EVALUATION OF CRITICAL RISK FACTORS (CRFs) AT THE TENDERING STAGE WHICH IMPACT THE SUCCESSFUL COMPLETION OF BUILDING CONSTRUCTION PROJECTS IN SRI LANKA

BY

AHAMED LEBBE ABDUL JALEEL (158951B)

SUPERVISED BY

DR. CHANDANA SIRIWARDANA

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Department of Civil Engineering
University of Moratuwa
Sri Lanka
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DECLARATION

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ABSTRACT

Construction industry is a competitive sector. Pricing the tender becomes more critical in order to get the contract being awarded. Most of the contracts are awarded to the lowest bidder after evaluating other required qualifications.

Contractors are compelled to analyse the risks and price appropriately to maximize the profits and avoid the unnecessary losses. Pricing for the risk in the tender is very essential. At the same time, the risk should be managed from the beginning of the project. It starts with the identification of the risk, assessing the risk, adequate risk responses etc.

This study intended to provide the most Critical Risk Factors, which affects the tendering process on the building construction projects in Sri Lanka. Hence, the contractor execute the tendering process productively.

In this research, the Delphi technique was used. The questionnaire survey was circulated within the experts in three rounds. Twenty five experts were selected based on the years of experience and their other qualifications. The respondents were such Senior Project Managers, Project Managers. Out of twenty five respondent, eighteen experts were responded to the questionnaire.

Through the literature review, thirty five Critical Risk Factors were identified. Those identified risk factors were evaluated through first Delphi survey and top fifteen risk factors were selected. After conducting the second Delphi round survey, Critical Risk Factors were narrowed down to five. Finally, the recognized top five risk factors were analysed by using Analytical Hierarchical Process (AHP) to prioritize the most Critical Risk Factors.

Since the analysis, experience and competence of the estimating team, experience of design team and contract document, past experience in similar projects, unforeseen site condition and shortage of skilled labour were found as the most Critical Risk Factors faced by the contractor during the tender process.

The findings of this research provide a basis to develop a framework which can be used to get prepared for the tender process of construction projects.

Key words: Critical Risk Factors, Risk Management, Tendering Risks, Successful Completion of Projects, Building Construction in Sri Lanka.

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LIST OF ABBREVIATIONS

Abbreviation	Description
CRF	Critical Risk Factors
PMI	Project Management Institute
DBB	Design Bid Build Procurement
DB	Design Builds Procurement
AR	Average Ranking
AHP	Analytic Hierarchy Process

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

When tendering for a job, a contractor bound to consider many risks in each bidding process. Therefore, the contractor have to assess the price of each bidding items properly. Furthermore, the bidder needs to maximize the expected profit and prevent the unnecessary losses.

There are few information on the various risks factors, which impact the successful bidding process. This study aimed to establish priority for the Critical Risk Factors in the Sri Lankan building construction industry. The questionnaires survey was done in contractors' perspective.

Being vigilant on identifying and prioritising the Critical Risk Factors, which will give more impact on the tender process for the successful completion of the projects. The application of the Critical Risk Factors can guide the contractors and the project team to carry out the most appropriate approach to the tender and win the construction contract. It may benefit the contractor to ensure more satisfactory project outcomes.

1.1 Background

Construction contracts are basically tense with risks (Mochtar & Arditi, 2011). Contractors are benefitted based on the risks they admit in a contract. This is agreed that risks should be transferred to those who are in the best position to deal the risks. Further, the provisions of the contracts governing the various parties' rights and obligations serves as the most appropriate tool for allocating the essential risks.

Mostly, some of the risks are not entitle to get the payment for the expenses directly. These ranges of risk lead the contract to loss rather profit. Therefore, the contractors are always advised to physically visit the site and study the site situation before quoting for the contract. The contractor should realize the best possible way to attend to those kind of risks.

If there are any risks unpredictable to the contractor at the time of tender, the expert contractor also faces the critical situation to allocate a margin to cover the cost in the project. These kinds of risks are the main reason to increase the cases of failure and bankruptcies of many contract companies in New Zealand (Mbachu, 2011).

Any loss or expense claims which could be viewed as being a result of lack of due on the part of the contractor and will not be compensated, except, if it can be proven that the supporting variations were beyond the expectations of any experienced and diligent contractor at the time of tender. These are the risks that can constrain the ability of the contractor to achieve the projected profit margin on a project.

It should be noted that the risk is present in every undertaking. The construction industry is particularly risk prone to the fact that construction projects are different one to another, with many features that make them unique even for projects with the designs. Long construction duration, time pressure, complexity and the very competitive market give rise to many risks which should be responded.

1.2 Research Problems

Internationally, wide range of researches have been carried out to identify the construction risks factors, and several risk factors have been identified. (Ling & Liu, 2005; Towner and Baccarini, 2008; Rowe, 1977). However, the construction industry has very less structured and formalized risk analysis when compared with other industries such as insurance or finance (Laryea & Hughes, 2008).

This express that there are essential needs for the construction industry to identify the Critical Risk Factors and formalize those identified risk factors. Particularly, the contractors have serious and vital constraints to find the risks they may face and associate facts through having a framework for risk analysis and response measures. The risk of failure in construction industry suggests that construction companies are not successfully calculating the risks and dealing with them effectively. (Oyewobi, Ibrahim, & Ganiyu, 2012).

The contractors have several methods to identify and manage the risks they would face. Mostly, the risks are managed by allocating contingency margins to price effectively for the risk. Smith & Bohn (1999) suggest an effective way of thinking to estimate the contingency as the extraordinary risks they may come across in a project. Other approaches, the contractor may avoid the risk or transfer the risk to other stakeholders involved in the project. There are several models for pricing risks. However, several empirical studies have shown that they are rarely used in practice (Laryea & Hughes, 2011; Mochtar & Arditi, 2001). But, the contractor price the risks is largely rely on experience and intuition in construction industry (Karim et al., 2012).

1.3 Objectives

The key objectives of this study are,

1. To identify the Critical Risk Factors (CRF) that the contractors face during the tender stage in Sri Lankan building construction projects.
2. To rank the identified Critical Risk Factors (CRF) in the perspective of the contractors.

1.4 Limitation of the Study

The target population consists of main contractors and less amount of other stakeholders. The industry role players were considered from the construction industry including government and private construction sectors.

This research was limited to the building construction industry in Sri Lanka. At the same time, this study focussed on the perspective of the contractors. The findings of the research recognise with the support of professionals such as project directors, senior managers in the building construction segments.

1.5 Research Deliverables.

- Identify the Critical Risk Factors (CRFs) face by the contractor during the tendering stage in Sri Lankan building construction projects.
- Confirm the most Critical Risk Factors (CRFs) in Sri Lankan building construction industry by using Delphi techniques.
- Evaluate the most Critical Risk Factors (CRFs) in Sri Lankan building construction industry through Application of Analytic Hierarchy Process (AHP) analysis.

1.6 Structure of the Thesis

Chapter 01 – Introduction

The introduction brief the back ground, problem identification, limitation of the study and structures of the thesis.

Chapter 02 - Literature Survey

Chapter 02 describes the previous studies related to the thesis topic. This elaborate the general information, and previously recognized risk factors.

Chapter 03 - Research Methodology

Chapter 03 discuss about the research methodology used for this research.

Chapter 04 - Data Collection and Analysis

Chapter 04 presents the details of data collection and analysis

Chapter 05 - Conclusion and Recommendation

Chapter 05 expresses about the research finding as conclusions and recommendations

CHAPTER 2: LITERATURE REVIEW

The main purpose of the literature review is to gather important knowledge about the relevant subject area covered by the previous studies. In this research, the tendering process is the most important stage. It is a critical activity for the contractor to get the project. Therefore, understanding about the tendering process and how the construction companies perform during the tendering become crucial to the contractor. In addition to the tendering process, risk management is also a significant component. The clear understanding of risk management is mandatory to handle the tendering situation. The comprehensive knowledge about risk management process will enable a contractor to handle the tender in an effective manner. A broad literature review will generate a higher reliability of the study. The literature review will have considerable effects on validity.

Bryman (2008) mentions several advantages to literature reviews. One main advantage is broad coverage of high-quality data when there is a limit of time and cost in the study. Even though there are advantages in literature reviews, it can be noted few disadvantages too and some shortcomings can be mentioned. One of them is the fact that the quality of the literature cannot be controlled and that the material is unknown. Another disadvantage is that it takes time to understand the materials.

2.1 The Construction Industry

In most of the countries, construction industries are extremely competitive, demonstrated with high risks and low-profit margins when compared with other sectors of the economy (Mochtar & Arditi, 2001). Tendering is the most common mean by which a company obtains work, and the price which they quote and forward in the tender is the only tool for earning revenue. During the bidding process, it is extremely important to consider the risks in construction contracts as the optimum mark-up needs to be achieved to increase the chances of being successful.

In general, the lowest bidding will be accepted in the competitive tender process, especially for government contracts (Nutakor, 2007). The obligation is then on the prospective contractor to deliver a bid as low as possible. This consequently shapes the treatment of risk and attitude as to how the bidder quotes the price for the tender. The tendering is the critical stage to identify the optimum mark-up for the project as this increases the chances to the contractor for being successful in the bidding and winning the tender (Yean Yng Ling & Liu, 2005).

2.2 Procurement Strategies

According to Potts (2008), the selection of procurement decides the level of risk in the construction project. Procurement involves four parts:

- Organizational method
- Payment system
- Tender procedure
- Conditions of contract

The organizational method illustrates how an organization is designed. Payment system defines how the client is paid. For examples, price based alternatives, lump sum and cost-based alternatives, cost reimbursement etc. Tender procedures can be open or selective. The conditions of contract in Sweden were regulated by two forms of standard agreements (Soderberg, 2011). According to Osipova and Eriksson (2011), there are two major types of procurement routes in the Swedish construction industry, i.e., design-bid-build and design-build. These are demonstrated as shown below in Figure 01.

Design Bid Build (DBB)

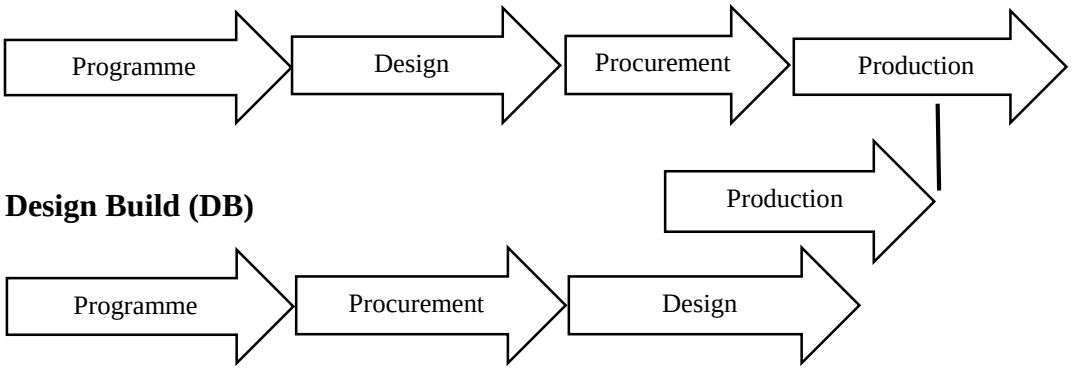

Figure 01: Difference between DBB and DB contracts

2.2.1 Design Bid Build Procurement (DBB)

In DBB contracts, the responsibility for construction design is in the hands of the client. When the design is completed it becomes a part of the tendering documents. Contractor's procurement phase, therefore, only involves the construction (Murdoch and Hughes, 2007). The process of a DBB contract can be visualized in Figure 01, which explains the procurement sequence and how the procurement phase relates to the design phase. DBB procurements can be arranged into two categories, where the essential difference is the involvement of the main contractor, called the general contractor (Osipova, 2008). In general contracting, there is only one contract between the client and the contractor and it is the general contractor's responsibility to coordinate work between the involved subcontractors. General contracting is sometimes referred to as traditional contracting. General contracting has been the most used forms of procurement method over the years (Murdoch and Hughes, 2007).

Potts (2008) consider that DBB contracts generate a distinct view on what the project cost is going to be before the construction starts. Murdoch and Hughes (2007) claim that

projects with advanced design are more suitable for DBB contracts. This is determined by what the design team creates and explains what should be built and thus, the contractor only focuses on construction. Osipova (2008) says that DBB contracts are less risky for a contractor, due to the absence of construction design. However, Potts (2008) argued that a disadvantage with the contract is that they are more time consuming than DB contracts. Osipova and Eriksson (2011) claim that a DBB contract gives the contractor a lower profit margin than a DB contract and it is a less expensive alternative for the client.

2.2.2 Design Build Procurement (DB)

In DB procurements, the contractor has a wider role than in DBB procurements due to the responsibility for the project design. The design can be performed by an internal division within the contractor's company or by an external body selected by the contractor. How detailed the design varies between projects and the client might have predetermined parts of the design in tendering documents. In those situations, the contractor will design the remaining parts. Another alternative is that the contractor is obligated to perform the entire construction design (Murdoch and Hughes, 2007). One main advantage of DB procurements is that the construction phase can begin before the design phase is completed.

However, the time for tendering is usually longer in a DB contract. The DB contractor composes a contract with each subcontractor. It is possible that each subcontractor can be in charge of the design within its actual theme (Murdoch and Hughes, 2007).

According to Osipova and Eriksson (2011), DB contracts become more frequently used due to the greater range of responsibility for the contractor and less responsibility for the client. An advantage with DB contracts is that the client establishes one agreement with the party responsible for both design and construction (Potts, 2008). This facilitates the communication between the client and the contractor and there is only one party for the client to exchange information with. Ling et al. (2004) reason out that DB contracts are more successful when it comes to construction and delivery speed.

On the other hand, they argue that DB contracts are more expensive to the client due to less competition in the process and a wider range of responsibility for the DB contractor. The DB contractor takes a big risk of being both in charge and responsible for accountabilities in Design and construction.

2.3 Stages in the Construction Projects

A construction must be conducted systematically from inception to completion in order to implement the sustainable projects (Sumanasekara, 1997).

1. Preliminary design stage.
2. Detailed design stage.
3. Tendering stage.
4. Construction stage.
5. Completion stage.

2.3.1 Preliminary Design Stage

In this stage the client's requirement will be discussed and the outline of the construction activities will be planned in order to satisfy with the client's needs. The purpose of this stage is to confirm the coordination of the design information.

The conceptual design should reflect the client's ideas. A number of buildability and design studies might be considered to prepare the concept design before work out the detailed design. (Kagioglou et al., 1998).

As expressed in the change management section of the PMBOK, sixth edition "Once the full conceptual design has been agreed by the client, any changes cannot be made unless formal change management processes are followed".

2.3.2 Detailed Design Stage

After the design concept is accepted by the client or client representative, the details design will be proceeded. The detailed information provided should enable the predictability of cost, production and maintenance issues. The client will ensure the financial arrangement in this stage before continuing the tendering procedures and construction activities. (Kagioglou et al., 1998).

2.3.3 Tendering Stage

Tendering is a process by which bids are invited from interested contractors to carry out the specific activities of construction work. During the tendering stage, the key values of fairness, clarity, simplicity, and accountability are implemented and the idea of transferring the risks to the party, who is in the best place to assess and manage the project is reinforced.

The documents are prepared for presentation to the contractors, so that they can completely understand what they will be requested to build. The drawings and specifications should appropriately define the works (Sumanasekara, 1997). Therefore, it will give the equal opportunity to correctly quote for the projects activities.

After finalizing the tender evaluation, the project will be awarded to the responsible party. The particular responsible party will be called as the contractor, who is legally bound to implement and successfully complete the project to the expected level of quality as stated in the contract documents. Further, it is strongly expected to complete the project within the allocated time frame and the cost.

2.3.4 Construction Stage

It is a very important stage that the project become to the reality from the dream. The main responsibility of the client or client's representative is to ensure that the project gets built as it has been designed to achieve the owner's expectation to comply with the contract documents.

The project should be carried out in conformity with the contract. The interim payments will be made according to the contract as quoted during the tendering stage. There are risks that the contractor should face to achieve the expected profit on a project. (Mbachu, 2011).

2.3.5 Completion stage

This is the final stage of the project. In this stage, the client takes over the project. All the relevant stockholders involve in the final official visit to the work site and prepare a report. The client can prepare the defects list stating any works that they feel which are not complete of do not satisfy their expectation, and include this list in the final site visit report.

Further, the liability period are defined according to the nature of the contract. According to the conditions of the contract, the particular percentage of the approved final bill amount will be kept with the client throughout the defect liability period and the rest of the payment is settled to the contractor. Finally, the completion certificate is issued to the contractor by client or client representative as official document. (FIDIC, 1999)

2.4 Tendering Process in Construction Projects

When an organization or an individual is planning to build a new facility or carry out renovation or maintenance of an existing facility, they will proceed with the procurement. There are many different methods to implement the procurement to appoint a suitable contractor to satisfactorily accomplish their requirement. Selecting the appropriate contractor to implement the construction leads to the success of a project.

The tendering procedure can be identified as one of the major activities in the construction process and competitive tendering has been the most frequently used methods to decide who is going to be responsible for a project's execution (Winch, 2010).

2.4.1 Tendering Methods

Two methods of tendering are most commonly used. Those are single-stage selective tendering and two-stage selective tendering. Both involve the invitation of tenders from firms on a pre-approved contractor, who are chosen from their interest and met certain minimum standards in general criteria such as financial standing, experience, capability, and competence. The competition element of the tender is provided on the basis of price.

The main difference between the two types of tender is that the contractor becomes involved in the planning of the project at an earlier stage in the two-stage process. At the same time, the tenders are submitted on the basis of minimal information.

Further, the employer's team will develop the precise specification in conjunction with the preferred tenderer in the second stage. This method is most common in more complex projects, where the contractor may have significant design input. It is worth remembering that every activity in the tendering process has time and cost implication. The two-stage tender makes economic sense.

Therefore, this kind of tender is not to overburden the participants with unnecessary information requirements and to concentrate on those which are relevant to the work which is to be undertaken. Faced with competing for financial pressures, most contractors will carry out their own assessment of the jobs they wish to tender for and will be less inclined to bid for those where the procedures involved are perceived as overly complicated or challenging.

In addition to the above costs, the preparation cost is also included in their overheads. This situation of the tender will ultimately be transferred as higher prices. The preparation of this information will also be reflected in higher consultancy costs for the employer's team.

2.4.2 Importance of Tendering

The principle of tendering is to make sure that true competition is achieved if the tender is evaluated by applying certain criteria. These criteria may be expressed in terms of financial matters, comprising a simple assessment relating to tender sums or more complex financial evaluation, including consideration of projected costs over the life cycle of the whole project. It could also address other nonfinancial factors such as time and proposed methods or levels of capability or sometimes a mixture of both collectively referred to as a 'quality/price balance' or 'matrix'.

European legislation describes this concept as the assessment of the most 'economically advantageous' option. In order to achieve the best outcome for the tender, each tenderer should be able to bid on an equal basis. It means that all the bidders must receive the same information. The most important thing that all the relevant information should be sufficient in content and accuracy to allow the bidder to properly assess the implications and bid accordingly.

In the public sector, failure to follow fair and transparent procedures can lead to automatic challenges to a subsequent contract. This may result in damages, or the contract is set aside, or both. While this may not apply equally in the private sector, it is sensible to adhere to these principles, if only to make the process itself easier to follow.

2.4.3 Challenges in Tendering

The planning for a tender should be started before the tendering is announced. The tender documents must be readily available for the contractor. The contractor observes potential projects by studying plans and announcements from public bodies where an example of a client publishing upcoming infrastructural project is the Swedish Transport Administration (Sˆderberg, 2011). The tendering documents are presented by the client, which is normally done electronically (Tinsley, 2008).

According to Brandt and Franssen (2007), the tendering documents can be divided into two parts, where the first part is the technical specification and the second part is the administrative conditions. Technical specifications can be included in general drawings, bill of quantities and descriptions. The administrative part contains contractual issues and other construction details concerning the project.

Preparation for tendering can be related to the high costs as well as time-consuming (Wilson and Kusomo, 2004 Hassel and Langstrm, 2004). The cost for tendering varies between 5-15% of the contract sum depending on the size and complexity of a project. Results show that one of six tenders have the chance to being awarded the contract. Thus, it is a critical situation to make a decision about participating in the competitive bidding. (Wilson and Kusomo, 2004).

The challenges in this scenario is to consider the factors to determine the decision of whether to tender or not. The type of project answers how well the project is suited to the business plan, number of competitors and time for the tender. Further, a bidder can have several intentions to tender for a project. Fayek et al. (1998) identify the most usual objective to win the contract, but also to maintain the company reputation.

Winning the contract is the most important activity to the bidders during the tendering process. This tendering process only determines the contractor to undertake the construction works. The process of competing with a fair price and best value for undertaking the work will give the higher chance to win the contract.

Therefore, the bidders are in most critical situation to identify the CRF which gives more impact during the tendering process.

2.5 Risk

There are more definitions for risk exists, however, they all make the same fundamental point that risk is an unwanted effect or uncertainty that can affect project objectives.

Risk is inherent in all construction projects and as such, it can never be completely eliminated, although as a best-case it can be handled effectively to reduce the negative effects on the expected project outcomes (Nieto-Morote & Ruz-Vila, 2011). At the same time, some other definitions also available to explain risk management in the construction project.

Risk handing is a mean of dealing with uncertainty identifying sources of uncertainty and the risks associated with them and then managing those risks such that negative outcomes are minimized or avoided to reduce the damages and any positive outcomes are maximized to enhance the benefits. The need to manage uncertainty is essential in almost all the projects, which require productive project management. If we consider risk management and the role of the project manager, it is the most important role of a manager to handle the risk.

However, it is noted that the risk management cannot be owned by an individual on a project, all team members must be aware of the risk and participate in activities to improve a project's situation through action plans, which are part of the main project plan. The two objectives for the implementation of the discipline of risk management are,

1. To plan and take action to achieve the target of removing or reducing the likelihood of negative risks and effects of negative risks before they occur and dealing with actual difficulties when they do.

2. To continuously monitor potential impacts of risks, review the associated action plans, and provide and manage adequate financial and schedule contingencies for risks should they occur.

Most of the risk related literature explains that the risk is as an event that occurs with a certain probability in combination with a consequence in the case of occurrence. Risk can in a simplistic approach be defined as below (McNeil et al., 2005). Risk is multiplication of Probability of Risk Occurring and Impact of Risk Occurring

Table 01. Summary of Risk Definition

Reference	**Definition**
PMI, 2010	*"Risk is an uncertain event or condition that, if it occurs, has an effect on at least one project objectives. Objectives can include scope, schedule, cost, and quality".*
Cleden, 2009	*"Risk is the statement of what may arise from that lack of knowledge. Risks are gaps in knowledge which we think constitute a threat to the project".*
Alessandri etal., 2004	*"Risk is defined as the exposure to loss/gain, or the probability of occurrence of loss/gain multiplied by its respective magnitude".*
Holton, 2004	*"Risk is exposed to a proposition of which one is uncertain".*

2.6 Risks in Construction Projects

Every human endeavor involves risk and the success or failure of any undertaking depends crucially on how we deal with these risks (Dey and Ogunlana, 2004). Ogunsami, Salako, and Ajayi (2011) also argued that risk occurs in every aspect of human life and as such construction projects are not exempted from this as they are characterized by activities that are predisposed to different types of risks ranging from political risks to construction risk. According to Oxford Advanced Learner's Dictionary (1995) defines risk as to the chance of failure or the possibility of meeting danger or of suffering harm or loss. In specific relation to construction, The Aqua Group (1990) defined risk as the possible loss resulting from the difference between what was anticipated and what finally happened. Common consequences of project risks are cost overruns, time overruns, poor quality, and disputes among the parties to a construction contract. Risk is an important issue for contractors as well as clients and consultants in the construction industry. However, the difficulties of risk assessment are poorly understood in practice.

Baloi and Price (2003) explained that the risk has different meanings to different people the concept of risk varies according to viewpoint, attitudes, and experience. Engineers, designers and contractors view risk from the technological perspective lenders and developers tend to view it from the economic and financial side health professionals, environmentalists, chemical engineers view the risk of safety and environmental perspective. Cooper and Chapman (1987) cited in John and Peter (1997) defined the risk as 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. Risk can also be defined as the uncertainty that exists as to the occurrences of some events (Odeyinka, 1999). Odeyinka (2006) described risk in construction as a variable in the construction process whose variation results in uncertainty as to the final cost, duration, and quality of the project.

According to Smith (1999), the risks specific to a project are interactive and sometimes cumulative that they affect the cost and benefits associated with the project. He submitted

that risks in construction projects arise from a variety of sources, environmental or political, hazard or safety and technical or functional.

Generally the recognized risk within the construction industry are continually faced with a variety of situations involving many unknowns, unexpected, frequently undesirable and often unpredictable factors that include timing schedule slippage of the project tasks, technological issues, people-oriented issues, finance, management and political issues (Lockyer and Gordon, 1996).

Osama and Salman (2003) also highlighted three kinds of construction risks, i.e., financial where project exceeds its budget and endangers the financial health of the company, time and design related. It has been generally established that in the execution of a building project, the final contract sum often varies from the budgeted sum of the contract. This could either be a decrease or an increase in the original contract sum and sometimes it is due to the complex nature and time span required for the execution of building construction.

2.7 Source of Estimating Risk

Nworuh and Nwachukwu (2004) argued the following sources of risks as predominant in construction projects, risks of error in estimating, risks of delay caused by the client, his representatives nominated subcontractors as nominated supplier risks due to inclement weather, risk of clients, financial failure, risk associated with cash flow problems and risk associated with industrial relation. The risks common to both Lump Sum and Unit Price Estimates are scheduled, weather, type of construction, design details, labour conditions, site location, duration of the project, familiar owner and contract language.

The responsibility of an adequate and proper evaluation of these risks lies on both the client and design advisers. Construction cost is conceived of this study as either initial contract sum or the tender sum or as actual construction cost or the final account sum.

According to Odeyinka (1999), the initial contract sum is comprised of site labour costs, material cost, and contractor cost plant, and establishment charges. Finally, that initial and final contract sum is never the same due to inherent risk factors such as fluctuation, variation, re-measurement of provisional quantities, adjustment of provisional and prime cost and any other risk factors.

Normally Construction is often cited as a high risk-prone business because of the unique nature of the industry and its projects. These peculiar factors include the necessity to price a product before production, competitive tendering as a means of awarding work, low fixed capital requirements, preliminary expenses, delays to cash inflows, intend to operate with too low a working capital, seasonal effects, fluctuations and their effects, Government intervention, activity related to development, uncertain ground conditions, unpredictable weather, no performance liability or long-term guarantees.

2.8 Risk Management Process

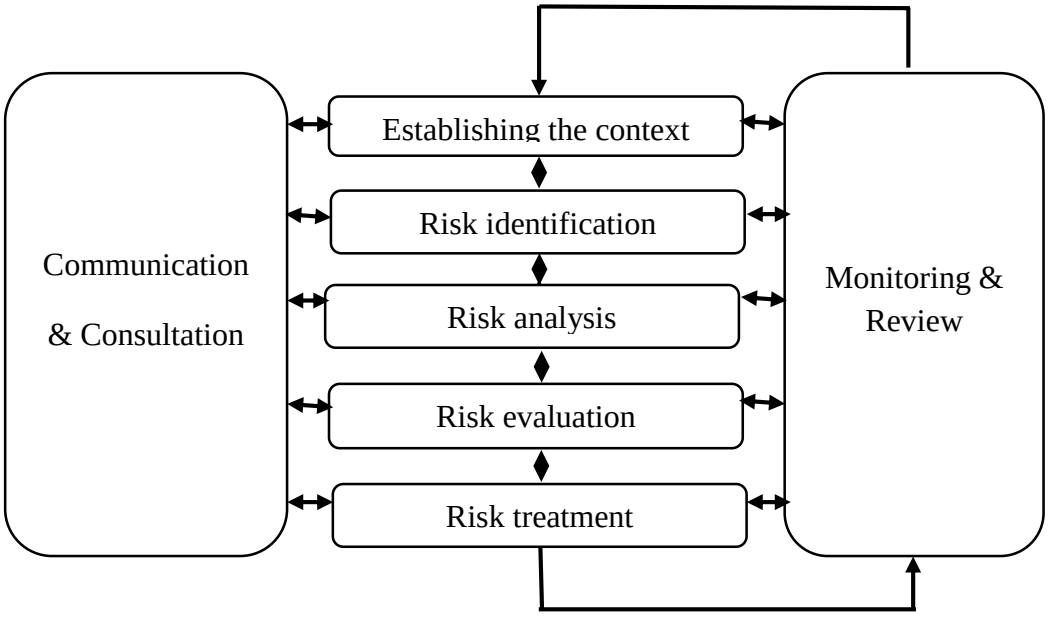

Figure 02: The Risk Management Model

2.9 Common other Risks in the Construction Industry

Financial risks	Legal risks
Political risks	Social risks
Environmental risks	Communications risks
Geographical risks	Geotechnical risks
Construction risks	Technological risks
Supply risks	Force majeure risks
Commissioning risks	Completion risks
Injury and safety risks	Design risks
Weather related risks	Client related risks
Third party risks	Subcontractor risks
Contract risks	

The above mentioned list of construction risk sources can be too detailed to successfully build a base for risk categorization in all projects. Therefore, a frequently used approach is to select a number of risk sources that characterizes the specific project and then separate them into more detailed risk elements. The risk source allocation technique can often be difficult to realize and is often associated with a high degree of personal subjectivity.

2.10 Risk Identification

The risk identification process should be a set of ongoing activities during the whole lifetime of a project. As a construction project makes progress it will be harder to make changes as these will be associated with high costs. Therefore, it will be crucial to identify project risks at an early stage while it still can be governed (Smith et al., 2006).

The risk identification activities can be separated into events where the project team identifies risks and events where the identified risks are separated into an appropriate structure (Chapman and Ward, 1997). Additionally, the method can create and maintain a risk register where some of the risks are counted twice as a consequence of attributing a specific risk to more than one risk source (Smith et al., 2006).

2.10.1 The Importance of Risk Identification

Risk identification is the process of developing which risks may affect the project and documenting their characteristics. The main advantage of this process is the documentation of principal risks and the knowledge and ability it provides to the project team to foresee events (PMI, 2013).

The risk register should be as comprehensive as possible and include risks, whether or not its consequences are under control of the organization (ISO 3100:2009). Bajaj et al. (1997) claim that if a risk is not identified it cannot be controlled, transferred or in any other aspects managed.

However, Potts (2008) claims that it is impossible to identify all project-related risks. He said that it will be counterproductive if a company think that they can and base the tender price on that assumption. Projects within the construction industry are unique projects, which results in a demand for an individual identification phase for each project.

Winch (2010) claims that risk identification activity is the most critical to entire risk management practices. This statement concurs with Bajaj et al. (1997), who claim that the main benefits of risk management arise from the identification phase rather than the risk analysis. Paradoxically, they argue that the identification phase is one of the less formalized elements in the risk management process.

2.10.2 Risk Identification Techniques

Flanagan et al. (2007) said that much of the resources for risk identification should be spent in an early project phase during the tendering process. The frequent limitation of time during tendering generates demand for effective identification methods. The risk identification process can be performed with a number of techniques. Brainstorming, consulting, and risk source identification are some of the most used methods within construction projects. Other important activities are contract studies, site visits, and further project detailed research process.

Bajaj et al. (1997) interviewed 19 contractors on how risks were identified in their projects. The conclusion highlights that the most of the contractors used risk identification activity is the risk review, which was performed by 70% of the respondents. Although it is important to realize that it is impossible to design a risk identification technique which is suitable for all organizations and projects. The brainstorming technique enables people from different departments and with different knowledge to share their point of view regarding risks. To obtain the best possible outcome, it will be crucial to engage the right mix of people with different background, gender, and age (Smith et al., 2006).

2.11 Delphi Survey Techniques

The Delphi method is a technique extensively used and recognized by scholars of various disciplines for gathering data from experts in this research. The Delphi technique is an appropriate method for consensus building through a series of questionnaires to collect data from a panel of selected experts (Delkey & Helmer, 1963). Hsu & Sandford (2007) stated that the Dehphi technique is established as a group communication procedure which achieves a precise opinion on any real issue.

Presently, the Delphi method is extensively utilized in studies related to health care, communications, public relations, education, and scientific disciplines (Kennedy, 2004).

Delphi technique uses multiple repetitions designed to develop a consensus of opinion about a particular topic. In particular, the feedback process provides an appropriate opportunity for the selected Delphi experts to reconsider their earlier decisions about the information provided in previous iterations (Hsu & Sandford, 2007).

The Delphi method is used in many complex situation to achieve a best decision on a particular topic. The Delphi method is a suitably organized way of communication that is planned to get the maximum amount of unbiased information from a panel of experts (Chan, Yung , Patrick T.I., Tam , & Cheung, 2001).

Further, the Delphi participant are not interected among them. The responses given by the experts are kept anonymous, and the experts give a chance to reconsider their responses after the collective feedback is received.

2.12 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) was introduced by Thomas Saaty (1980). The AHP is an active tool for finding the best result during complex decision-making situation. It supports the decision maker to set priorities and make the most suitable decision by reducing complex decisions to a series of pairwise comparisons, and then constructing the results.

The AHP benefits to gain both the subjective and objective facets of a decision. Also, the AHP fits with a beneficial technique for checking the consistency of the decision make's assessments, thus reducing the partiality in the decision-making process.

2.12.1 Process of the AHP

The AHP is executed in three simple serial steps:

1) Computing the vector of criteria weights.
2) Computing the matrix of option scores.
3) Ranking the options.

2.12.2 Computing the Vector of Criteria Weights

To figure out the weights for the different criteria, the AHP commences with creating a pairwise comparison matrix A. The matrix A is an $m \times m$ real matrix, where m is the number of evaluation criteria to be considered.

Each entry a_{jk} of the matrix A represents the importance of the j^{th} criterion relative to the k^{th} criterion. If $a_{jk} > 1$, then the j^{th} criterion is more important than the k^{th} criterion, while if $a_{jk} < 1$, then the j^{th} criterion is less important than the k^{th} criterion. If two criteria have the same importance, then the entry $a_{jk} = 1$. The entries a_{jk} and a_{kj} satisfy the following constraint:

$$a_{jk}.\ a_{kj} = 1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad \textbf{(A)}$$

Obviously, $a_{jj} = 1$ for all j. The relative importance between two criteria is valued based on a numerical scale ranging from 1 to 9, as shown below in Table 02.

The paired comparison scale between the comparison pair (a_{ij}) of two items (items i and item j) is as follows:

(Item i) 9-8-7-6-5-4-3-2-1-2-3-4-5-6-7-8-9 (Item j)

The preference scale for pair-wise comparisons of two items ranges from the maximum value 9 to 1/9 (0.111 in decimal from). Let aij represent the comparison between item-i (left) and item-j (right). If item-i is 5 times (strong importance) more important than item-j for a given criteria or product, then the comparison $a_{ji} = 1/a_{ij} = 1/5$ (0.200) or the reciprocal value for the paired comparison between both items.

Table 02 AHP Relative Scale (Saaty, 2008)

Level of Criticality	Score
Extreme Importance	9
Very strong to Extreme	8
Very Strong Importance	7
Strongly to Very Strong	6
Strong Importance	5
Moderately to Strong	4
Moderate Importance	3
Equally to Moderate	2
Equal Importance	1

After the Comparison matrix is formed, AHP terminates by computing an eigenvector (also called a priority vector) that represents the relative ranking of importance (or preference) attached to the criteria or objects being compared.

2.13 Summary

It is found significant amount of researches have been carried out in the past on risk management in construction industries around the world. However, very few researches have been carried out in connection with contractual risks in Sri Lanka. It clearly indicates that there is a strong need to conduct more researches in order to examine the most critical risk factors in Sri Lankan building construction projects.

From the literature evidence and observations, it can be said that Critical Risks faced by contractors during the tendering in Sri Lankan construction industry is relatively less practiced knowledge area, and most of the projects do not pay significant attention to risk, which resulted in bad consequences on construction projects. Therefore, the present study is conducted in order to answer the question “How the contractor can understand the risks, which are faced during the tendering procedure”

In order to provide answers to this question, the present study will explore the most CRFs at the tendering stage of the project. This study will attempt to give a framework to overcome the complexity of tendering process. Identifying the most influential Risk Factors, which will play an immense role to enhance the tendering process in order to get the contract and complete the project successfully within the budget without budget overrun and unwanted delays.

In this study, the Delphi technique was used to explore the most influential CRFs in order to increase the accuracy of the findings. Initially, Delphi surveys were done in a few rounds. Finally, the AHP analysis was adopted to derive the useful and precise ranking within the identified most influential CRFs.

CHAPTER 3: RESEARCH METHODOLOGY

This chapter will describe the data collection and data analysis. It will also explain the reasons behind the selection of the data collection method. This survey was planned to find the most CRF at the tendering stage for the building construction projects in Sri Lanka.

The information required for this study was collected through a comprehensive literature review from reputed journals, publications, and websites. The literature survey and details from the sources were the basis to get the most CRFs during the tendering process for construction industry in Sri Lanka

Initially, 49 risk factors were identified from the literature studies. From those identified forty nine risk factors, it was short listed to 35 important risk factors since the many researcher identified them as important risk factors meanwhile a few factors were recognized as most influential risk factors by the limited researchers.

3.1 Method of Data Collection

The questionnaire survey was done for validating the finding from the previous literatures to the Sri Lankan context and identifying the most CRFs. Twenty five responded were selected for the expert panel for the questionnaire survey who are working in various professional backgrounds representing almost all the discipline in the building construction industry in Sri Lanka.

The Delphi technique were used to collect the data. During the first Delphi round, the thirty five identified risk factors were distributed within the recognized expert panel.

The questionnaire was prepared as consisting of two parts. Part one was to gather the respondents' background information such as professional, years of experience in the construction industry, nature of the organization. The second part was the questionnaire.

The participants were requested to rate the most CRFs by using 1-5 Likert-scale as follows:

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

After analysing the first Delphi round survey, the top fifteen CRFs were identified and presented for the Second Delphi round.

Accordingly, the prepared second questionnaire were sent to the same experts' panel. During this time, the respondents were requested to rank the risk factors among the top fifteen risk factors. The previous ranks also stated for the panel members' review in a separate column. The respondents were instructed to rank use the number from one to fifteen in order to provide the ranking to the CRFs.

Average Ranking method were preferred for the Delphi round two during analysis. Average Ranking method is commonly used to rank the preferences from the identified results (Brazdil & Soares, 2018).

Rank number 1 was given the weight of 15

Rank number 2 was given the weight of 14

Rank number 3 was given the weight of 13

Rank number 4 was given the weight of 12

Rank number 15 was given the weight of 1

3.2 Selection of Delphi expert panel

The most important objective in the Delphi technique is selecting an appropriate panel members. This will lead to a successful results. The key feature of the selection of expert panel includes panel members the right qualification background and personal commitment towards the research.

In this study, 25 Delphi participants were selected as a expert panel in building construction. The following criterion was taken in to account during the selection of the panel of experts.

- Having more than 10 years of working experience in Sri Lankan construction industry.
- Practicing the construction risk management in their roles.

The panel comprised of Senior Project Managers, Senior Engineers, Senior Quantity Surveyors, Senior Architects from private and public sectors**.**

3.3 Design of Delphi Survey

This study had three rounds of the questionnaires survey to identify the most CRFs. The process of questionnaire for each rounds are explained as below.

3.3.1 Delphi Round 1

In the first round of survey, the initial questionnaires were distributed within the selected experts' panel to find the most CRFs faces at the tendering stage in Sri Lankan Building Construction Projects. The factors, which had been identified from a detailed literature review were used at the questionnaire survey round 01. Further, based on the knowledge and experience of experts, the experts panel members were requested to introduce any important critical risk factors in addition to factors the listed in the initial questionnaire.

3.3.2 Delphi Round 2:

During the second round, each respondent was asked to review the items summarized after analyzed the data based on the information provided in the first round questionnaire. Further, the Delphi panel members were invited to express rank order items to establish priorities among identified factors in order to find the most Critical Risk Factors.

3.3.3 Delphi Round 3:

From the opinions received from Delphi round two, the top five most CRFs were picked. Those selected particular top five factors were used for the third round, where it was tested by means of Analytical Hierarchical Process (AHP). The most CRFs were tested using AHP through pairwise comparison. AHP software, version 04.05.2016, developed by Business Performance Management Singapore was used to analyze the data received by means of 1-9 rating scales between any two Risk Factors.

This software was an AHP Excel template with maximum 20 inputs. The Excel template consists of worksheets for pair-wise comparison, a sheet for the consolidation of all feedbacks, a summary sheet to display result, a sheet for solving the eigenvalue problem using Eigen Vector Method (EVM), and a sheet with reference tables which include random index, limits for geometric consistency index GCI, and judgment scales.

After the assessment matrix is formed, AHP terminates by computing an eigen vector (also called a priority vector) that represents the relative ranking of importance (or preference) attached to the criteria or objects being compared.

CHAPTER 04: ANALYSIS AND RESULTS

4.1 Introduction

Questionnaire Survey would be conducted in numerous rounds to gather the data in accordance with the Delphi survey methodology. The analysis of the collected data reveals the following. In this study, questionnaire surveys were conducted in three rounds to collect the data required for the research.

4.2 Delphi Round One

The purpose of the first round of Delphi survey was to identify the CRFs in the Sri Lankan building construction projects. The first questionnaire was prepared comprising a list of risk factors identified through literature reviews (Appendix 01). In this round, twenty five experts were selected to circulate the questionnaires. The questionnaire survey were conducted within the selected expert panel. In total, eighteen members had successfully responded to the survey in round one. And the response rate is 72 percentage. The panel members were identified based on their working experience in Sri Lankan building construction industry and maturity to understand the current status of risk management practices in Sri Lanka.

All panel members have got bachelor degree in civil engineering or architect and all are practicing professionals such as Senior Project Managers, Project Managers, Senior Engineers and Planning Engineers. Out of the all panel members, ten members are working in contractor companies, six members are working in consultant firms and two of them are from client's organization.

Table 03: Cross-section of Respondents (Sector-wise)

Participants Discipline	**Numbers of respondents**
Contractor	13
Consultant	4
Client	1
Total	**18**

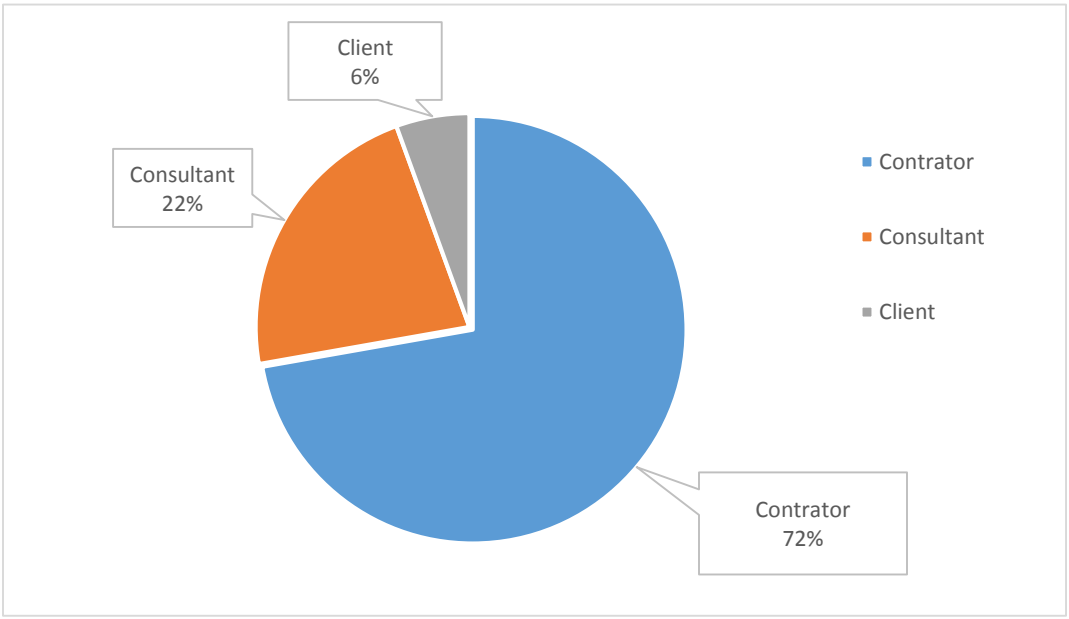

Figure 03: Cross-section of Respondents (Sector-wise)

Table 04: Cross-section of Respondents (Professional-wise)

Participants Professional	**Numbers of respondents**
Engineer	16
Architect	2
Total	**18**

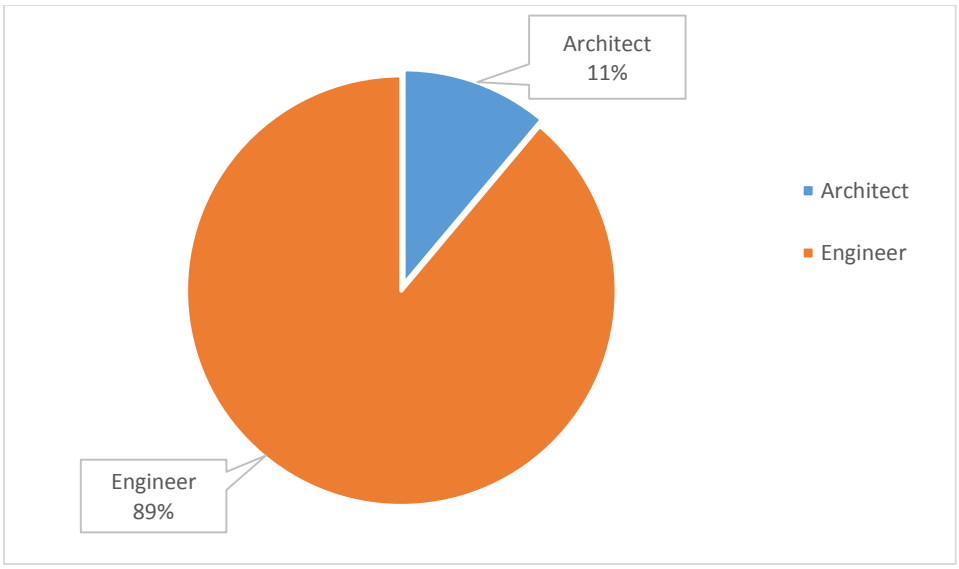

Figure 04: Cross-section of Respondents (Professional-wise)

The analysis of the risk factors from Delphi round 1is shown below in the Table 05.

Table 05: Analysis of Risk Factors from the Delphi Round 01

Risk Factors	Significant Level Rating					Total	RII Value	Cate-gory Rank	Over all Rank
	1 %	2 %	3 %	4 %	5 %				
A. Site related risk factors									
1. Inclement weather	0	0	61	39	0	18	0.678	2	23
2. Unforeseen site condition	0	0	17	50	33	18	0.832	1	4
B. Project related risks									
3. Buildability issues such as complex site details, unfamiliar methods	0	0	44	50	6	18	0.726	5	15
4. Availability of resources such as materials, labour, equipment	0	0	50	39	11	18	0.722	7	19

5. Productive of sub-contractors	0	0	56	44	0	18	0.688	8	21
6. Procurement / type of contract	0	39	39	17	6	18	0.586	9	29
7. Long duration of project	0	0	28	56	17	18	0.786	1	9
8. Unrealistic project duration	0	6	33	44	17	18	0.744	4	13
9. Feasibility studies to carry out the work	0	11	17	44	28	18	0.778	2	10
10. Project start time	0	6	28	44	22	18	0.764	3	11
11. Fast delivery of materials to site	0	11	44	11	33	18	0.724	6	16
C. Estimating risks									
12. In sufficient time duration given to price the works	0	0	39	44	17	18	0.756	3	12
13. Poor design and documentation	0	6	17	50	28	18	0.806	23	7
14. Experience and competence of the estimating team	0	0	22	33	44	18	0.836	1	3
D. Risk within own organization									
15. Concerns around skills of competence of project team	0	33	28	28	11	18	0.634	7	27
16. Current work load	0	6	28	28	39	18	0.806	2	7
17. Past experience in similar project	0	11	6	50	33	18	0.810	1	6
18. Pressure from management	0	11	22	61	6	18	0.724	3	16
19. Database in estimating activities	6	6	39	33	17	18	0.704	5	20
20. Adequate equipment in company	0	11	22	61	6	18	0.724	3	16
21. Fast maintenance of equipment	0	11	39	50	0	18	0.678	6	23

E. Client related risks									
22. Unreasonable expectation of the client	0	44	56	0	0	18	0.512	6	34
23. Perceived risks that may arise as a result of dealing with the particular client	0	11	78	11	0	18	0.600	5	28
24. Concerns around the financial viability of the client	0	6	56	39	0	18	0.672	3	25
25. Contracting negotiations	0	22	33	44	0	18	0.638	4	26
26. Design changes by owner or consultant	0	6	44	50	0	18	0.688	2	21
27. Experience of design team and contract document	0	0	6	67	28	18	0.852	1	1
F. Financial related risks									
28. Possible cash flow risk due to stacking	0	39	61	0	0	18	0.522	2	31
29. Delays in payments	0	50	39	11	0	18	0.522	2	31
30. Unavailability of working capital	0	0	11	56	33	18	0.844	1	2
G. External risks									
31. General market conditions	0	39	61	0	0	18	0.522	4	31
32. Shortages of skilled labours	0	0	28	33	39	18	0.822	1	5
33. Compliance risks Health and Safety Environment act.	0	67	33	0	0	18	0.466	5	35
34. Economic performance in country	0	0	56	28	17	18	0.730	2	14
35. International environment change such as fuel price, exchange rates	0	50	33	17	0	18	0.534	3	30

Descriptive statistics were used in the data analysis. This involved computation of statistical measures of central tendency - mean, median and mode – as well as measures of dispersion –variance and standard deviation. This helped to understand the mean ratings for each group and the variances in opinions.

Relative Significance Index (RSI) values computed from the data helped to rank-order the factors according to their risk levels.

$RSI = (\sum_{i=1}^{5} Wi * Fi) * 1/n$ X 100%

Where:

i: Represents the ratings 1-5 from the questionnaire

f_i: The frequency of responses

n: The number of total responses

w_i: The weight for each rating (ranging from 1 to 5 on a 5-point Likert rating scale).

The Relative Importance Index (RII) was computed as:

$$RII = (W_1 + W_2 + \ldots + W_n) / A * N \text{.....} \textbf{(B)}$$

Where W = weights given to each factors by the respondents from 1 to 5, ("1" is Very low use and "5" is Very high use), A = highest weight (i.e. 5 in this case), and N = total number of respondents.

Eighteen responses were received out of twenty five distributed questionnaires. This represented a usable response rate of 72%.

All the respondents (100%) have more than 10 years of experience in Sri Lanka construction industry. Ten of the responded have more than 20 years of experience (55% of the participants). At the same time, 11% of respondents have 16-20 years of experience and 33% of the respondents have 11-15 years of experience in the building construction.

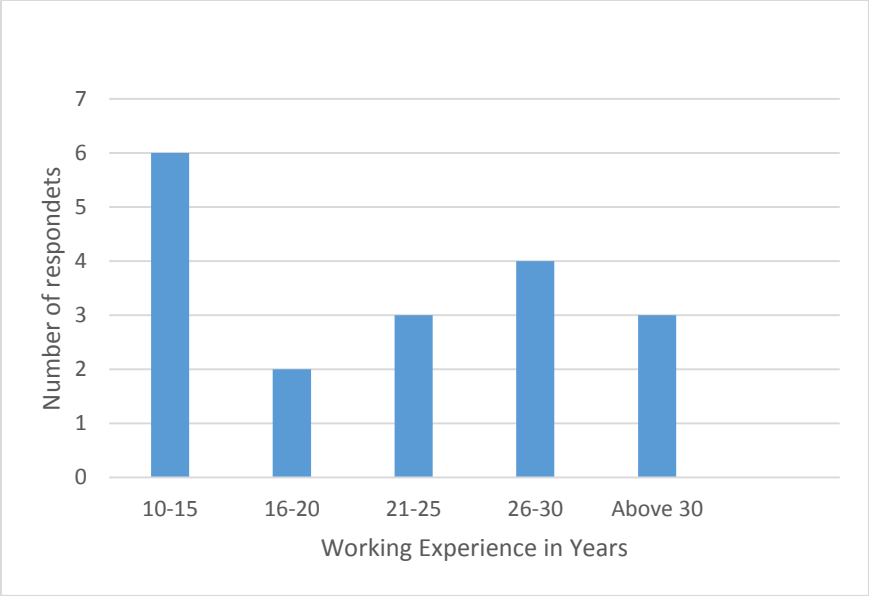

Figure 05: Experience Level of Expert Panel

Experience of design team and contract document had been identified as the most CRF at the tendering stage with the RII value of 0.852 after analysing the first Delphi round survey. Likewise, Unavailability of working capital was invented as second most CRF and experience and competence of the estimating team found as third most CRF. After the first round study of this research, the top fifteen factors were recognized from the overall ranks.

Table 06: The Top Fifteen CRFs Derived from Delphi Round 01

Risk category	Risk Factors	Rank in round 1
Site related risk factors	1. Unforeseen site condition	4
Project related risks	2. Buildability issues such as complex site details, unfamiliar methods	15
	3. Long duration of project	9
	4. Unrealistic project duration	13
	5. Feasibility studies to carry out the work	10
	6. Project start time	11
Estimating risks	7. In sufficient time given to price the works	12
	8. Poor design and documentation	7
	9. Experience and competence of the estimating team	3
Risk within own organization	10. Current work load	7
	11. Past experience in similar project	6
Client related risks	12. Experience of design team and contract document	1
Financial related risks	13. Unavailability of working capital	2
External risks	14. Shortages of skilled labours	5
	15. Economic performance in country	14

4.3 Delphi Round Two

In the second Delphi round, the most CRF at tendering stage were ranked according to the first Delphi round results. The purpose of Delphi round two questionnaires (Appendix 02) were to allow the expert to reviews the rank derived from the Delphi round one and required to state their new ranking form the top fifteen contractual risk factors. The expert panel members instructed to use the numerical value 1-15. Rank 1 would be provided for the most important CRF and rank 2 could be given for the second most important CRF. Similarly, all other ranks were marked.

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Table 7 to be inserted from Excel sheet

Table 08: The Comparison of CRFs between First and Second Delphi Rounds

Risk category	Risk Factors	Rank in round 02	Rank in round 01
Site related risk factors	1. Unforeseen site condition	2	4
Project related risks	2. Buildability issues such as complex site details, unfamiliar methods	9	15
	3. Long duration of project	10	9
	4. Unrealistic project duration	14	13
	5. Feasibility studies to carry out the work	15	10
	6. Project start time	11	11
Estimating risks	7. In sufficient time given to price the works	13	12
	8. Poor design and documentation	7	7
	9. Experience and competence of the estimating team	3	3
Risk within own organization	10. Current work load	7	7
	11. Past experience in similar project	4	6
Client related risks	12. Experience of design team and contract document	1	1
Financial related risks	13. Unavailability of working capital	6	2
External risks	14. Shortages of skilled labours	5	5
	15. Economic performance in country	12	14

4.4 Delphi Round Three

From the facts established in round two, the top five CRFs were selected for the third round where it was tested by means of Analytical Hierarchical Process (AHP). The selected Risk Factors used for Delphi round three are listed below.

RF1 - Experience of design team and contract document (**Criteria 1**)

RF2 - Unforeseen site condition (**Criteria 2**)

RF3 - Experience and competence of the estimating team (**Criteria 3**)

RF4 - Past experience in similar project (**Criteria 4**)

RF5 - Shortages of skilled labours (**Criteria 5**)

The Most influential risk factors were tested using AHP by pairwise comparison. AHP software, version 04.05.2016, offered by Business Performance Management Singapore was used to analyze the data received by means of 1-9 rating scales between any two Risk Factors.

Table 09: AHP Relative Scores

Level of Criticality	Score
Extreme Importance	9
Very strong to Extreme	8
Very Strong Importance	7
Strongly to Very Strong	6
Strong Importance	5
Moderately to Strong	4
Moderate Importance	3
Equally to Moderate	2
Equal Importance	1

To investigate the criticality of the each risk factor in order to recognize the priority of the elements. The decision making process suitable by analyzing a pair-wise comparison of each of the identified factors. A sample of response collected from the expert panel member was illustrated as below.

RF 1 VS. RF 2, RF 3, RF 4 & RF5

RF 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**RF 2**
RF 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**RF 3**
RF 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**RF 4**
RF 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**RF 5**

RF 2 VS. RF 3, RF 4 & RF5

RF 2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**RF 3**
RF 2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**RF 4**
RF 2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**RF 5**

RF 3 VS. RF 4 & RF5

RF 3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**RF 4**
RF 3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**RF 5**

RF 4 VS. RF5

RF 4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**RF 5**

A sample of response input into the AHP software excel sheet as shown below in Table 10.

Table 10: Sample response for pair-wise comparison

Criteria		More Important A or B	Scale (1 - 9)
A	**B**		
Criteria 1	Criteria 2	A	3
	Criteria 3	B	2
	Criteria 4	B	3
	Criteria 5	A	7
Criteria 2	Criteria 3	B	3
	Criteria 4	B	7
	Criteria 5	A	4
Criteria 3	Criteria 4	B	3
	Criteria 5	A	5
Criteria 4	Criteria 5	A	6

Table 11: Summary of Result of pair-wise comparison

	Criteria 1	Criteria 2	Criteria 3	Criteria 4	Criteria 5	**Weights**	**Rank**
Criteria 1		2	8/9	4/9	3 3/4	20.4%	2
Criteria 2	1/2		1 4/9	2/7	4 1/5	16.6%	4
Criteria 3	1 1/8	2/3		3/8	4 1/3	17.3%	3
Criteria 4	2 1/4	3 2/5	2 5/8		4	40.1%	1
Criteria 5	1/4	1/4	2/9	1/4		5.5%	5

As per the results obtained from the **AHP** calculator, the rank of the risk factors are as follow.

Rank 1 – Past experience in similar project
Rank 2 – Experience of design team and contract document
Rank 3 – Experience and competence of the estimating team
Rank 4 – Unforeseen site condition
Rank 5 – Shortages of skilled labours

4.5 Discussion on analysis

The tendering process is extreme important to the construction company. Because, tendering is the most common means by which a company obtains work and the price which they quote and forward in the tender is the only tool for earning revenue. This bidding process has critical risks.

In this research, eighteen experts involved and shared their experiences throughout the surveys in order to find the most influential Critical Risk Factors (CRFs). The top three ranked factors are directly related to the experience. The first and third most CRFs are past experience in similar projects, experience and competence of the estimating team respectively. At the same time the second most CRF is the experience of design team and about contract document. Even though the second most CRF is importance to the bidder at tendering stage. But, this factor gives the equal opportunity to all the bidders to understand the document clearly and carry out the tendering process.

The first CRF is experience in similar projects. If the bidder already has the experience in the similar type of projects, then it will be the advantages to the bidder to make a speedy and precise analysis to the tender procedure with the limited resources. The experience in similar project of the bidder will contribute to minimize the tendering expenses too.

The third CRF is experience and competence of the estimating team. Hence, the experience and competence of the estimating team give more advantages to the bidder. This CRF provides the higher chances to win the project by doing a better analysis for the tender in the market. It confirms that the experienced estimating team will contribute to the successful growth of construction organization.

The fourth and fifth CRFs are unforeseen site condition and shortages of skilled labours respectively. These two factors are really unpredictable and may effect on the expected profit margin. However, the experienced estimation team may have the capable to make a good decision at the tendering stage.

I believe that the experienced estimation team will serve the organization with their best effort to the company’s sustainable growth.

CHAPTER 05: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The tendering risk in building construction has become an everlasting crisis in the construction sector all over the world and also in the Sri Lanka. Obviously there are number of reasons behind the construction tendering risk in the construction industry. The construction professionals have recognized the most causes for the risks during the construction stage as well as the most significant causes for tendering risks.

The complicated tendering risks and pricing risks for the BOQ items are different. The contractors have been realized through practice. The main purpose of the contractor is to win the contract and maximize the expected profit by successfully completing the construction project. Hence, the tendering process becomes more critical to the contractor to get the project. However, the contractor should understand the most CRF for processing the tender successfully.

Contractor should select the projects carefully in order to eliminate the unnecessary cost during the tendering process. Serious losses may be occurred to the contractor if the contractor quoted the lowest price without considering the possible risks. Therefore, identifying and analyzing the possible risks increase the chances to maximize the profit to the organization. Certain risk factors which are highly significant in a particular project may be low significant to another project.

Systemized approach to the risk will enable the contractor to analyze the risk easily and quickly in order to process the bidding. In this research, considerations given to recognize the applicable causes of building construction projects in Sri Lanka. In this scenario, most significant causes of risk that has hindered the initial process of the construction works.

Initially, from the literature review, forty nine risk factors were identified. After analyzing the importance of the risk factors, thirty five risk factors were identified as Critical Risk Factors for the analysis.

In order to finding the most CRFs, the Delphi technique was used to assess the identified CRFs. The questionnaires were consulted with the support of selected construction industry experts. Then, the questionnaires were distributed to the expert panel in significant rounds to identify most CRFs, faced by the contractors the tendering stage in Sri Lankan building construction projects.

This research has explored the leading CRFs in the Sri Lankan building construction industry. The results highlighted 35 risk factors which were segregated into 7 broad categories. The most risky factors under the broad categories comprise, site related risk factor, project related risk factors, estimating risks, risk within the own organization, client related, financial related and external risks.

After all the questionnaire survey had been conducted successfully, the analysis was carried out as elaborated in the chapter 04 of this research. Finally, the most top CRFs were derived.

Based on this study, the following factors were derived as most CRFs. Those are past experience in similar project, experience of design team and document, experience and competence of the estimating team, unforeseen site condition and shortage of skilled labour.

Unforeseen site condition and shortage of skilled labour were identified as fourth and fifth most significant CRFs. The condition of the both risk factors are depend on the external conditions. Therefore, these two CRFs are beyond the control.

The second most CRF indicates that the experience of the design team and documentation. This will give the equal opportunity to the contractor to do a fast and strong analysis during the tendering process. However, it will not be useful only to the particular contractor.

The first and third most CRFs are directly related to the experience of a contractor. While the first most CRF expresses the past experience in a similar project, the third most CRF indicates that the experience and competence of the estimating team. Therefore, the successful and effective tendering process is mainly based on the experience of the estimating team, who are engaged with the tendering process.

It is recommended that the experience of the estimating team will provide the best fit estimation in order to carry out the tendering process effectively and win the tender. The above findings in this research study could be useful if the industry develops the general precautionary action to maximize the profit.

Further, it should be noted that the conclusion is made by considering the Sri Lankan building construction industry only. However, the above identified CRFs are applicable to Sri Lankan construction industry as well.

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APPENDICES