4.2 : Severity Index of significant risk factors against each Procurement Systems used in high rise buildings in Sri Lanka

According to the table 4.5, it can be concluded that only 5 risk taxonomy among 9 are significant to the high rise buildings in Sri Lanka such as personal risks, technical risks, construction design cause risks, political and regulation risks and financial risks irrespective of procurement systems. Insignificant risks are physical risks, safety accident risks, contractual risks and governmental regulations cause risks. Moreover, it was observed that even though the impact of physical and safety accidents risks are comparatively high, probability of occurrence is very low which resulted to insignificant. This is because of the mitigation actions already taken by each high rise projects in Sri Lanka due to its high risks and legal influenced.

All above 5 risk taxonomies are significant to D&B with Lump Sum systems but only 3 taxonomies named personal risks, technical risks and political and regulation risks are significant to both Separated with Lump Sum & Separated with Measure & Pay systems.

Only 22 risk factors are significant to the high rise buildings in Sri Lanka among 128 identified risk factors. Among them 16 risk factors are significant to Separated with Lump Sum systems and 15 risk factors are significant to Separated with Measure & Pay systems where 18 risk factors are significant to D&B with Lump Sum systems as given in the table 4.5 above. Risk severity has been highlighted in colour scale where dark brown is the highest and light brown is the lowest.

It can be observed that four consultant relevant risk factors namely, does not understand his role/duty, Delays in materials and shop drawings approval, Communication and coordination problem and Delay of information from designers are not significant to D&B with Lump Sum systems even though it is significant to other two procurement systems. Reason for it may be the comparatively less involvement of consultant in D&B with Lump Sum systems as they only involve for the construction supervision part but not for the design part. However, delay of information from designers is not applicable as design part is done by Contractor itself.

Six risk factors namely Lack of experienced contractor's staff, New technique is required, Need innovative construction methods, Need new materials and equipment, Frequent changes in law and Labour cost is higher than predicted are only significant

to D&B with Lump Sum systems but not for other two procurement systems. Basically this is because of the design part is under the contractors scope and fixed price is agreed before detailed design in D&B with Lump Sum systems.

One risk factor named Insufficient time to prepare bids is not significant only for separated with measure & pay systems, because in this system, the contract sum is not fixed before the construction starts and the contractor is paid according to the amount of work done as measured after the physical completion. Therefore risk is comparatively lesser than the other systems.

It was observed that "lack of skilled labours and unable to finish work on time" are the most significant risk factors for all procurement systems as elaborated in figure 4.2. Third highest risk factor is "need innovative construction methods" which is only significant to D&B with lump sum system but not for others.

High rise typology require some special skills where it is new to Sri Lankan labours. For instance, building maintenance unit, aluminium & glazing systems, IT infrastructure systems, building management service, garbage disposal systems and vertical transportation systems are mostly unique to high rise projects which require special skills. Even though most of other buildings also have services such as LPG gas, fire protection, mechanical ventilation and air conditions, electrical, drainage, home automation, high rise buildings require special skills for those due to its complexity. For instance, chiller system may require for high rise buildings while others are using normal split units. Moreover, there is a construction boom in Sri Lanka as a result of foreign investments with the post war development where it has been ultimately resulted to have a high skill labour scarcity. However, in accordance with the Sri Lankan law, foreign labours are not allowed to work in Sri Lanka and only few can be recruited for Board of Investment (BOI) projects under the special approval of BOI.

Construction is however, complex in nature and complexity is amplified when the height is going up. As explained above it requires special features and services. Even though the planning is done considering all above factors time extension cannot be avoided. Variations issued by clients is one of the other reason for the time extension. Basically most of the high rise buildings are apartments where clients usually request

for changes which delay all interrelated works ultimately resulted to time extension. Therefore, there is a high risk of unable to finish work on time.

"Need innovative construction methods-under design caused risk" is the third most significant risk but only for D&B with lump sum system where both design and construction is done by the contractor for pre-determined fixed price. It is a great challenge to design and construct innovative construction methods required high rise buildings without involving specialist consultants for a country like Sri Lanka who has less experience in high rise construction. Even though the D&B contractor can outsource specialist consultants, it is difficult to determine the cost in advance which is fixed for D&B with lump sum projects. Therefore, the risk is high. For instance, Altair project is required innovative construction methods especially because of sloping tower. After construction there was a deflection of the building of around 50mm which caused to cutting and filling of each slabs to level them which consumed huge time and cost. This can be treated as a variation for separated method but it can't be for D&B method since they should take both design and construction responsibility for fixed price.

4.5. Analysis and Results of phase two of structured questionnaire survey

The second phase was held to determine the opinion on the risk allocation among the stakeholders (client, contractor and consultant) and the risk response methods of significant risk factors which leads to disputes against each procurement systems used in high rise buildings in Sri Lanka. Here the consultant means the party who responsible for the design and appointed by the client before awarding the contract to the contractor. In this phase also 100 questionnaires were distributed and only 30 (30%) were responded as given in table 4.1.

4.5.1. The allocation of significant risk factors which lead to disputes among the stakeholders (Employer, Contractor and Consultant) of above identified procurement systems (objective 03)

It was consisted of two questions and in the first question, the respondents were asked to indicate the risk allocation percentage among client, contractor and consultant against each risk factors for all three procurement systems maintaining the total percentage as hundred (100%).

Risk is allocated among the parties to the contract through each constituent of the contract, such as contract agreement, conditions of contract, specifications, preamble notes, bills of quantities, drawings, etc… Generally, in Sri Lanka, contracts are based on FIDIC or SBD documents where parties to the contract are only the client and the contractor. However, client can allocate some risk owed by him under the agreed contract to the consultant separately through consultancy agreement. Therefore for this study risk allocation were considered for all three parties i.e. client, contractor and consultant.

Table 4.6 : Risk allocation of significant risk factors against each Procurement Systems used in high rise buildings in Sri Lanka

Risk Taxonomy	Risk Sub Taxonomy	Risk Factors	Risk Allocation Percentage								
			Separated with Lump Sum			Separated with Measure & pay			D&B with Lump Sum		
			Contractor	Client	Consultant	Contractor	Client	Consultant	Contractor	Client	Consultant
01	1.1	R1	93%	6%	1%	93%	7%	0%	94%	6%	0%
		R2	88%	12%	1%	87%	12%	0%	89%	11%	0%
		R3	88%	11%	1%	88%	12%	0%	89%	11%	0%
		R4	95%	5%	0%	94%	6%	0%	95%	5%	0%
	1.2	R5	91%	9%	0%	91%	9%	0%	91%	9%	0%
		R6	90%	10%	0%	90%	10%	0%	91%	9%	0%
		R7	91%	9%	0%	90%	10%	0%	92%	8%	0%
		R8	91%	9%	0%	91%	9%	0%	93%	7%	0%
	1.3	R9	N/A			N/A			96%	4%	0%
	1.4	R10	0%	31%	69%	0%	29%	71%	N/A		
		R11	0%	30%	70%	0%	30%	70%	N/A		
		R12	5%	43%	52%	5%	43%	52%	N/A		
	1.5	R13	13%	87%	0%	14%	87%	0%	16%	85%	0%
		R14	18%	83%	0%	19%	81%	0%	20%	80%	0%
02	2.1	R15	N/A			N/A			16%	81%	4%
	2.2	R16	77%	23%	1%	N/A			75%	24%	1%
		R17	8%	24%	68%	7%	22%	71%	N/A		
03		R18	N/A			N/A			81%	18%	1%
		R19	N/A			N/A			81%	18%	1%
04		R20	N/A			N/A			33%	67%	0%
		R21	45%	55%	0%	43%	57%	0%	42%	58%	0%
05		R22	N/A			N/A			30%	70%	0%

According to the survey results shown in the table 4.6, it is recommended to allocate all Personal risk factors relevant to Technician and labour, Subcontractor and Contractor to the contractor while allocating personal risk factors relevant to consultant to the consultant and personal risk factors relevant to client to the client irrespective of procurement method.

Further the table shows that it is recommended to allocate "Insufficient time to prepare bids" and "Construction Design causes risk" to the contractor while "Delay of information from designers" to the consultant and "Frequent changes in law" and "Labour cost is higher than predicted" are recommended to the client. However, it is recommended to allocate risk of "Requirement to use local labour" to both the client and the contractor.

Above research finding confirm the principle of allocating the risk to the best party who can tolerate and manage the risk.

4.5.2. The risk response methods for significant risk factors which lead to disputes of above identified procurement systems (objective 04)

In the second question of the questionnaire survey, the respondents were asked to select the most recommended first five risk response methods among the given list against each risk factors for all three procurement systems. This list was prepared by validating the risk response methods collected from the literature review, from preliminary survey as described in the above 4.2.2. However, respondents were free to list out any more suitable risk response methods and recommend the appropriate methods accordingly. Survey results shows that only given 15 risk response methods has been used but no new response methods were suggested.

Table 4.7 : Risk response methods for significant risk factors against each Procurement Systems used in high rise buildings in Sri Lanka

Risk Taxonomy	Risk Sub Taxonomy	Risk Factors	Recommended Risk Response methods														
			Separated with Lump Sum					Separated with Measure & pay					D&B with Lump Sum				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
01	1.1	R1	RR11	RR9	RR6	RR8	RR1	RR11	RR9	RR6	RR8	RR1	RR11	RR9	RR6	RR8	RR1
		R2	RR10	RR1	RR6	RR8	RR2	RR10	RR1	RR6	RR8	RR2	RR10	RR1	RR6	RR8	RR2
		R3	RR1	RR10	RR6	RR8	RR2	RR1	RR10	RR6	RR8	RR2	RR1	RR10	RR6	RR8	RR2
		R4	RR10	RR6	RR2	RR8	RR12	RR10	RR6	RR2	RR8	RR12	RR10	RR6	RR2	RR8	RR12
	1.2	R5	RR10	RR1	RR4	RR8	RR2	RR10	RR1	RR4	RR8	RR2	RR10	RR1	RR4	RR8	RR2
		R6	RR2	RR12	RR4	RR8	RR6	RR2	RR12	RR4	RR8	RR6	RR2	RR12	RR4	RR8	RR6
		R7	RR10	RR12	RR4	RR1	RR8	RR10	RR12	RR4	RR1	RR8	RR10	RR12	RR4	RR1	RR8
		R8	RR2	RR12	RR4	RR8	RR6	RR2	RR12	RR4	RR8	RR6	RR2	RR12	RR4	RR8	RR6
	1.3	R9											RR10	RR1	RR6	RR8	RR2
	1.4	R10	RR12	RR3	RR10	RR7	RR8	RR12	RR3	RR10	RR7	RR8					
		R11	RR12	RR3	RR11	RR8	RR7	RR12	RR3	RR11	RR8	RR7					
		R12	RR12	RR3	RR11	RR8	RR7	RR12	RR3	RR11	RR8	RR7					
	1.5	R13	RR7	RR8	RR9	RR2	RR1	RR7	RR8	RR9	RR2	RR1	RR7	RR8	RR9	RR2	RR1
		R14	RR9	RR3	RR8	RR11	RR7	RR9	RR3	RR8	RR11	RR7	RR9	RR3	RR8	RR11	RR7
02	2.1	R15											RR10	RR15	RR9	RR2	RR3
	2.2	R16	RR9	RR2	RR3	RR1	RR8						RR9	RR2	RR3	RR1	RR8
		R17	RR11	RR9	RR12	RR2	RR3	RR11	RR9	RR12	RR2	RR3					
03		R18											RR10	RR13	RR15	RR14	RR9
		R19											RR10	RR13	RR14	RR15	RR9
04		R20											RR9	RR7	RR1	RR8	RR2
		R21	RR10	RR7	RR9	RR1	RR2	RR10	RR7	RR9	RR1	RR2	RR10	RR7	RR9	RR1	RR2
05		R22											RR9	RR8	RR1	RR3	RR2

Table 4.8 : The legend of risk response methods

Tag	Risk response methods
RR1	Tendering a high bid
RR2	Including conditions on the bid
RR3	Pre contract negotiations as to which party takes certain risks
RR4	Transferring risk to subcontractor
RR5	Transferring risk to insurance company
RR6	Transferring risk to main contractor
RR7	Retaining risk with the client
RR8	Claiming for the damages
RR9	Allocation of contingency plan
RR10	Education and Training
RR11	Encourage team work culture
RR12	Using suitable standard conditions of contract
RR13	Physical protection to reduce the likelihood of risk
RR14	Physical protection for people and property
RR15	Brainstorming to identify new risks

Results as shown in the table 4.7, it reveals that risk response methods are independent from the procurement systems where same results has been applicable for all procurement systems. Education and training has been highly recommended as the best response method for most of the (5) risk factors. On the other hand, this revealed in experience of the high rise buildings in Sri Lanka.

Further it can be noticed that "Using suitable standard conditions of contract" has been mostly recommended as risk response method for personal caused risks under both consultant and subcontractor. Usually nonstandard contracts are used for both subcontract and consultant's contracts in Sri Lanka. Therefore, it is thoroughly recommended to use standard conditions of contract in order to minimize/avoid risks. For instance, FIDIC –Subcontract 2011 can be used for subcontracts and FIDIC white can be used for consultant's contracts.

It is mostly recommended to allocate a contingency plan for unavoidable risks such as "change orders" and "New technique is required" as there may be no any other option.

It is highly recommended to encourage team work culture for risk factors such as "Frequent job change by skilled labour" and "Delay of information from designers". It can be expected happiness of the labours and keep the labour gang for long time. And it reveals that the reason for delay information is not the incapability but their lack of team work culture.

Results suggest to tender a high Bid for lack of unskilled labour risk factor this is probably to avoid the project.

For the risk factors such as "Unable to finish work on time" and "Subcontractor takes jobs in several projects" it is highly recommended to include conditions on the Bid. For "Unable to finish work on time" Time for completion can be included as the condition and in case of delay "delay damages" (penalty) can be charged. For "Subcontractor takes jobs in several projects" condition can be included that limiting to getting other projects in the contract.

It is recommended to retain the risk with the client for the risk factors such as client's unnecessary interference.

4.6. Systematic frameworks of risk management for different procurement systems commonly used in high rise building projects in Sri Lanka to avoid disputes (Aim of the research)

The aim of this research is to develop systematic frameworks of risk management for different procurement systems commonly used in high rise building projects in Sri Lanka which will be ultimately help to avoid disputes. Therefore, combining all the above research finding systematic risk management frameworks have been developed for each procurement systems as shown in the table 4.9, 4.10 and 4.11. Four step systematic process as described in the figure 2.1 of literature review which includes Risk Identification, Risk Analysis, Risk Allocation, Risk Response was applied to develop the systematic risk management frame works.

This systematic risk management framework can be used as a tool for procurement selection as well as a guidance for risk management where ultimately help to avoid disputes of the high rise projects in Sri Lanka.

4.6.1. Separated with Lump Sum Procurement System

Table 4.9 : Systematic risk management framework for Separated with Lump Sum Procurement System

Risk Identification and classification			Risk Analysis	Risk Allocation			Risk Response				
Risk Taxonomy	**Risk Sub Taxonomy**	**Risk Factors**	**Severity Index**	**Contractor %**	**Client %**	**Consultant %**	**1**	**2**	**3**	**4**	**5**
01. Personal risk	1.1 Technician and labour	01. Frequent job change by skilled labour	14.94	93%	6%	1%	RR11	RR9	RR6	RR8	RR1
		02. Lack of skilled labour	20.41	88%	12%	1%	RR10	RR1	RR6	RR8	RR2
		03. Lack of unskilled labour	14.76	88%	11%	1%	RR1	RR10	RR6	RR8	RR2
		04. Poor workmanship	13.91	95%	5%	0%	RR10	RR6	RR2	RR8	RR12
	1.2 Subcontractor	01. Lack of required technical skill	15.12	91%	9%	0%	RR10	RR1	RR4	RR8	RR2
		02. Unable to finish work on time	19.44	90%	10%	0%	RR2	RR12	RR4	RR8	RR6
		03. Subcontractor unable to afford required labour	13.06	91%	9%	0%	RR10	RR12	RR4	RR1	RR8
		04. Subcontractor takes jobs in several projects	14.09	91%	9%	0%	RR2	RR12	RR4	RR8	RR6
	1.3 Consultants	01. Does not understand his role/duty	15.50	0%	31%	69%	RR12	RR3	RR10	RR7	RR8
		02. Delays in materials and shop drawings approval	16.82	0%	30%	70%	RR12	RR3	RR11	RR8	RR7
		03. Communication and coordination problem	16.15	5%	43%	52%	RR12	RR3	RR11	RR8	RR7
	1.4 Client	01. Interference	15.94	13%	87%	0%	RR7	RR8	RR9	RR2	RR1
		02. Change orders	15.06	18%	83%	0%	RR9	RR3	RR8	RR11	RR7

Risk Identification and classification			Risk Analysis	Risk Allocation			Risk Response				
Risk Taxonomy	**Risk Sub Taxonomy**	**Risk Factors**	**Severity Index**	**Contractor %**	**Client %**	**Consultant %**	**1**	**2**	**3**	**4**	**5**
02. Technical risk	2.1 Construction process	01. Insufficient time to prepare bids	16.94	**77%**	**23%**	**1%**	**RR9**	**RR2**	**RR3**	**RR1**	**RR8**
		02. Delay of information from designers	14.94	**8%**	**24%**	**68%**	**RR11**	**RR9**	**RR12**	**RR2**	**RR3**
03. Political and regulation risk		01. Requirement to use local labour	13.06	**45%**	**55%**	**0%**	**RR10**	**RR7**	**RR9**	**RR1**	**RR2**

Among 128 identified risk factors against 9 risk taxonomy of the high rise buildings in Sri Lanka, 16 risk factors against 3 risk taxonomy are significant to Separated with Lump Sum procurement system as shown in the table 4.9 above. Significant risk taxonomies are only personal risk, technical risk, and political and regulation risk.

It was recommended to allocate all personal risk factors relevant to technician and labour, subcontractor and contractor to the contractor while allocating personal risk factors relevant to consultant to the consultant and personal risk factors relevant to client to the client. Insufficient time to prepare bids was recommended to allocate to the contractor and delay of information from designers was allocated to the consultant while requirement to use local labour to both contractor and client.

Education and training, using suitable standard conditions of contract, encourage team work culture, tendering a high Bid, including conditions on the Bid, retaining risk with the client and allocation of contingency plan can be identified as most recommended risk response methods for Separated with Lump Sum Procurement System.

It can be observed that lack of skilled labours, unable to finish work on time and insufficient time to prepare bids are the most significant three risk factors to Separated with Lump Sum procurement system. It was recommended to allocate all these three significant risk factors to the contractor since contractor should be responsible for all these risk factors; therefore he can easily manage these risk compared to others. Education and training, including conditions on the bid and allocation of contingency plan are the highly recommended risk response methods for each significant risk factors respectively.

4.6.2. Separated with Measure and Pay Procurement System

Table 4.10 : Systematic risk management framework for Separated with Measure and Pay Procurement System

Risk Identification and classification			Risk Analysis	Risk Allocation			Risk Response				
Risk Taxonomy	**Risk Sub Taxonomy**	**Risk Factors**	**Severity Index**	**Contractor %**	**Client %**	**Consultant %**	**1**	**2**	**3**	**4**	**5**
01. Personal risk	1.1 Technician and labour	01. Frequent job change by skilled labour	14.85	93%	7%	0%	RR11	RR9	RR6	RR8	RR1
		02. Lack of skilled labour	20.68	87%	12%	0%	RR10	RR1	RR6	RR8	RR2
		03. Lack of unskilled labour	15.00	88%	12%	0%	RR1	RR10	RR6	RR8	RR2
		04. Poor workmanship	14.03	94%	6%	0%	RR10	RR6	RR2	RR8	RR12
	1.2 Subcontractor	01. Lack of required technical skill	15.12	91%	9%	0%	RR10	RR1	RR4	RR8	RR2
		02. Unable to finish work on time	19.71	90%	10%	0%	RR2	RR12	RR4	RR8	RR6
		03. Subcontractor unable to afford required labour	12.97	90%	10%	0%	RR10	RR12	RR4	RR1	RR8
		04. Subcontractor takes jobs in several projects	13.97	91%	9%	0%	RR2	RR12	RR4	RR8	RR6
	1.3 Consultants	01. Does not understand his role/duty	16.09	0%	29%	71%	RR12	RR3	RR10	RR7	RR8
		02. Delays in materials and shop drawings approval	16.35	0%	30%	70%	RR12	RR3	RR11	RR8	RR7
		03. Communication and coordination problem	16.32	5%	43%	52%	RR12	RR3	RR11	RR8	RR7
	1.4 Client	01. Interference	15.88	14%	87%	0%	RR7	RR8	RR9	RR2	RR1
		02. Change orders	15.29	19%	81%	0%	RR9	RR3	RR8	RR11	RR7
02. Technical risk	2.1 Construction process	01. Delay of information from designers	15.32	7%	22%	71%	RR11	RR9	RR12	RR2	RR3
03. Political and regulation risk		01. Requirement to use local labour	13.06	43%	57%	0%	RR10	RR7	RR9	RR1	RR2

Among 128 identified risk factors against 9 risk taxonomy of the high rise buildings in Sri Lanka, 15 risk factors against 3 risk taxonomy are significant to Separated with Measure & Pay procurement system as shown in the above table 4.10. Significant risk taxonomies are only personal risk, technical risk, and political and regulation risk which is similar to the Separated with Lump Sum procurement system.

Here also it was recommended to allocate all personal risk factors relevant to technician and labour, subcontractor and contractor to the contractor while allocating personal risk factors relevant to consultant to the consultant and personal risk factors relevant to client to the client. Insufficient time to prepare bids was recommended to allocate to the contractor while delay of information from designers was allocated to the consultant and requirement to use local labour to both contractor and client.

Education and training, using suitable standard conditions of contract, encourage team work culture, tendering a high bid, including conditions on the Bid, retaining risk with the client and Allocation of contingency plan can be identified as most recommended risk response methods for Separated with Lump Sum Procurement System.

It can be observed that lack of skilled labours and unable to finish work on time are the most significant risk factors to Separated with Measure & Pay procurement system. It was recommended to allocate all these significant risk factors to the contractor since contractor should be responsible for all these risk factors; therefore he can easily manage these risk compared to others. Education and training and including conditions on the bid are the highly recommended risk response methods for each significant risk factors respectively.

4.6.3. Design and Build with Lump Sum Procurement System

Table 4.11 : Systematic risk management framework for Design and Build with Lump Sum Procurement System

Risk Identification and classification			Risk Analysis	Risk Allocation			Risk Response				
Risk Taxonomy	**Risk Sub Taxonomy**	**Risk Factors**	**Severity Index**	**Contractor %**	**Client %**	**Consultant %**	**1**	**2**	**3**	**4**	**5**
01. Personal risk	1.1 Technician and labour	01. Frequent job change by skilled labour	14.76	94%	6%	0%	RR11	RR9	RR6	RR8	RR1
		02. Lack of skilled labour	20.44	89%	11%	0%	RR10	RR1	RR6	RR8	RR2
		03. Lack of unskilled labour	14.88	89%	11%	0%	RR1	RR10	RR6	RR8	RR2
		04. Poor workmanship	14.12	95%	5%	0%	RR10	RR6	RR2	RR8	RR12
	1.2 Subcontractor	01. Lack of required technical skill	15.35	91%	9%	0%	RR10	RR1	RR4	RR8	RR2
		02. Unable to finish work on time	19.85	91%	9%	0%	RR2	RR12	RR4	RR8	RR6
		03. Subcontractor unable to afford required labour	12.94	92%	8%	0%	RR10	RR12	RR4	RR1	RR8
		04. Subcontractor takes jobs in several projects	13.74	93%	7%	0%	RR2	RR12	RR4	RR8	RR6
	1.3 Contractor	01. Lack of experienced staff	16.29	96%	4%	0%	RR10	RR1	RR6	RR8	RR2
	1.4 Client	01. Interference	15.79	16%	85%	0%	RR7	RR8	RR9	RR2	RR1
		02. Change orders	15.56	20%	80%	0%	RR9	RR3	RR8	RR11	RR7
02. Technical risk	2.1 Technique	01. New technique is required	13.44	16%	81%	4%	RR10	RR15	RR9	RR2	RR3
	2.2 Construction process	01. Insufficient time to prepare bids	16.59	75%	24%	1%	RR9	RR2	RR3	RR1	RR8
03. Construction Design causes risk		01. Need innovative construction methods	17.91	81%	18%	1%	RR10	RR13	RR15	RR14	RR9
		02. Need new materials and equipment	13.97	81%	18%	1%	RR10	RR13	RR14	RR15	RR9

Risk Identification and classification			Risk Analysis	Risk Allocation			Risk Response				
Risk Taxonomy	**Risk Sub Taxonomy**	**Risk Factors**	**Severity Index**	**Contractor %**	**Client %**	**Consultant %**	**1**	**2**	**3**	**4**	**5**
04. Political and regulation risk		01. Frequent changes in law	14.88	**33%**	**67%**	**0%**	**RR9**	**RR7**	**RR1**	**RR8**	**RR2**
		02. Requirement to use local labour	13.15	**42%**	**58%**	**0%**	**RR10**	**RR7**	**RR9**	**RR1**	**RR2**
05. Financial risk		01. Labour cost is higher than predicted	14.76	**30%**	**70%**	**0%**	**RR9**	**RR8**	**RR1**	**RR3**	**RR2**

Among 128 identified risk factors against 9 risk taxonomy of the high rise buildings in Sri Lanka, 18 risk factors against 5 risk taxonomy are significant to D&B with Lump Sum procurement system as shown in the above table 4.11. Significant risk taxonomies are only personal risk, technical risk, construction design causes risk, political and regulation risk and financial risk.

Similar to other procurement methods here also it was recommended to allocate all personal risk factors relevant to technician and labour, subcontractor and contractor to the contractor while allocating personal risk factors relevant to consultant to the consultant and personal risk factors relevant to client to the client. Additionally construction design cause risks and insufficient time to prepare bids were recommended to allocate to the contractor and frequent changes in law and labour cost is higher than predicted were allocated to the contractor while requirement to use local labour was allocated to both contractor and client.

Education and training, using suitable standard conditions of contract, encourage team work culture, tendering a high bid, including conditions on the bid, retaining risk with the client and allocation of contingency plan can be identified as most recommended risk response methods for Separated with Lump Sum procurement System.

It can be observed that lack of skilled labours, unable to finish work on time" and need innovative construction methods are the most significant risk factors to Design & Build with Lump Sum procurement system. It was recommended to allocate all these three significant risk factors to the contractor since contractor should be responsible for all these risk factors; therefore he can easily manage these risk compared to others. Education and training and including conditions on the bid were highly recommended risk response methods for these significant risk factors.

4.7. Summary

128 risk factors and 15 risk response methods were identified as applicable to the high rise building projects in Sri Lanka using preliminary survey. Further it was identified that three procurement systems are used in the high rise building projects in Sri Lanka named separated with lump sum, measure & pay with lump sum and design & build with lump sum. Systematic risk management process identified through literature review which is comprised of Risk Identification, Risk Analysis, Risk Allocation and Risk Response was applied for this research. Accordingly, significant risk factors which lead to disputes against each procurement systems commonly used in high rise building projects in Sri Lanka were identified. These identified significant risk factors, were allocated among each parties to the contract named client, contractor and consultant. Finally recommended first five risk responses methods were determined against each procurement systems. Using all above research findings of preliminary survey and two phase of questionnaire survey, a systematic risk management frameworks for three procurement systems named separated with lump sum, measure & pay with lump sum and design & build for high rise building projects in Sri Lanka which will be ultimately help to avoid disputes.

Chapter 5

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary of the study

Disputes drive endemic problem in the construction industry where it is required to avoid disputes for successful project completion. Consequently, as a root causes of the disputes, risks should be managed systematically. Risk management is massively affected by procurement system used in the construction projects. Hence, it is important to study on risk management against each procurement variables. Even though there are several researches on risk management on individual procurement systems, systematic risk management process is not applied in either. Hence the research gap became crystal clear of developing systematic frameworks of risk management for different procurement systems. However it is estimated that the high-rise are the most important part of the construction in Sri Lanka, hence, this research focused to develop systematic risk management frameworks for different procurement systems commonly used in high rise building in Sri Lanka which will be ultimately help to avoid disputes. This study is summarized in this chapter under the research objectives mentioned in 1.3 and finally conclusions, recommendations, limitations and further developments are presented.

Objective 01: Identify commonly used procurement systems in high rise building projects in Sri Lanka.

In order to achieve the first objective of the research, preliminary survey was held among 35 professionals who are working in 35 different ongoing high rise building projects in Sri Lanka. As the third question of preliminary survey, it was asked to mention the procurement systems applied for each project based on the delivery methods and payment methods. Survey results showed that three procurement systems are commonly used in high rise buildings in Sri Lanka named separated with measure & pay, separated with lump sum, and design & build with lump sum as mentioned in the figure 4.1. Even though it has been identified that Design & Build with Measure & Pay system also used in very few projects it was not considered further as it is not

a correct practice.

Systematic risk management process identified through literature review which is comprised of Risk Identification, Risk Analysis, Risk Allocation and Risk Response was applied for this research as mentioned hereafter.

Objective 02: Evaluate the significant risk factors which lead to disputes of above identified procurement systems.

In order to achieve the second objective preliminary survey and thereafter phase 1 of questionnaire survey was applied.

As the first question of the preliminary survey, it was identified that only 128 risk factors are applicable to the high rise buildings in Sri Lanka among identified 130 risk factors through literature review and these risk factors were used for the further research. And it was identified that all risk factors lead to disputes.

In the first phase of questionnaire, 100 questionnaires were distributed and only 34 (34%) were responded. Respondents were asked to mention the significance and frequency of each risk factors leads to disputes against each procurement systems found in the objective 1. Data were analysed by calculating severity index and risk factors which exceed 50% of risk severity (>12.5) were identified as significant risks factors. Accordingly, only 22 risk factors are significant to the high rise buildings in Sri Lanka among 128 identified risk factors. Among them 16 risk factors are significant to Separated with Lump Sum systems and 15 risk factors are significant to Separated with Measure & Pay systems where 18 risk factors are significant to D&B with Lump Sum systems as given in the table 4.2. “Lack of skilled labours” and “unable to finish work on time” are the most significant risk factors for all procurement systems. Third highest risk factor is “need innovative construction methods” which is significant to only D&B with lump sum system but not for others.

Objective 03: Determine the allocation of significant risk factors which lead to disputes among the stakeholders (Employer, Contractor and Consultant) of above identified procurement systems.

The second phase of questionnaire was held to determine the opinion on the risk allocation among the stakeholders which leads to disputes against each procurement

systems used in high rise buildings in Sri Lanka. In this phase also 100 questionnaires were distributed and only 30 (30%) were responded.

In the first question of the second phase of questionnaire, the respondents were asked to indicate the risk allocation percentage among client, contractor and consultant against each risk factors for all three procurement systems maintaining the total percentage as hundred (100%). Average percentage of each respondents were calculated against each risk factor to decide the risk allocation of each risk factors. Survey results confirm the principle of allocating the risk to the best party who can tolerate and manage the risk.

Objective 04: Determine the risk response methods for above identified significant risk factors

In the second question of the phase 2 of questionnaire survey, the respondents were asked to select the most recommended first five risk response methods among the given list against each risk factors for all three procurement systems. This list was prepared through preliminary survey by validating response methods observed from literature review. Accordingly, 15 risk response methods were identified as appropriate to high rise buildings in Sri Lanka and used for the questionnaire survey. Survey results reveal that risk response methods are common for all procurement systems as same results has been applicable for all procurement systems. Education and training has been highly recommended as the best response method for most of the risk factors.

5.2. Conclusion

With the above mentioned research summary following conclusions can be highlighted.

Three procurement systems are identified as commonly used in high rise buildings in Sri Lanka, named separated with measure & pay, separated with lump sum, and design & build with lump sum.

128 risk factors are identified as applicable to the high rise building in Sri Lanka. Further all these risk factors lead to disputes. However only 22 risk factors are significant to the high rise buildings in Sri Lanka. Among them 16, 15 & 18 risk factors

are significant to Separated with Lump Sum systems, Separated with Measure & Pay systems and D&B with Lump Sum systems respectively.

"Lack of skilled labours" and "unable to finish work on time" are the most significant risk factors for all procurement systems. Third highest risk factor is "need innovative construction methods" significant to only D&B with lump sum system.

Survey results confirm the principle of allocating the risk to the best party who can tolerate and manage the risk.

15 Risk response methods appropriate in high rise building projects in Sri Lanka were identified. Most suitable first five risk response methods against each significant risk factor were identified. Risk Response methods are common to all procurement systems. "Education and training" has been highly recommended as the best response method for most of the risk factors. This research finding can be interrelated with the survey finding of most significant risk factor which is "Lack of skilled labours" where "Education and training" is the best risk response method for this.

It is recommended to use standard conditions of contract for subcontracts and consultant contracts.

On the basis of the above mentioned research findings, systematic risk management frameworks for three procurement systems named separated with lump sum, measure & pay with lump sum and Design & build were developed for high rise building projects in Sri Lanka which will be ultimately help to avoid disputes. This frameworks can be used as a tool for procurement selection and as a guidance for risk management where ultimately help to avoid disputes of the high rise projects in Sri Lanka.

5.3. Recommendation

Taking into consideration the findings of this research, recommendations can be made to the main stakeholders of the high rise buildings in Sri Lanka. Based on this research it can be concluded that high rise building are consistently exposed to different types of risks depending on the different procurement systems applied and these risks ultimately caused to disputes which adversely affect the successful project completion. Therefore these risks should be managed following systematic risk management framework without ignoring them. Therefore following resolutions are recommended.

It is recommended to select the most appropriate procurement system before starting high rise projects considering significant risks which can be affected where risk management should be a parameter of selecting procurement methods.

Further it is recommended to prepare risk management frameworks for the selected procurement system before starting high rise building projects.

When doing so, it is recommended to allocate the risks to the best party who can tolerate and manage the risk.

It is recommended to held education and training programme in order to increase the awareness of the of high rise buildings due to in experience in high rise in Sri Lanka. This will be helped to reduce risks and successful project completion.

Further it is thoroughly recommended to use standard conditions of contract for subcontracts and consultant contracts in order to minimize/avoid risks. For instance, FIDIC –Subcontract 2011 can be used for subcontracts and FIDIC white can be used for consultant's contracts.

5.4. Limitations

Several difficulties were encountered in carrying out this research. The selection of a respondents were really difficult since in experience in Sri Lankan high rise buildings. There are only limited professionals who had experience in Sri Lankan high rise buildings, but most of them had overseas experience in high rise. Therefore this research was limited to only 30 and 34 respondents in both phases. However project directors, project managers, construction managers, contracts managers, quantity surveyors and Architects of each ongoing high rise projects were selected.
It was very difficult to get the response from industry practitioners for each phases as they were really busy with work. Many reminder calls and return visits to the organizations had to be made in order to mobilize the non-respondents.

Procurement systems can be classified in different ways based on project delivery methods, costs, rewards, etc…However, This research was limited to commonly used procurement systems for high rise projects in Sri Lanka. It was considered 20 floors as the cut-off level of high rise based on the information derived from the literature as already explained in the chapter 2 and this was confirmed through the preliminary

interviews where most of the construction professionals suggested to consider 20 and above for this research as risks factors may vary accordingly.

In order to calculate risk severity, respondents were asked to mention the level of frequency of risk occurrence and significance of risk impact according to a 5 point scale denoting 1=Very Low, 2=Low, 3=Medium, 4=High, 5=Very High. Here only rated magnitude was used as it is not possible to find the absolute magnitude of each risk factors.

Further only risk factors which leads to disputes were focused under this research. However it was identified that all risk factors lead to disputes.

Definition of the Consultant for this study purpose is the consultants who appointed by the client but not the in house consultants appointed by the D&B contractor.

Definition of the subcontractor for this study purpose is only domestic subcontractors but not nominated subcontractors.

5.5. Further Development

The following issues have been identified as areas for further development.

Delphi method can be applied for the same research to increase the reliability of the research. The objective of the Delphi method is to obtain a reliable response to a problem or question from a group of experts. This is done by giving individuals in the group a series of questionnaires (or interviews) that reiterate the same questions while providing group feedback from previous rounds.

It should be pointed out that the research was conducted only for high rise building projects in Sri Lanka, therefore the conclusions drawn from the study may have purely local applications of high rise building. It is therefore recommended to repeat the survey for other buildings as well as infrastructure projects in Sri Lanka.

When focusing on other projects, there may be other procurement systems used in Sri Lanka and the research can be extended accordingly. Then those frameworks can be used as a tool for procurement selection and as a guidance for risk management where ultimately help to avoid disputes of the other buildings and infrastructure projects in Sri Lanka.

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Appendix 1 – Preliminary Survey

TOPIC

Risk Management for Dispute Avoidance in Different Procurement Systems used in High Rise Buildings in Sri Lanka

AIM

This research aims to develop systematic risk management frameworks for different procurement systems commonly used in high rise building projects in Sri Lanka which will be ultimately help to avoid disputes.

Name of the Respondent: ……..

Name of the Organization: ……

Designation of the Respondent: ……

Name of the Project: ……..

Working Experience: ……

Working Experience in high rise building: ……..…….

Q1. Fill the below table with “YES” or "NO" in front of each risk factor by considering its applicability to the Sri Lankan high rise building projects.

Risk Taxonomy	Sub Taxonomy	Risk Factor	Applicability
01. Physical risk		01. Earthquake	
		02. Landslide and subsidence	
		03. Fire	
		04. Lightning	
		05. Heavy rain	
		06. Flood	
		07. Extraordinary wind	
		08. Pestilence	
02. Personal risk	2.1 Technician and labour	01. Frequent job change by skilled labour	

Risk Taxonomy	Sub Taxonomy	Risk Factor	Applicability
		02. Lack of skilled labour	
		03. Lack of unskilled labour	
		04. Strikes and labour disputes	
		05. Low productivity	
		06. Poor workmanship	
		07. Brawls and fighting	
		08. Use of illegal foreign labour	
		09. Gambling on site	
		10. Absenteeism	
		11. Unable to understand drawings	
		12. Communication problems	
	2.2 Subcontractor	01. Lack of funds to proceed with work (Insolvency)	
		02. Lack of required technical skill	
		03. Unable to finish work on time	
		04. Low quality of work	
		05. Unable to find qualified subcontractor	
		06. Low productivity	
		07. Coordination problems	
		08. Subcontractor unable to afford required labour	
		09. Subcontractor takes jobs in several projects	
		10. Subcontractor abandons project	
	2.3 Contractor	01. Incompetence and lack of responsibility	
		02. Absenteeism	
		03. Brawls	
		04. Lack of experienced staff	
	2.4 Engineer	01. Incompetence and lack of responsibility	
		02. Absenteeism	
		03. Brawls	
		04. Lack of experienced staff	
	2.5 Consultants	01. Does not understand his role/duty	

Risk Taxonomy	Sub Taxonomy	Risk Factor	Applicability
		02. Poor construction method	
		03. Delays in materials and shop drawings approval	
		04. Communication and coordination problem	
		05. Dishonesty	
		06. Unaccountability of work	
	2.6 Client	01. Interference	
		02. Change orders	
		03. Client lacks managerial capability	
		04. Quality expected beyond standard and specification	
03. Technical risk	3.1 Materials	01. Affordable material is more expensive than presented in BOQ	
		02. Proposed materials are not approved	
		03. Material shortage	
		04. Late in material delivery	
		05. Quality of material below standard	
		06. Marital damage during storage	
		07. Marital damage during transportation	
	3.2 Equipment	01. Low productivity and efficiency	
		02. Frequently out of order or damaged	
		03. Inappropriate equipment causes problems	
		04. Unavailability of spare parts or cost is high	
		05. No reserve equipment	
		06. Need to import from other countries	
		07. High maintenance cost	
	3.3 Technique	01. New technique is required	
		02. Quality criteria are difficult to achieve	
	3.4 Construction process	01. Failure to construct as planned	
		02. Coordination problems	

Risk Taxonomy	Sub Taxonomy	Risk Factor	Applicability
		03. Delay on procession of site after LOA	
		04. Communication problems	
		05. Red tape in liaisons with public service consumes too much time	
		06. Irregularity of work load	
		07. Severe climate causes low productivity	
		08. Errors or omissions in BOQ	
		09. Insufficient time to prepare bids	
		10. Delay of information from designers	
	3.5 Construction Site	01. Access problem	
		02. Construction site is adjacent	
		03. Work hours are limited	
		04. Traffic congestion	
		05. Local regulations	
		06. Theft	
		07. Project is threatened by hooligans	
	3.6 Ground condition	01. No site investigation or boring log	
		02. Inadequate site investigation	
		03. Errors in information of site investigation	
		04. Unforeseen problems	
04. Safety-accident risk		01. Severe accidents occur	
		02. Inappropriate machine induces accident	
		03. Machine is not checked before operating	
		04. There is no fence or protection net	
		05. There is no fire protection system at site	
05. Construction Design causes risk		01. Inadequate od ambiguous specification	
		02. Errors in drawings	
		03. Incomplete design scope	

Risk Taxonomy	Sub Taxonomy	Risk Factor	Applicability
		04. Need innovative construction methods	
		05. Need new materials and equipment	
		06. Non-standard details of drawing induces low quality of work and error in estimate	
		07. Likelihood of change	
		08. Incompatibility between drawings and method	
06. Political and regulation risk		01. Frequent changes in law	
		02. War, revolution and civil disorder	
		03. Requirement to use local labour	
		04. Customs and import restrictions	
		05. Unstable politics	
		06. Embargo	
		07. Long procedure for approval and permits	
		08. Cost for corrupt government officials	
07. Financial risk		01. Payment risk of completed work	
		02. Slow payment by clients due to disputes	
		03. Retention is not returned	
		04. Liquidated damages for delay	
		05. Adequate payment for variations	
		06. Financial problems due to errors in estimating	
		07. Loss due to default of contractor, subcontractor, supplier or client	
		08. Inflation	
		09. Exchange rate fluctuation	
		10. Local and national taxes are high	
		11. Bid and performance bond are unfairly called	

Risk Taxonomy	Sub Taxonomy	Risk Factor	Applicability
		12. Insufficient insurance	
		13. Labour cost is higher than predicted	
		14. Material cost is higher than predicted	
08. Contractual risk		01. Unfair and unreasonable stipulation	
		02. Ambiguous clauses that have several meanings	
		03. Work conditions differ from contract	
		04. Misinterpretation	
		05. Extent of work differs from contract	
		06. Red tape in litigation	
09. Governmental regulations cause risk		01. Construction process causes pollution	
		02. Waste treatment required by law	
		03. Preserving historical finds	
		04. Local environment regulations obstruct construction process	

Q2. Fill the below table with “YES” or "NO" by considering the applicability of following mention Risk Response Methods used in high rise building projects in Sri Lanka. If there are any other Risk Response Methods used in high rise building projects in Sri Lanka please suggest them.

Sr. Nr	Risk Response Methods	Applicability
1	Tendering a high Bid	
2	Including conditions on the Bid	
3	Pre contract negotiations as to which party takes certain risks	
4	Transferring risk to subcontractor	
5	Transferring risk to insurance company	
6	Transferring risk to main contractor	
7	Claiming for the damages	
8	Allocation of contingency plan	
9	Education and Training	

Sr. Nr	Risk Response Methods	Applicability
10	Physical protection to reduce the likelihood of risk	
11	Brainstorming to identify new risks	
12	Physical protection for people and property	
13	Encourage team work culture	
14	Using suitable standard conditions of contract	
15		
16		
17		
18		

Q3. Please fill the below table with the procurement method used in high rise building projects in Sri Lanka

Sr Nr	Project	Nr of floors	Procurement system					
			Delivery Method			Payment Method		
			Separated	D&B	Other (Specify)	Lump Sum	M&P	Other (Specify)

Appendix 2 – Questionnaire Survey

QUESTIONNAIRE – PHASE 01

TOPIC

Risk Management for Dispute Avoidance in Different Procurement Systems used in High Rise Buildings in Sri Lanka

AIM

This research aims to develop systematic risk management frameworks for different procurement systems commonly used in high rise building projects in Sri Lanka which will be ultimately help to avoid disputes.

Name of the Respondent: ……..……..

Name of the Organization: ……

Designation of the Respondent: ……

Name of the Project: ……..

Working Experience: ……

Total Working Experience in high rise building: …….

High rise Experience as Client organization: ……....

High rise Experience as Consultant organization:…….……..

High rise Experience as Contracting organization:……..……

1. Fill the below table with “YES” or "NO" in front of each risk factor if it is lead/ not lead to disputes in high rise building.
2. Fill the below table with “1 to 5" in front of each risk factor against each mentioned procurement method, considering their frequency of occurrence and impact to the Project objectives such as cost, time, quality, safety and environmental sustainability.

2.1. Considering the Frequency of occurrence of each risk factor against each mentioned procurement method, has to be filled in first five boxes whether it is,

1 – Very Low
2 – Low
3 – Medium
4 – High
5 – Very High

2.2. Considering the impact of each risk factor to the project objectives against each mentioned procurement method, has to be filled in second five boxes whether it is,

1 – Very Low
2 – Low
3 – Medium
4 – High
5 – Very High

Note:

Risk Taxonomy = Risk Classification

Definition of procurement systems

- **Separated system –** The key characteristics are the rigid separation of design and the construction process and lack of integration across this boundary. Client first appoint a consultant to do the design and after designing is fully completed tendering procedure is being held and a contractor is selected to carry out the project.
- **Design and Build system-** The contractor develops the design and constructs the building based on a set of requirements provided by the employer.
- **Lump Sum –** Contract sum is agreed (which is fixed) before the construction starts. The contractor is paid based on percentage.
- **Measure and Pay -** The contractor is paid according to the amount of work done as measured after the physical completion.

Risk Taxonomy	Sub Taxonomy	Risk Factor	Lead to dispute	Separated with Lump Sum		Separated with Measure & pay		D&B with Lump Sum	
				Frequency of occurrence	Impact	Frequency of occurrence	Impact	Frequency of occurrence	Impact
01. Physical risk		01. Fire							
		02. Lightning							
		03. Heavy rain							
		04. Flood							
		05. Extraordinary wind							
		06. Pestilence							
02. Personal risk	2.1 Technician and labour	01. Frequent job change by skilled labour							
		02. Lack of skilled labour							
		03. Lack of unskilled labour							
		04. Strikes and labour disputes							
		05. Low productivity							
		06. Poor workmanship							
		07. Brawls and fighting							
		08. Use of illegal foreign labour							
		09. Gambling on site							
		10. Absenteeism							
		11. Unable to understand drawings							

Risk Taxonomy	Sub Taxonomy	Risk Factor	Lead to dispute	Separated with Lump Sum		Separated with Measure & pay		D&B with Lump Sum	
				Frequency of occurrence	Impact	Frequency of occurrence	Impact	Frequency of occurrence	Impact
		12. Communication problems							
	2.2 Subcontractor	01. Lack of funds to proceed with work (Insolvency)							
		02. Lack of required technical skill							
		03. Unable to finish work on time							
		04. Low quality of work							
		05. Unable to find qualified subcontractor							
		06. Low productivity							
		07. Coordination problems							
		08. Subcontractor unable to afford required labour							
		09. Subcontractor takes jobs in several projects							
		10. Subcontractor abandons project							
	2.3 Contractor	01. Incompetence and lack of responsibility							
		02. Absenteeism							

Risk Taxonomy	Sub Taxonomy	Risk Factor	Lead to dispute	Separated with Lump Sum		Separated with Measure & pay		D&B with Lump Sum	
				Frequency of occurrence	Impact	Frequency of occurrence	Impact	Frequency of occurrence	Impact
		03. Brawls							
		04. Lack of experienced staff							
	2.4 Engineer	01. Incompetence and lack of responsibility							
		02. Absenteeism							
		03. Brawls							
		04. Lack of experienced staff							
	2.5 Consultants	01. Does not understand his role/duty							
		02. Poor construction method							
		03. Delays in materials and shop drawings approval							
		04. Communication and coordination problem							
		05. Dishonesty							
		06. Unaccountability of work							
	2.6 Client	01. Interference							
		02. Change orders							
		03. Client lacks managerial capability							

Risk Taxonomy	Sub Taxonomy	Risk Factor	Lead to dispute	Separated with Lump Sum		Separated with Measure & pay		D&B with Lump Sum	
				Frequency of occurrence	Impact	Frequency of occurrence	Impact	Frequency of occurrence	Impact
		04. Quality expected beyond standard and specification							
03. Technical risk	3.1 Materials	01. Affordable material is more expensive than presented in BOQ							
		02. Proposed materials are not approved							
		03. Material shortage							
		04. Late in material delivery							
		05. Quality of material below standard							
		06. Marital damage during storage							
		07. Marital damage during transportation							
	3.2 Equipment	01. Low productivity and efficiency							
		02. Frequently out of order or damaged							
		03. Inappropriate equipment causes problems							
		04. Unavailability of spare parts or cost is high							

Risk Taxonomy	Sub Taxonomy	Risk Factor	Lead to dispute	Separated with Lump Sum		Separated with Measure & pay		D&B with Lump Sum	
				Frequency of occurrence	Impact	Frequency of occurrence	Impact	Frequency of occurrence	Impact
		05. No reserve equipment							
		06. Need to import from other countries							
		07. High maintenance cost							
	3.3 Technique	01. New technique is required							
		02. Quality criteria are difficult to achieve							
	3.4 Construction process	01. Failure to construct as planned							
		02. Coordination problems							
		03. Delay on procession of site after LOA							
		04. Communication problems							
		05. Red tape in liaisons with public service consumes too much time							
		06. Irregularity of work load							
		07. Severe climate causes low productivity							
		08. Errors or omissions in BOQ							

Risk Taxonomy	Sub Taxonomy	Risk Factor	Lead to dispute	Separated with Lump Sum		Separated with Measure & pay		D&B with Lump Sum	
				Frequency of occurrence	Impact	Frequency of occurrence	Impact	Frequency of occurrence	Impact
		09. Insufficient time to prepare bids							
		10. Delay of information from designers							
	3.5 Construction Site	01. Access problem							
		02. Construction site is adjacent							
		03. Work hours are limited							
		04. Traffic congestion							
		05. Local regulations							
		06. Theft							
		07. Project is threatened by hooligans							
	3.6 Ground condition	01. No site investigation or boring log							
		02. Inadequate site investigation							
		03. Errors in information of site investigation							
		04. Unforeseen problems							
		01. Severe accidents occur							

Risk Taxonomy	Sub Taxonomy	Risk Factor	Lead to dispute	Separated with Lump Sum		Separated with Measure & pay		D&B with Lump Sum	
				Frequency of occurrence	Impact	Frequency of occurrence	Impact	Frequency of occurrence	Impact
04. Safety-accident risk		02. Inappropriate machine induces accident							
		03. Machine is not checked before operating							
		04. There is no fence or protection net							
		05. There is no fire protection system at site							
05. Constructi on Design causes risk		01. Inadequate od ambiguous specification							
		02. Errors in drawings							
		03. Incomplete design scope							
		04. Need innovative construction methods							
		05. Need new materials and equipment							
		06. Non-standard details of drawing induces low quality of work and error in estimate							
		07. Likelihood of change							
		08. Incompatibility between drawings and method							

Risk Taxonomy	Sub Taxonomy	Risk Factor	Lead to dispute	Separated with Lump Sum		Separated with Measure & pay		D&B with Lump Sum	
				Frequency of occurrence	Impact	Frequency of occurrence	Impact	Frequency of occurrence	Impact
06. Political and regulation risk		01. Frequent changes in law							
		02. War, revolution and civil disorder							
		03. Requirement to use local labour							
		04. Customs and import restrictions							
		05. Unstable politics							
		06. Embargo							
		07. Long procedure for approval and permits							
		08. Cost for corrupt government officials							
07. Financial risk		01. Payment risk of completed work							
		02. Slow payment by clients due to disputes							
		03. Retention is not returned							
		04. Liquidated damages for delay							
		05. Adequate payment for variations							

Risk Taxonomy	Sub Taxonomy	Risk Factor	Lead to dispute	Separated with Lump Sum		Separated with Measure & pay		D&B with Lump Sum	
				Frequency of occurrence	Impact	Frequency of occurrence	Impact	Frequency of occurrence	Impact
		06. Financial problems due to errors in estimating							
		07. Loss due to default of contractor, subcontractor, supplier or client							
		08. Inflation							
		09. Exchange rate fluctuation							
		10. Local and national taxes are high							
		11. Bid and performance bond are unfairly called							
		12. Insufficient insurance							
		13. Labour cost is higher than predicted							
		14. Material cost is higher than predicted							
08. Contractual risk		01. Unfair and unreasonable stipulation							
		02. Ambiguous clauses that have several meanings							
		03. Work conditions differ from contract							
		04. Misinterpretation							

Risk Taxonomy	Sub Taxonomy	Risk Factor	Lead to dispute	Separated with Lump Sum		Separated with Measure & pay		D&B with Lump Sum	
				Frequency of occurrence	Impact	Frequency of occurrence	Impact	Frequency of occurrence	Impact
		05. Extent of work differs from contract							
		06. Red tape in litigation							
09. Governmental regulations cause risk		01. Construction process causes pollution							
		02. Waste treatment required by law							
		03. Preserving historical finds							
		04. Local environment regulations obstruct construction process							

Thank you very much for your Cooperation

D.M. Chandima Kumari Dissanayake

Appendix 3 – Questionnaire Survey

QUESTIONNAIRE – PHASE 02

TOPIC

Risk Management for Dispute Avoidance in Different Procurement Systems used in High Rise Buildings in Sri Lanka

AIM

This research aims to develop systematic risk management frameworks for different procurement systems commonly used in high rise building projects in Sri Lanka which will be ultimately help to avoid disputes.

Name of the Respondent: ……..

Name of the Organization: ……

Designation of the Respondent: ……

Name of the Project: ……..

Working Experience: ……

Total Working Experience in high rise building: …….

High rise Experience as Client organization: ……....

High rise Experience as Consultant organization:…….……..

High rise Experience as Contracting organization:……..……

Please fill the three (03) tables which is in the 03 tabs (sheets) named Q1, Q2, Q3. Don't fill the CELLS mentioned as N/A.

Note:

Risk Taxonomy = Risk Classification

Definition of procurement systems

- **Separated system –** The key characteristics are the rigid separation of design and the construction process and lack of integration across this boundary. Client first appoint a consultant to do the design and after designing is fully completed tendering procedure is being held and a contractor is selected to carry out the project.
- **Design and Build system-** The contractor develops the design and constructs the building based on a set of requirements provided by the employer.
- **Lump Sum –** Contract sum is agreed (which is fixed) before the construction starts. The contractor is paid based on percentage.

Measure and Pay - The contractor is paid according to the amount of work done as measured after the physical completion.

1. Fill the below table with “applicable risk allocation percentage among contractor, owner/client and consultant" against each procurement method, in front of each risk factors as applicable to high rise buildings in Sri Lanka . Total percentage for each procurement method should be 100%.

Risk Taxonomy	Risk Sub Taxonomy	Risk Factors	Risk Allocation Percentage (Total should be 100%)											
			Separated with Lump Sum				Separated with Measure & pay				D&B with Lump Sum			
			Contractor %	Client %	Consultant %	Total %	Contractor %	Client %	Consultant %	Total %	Contractor %	Client %	Consultant %	Total %
01. Personal risk	1.1 Technician and labour	01. Frequent job change by skilled labour				0%				0%				0%
		02. Lack of skilled labour				0%				0%				0%
		03. Lack of unskilled labour				0%				0%				0%
		04. Poor workmanship				0%				0%				0%
	1.2 Subcontractor	01. Lack of required technical skill				0%				0%				0%
		02. Unable to finish work on time				0%				0%				0%
		03. Subcontractor unable to afford required labour				0%				0%				0%
		04. Subcontractor takes jobs in several projects				0%				0%				0%
	1.3 Contractor	01. Lack of experienced staff	N/A				N/A							0%
	1.4 Consultants	01. Does not understand his role/duty				0%				0%	N/A			
		02. Delays in materials and shop drawings approval				0%				0%	N/A			
		03. Communication and coordination problem				0%				0%	N/A			
	1.5 Client	01. Interference				0%				0%				0%
		02. Change orders				0%				0%				0%
02. Technical risk	2.1 Technique	01. New technique is required	N/A				N/A							0%
		01. Insufficient time to prepare bids				0%	N/A							0%

Risk Taxonomy	Risk Sub Taxonomy	Risk Factors	Risk Allocation Percentage (Total should be 100%)											
			Separated with Lump Sum				Separated with Measure & pay				D&B with Lump Sum			
			Contractor %	Client %	Consultant %	Total %	Contractor %	Client %	Consultant %	Total %	Contractor %	Client %	Consultant %	Total %
	2.2 Construction process	02. Delay of information from designers				0%				0%	N/A			
03. Construction Design causes risk		01. Need innovative construction methods	N/A				N/A							0%
		02. Need new materials and equipment	N/A				N/A							0%
04. Political and regulation risk		01. Frequent changes in law	N/A				N/A							0%
		02. Requirement to use local labour				0%				0%				0%
05. Financial risk		01. Labour cost is higher than predicted	N/A				N/A							0%

2. Considering the each risk factors as applicable to high rise projects in Sri Lanka, fill the below table with appropriate number or numbers of Risk Response methods given below the table. You can choose maximum 5 numbers in the order of suitability for one procurement method. You can insert additional methods in the given space.

Tendering a high Bid	**RR1**
Including conditions on the Bid	**RR2**
Pre contract negotiations as to which party takes certain risks	**RR3**
Transferring risk to subcontractor	**RR4**
Transferring risk to insurance company	**RR5**
Transferring risk to main contractor	**RR6**
Retaining risk with the client	**RR7**
Claiming for the damages	**RR8**
Allocation of contingency plan	**RR9**
Education and Training	**RR10**
Encourage team work culture	**RR11**
Using suitable standard conditions of contract	**RR12**
Physical protection to reduce the likelihood of risk	**RR13**
Physical protection for people and property	**RR14**
Brainstorming to identify new risks	**RR15**
Specify below; if any	
…….	**RR16**
…….	**RR17**
…….	**RR18**
…….	**RR19**
…….	**RR20**

Risk Taxonomy	Risk Sub Taxonomy	Risk Factors	Risk Response methods														
			Separated with Lump Sum					Separated with Measure & pay					D&B with Lump Sum				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
01. Personal risk	1.1 Technician and labour	01. Frequent job change by skilled labour															
		02. Lack of skilled labour															
		03. Lack of unskilled labour															
		04. Poor workmanship															
	1.2 Subcontractor	01. Lack of required technical skill															
		02. Unable to finish work on time															
		03. Subcontractor unable to afford required labour															
		04. Subcontractor takes jobs in several projects															
	1.3 Contractor	01. Lack of experienced staff	N/A					N/A									
	1.4 Consultants	01. Does not understand his role/duty											N/A				
		02. Delays in materials and shop drawings approval											N/A				
		03. Communication and coordination problem											N/A				
	1.5 Client	01. Interference															
		02. Change orders															
02. Technical risk	2.1 Technique	01. New technique is required	N/A					N/A									
	2.2 Construction process	01. Insufficient time to prepare bids						N/A									
		02. Delay of information from designers											N/A				

Risk Taxonomy	Risk Sub Taxonomy	Risk Factors	Risk Response methods														
			Separated with Lump Sum					Separated with Measure & pay					D&B with Lump Sum				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
03. Construction Design causes risk		01. Need innovative construction methods	N/A					N/A									
		02. Need new materials and equipment	N/A					N/A									
04. Political and regulation risk		01. Frequent changes in law	N/A					N/A									
		02. Requirement to use local labour															
05. Financial risk		01. Labour cost is higher than predicted	N/A					N/A									

Thank you very much for your Cooperation

D.M. Chandima Kumari Dissanayake