A FRAMEWORK TO IMPROVE THE PERFORMANCE OF PUBLIC TENDER EVALUATION PROCEDURES IN NEW ZEALAND

Mehrdad Soltanifar

A thesis submitted to

Auckland University of Technology

in fulfilment of the requirements for the degree of

Doctor of Philosophy (PhD)

July 2019

School of Engineering

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ANOVA - Analysis of Variance

AUT - Auckland University of Technology

AUTEC - Auckland University of Technology Ethical Committee

BIFNZ - Building Industry Federation New Zealand

BRANZ - Building Research Association of New Zealand

CAQDAS - Computer-Aided Qualitative Data Analysis Software

CENZ - Constructing Excellence New Zealand

CIC - Construction Industry Council

CII - Construction Industry Institute

CS- Contractor Selection

DMs- Decision Makers

DOL - Department of Labour

ICE - Institution of Civil Engineers

M - Mean

MBIE - Ministry of Business, Innovation and Employment

NZBC - New Zealand Building Code

NZCF - New Zealand Contractors' Federation

NZCIC - New Zealand Construction Industry Council

NZIA - New Zealand Institute of Architects

NZIOB - New Zealand Institute of Building

NZS - New Zealand Standard

NZTA- New Zealand Transport Agency

PhD - Doctor of Philosophy

PIS - Participant Information Sheet

PMINZ - Project Management Institute New Zealand

QUAL - Qualitative

QUANT - Quantitative

RFP- Request for Proposal

SCM - Supply Chain Management

SD - Standard Deviation

ACKNOWLEDGEMENTS

It is my pleasure to acknowledge the roles of several individuals who were instrumental for completion of my Ph.D. research. Firstly, I would like to express my sincere gratitude to my primary supervisor Professor John Tookey for his continuous support, patience and immense knowledge. I truly enjoyed working in a cooperative and collaborative environment he created. I could not have imagined having a better mentor and advisor for my Ph.D. journey. Many thanks to my secondary supervisor Dr. Fei Ying for her academic and mental support during my study. I deeply appreciate her guidance and valuable feedback.

Many sincere thanks also goes to Dr. Ali Ghaffarian Hosseini for his insightful comments and encouragement. The core of this research was created by the research participants. Thus, I'd like to thank New Zealand construction industry practitionaires and academic scholars who contributed to this study by participating in my semi-structured interviews, survey questionnaires and validation interviews, for their time and their insight.

Furthermore, I am deeply grateful to pursue my Ph.D. journey at Auckland University of Technology (AUT) which provides a great learning environment for students. I thank our engineering Ph.D. team and all academic and non-academic staff of our postgraduate office.

Dedication

Dedicated to My lovely parents Hossein and Tahereh, whose unyielding love and support have enriched me to complete this thesis. My parents taught me to always try to be a good citizen of the world by contributing to the society, and this is the best lesson I've learnt in my life.

ABSTRACT

One of the vital factors that contribute to the success of a project is the selection of an appropriate contractor. Contractors play a major role in projects. However, choosing the best contractor for construction projects has been one of the significant challenges which aroused a lot of concerns and discussions. Concurrent with the recent development in construction, there has been increasing interest in tender evaluation management in this sector. However, the decision-making problem is multi-criteria in the formulation. It contains different variables require clients to make judgements between competing objectives and limited resources. One of the common failures associated with construction projects were attributed to inefficient tools to properly measure contractors before awarding the contract.

This study investigates the nature of the tender evaluation procedures in the New Zealand public construction sector and suggests a possible framework that could improve the performance of contractor selection practices. The study employed mixed-method approach starting with conducting ten semi-structured interviews with construction experts in the Auckland region. Based on the results obtained, an online survey was later administered to a wider population across New Zealand. The findings of these two phases then resulted in developing a tender evaluation framework for the New Zealand public construction sector. The information gathered from previous approaches were then synthesised and validated using subject matter expert interviews.

The study results illustrated the absence of a formalised framework that can evaluate and select contractors appropriately. With this in mind, the literature review of this research explored the key components of tender evaluation processes. Different evaluation methods including mathematical, AI and hybrid approaches were reviewed, and a comprehensive list of advantages and disadvantages of each method was provided. Furthermore, the study demonstrated that some challenges such as over workload, low productivity and inappropriate risk allocation practices are affecting the construction tender evaluation processes in New Zealand.

Thus, this research proposed a comprehensive tender evaluation framework consists of three stages of (1) market analysis, (2) criteria selection and (3) tender evaluation protocols. The market analysis stage includes vital information to assist public clients and decision-makers in their pretender procedures, including; plan approach to the market, specifying the project requirements and project management planning. The second stage consists of the identification of the most suitable attributes to be evaluated in the tender. A list of criteria with 20 categories and 178 criteria was established in this stage to assist decision-makers in finding the best set of attributes based on the project specifications. The final stage of the framework is the evaluation process, which consists of a hybrid approach using AHP and TOPSIS methods. On the whole, the study

provided rich and in-depth information on current tender evaluation protocols in New Zealand and emphasised on the benefits of using modern decision-making tools. It is anticipated that this research will improve the current public tendering procedures in New Zealand public construction sector. Finally, the study reported here adds significantly to the understanding of contemporary perceptions on contractor selection processes in the New Zealand construction industry.

1. Chapter 1 - Introduction

2.1 Aims of the chapter

This chapter aims to provide an introduction to the reader about the objectives and scopes of this study. A summary of the research questions, problems, methodology and limitations has been provided in this chapter as well. At the end of this chapter, an outline of the thesis has been demonstrated.

2.2 Background

One of the vital factors to measure the economic growth of a country is its developments in construction projects such as buildings and infrastructures. Thus, the success of construction projects is an important issue for the government.

The construction sector in New Zealand is one of the largest sectors in the economy generating more than $30 B annual revenue and employing more than 171,000 people, which is over 7% of the New Zealand workforce (MBIE). To ensure the successful delivery of the project, advances in technology need to be matched by the process that is used to procure buildings (Masterman 2003; Morledge & Smith, 2013). Despite the increasing use of alternative forms of project delivery systems, the performance of the construction industry has declined as many projects end up with sub-standard work, delays and cost over-runs (Hatush & Skitmore, 1997).

Different factors contribute to the success of a project, and one of the most vital ones is Contractor Selection (Nieto-Morote & Ruz-Vila, 2012). Martine et al. (2016) stated that Contractor Selection (CS) is deemed by most of the clients to be the most important element in construction procurement. Selecting the most appropriate contractor will potentially increase the probability of delivering the right project at the right time with sufficient quality (Chiang, Vincent, & Luarn, 2017; G. Holt, 2010).

Previous studies suggest that inappropriate contractor evaluation procedures are one of the reasons for poor performance in the construction sector (G. D. Holt, 1998). It has been known for many years that the construction industry has significant problems with respect to choosing the most suitable contractors for projects (Darvish, Yasaei, & Saeedi, 2009; G. Holt, 2010). Tender evaluation processes have remained relatively unchanged for decades (Darvish et al., 2009). Especially in the public sector, accepting contractors based on the lowest price is still the dominant tendering approach (Hatush & Skitmore, 1997; G. Holt, 2010).

A comprehensive evaluation process should be conducted to measure the contractor's ability to success based on a proper set of criteria that reflect the requirements of that project. However,

the objective of the selection process is not only to ensure that the contractor's characteristics match the requirements of the project and fulfils the basic criteria, but also to what degree those criteria fulfilled (Kashiwagi & Byfield, 2002). The decision-making problem is multi-criteria in the formulation. It contains different variables requires clients to make judgments between competing objectives and limited resources (G. Holt, 2010; M. Sönmez, J. Yang, & G. D. Holt, 2001a).

As has been mentioned, CS is one of the important elements of project success. However, it has not attracted significant attention from construction practitioners and researchers in New Zealand. To date only three publications since the year 2000. This is much less than 23 publications in China, 20 publications in the US and 15 publications in Australia.

Because of the lack of ability of the contractor, a significant number of construction projects have been delayed or failed in New Zealand (MBIE). This may have been due to the absence of suitable CS procedures. All of these challenges indicates that CS procedures require greater attention in New Zealand.

2.3 Rationale and significance of the study

The construction industry is one of the key sectors in the New Zealand economy (Page, 2009). The construction sector is the third-largest industry in New Zealand, comprising more than 50,000 businesses (MBIE). This sector is considered to be one of the principal contributors to the New Zealand economy and has been identified as the most vital industry for future economic developments (Page, 2009). However, in recent years, this sector has suffered from various challenges such as high workloads, skills shortages and financial failures. It has been observed that major top-end contractors are going bust due to the fact that risks are not being fairly allocated (MBIE). Figure 1 illustrates some of the challenges involved in a New Zealand construction sector, which can lead to project failure.

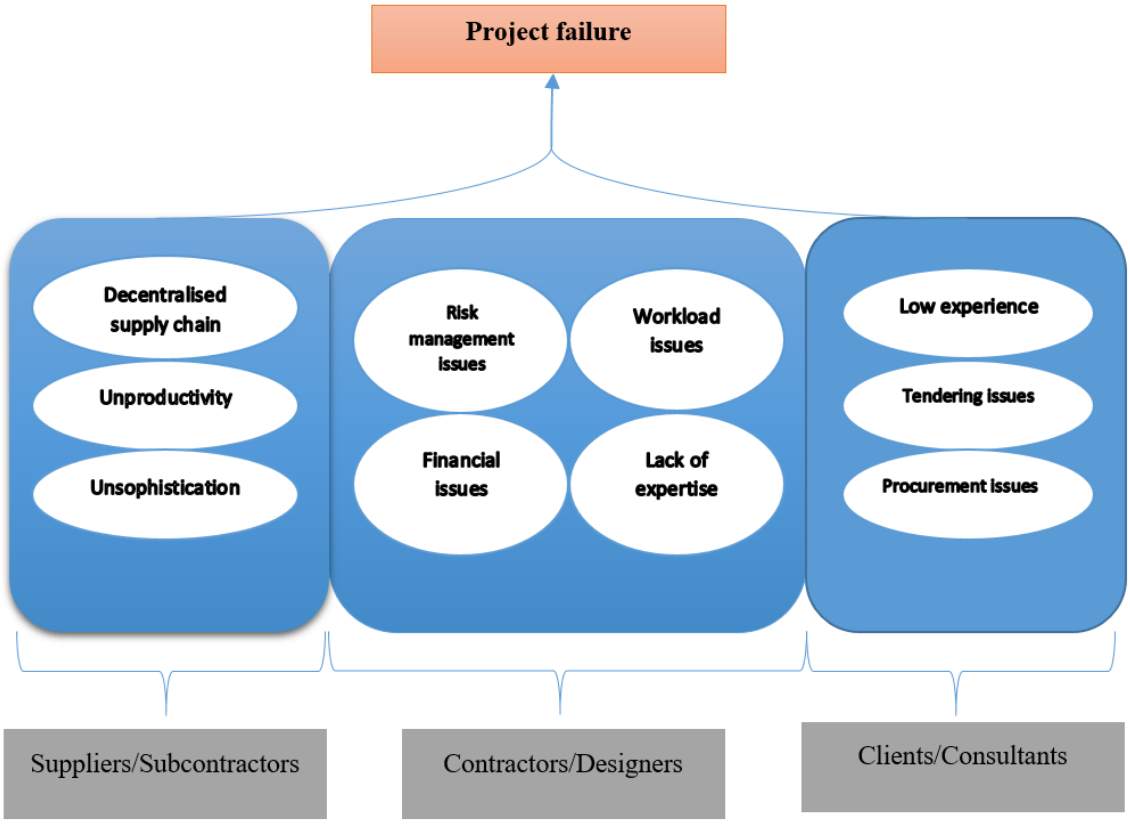

Figure 1 - Challenges of the New Zealand construction market

There is no room for doubt that different parties involved in the New Zealand construction are aware of these challenges and their consequences and are trying to overcome these issues. However, in this traditional market, developing a modern managing system that can communicate and optimise the efforts from different participants is a sine qua non. The market is developing rapidly in response to the high demand for new buildings. However, most of the public and private participants are using traditional approaches which sometimes cannot answer the current problems.

This research is trying to address contractor selection challenges in New Zealand by identifying areas for potential improvement and design a comprehensive tender evaluation framework that can assist public clients in forming the best possible contractor for their projects.

2.4 Problem statement

The first step in design and development study should be the identification of the problem (Ellis & Levy, 2010). According to Alptekin (2014), the success of any construction project is considered a complementary procedure. If any participating body is wrongly chosen, that will certainly influence the achievement of the completed project.

Previous studies illustrated that many failures associated with construction projects were attributed to the lack of effective tools to properly measure contractors before awarding the contract (Darvish et al., 2009; Kashiwagi & Byfield, 2002; Zavadskas, Turskis, & Tamošaitiene, 2008). The standard level of CS methods and criteria in New Zealand is inadequate as several significant factors are not presently taken into account by Decision Makers (DMs). Such factors include poor qualification of the contractor's technical staff, shortage of equipment, financial challenges, etc (MBIE).

Identifying the key elements affecting the industry is a critical first step to improve the operations of the New Zealand construction. From literature, it is clear that CS is one of the important factors in project success. Thus, an effective framework should be designed, which can assist New Zealand clients in selecting the best contractor who can satisfy the project requirements from amongst possible candidates.

2.5 Objectives

The overarching impact of CS processes in construction procurement has been the subject of research and debate for decades (El-Sawalhi, Eaton, & Rustom, 2008; Fong & Choi, 2000; G. Holt, 2010). A misunderstanding of the importance of selecting best value contractors and not low bid tenderers is considered to be one of the major reasons of project failures (Abbasianjahromi, Rajaie, & Shakeri, 2013; Darvish et al., 2009; G. Holt, 2010; Watt, Kayis, & Willey, 2009). As Chan et al. 2002 shrewdly observed, the biggest problem is that "Nobody likes it, but everyone understands this old system". However, according to recent construction plan published by the government, New Zealand construction is receiving the significant boom of $50 billion investment in infrastructure projects for the next ten years. One of the most important visions that this plan supports is the improvement of knowledge and management to tackle the challenges and ensure that the best decisions have been made in the future of this industry.

With this in mind, the objectives of this research are to improve the processes that construction of New Zealand evaluate contractors by establishing the current state of knowledge of this sector and provide a framework to transfer from traditional evaluation procedures to modern selection methods. It is hoped that eventually, both clients and consumers of the construction industry will benefit from this development. Clients and stakeholders will achieve better value for money and costumers and New Zealand residents will experience more satisfaction from their homes. Moreover, by clarifying the potential areas for improvement of selection procedures, the government can consider this information to improve their "Request for Proposal" (RFP) and tender evaluation protocols. Thus, the objectives of this research are four-fold:

- To find the advantages and disadvantages of CS methods, establish a universal set of Price/Non-Price Attributes and identify their priorities.
- To identify potential areas for improvement of CS procedures in New Zealand.
- To create recommendations that evolve traditional criteria to optimal price and non-price attributes.
- To develop a framework for CS that can increase the efficiency of public tendering procedures of the New Zealand construction industry.

2.6 Research questions

To achieve identified objectives, the following research questions have been formulated. Figure 2 shows how these research questions related to the research objectives. Different chapters of this research try to address this list of questions and design a framework based on these results.

1. **What are the features of construction contractor selection?**
    a. What are the different tender evaluation methods?
    b. What are the advantages and disadvantages of each method?
    c. What are the different tender assessment criteria?
    d. What are the priorities in the universal set of criteria?
2. **What are the elements of tender evaluation in the New Zealand construction sector?**
    a. What are the current challenges of public tendering in the New Zealand construction sector?
    b. Which methods and criteria do New Zealand clients use to assess tenders?
    c. What are the benefits and barriers of current contractor selection practices in New Zealand?
3. **What universal tendering methods can be benchmarked to New Zealand industry?**
    a. Which CS methods are more suited to be used in New Zealand?
    b. Which criteria are more important for the New Zealand construction sector?
    c. Which modern principles are more important to be added to CS?

4. **What would be the elements of a comprehensive CS framework for the New Zealand context?**

    a. How to develop the current methods of CS to fit into New Zealand industry?

    b. Which criteria should be considered to optimise the framework?

5. **What would be the challenges of implementing a CS framework in New Zealand?**

    a. What would be the challenges of implementing this framework in the New Zealand industry?

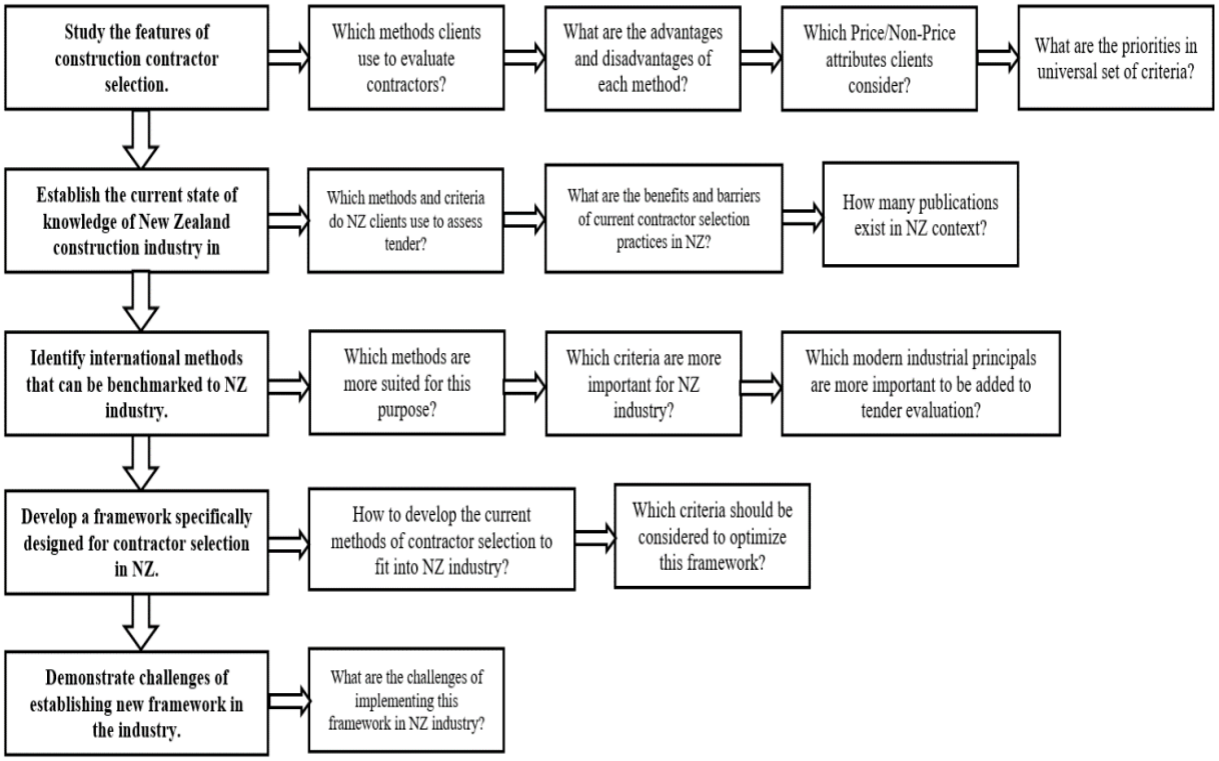

Figure 2 - Research objectives and related questions

2.7 The context and scope of the study

As stated previously, the main aim of this research is to improve the New Zealand construction industry. New Zealand, is made up of two major lands, North Island and South Island and several smaller islands that populates 4.5 million people (Page, 2009). New Zealand is located approximately 1,500km east of Australia and about 1,000km from the Pacific Islands (Page, 2009).

To manage the research in terms of time and effort, the interview approach has been limited to a specific area. Thus, the role of the city in national, facilities, social and economic activities, and

accessibility and variety of data and availability of their sources, made Auckland the best context for the first phase of the study (Qualitative phase) for investigating the CS, its related procedures, obstacles and operations (Kumar, 2019). Moreover, this research has been limited to public-funded projects since their scopes, procedures and requirements are better defined.

2.8 Summary of research methodology

A comprehensive literature review on the New Zealand construction sector encouraged the researcher to try to address the identified research problem. The primary objective of this study is to design an efficient framework of construction tender evaluation procedures in New Zealand, which can assist public clients in deriving the optimum value for their projects. A research philosophy was defined considering the nature of the problem. After reviewing the philosophical assumptions and the researcher's approach to achieve study objectives, it has been recognised that this research belongs to the positivism paradigm.

In this study, the descriptive sequential mixed-method approach used to collect both qualitative and quantitative information to carry out the most parsimonious and advantageous means for arriving at theory. Neither qualitative nor quantitative approach is adequate to best understand the problems and gaps in CS procedures of New Zealand construction. Thus, the first aim of this research is to develop a detailed view of the current practices in New Zealand and generally learn what variables to study and then study those variables with adequate` sample of individuals and generalise the findings to the industry.

Phase one: To understand the nature of the problem and recognise the best approaches to achieve the objectives of the study, a literature review has been considered as the vital first step. It includes the investigation of tender evaluation strategies, methods, assessment criteria and protocols developed and implemented in New Zealand and other countries. The primary purpose of the literature review in this study is to provide rich information about the history and development of CS and identifying its key elements that can assist the researcher in developing a comprehensive CS framework.

Phase two: To understand the current challenges of public tendering in New Zealand construction and routine tender evaluation protocols that public clients use, an exploratory qualitative survey involving semi-structured interviews was conducted. Moreover, qualitative analysis was used to look for patterns in the collected data to design a reliable quantitative survey later in the study.

A sample of 10 participants was selected by "snowball sampling". This method is an effective and purposeful sampling method to reach the most knowledgeable people in the industry. Population for this phase of the study was major construction clients (universities, hospitals and

health care districts and government departments), construction engineers, builders and architects who were involved in public contractor selection procedures. The results of the interviews were analysed using content analysis. NVIVO 11 software was used to eliminate unnecessary information and reduce a large amount of qualitative data collected through interviews by coding and describing the data.

Phase three: The findings from the literature review and qualitative phase were used to form a quantitative survey targeting a wider population. The quantitative stage tried to address the key research question of finding the priorities of assessment criteria targeting the aforementioned parties around New Zealand. Before distributing the survey, three copies of the questionnaire were distributed to the experts in Auckland, as a pilot study to find the gaps, investigate the precision of questions and improve the survey.

After analysing the pilot results and designed the final survey, the questionnaire has been distributed to the experts in New Zealand. Descriptive statistical and Wilcoxon Signed rank test was used to analyse the survey results. SPSS 20 software was utilised to analyse these statistical tests.

Phase four: This phase is divided into two steps. The first step is to design and develop a theoretical CS framework for New Zealand based on the data collected through previous stages.

The second step is the validation of the results. The main purpose of this phase is to validate the designed framework and both qualitative and quantitative research findings from previous stages by conducting interviews with industry experts. To validate the research, the data from semi-structured interviews and online survey were analysed, and the results presented to multiple construction leader along with the suggested framework for their verification and additional input. Validation process allowed the experts to evaluate the findings in terms of practicality and effectiveness of the framework and establish a roadmap for improvement.

It is worth mentioning that for both semi-structured interviews and validation procedures, the elite interview sampling method was used. This is a method of using interviews to study those at the top of the system to gain rich and in-depth information about an issue (Kumar, 2019). This is an effective method when there is a lack of previous data exists in the literature. Therefore, in this research, specific participation requirements were considered in data collection phases, which limited the number of potential candidates.

Phase five: Final phase of this study is the conclusion and recommendations drawn on the strength of the syntheses of the study results. Recommendations are based on both the identified gaps in previous stages and suggested approaches of the experts in the qualitative phase and validation interviews. Table 1 shows the research objectives, questions and methods of data

collection. Figure 3 illustrates the overall research design and data collection methods to address research problems.

Table 1 - Research objectives, questions and data collection methods

Research objectives	Research questions	Data collection techniques
1. To find the advantages and disadvantages of CS methods, establish a universal set of Price/Non-Price Attributes and identify their priorities.	1) What are the different tender evaluation methods? 2) What are the advantages and disadvantages of each method? 3) What are the different tender assessment criteria? 4) What are the priorities in the universal set of criteria?	Literature review
2. Identify potential areas for improvement of CS procedures in New Zealand.	5) What are the current challenges of the New Zealand construction sector in terms of public tender evaluation procedures? 6) Which methods and criteria do New Zealand clients use to assess tenders? 7) What are the benefits and barriers of current contractor selection practices in New Zealand?	Literature review and semi-structured interviews
3. To create recommendations that evolve traditional criteria to optimal price and non-price attributes.	8) Which CS methods are more suited for this purpose? 9) Which criteria are more important for the New Zealand construction sector? 10) Which modern principles are more important to be added to CS?	Semi-structured interviews and survey questionnaire
4. Develop a framework for CS that satisfy the requirements of the New Zealand construction industry.	11) How to develop the current methods of CS to fit into New Zealand industry? 12) Which criteria should be considered to optimise the framework? 13) What would be the challenges of implementing this framework in New Zealand industry?	Literature review, Semi-structured interviews, Questionnaire survey, Validation interviews

Establishment of the research problem	Reviewing literature
Research questions	1. What are the different tender evaluation methods? 2. What are the advantages and disadvantages of each method? 3. What are the different tender assessment criteria? **4.** What are the priorities in the universal set of criteria? 5. What are the current challenges of New Zealand construction sector? 6. Which methods and criteria do New Zealand clients use to assess tenders? **7.** What are the benefits and barriers of current contractor selection practices in New Zealand? 8. Which CS methods are more suited for this purpose? 9. Which criteria are more important for New Zealand construction sector? 10. Which modern principles are more important to be added to CS? 11. How to develop the current methods of CS to fit into New Zealand industry?
Research philosophy	Positivism paradigm
Research approach	Mixed-methods approach
Research strategy	Semi-structured interviews, Surveys, Validation interviews
Qualitative stage	Semi-structured interviews in Auckland region-Exploratory / Content analysis with QSR NVIVO 11
Quantitative stage	New Zealand wide questionnaire survey / Descriptive and inferential statistics with SPSS 20
Research findings	Combining both qualitative and quantitative findings
Research validation	Validation interviews
Results and recommendations	

Figure 3 - Research design

2.9 Limitations

To interpret the results properly, it is vital to state the possible limitations of the research. One of the main limitations of this study is associated with the accuracy of the responses provided by our participants in the qualitative and quantitative phase of this research.

Research participation requirements limited the number of potential candidates in the qualitative and quantitative phases of the study. Semi-structured interviews were limited to 10 participants in the Auckland region and 38 responses received for the survey phase in the New Zealand region. Thus, it is important to notice that in this research, the perceptions offered by the participants form only parts of the real challenges. Moreover, the generalisability of the research findings might be a potential limitation due to the fact that the New Zealand construction sector is unique.

2.10 Thesis outline

This thesis has eight chapters. A summary guide to each chapter can be found below:

Chapter one: This chapter is an introduction to the study. A brief history of the contractor selection, the current gaps and objectives of the study are explained. Moreover, the design methodology and scopes of the study have been discussed and are followed by the limitations of the research.

Chapter two: The general information of the construction industry will be discussed in this chapter. Furthermore, the unique characteristics of the New Zealand construction sector will be illustrated.

Chapter three: This chapter reviews the literature and previous studies on construction tender evaluation methods and criteria. Different CS approaches and their advantages and disadvantages will be discussed.

Chapter four: Different research methodologies will be reviewed in this chapter. This is followed by a discussion of the best approach that can best answer the issues identified in this study. Moreover, the data collection and analysis approaches will be briefly explained in this chapter.

Chapter five: This chapter discusses the qualitative phase of the study and reports the results of the semi-structured interviews.

Chapter six: Characteristics of the quantitative survey, distribution and analysis of the results will be demonstrated in this chapter.

Chapter seven: This chapter provides the findings of the qualitative and quantitative analysis and develops a CS framework for the New Zealand construction sector by considering its unique

environment. Also, the validation procedures of the framework and the findings of this study will be illustrated in this chapter.

Chapter eight: Conclusions and recommendations of the study will be explained in the final chapter of the thesis. This chapter briefly discusses all of the chapters and review the objectives of the research. Finally, the identified knowledge gaps will be presented, and future researches will be recommended, and a summary of the conclusions will be given.

2.11 Summary

This chapter provided an introduction to the study. Research problems and objectives have been demonstrated, and methodology approach has been discussed. Moreover, the scopes of the study have been defined. Finally, the chapter concluded with the thesis outline.

2. Chapter 2 - General characteristics of construction

2.1 Type of industry

Construction principally aims to bring together various businesses into one goal-oriented concept of assembling materials and products (Gould & Joyce, 2009). Despite the peculiar challenge of forging a partnership between different participants of the project, the construction industry is one of the most vital to the economy and our daily lives. Unlike other industries that depend mostly on the new technologies, success and failure of a construction project rely heavily on qualities of its people (Gould & Joyce, 2009). This industry comprises various types of business organisations and a diverse range of professionals. The construction industry is one of the key sectors in the New Zealand economy (Page, 2009). This sector is considered to be one of the principal contributors to the New Zealand economy and has been identified as the most vital industry for future economic developments (Page, 2009).

Demographics, market trend, governmental funding and unpredictable nature of the work, caused higher risks in construction than it is in other sectors. To overcome planning and controlling challenges of construction projects, construction practitioners need to apply systematic methods to ensure successful project outcome for the owner. However, since construction projects are unique, it is difficult to use managing techniques from other industries, which makes it difficult to accurately predict the outcome of the project. This makes this industry at a higher risk of failure than other sectors. During the past decades, these technical complexities of construction projects have pushed project participants into more collaborative methods of delivering the projects.

2.1.1 Construction sectors

All of the construction projects must be planned, scheduled, financed, controlled and managed to be completed successfully. However, due to the complexity of the projects, construction encompasses numerous specialized sectors which have a huge influence on how the project would be funded and in what manner would designers, builder and owners interact. Construction has often categorised into these four sectors:

1. Residential: This sector usually comprises privately funded homes and apartment complexes. This sector has a direct relationship with the strength of the economy. In a strong economy, usually, 50% of the construction funds will be spent on the residential sector.
2. Commercial: Although some public funding would be available for hospitals and education centres, similar to residential, these buildings tend to be funded privately. The

complexity of the commercial projects is greater than the residential sector, which leads to fewer project participants.

3. Infrastructure: Highways, bridges and tunnels are examples of the projects in this sector. Since infrastructure projects are usually large and very sophisticated, they are often funded with public money because they serve the public's needs. However, during past years, there is a growing trend toward public private partnership for infrastructure projects.
4. Industry: This sector includes huge production facilities such as refineries and steel mills. The design and construction of these buildings are highly sophisticated and needs specific equipment.

The construction industry can also be divided into the public and private sector. There is a big difference exists between these two sectors in terms of their definition and function (Page, 2009). Public projects, often running by public entities, are being completed within the context of not-for-profit organisations and funded by public money (Gould & Joyce, 2009). Thus, there are limitations to the flexibility in their spending and methods of funding. On the other hand, private projects that are completed for profit within privately-owned companies which has more flexibility and agility within budgeting (Gould & Joyce, 2009). Public projects usually focus on adding social values to the society, while private projects has a centralized focus on driving revenue.

One of the main differences between these two sectors is that there are very specific regulations and constraints exist in public-funded projects. Public construction is defined and regulated by legislation in every country. The private sector is also regulated at some level, such as laws for monitoring equality and anti-bribery. However, the public sector is more regulated in terms of construction procurement and project management. Thus, this research focused primarily on the public sector since there are more guidelines, regulations and literature exists in these types of projects.

2.1.1.1 Project participants

For a construction project to be successful, different parties should interact, collaborate and cooperate. Buildings are born from owners ideas, translated into graphics by designers and produced by builders (Gould & Joyce, 2009). These participants make up a diverse group.

2.1.1.1.1 Owners:

The owner is the entity that has a specific need for a construction building and has money to pay for it (Fellows & Liu, 2015). The owner is where the project is born (Fellows & Liu, 2015). Thus, the first step of the construction project is to identify the owner's needs. Moreover, the owner is

responsible to financially back the project during its construction. Depending on the source of the project funding, construction owners can be categorised into different types:

- Public owners: There are different entities representing the public in the government, but in all cases, the real owners are taxpayers. Public entities have to follow specific guidelines and approval processes to prove that the public money is being spent to achieve the best results. There should be a clear procedure to choose designers and constructors.

- Private owners: Construction projects are mostly financed by private owners. Large organisations usually have a team of professionals who represent their interest during the project. In this case, one of the vital steps is to spend proper time early in the project to outline the objectives of the company for the team. Experienced owners are usually very clear about their organisational goals, while others sometimes are less clear about their motivations.

2.1.1.1.2 Designers:

Architects are usually the first participants of the projects that the owner goes to. The architect's responsibility is to translate the owner's idea into architectural drawings and specifications. After that, the conceptual design is prepared, the engineers usually being hired to develop the building systems such as structure as well as electrical and mechanical (Cooke & Williams, 2013). Since architects are the first members of the team, they usually influence the choice of constructors and procurement methods.

2.1.1.1.3 Contractors:

Clients appoint contractors to carry out the construction works. However, in most cases, contractors do not have all the trades required to build the project. Thus, they have to employ construction professionals to build working packages.

2.1.1.1.4 Sub-contractors:

The objective of all of the previous processes from concept design to IFC drawings is to instruct the Construction professionals who actually perform the field work (Cooke & Williams, 2013). Sub-contractors play a vital role in construction projects with 25 to 65 percent of the construction costs going to these trades (Gould & Joyce, 2009). They are responsible to complete their work packages on time, on budget and with adequate performance. They provide highly skilled professionals include mechanical and electrical contractors.

2.1.1.1.5 Other participants:

In addition to the people who are directly involved in the construction of the job, there are various organisations that ease the way throughout the project. Material and equipment suppliers play a

key role in any construction job. Without materials and equipment, the project would be only a dream (Gould & Joyce, 2009). Governments and financial organisations are involved in funding the projects. Lawyers assist the owners to minimise the risk and to negotiate during their dispute resolutions.

2.1.1.2 Project chronology

A construction project has different phases starts with an idea. Then it will be translated into graphic forms by the designers. Contractors and sub-contractors will be chosen, and it is then built and turned over to the client. However, each of these phases can be very sophisticated and required teams of specialists working for years to be completed.

2.1.1.1.1 Initiation of the project

A project starts when the owner identifies a need. However, moving from an idea to reality by recognising the parameters to satisfy these needs is a vital step toward a successful start. The owner should be sure that the result can have adequate return and worth the investment. Thus, he or she often consults with designers and constructors and ask them to run several analysis from different standpoints to examine the investment. After evaluating the profitability of the work, the owner should then find sources to financially back the work. Especially for major projects, owners have to acquire outside funds which can be obtained in the form of bank loans, bonds or government funds.

2.1.1.1.2 Design of the project

The design of a project usually performs in four main steps:

1. Programming: First, the project objectives will be written and checked to satisfy the client's needs, budget and schedule.

2. Schematic design: Second step is to evaluate different designs that match the project objectives.

3. Design development: Third step is to define important parameters of the project from technical specifications to a selection of the materials.

4. Construction documents: these documents are sets of detailed designs including specifications, technical drawings and instructions which are necessary for the use of construction packages. Moreover, it contains final documents of specifications to be submitted to local government and authorities for approvals and building permits.

2.1.1.1.3 Procurement

Construction procurement refers to an organisational system that assigns responsibilities to different participants of the project (Gould & Joyce, 2009; Masterman, 2003). The selection of procurement strategy depends on various elements, specially risks of the project and client's objectives. Figure 4 illustrates the relation between a number of procurement strategies and the distribution of the risk between client and contractor. Numerous delivery methods have been developed during the past decades. Here some of the most common approaches that are currently being used in the New Zealand construction sector will be reviewed.

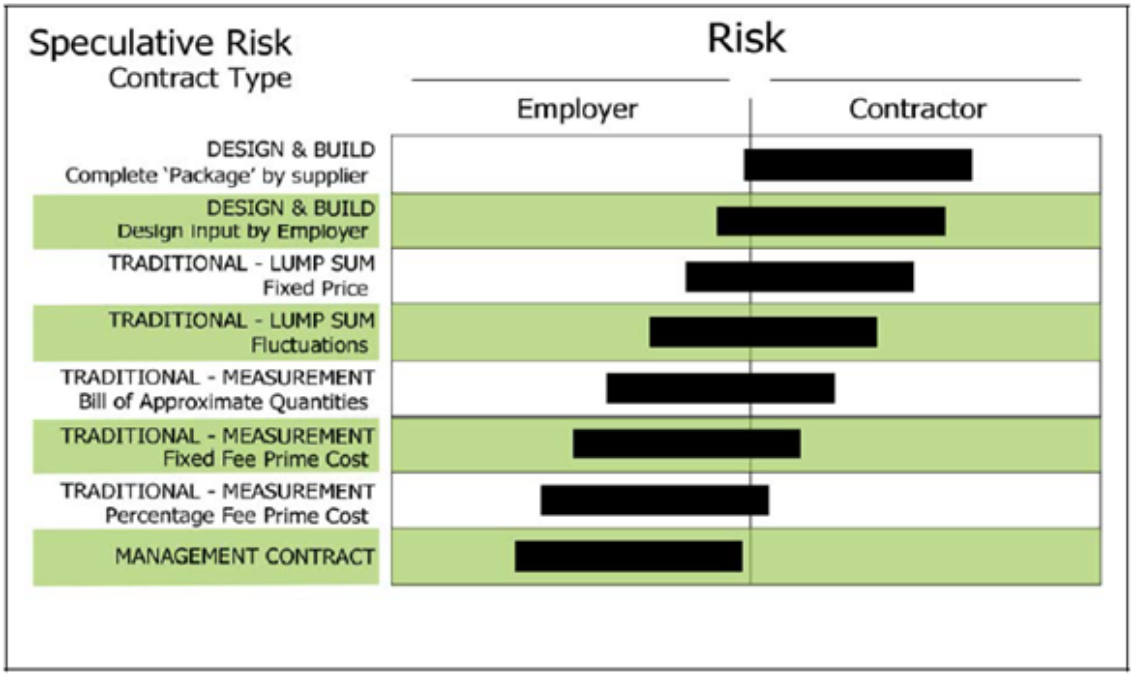

Figure 4 - Risk apportionment between client and contractor

2.1.1.1.1.1 Traditional (Design/bid/build)

With this approach, the owner accepts that the design is separated from the construction work. He/she first hire a designer/consultant to complete the design package and control the cost and then select a contractor who is responsible for the construction work. This selection can be made either by requesting bids from contractors to obtain best-value or by negotiating with a specific contractor. The traditional approach has been the predominant method for decades. The most important advantage of this approach is that since it has been employed by the construction practitioners for years, procedures and contractual arrangements are well understood.

However, one of the main disadvantages of this approach is that usually, the buildability of the design has not been reviewed before it is completed. Thus, if some aspects have been missed by the designer, the contractor can submit change orders that increase the overall cost of the project. Moreover, less collaboration between architects and contractors can cause numerous delays

throughout the project. The overall project duration of the traditional approach is usually longer than other delivery methods.

2.1.1.1.1.2 Design/build

With this approach, the contractor accepts the responsibility of the project design in addition to the construction of the job. This method generally has less risk for the client by providing a single point of contact and less responsibility (Cooke & Williams, 2013; Gould & Joyce, 2009). By choosing this method, design/build firms can avoid the problems associated with a lack of cooperation between different participants and benefit from good communication between the design and construct teams. It is also easier to apply changes in the project since it occurs within one organisation.

On the other hand, it is difficult to have a guaranteed price at the early stages of the project since the design usually develops during the construction work. One of the main reasons that sometimes, clients avoid this approach is that they are afraid to lose control over the project. Because both of the design and construct teams are working for the same organisation, they might force into situations to choose between solving project problems and protecting the firm's profit.

2.1.1.1.1.3 Early Contractor Involvement (ECI)

As its name suggests, ECI tries to exploit the constructor's knowledge of the work to improve the design process (Durdyev & Mbachu, 2011). A capable contractor will be hired at the early stages to evaluate the constructability of the design documents. This early involvement in project planning can increase the possibility of achieving a great influence on project costs and outcomes. One of the primary reasons that ECI is currently in favour with the clients is that it enables risks to be identified, evaluated and managed. Another advantage of this approach is that it reduces the cost of tendering procedures. However, some clients believe that they cannot employ the potentials of proper competitive pricing with ECI (Durdyev & Mbachu, 2011). Moreover, a poorly structured ECI can create new challenges and conflicts in the project team.

Due to the collaborative advantages and greater cost certainty of it, ECI is currently in favour of New Zealand clients. It assists clients to underlie project objectives more efficiently. The structure of the ECI and the relationship between the participants is one of the significant elements influencing the process outcomes. Furthermore, depending on the scopes and objectives of the project, the client can also benefit from the involvement of the contractor's key supply chain in the ECI phase.

2.1.1.1.1.4 Public Private Partnerships (PPP)

Originally developed in the UK in the 90s, PPP is a collaborative agreement between public and private sectors for some mutual benefits (Gould & Joyce, 2009). During the past decades, it has

been observed that sometimes private sector can provide services more effectively and so a partnership of the two sectors might deliver better value for the public money (Gould & Joyce, 2009). Integrating asset and design, incentivising the design and asset management and improving risk management are some of the advantages of the PPP approach identified by the New Zealand Treasury (Gould & Joyce, 2009).

PPPs are usually long-term contractual agreements typically 20-30 years involving one or multiple private firms in the delivery of public asset or services. The public entity concentrates on defining the project objectives, and the private sector is responsible for providing finance, design, construction and maintenance of the asset during the contract time. At the end of the contract, control of the asset will be returned to the public entity (Gibson, 2010). In New Zealand, the PPP guidelines will be provided to all of the governmental organisations by the Treasury.

2.1.1.1.4 Construction

The next step is to initiate the field operation of the construction project, which includes the main factors of ordering the proper materials and equipment, monitor project schedules, managing construction techniques, and coordinating the site operation.

2.1.1.3 Tender process and bidding

Some construction firms negotiate most or all of their works. Others have to create their opportunities by tendering in a competitive market because there are always other companies who are chasing good opportunities (Cooke & Williams, 2013). However, bidding takes significant time and costs from contractors, so the decision of bidding on a tender depends on several factors. One of the most important elements is the strength of the market (Cooke & Williams, 2013). When the market is strong, firms have more opportunities to bid on projects with better values. But when the market is down, they have to bid on less desirable projects. Sometimes contractors have another motivation besides profits to bid on a project. They may want to establish a relationship with a prospective client who might have a pipeline of work in the future.

Whatever the reason is, due to the competitive nature of the tendering market, contractors have to convince the clients that they have the required skills and can offer services to satisfy the project needs. Thus, project owners evaluate contractor's characteristics and select the best for their projects. Tender evaluation is a challenging procedure associated with many uncertainties. It is a multi-criteria decision-making problem required clients to make subjective judgments (Watt, Kayis, & Willey, 2010). Numerous scholars believe that contractor selection is one of the most important decisions that project owners should make (Darvish et al., 2009; Doloi, 2009; G. Holt, 2010; Jafari, 2013; Watt et al., 2009).

2.1.1.1.1 Invitation to tender

To illustrate that everyone in the market has an equal opportunity to participate in the project, clients publish an advertisement for their tenders. This advertisements usually provide basic information of the drawings and specifications and a request for pricing. The information usually includes type and scope of the project, location, bid due date, bonds and other legal requirements (Gould & Joyce, 2009). Sometimes for major projects, a pre-bid conference will be held by the owner, which allows designers to demonstrate the intent of the project to the potential bidders. Moreover, it also allows contractors to ask their questions and uncover holes in the published documents (Gould & Joyce, 2009).

2.1.1.1.2 Type of tenders

Depending on the complexity of the project and various other reasons, the client should choose a tendering type to approach the market. Three different types of tendering in construction projects including Open, closed and negotiation has been demonstrated as follows.

2.1.1.1.1.1 Open tenders

In this method, clients publish their advertisement in a public newspaper or website and permit as many contractors as are interested in participating in the bidding process. This is the most common method for public projects to ensure the market that the procedure has been done fairly. However, this method has been considered as a time and cost consuming method since many contractors may spend a lot of time and cost preparing bids to no effect. Moreover, due to the small chance of winning, contractors may bid without studying the contract in details and end up losing profits.

2.1.1.1.1.2 Closed tender

Although open tenders are the most common method of tendering, due to their limitations, they may not attract a lot of reputable contractors. An alternative way to address this problem is closed (selective) tendering. Under this method, clients first shortlist around five contractors who are capable of completing the project and invite them to submit their proposals. One of the main benefits of this method is that it can improve the quality of the tender and evaluation procedures would be more manageable. Contractors also prefer this method since it gives them a proper idea about how much chance they have to win the job. However, the main disadvantage of this approach is that favouritism may occur in shortlisting, which reduces the chances of other contractors to get a good deal (Essays, 2013).

2.1.1.1.1.3 Negotiation

This method is usually being used when particular equipment is required, or there is a need for an extension of the existing project. In this case, the client selects a construction firm of his choice

to review the project and submit a methodology and price. At the end of the negotiating period, if both parties agreed on the terms, the contractor can start the project. Otherwise, clients will have to find another constructor to propose a request.

2.1.1.4 Tendering strategy

One of the vital decisions that clients should make is their strategy to approach the market. A clear understanding of the project objectives can assist the owners in making the best decision. Depending on the nature, scope and complexity of the construction work, a number of questions should be clarified. In this step, clients should consider several options such as level of details of pretender documents, open/closed or negotiated tender, single or multi-stage tender, type of RFx documents, Advertising the tender, process plan and evaluation methodology (Development, 2011).

2.1.1.1.1 New Zealand public tendering

Public tendering is a critical element of developing the New Zealand economy. Almost 18% of New Zealand's GDP is the goods and services provided to the government entities by third-party companies (MBIE, 2015). Better value for public money can be achieved by effective and well-designed procurement guidelines. To gain the public's trust and demonstrate that the New Zealand government is spending public funds on well-planned projects, an efficient set of rules is required to design tendering processes. It is vital for the New Zealand government to illustrate its transparency and accountability to build confidence in their practices.

To make it easier for construction participants to understand the components of a good procurement strategy, New Zealand Ministry of Business developed a comprehensive guideline to demonstrate the mandatory rules for planning public procurement (MBIE, 2015). First published in 2013, this guideline replaced the rules of public procurement published by the Ministry of Economics in 2006. Modernising the government's approach to public procurement, encourage public entities to use more strategic approaches of competitive tendering and providing simple and up-to-dated rules are among the main purposes of publishing this guideline. The main five principles of New Zealand public procurement consists of:

1. Plan and manage for great results
2. Be fair to all participants
3. Get the right team
4. Get the best deal for everyone
5. Play by the rules

Moreover, other rules have been illustrated, including non-discrimination, protection of participant's information and integrity of approach, which is mandatory for the agencies to follow.

There are numerous other documents published to support good public procurement practices in New Zealand such as "Mastering public procurement" published by Ministry of Economy in 2011 and "Planning construction procurement" published by MB in 2016. "Mastering public procurement" developed a guideline to assist government agencies to have a proper understanding of the market, business visions and delivery approaches. By reading this guideline, organisations will be encouraged to achieve strategic procurement outcomes and adopt a structured approach to planning and management. "Planning construction procurement" aimed to provide key points of developing strategic procurement approach for agencies of the New Zealand public construction sector. Different types of project delivery, methods for assessing strategic models and issues to be considered when planning the approach to the market has been provided in this guideline.

Although different government agencies have their guidelines, all of them should follow a specific set of rules for tendering. Some of the mandatory rules of tendering for public projects are as follows:

- All of the public agencies should advertise their contract opportunity on Government Electronic Tenders Service (GETS) unless an exemption applies. They should also publish a Notice of Procurement free of charge and provide access to all relevant tender documents.
- Agencies should not use RFI to shortlist potential suppliers.
- Any additional information should be available to all participant at the same time.

2.1.1.5 Types of construction contracts in New Zealand

One of the most important means to balance the risks between parties is the construction contract (Gould & Joyce, 2009). Different types of contracts define a different relationship between the project participants and their rights and obligations will be defined. Contracts establish a mechanism to administrate project procedures as well as dealing with payments, delays and disputes (Cooke & Williams, 2013).

Numerous types of standard contracts are being used in construction projects around the world. Joint Contract Tribunal (JCT), Engineering and Construction Contract (ECC) and Institution of Civil Engineers (ICE) are among the well-known contracts. In New Zealand, NZS 3910 and NZS 3916 are the most commonly used contracts in engineering and construction projects. NZS 3910 is intended for separated (traditional) procurement, and NZS 3916 is for integrated (design & build) projects. Other contracts being used in New Zealand include NZIA: SCC1, Building Right BCC, IPENZ and NEC3. Each of these contracts can be used to serve the objectives of the project. However, depending on how the project would be funded and the nature of the risks associated, the client should choose a mean of payment for the project costs. Here four types of contracts commonly used in New Zealand will be discussed (Development, 2011).

A single fixed price (lump sum): In this type of contract, the contractor agrees to complete the project for a specific sum. This contract is often used with traditional procurement (Gould & Joyce, 2009). The most important benefit of this contract is that the owner can fix the final cost before the project begins. On the other hand, if errors exist in the project documents or if the specification of the project changes, there is a good chance that it exposes the client to the risk of an increase in project costs. If errors occur by the constructor, they'll be liable for absorbing the costs. These disagreements usually result in litigation (Cooke & Williams, 2013). Thus, designers and contractors try to specify and estimate the job accurately, which takes time and prevents the construction from the beginning (Gould & Joyce, 2009).

1. Unit price: With the unit price contract, clients ask contractors to submit their bids with a price charged per each unit of the project work packages. Then, the overall price of the bid will be determined by the total value of these separate quotes. The most vital benefit of this method is that it allows the construction work to start even if the design documents are not completed. Moreover, it reduces the risk of renegotiating the work when an unexpected condition occurs during construction. The disadvantage of this contract type is that the owner doesn't know the actual price until the work is nearly complete.

2. Cost-plus contract: In cost-plus agreement, the owner agrees to reimburse the contractor for the cost of labour and material plus an additional agreed-upon fee or as a percentage of costs (Fellows & Liu, 2015; Gould & Joyce, 2009) This is a common contract type when it's difficult to define the scope of the project at the beginning. One of the main success factors of this agreement is that the owner and the contractor should agree on upfront on what materials and labour will exactly be reimbursable. Because there is a risk that the client suspects that the contractor reimbursed for a work that could be done less expensively. However, this risk can be minimised by project participant working collaboratively in the process which encourages good value engineering and project management.

3. Guaranteed maximum price: This type of contract is self-explanatory. As is name implies, client and contractor will agree on a maximum price. If the construction work exceeded the maximum price, the contractor is liable for the overage (Gould & Joyce, 2009). Any savings during the construction project will be shared between the project participants. This approach encourages collaboration and teamwork among the project participants, which often leads to finish on time and within the budget.

2.1.1.6 The New Zealand construction environment

The construction sector plays a vital role in New Zealand's economy. It is the third-largest sector in the industry, which contributes around 8% of New Zealand's GDP. More than 170,000 people

are currently employed in construction-related works that accounts for 10% of total New Zealand's employment. Figure 5 illustrates the percentage of new investments by different industries in New Zealand. As it can be seen, the construction sector is the largest investor in New Zealand (Black, Guy, & McLellan, 2003). Appreciating the key characteristics of this industry can assist us to better understand the elements that affect New Zealand's CS framework. Here, some general information about New Zealand's geographical, social and cultural characteristics will be discussed. Moreover, the role of labour force in this sector and current status of the industry will be presented.

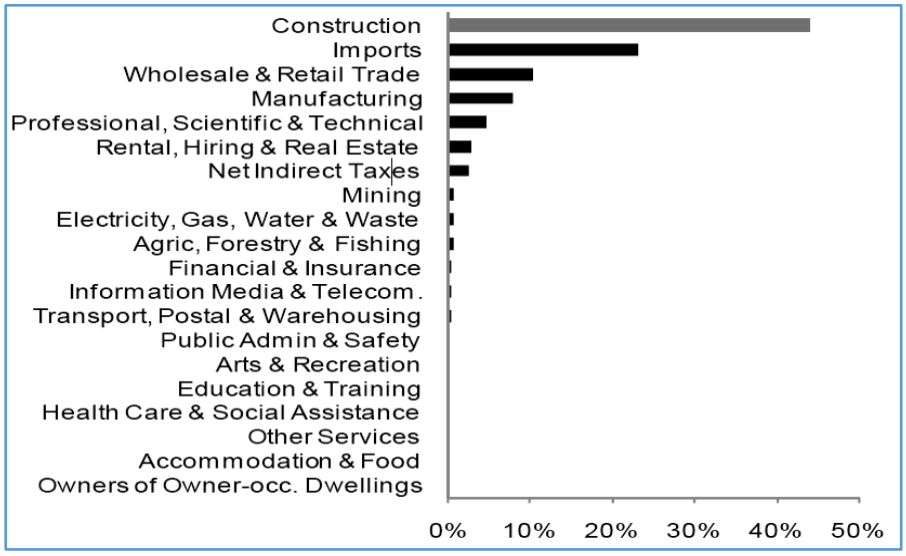

Figure 5 - Investments in New Zealand by different sectors

2.1.1.1.1 Geographical and climate characteristics

New Zealand consists of two large islands and several smaller islands. New Zealand's land area is more than 250,000 KM_2, which is about similar to the UK. New Zealand's position on the boundary of two tectonic plates caused the country to have numerous earthquakes. Thus, New Zealand is extremely vulnerable to seismic activity. Previous experiences in New Zealand illustrated that the failure of the earthquake-prone building could endanger people's lives, which makes earthquake risk reduction a priority in New Zealand. With advancements in the knowledge of seismicity, New Zealand has had a progressive approach to introduce new standards for earthquake resistant buildings which most recently was a standard introduced in July 2017 for a guideline on how to procure earthquake-resistant designs and developments.

New Zealand's weather is influenced by geographic factors. The climate is complex and varies from cold weather in the south to warm subtropical temperate climates in the north. It varies

considerably depending on the location. However, the average rainfall experiencing in New Zealand is higher (between 600 to 1600 mm of rainfall) than that of other continental countries which often cause delays in construction jobs. These specific characteristics are highly influencing New Zealand's building form, material choices and construction equipment.

2.1.1.1.2 Culture characters

Culture gives identity to a country. Continuous improvement in efficiency is a vital aspect of construction industry identified by numerous reviews, and progressive and enduring culture is believed to be a foundation of these developments (Chan, Lam, Chan, Cheung, & Ke, 2010; Egan, 1998; Latham, 1994). Therefore, before designing any framework, the cultural aspects of the New Zealand construction sector should be identified and taken into account.

Construction in New Zealand have some similarities and differences comparing to other countries. Some of the main differences identified are different construction standards and materials, the strict requirement to follow the health & safety laws and informal communication style. New Zealand laws necessitate employers to provide a safe workplace for their employees. Especially for the construction environment that pose various hazards to people working on site. In New Zealand, employees should be trained to operate equipment safely and use appropriate protective equipment. Furthermore, the ways of communication between employer and employees may be different in New Zealand. They have a less formal relationship, and employees can question or complain about politely more than some countries. These are some of the examples that make New Zealand construction a unique environment which requires a deep understanding of its characteristics before developing improvement plans.

2.1.1.1.3 The labour force in New Zealand

Construction is the fifth largest sector by employment in New Zealand. Around 170,000 employees are working in core construction, and construction-related services are estimated to have 53,000 workers, which account for 10% of total employment in New Zealand (Black et al., 2003). The results also demonstrate an annual average of 3% growth in construction-related employment over the past five years. However, by reviewing the expected demand for the next five years, Ministry of Business considered this as not adequate and looking for the construction employees to be projected to increase by around 10 % between 2015 to 2021 (Ministry of Business, 2015). Figure 6 illustrates the expected increase in construction-related occupations. Similar to the rest of the New Zealand economy, construction has a high portion of small businesses, specially in building construction and construction services.

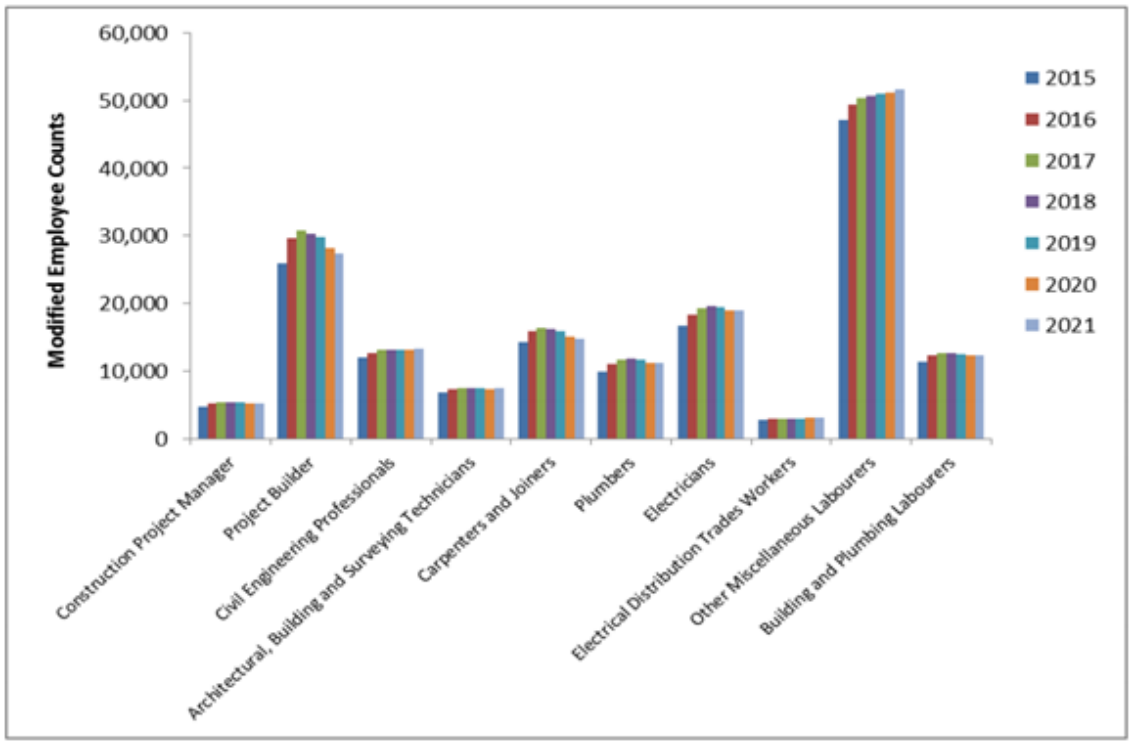

Figure 6 - Total New Zealand key construction Occupations

2.1.1.1.4 New Zealand construction industry classification system

Classification or rating systems exist in every industry to describe the size and capabilities of the firms. The construction sector in New Zealand has a rating system that classifies companies as Tier1, Tier 2 and Tier 3. Construction organisations based on their size, resources, skills, experiences and financial viabilities can take a different kind of projects. For instance, Tier 1 contractors are the major head contractors, which are the most experienced in the industry and Tier 3 companies are the more modest firms.

The largest, wealthiest and most experienced companies in the industry can be considered as Tier 1 companies. This category is so exclusive that there are only a few Tier 1 companies currently working in New Zealand. These companies take on major commercial and infrastructure projects such as motorways, railways, hospitals and universities. These companies have the capability of taking jobs projects with contract values in the billions and hundreds of millions of dollars.

Tier 2 companies are mid-tier organisations which are still key players in the industry. Tier 2 companies are often taking large scale commercial projects and small to mid-sized infrastructure projects with contract values in the tens of millions of dollars. Tier 3 companies are essential to the industry who take residential jobs and small-scale commercial projects. There is a lot of Tier 3 companies in the market which have plenty of work in the contract value of around the million-dollar range.

2.2 Current statue of New Zealand construction industry

The New Zealand construction sector has experienced substantial growth during the past years. Christchurch rebuilds, housing shortages and construction boom in Auckland are the main reasons for this growth. However, compared to other sectors, the building industry has long been criticised for its conservatism and lack of innovation (Lobo & Wilkinson, 2008). Moreover, compared with the construction in other countries, New Zealand's productivity is relatively low. Results indicate that there has been no significant growth in New Zealand construction productivity in the last 20 years (Lobo & Wilkinson, 2008).

One of the main reasons for the low productivity in New Zealand is the cyclical nature of the construction industry, which can cause a lack of experience and requires more training (Lobo & Wilkinson, 2008). Another reason is the lack of scale and balance sheets of the firms involved in the sector. Due to their uncertain future, there are less likely to invest in improvements. Furthermore, current contracting and procurement issues constrain innovation and flexibility in the practices. This condition urges the need for transforming the New Zealand construction sector to a more productive industry which can also boost the economy. Without proper attention to these issues, there would struggle to meet the medium demand of the industry. PWC report illustrated a number of areas for improvement, which can increase the overall productivity of the industry. These initiatives include increasing the use of standardised contracts, integrating D&B procurement and procuring at the scale of the economic objectives. Moreover, the industry can benefit from further investment in training, innovation and promoting better contracting practices.

During the past decades, the New Zealand government tried to reduce the risks by employing traditional methods of project delivery. This approach separates different participants of the project. However, the government can broadly benefit from a more integration between design and build, which provides flexibility, better communication and more innovation throughout the project.

3. Chapter three - Literature review

2.1 Introduction

This chapter reviews the general information about construction tender evaluation and history of contractor selection procedures. It has been structured into four key sections of an overview of construction Contractor Selection (CS), tender evaluation methods, assessment criteria and research gaps. First, the key components of CS and related processes will be introduced. The chapter then explores the background and history of CS in construction procurement. To establish a better understanding of the elements of construction CS, related subjects include evaluation techniques, and assessment criteria will be demonstrated. Finally, the last section discusses the advantages and disadvantages of different processes and current issues that need to be addressed in the research.

2.2 Overview of CS

The construction industry is developing rapidly and becoming extremely competitive. To ensure the successful delivery of the project, advances in technology need to be matched by the processes that are used to procure buildings (Morledge & Smith, 2013; Masterman, 2003). A well-documented procurement strategy, based on professional analysis, is a vital step toward successful delivery of construction projects (Watt et al. 2009; Morledge et al. 2013; New Zealand government 2013]. The most vital step in construction procurement is contractor selection (Darvish 2008).

Martin et al. (2016) stated that Contractor Selection (CS) is deemed by most of the clients to be the most important element in construction delivering strategy. Selecting the most appropriate contractor will potentially increase the probability of delivering the right project at the right time with sufficient quality (Chiang, 2017; Rashvand, 2015; Holt, 2010; Kashiwagi, 2002). A diligently conducted tender proceeding allows for avoiding various problems which may occur during the execution phase of the project (K. C. Lam, E. Palaneeswaran, & C.-y. Yu, 2009).

The correct execution of the tender proceeding, based on a comprehensive analysis of the bidders, will increase the probability of delivering the project successfully. Since tender evaluation problems are multi-criteria in the formulation, designing a proper model is not easy. It contains different variables require clients to make a judgement between competing objectives and limited resources (M. Sönmez, J. Yang, & G. D. Holt, 2001b). More complex projects require more variables to consider, necessitating the use of more advanced mathematical models and more powerful algorithms working at a higher level.

2.3 Key components of CS

CS, in its simplest form, consists of three different approaches of pre-tender, pre-qualification and tender evaluation. However, each of these approaches can be extended to a various range of processes (Figure 7). Although different protocols of public tendering exists, some steps such as defining the project objectives, selecting the assessment method and evaluation criteria are key components of CS.

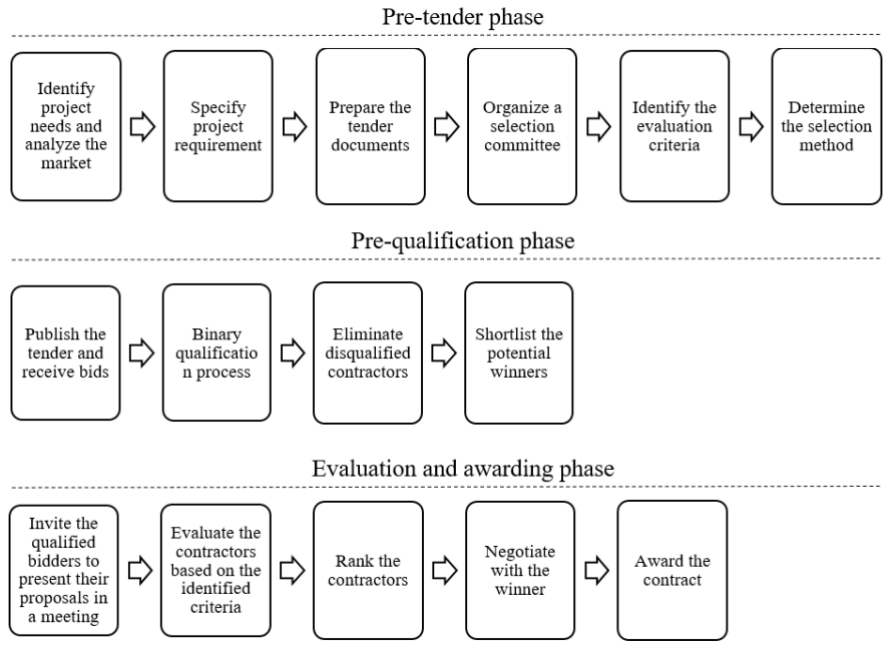

Figure 7 - Contractor selection phases

2.1.1 Pre-tender

CS process takes place in the early stages of a construction project and is plagued with many uncertainties (Elsayah, 2016). Thus, setting strategic direction and identifying the project requirements is a vital step toward successful delivery of the job. Especially, government entities are encouraged to develop an overarching procurement strategy for managing public funds. To achieve optimal outcome in construction projects, the clients should make sure that the right people are doing the right activity at the right time. This objective requires the early engagement of the clients and their consultants to identify the stakeholders, the project team and project objectives to design a proper management framework.

At the very first stages of any project, it is vital to conduct analysis and find the key internal and external stakeholders. New Zealand's mastering procurement guideline divided the public project's stakeholders into five groups.

1. Responsible: People who are responsible for delivering the project successfully.

2. Accountable: People who have the ultimate authority.
3. Supportive: People who do physical work.
4. Consulted: People whose input secure the successful implementation of the tasks.
5. Informed: People who are not involved in decision-making procedures but need to be notified.

Another essential activity in pre-tender phase is to assemble a team of stakeholder representatives. Depending on the nature and complexity of the project, the size and composition of the teams may vary significantly. Especially in more complex projects, usually, a proper mix of skills and knowledge is required to appropriately plan, manage and execute the procedures.

Next step is identifying the project needs, which requires research and analysis of the client objectives. A statement of needs consists of key elements such as the projects purposes, impacts, major internal clients and external users should be recorded. This statement should later be developed into a detailed specification of needs to inform participants about the nature and scope of the project, risks and sustainability impacts of the construction project. Furthermore, the market should be closely monitored and analysed to develop a comprehensive understanding of the market and what impacts does it have on the overall procurement strategy (Development, 2011). Finally, the tender documents should be prepared by considering an appropriate approach to the market, establishing a selection committee and finding proper evaluation methods and criteria.

2.1.2 Pre-qualification

Financial problems, poor management and over-commitment, are among various reasons that construction projects are still witnessing failure from the contractor side (Doloi, 2009). The main objective of the pre-qualification phase is to eliminate unqualified candidates and restrict the number of eligible contractors involved (Ksiazek & Ciechowicz, 2016). Pre-qualification is a vital step in construction CS. A well-performed pre-qualification can assure clients that the shortlisted contractors are highly likely to be able to complete the project successfully (Abdelrahman, Zayed, & Elyamany, 2008; Jafari, 2013).

In complex and high-value projects, pre-qualification is crucial for both contractors and clients, as it targets towards best value (G. Holt, 2010). Its approach can also assist contractors in discovering strength as well as areas for improvement in the company. Palaneeswaran et al. 2000 considered some objectives of pre-qualification as follows:

- To eliminate contractors who are not responsive, responsible and competent.
- To enhance and assure bidding opportunities for ‘‘eligible” contractors.
- To encourage healthy competition among ‘‘eligible” contractors.

- To minimise risks of contractor failure and improve client satisfaction.
- To optimise the CS regarding achieving a better balance between price and performance parameters.

This procedure is often a before-tendering CS method in many countries (Edyta Plebankiewicz, 2010). It usually defines as registration of capable contractors. However, identifying a model that comprise all the conditions of pre-qualification is a difficult process (Edyta Plebankiewicz, 2010). Various criteria should be selected, scaled and evaluated. This evaluation procedure is usually subjective and ambiguous.

To date, there are numerous researches carried out in different countries to identify the best set of criteria for pre-qualification. For instance, Doloi 2009, determined relative importance and impacts of different attributes using factor analysis and identified seven most significant factors in Australian pre-qualification stages. These attributes include (1) soundness of business and workforce; (2) planning and control; (3) quality management; (4) past performance; (5) risk management; (6) organisational capability; and (7) commitment and dedication.

To recognise the attributes that have the most impacts on construction pre-qualification (Edyta Plebankiewicz, 2010) explored the procedure of tendering in Poland. In this study, financial standing, Technical ability, Management capability, Health and safety, and Reputation have been identified as the dominant attributes in Poland's pre-qualification process.

The nine criteria that Jafari 2013 pointed out by evaluating construction pre-qualification in Iran are Work experience, Technology and equipment, Management, Experience and knowledge of the technical staff, Financial stability, Quality, Being familiar with the area or being domestic, Reputation, Creativity and innovation. Moreover, in that study, a pre-qualification score calculation matrix has been suggested using the Quality function deployment (QFD) method. QFD is a method to systematically evaluate the contractor's capability to satisfy the client's needs using a series of matrics (Y.-K. Juan, Y.-H. Perng, D. Castro-Lacouture, & K.-S. Lu, 2009).

2.1.3 Evaluation of bids

The construction is characterised by cost and duration overruns, serious problems in quality standards and safety measures, and an increased number of claims, counterclaims, and litigation (Chan, Scott, & Lam, 2002). To minimise or optimise all these risks, selection of an appropriate contractor to deliver the project under consideration as per requirements is the most crucial challenge faced by any construction client (Chiang et al., 2017; Doloi, 2009; Darvish et al., 2009).

However, the decision-making problem is multi-criteria in the formulation. It contains different variables require clients to make judgements between competing objectives and limited resources. Previous studies illustrated that many failures associated with construction projects were

attributed to the lack of effective tools to properly measure contractors before awarding the contract (Kashiwagi & Byfield, 2002; Zavadskas et al., 2008; Darvish et al., 2009). These tools vary significantly and are typified by Non-linearity, uncertainty, subjectivity and volatility (G. Holt, 2010). How effective these measures could work is subject to how efficiently the knowledge could be absorbed.

2.1.1.1 Lowest price

Lowest price has been considered as the most basic technique of tender evaluation. In this approach, the total price of each offer is the sole criteria of the CS. This methodology is being used when quality and other attributes are not deemed important, and the price is the main concern (Development, 2011). The lowest price is often not recommended for complex construction projects where wider elements of value for money are important.

It has been proven that choosing contractors based on the lowest initial bid will expose the client to an increased risk of post-contract claims and cost over-runs because most of the times contractors desperately quote low prices by reducing project quality (M Sönmez et al., 2001a). Thus, multi-criteria selection methods became more popular to overcome the issue that the lowest tendered price does not guarantee the lowest project cost (G. Holt, 2010; ALPTEKİN, 2014).

During the past decades, the lowest price method has altered to the Best-Value (BV) approach to award contracts in many countries (Hasnain, Thaheem, & Ullah, 2017; Wang et al., 2013; Palaneeswaran, Kumaraswamy, & Ng, 2003). For instance, the Australian government implement a two-stage process to assess contractors. First, they evaluate applicants based on some mandatory criteria and then opening the proposed price envelope (Darvish et al., 2009). In some countries such as Italy, Portugal, Peru, South Korea and Denmark, the closest proposed prices to the average will remain in the competition, and the highest and the lowest prices will be excluded (Wang et al., 2013; Enshassi, Mohamed, & Modough, 2013).

2.1.1.2 Price-quality methods

The Price-quality method is a tendering tool to consider both price and quality attributes of the construction contractors. PQM should be used where clients determine that best value for money will be obtained by having contractors compete on both price and non-price criteria. In this approach, decision-makers try to find the most suitable contractor by translating qualitative attributes into quantitative scores and combine it with the price score. This is a common methodology in public projects. Both price and non-price attributes will be given weightings and scores based on their importance. To choose the best contractors, it is indispensable to attain their ranking. Mathematical models are used for this purpose.

Decision-makers assess contractor's attributes against different criteria (G. D. Holt, 1998). A series of decision models based on various approaches were developed to estimate the value of contractors regarding the specific project, such as Multi-Attribute Analysis (MAA), Graph Theory and Matrix (GTM), Artificial Neural Network (ANN), Analytical Hierarchy Process (AHP), Analytic Network Process (ANP), Fuzzy Set Theory (FST) and Multivariate Discriminant Analysis (MDA) (G. D. Holt, 1998; Palaneeswaran & Kumaraswamy, 2000; Chan et al., 2002). The following context briefly explains some of the routine CS methods. It is expected that these reviews on CS methods will assist the research in finding suitable approaches to the suggested model.

This research identified, collected and recorded 16 methods from reviewing 26 papers on the topic of CS evaluation models published from 2007 to 2018. These methods have been summarised into three categories of Mathematical models, Artificial Intelligence (AI) models and Hybrid models (See Figure 6 and Table 3).

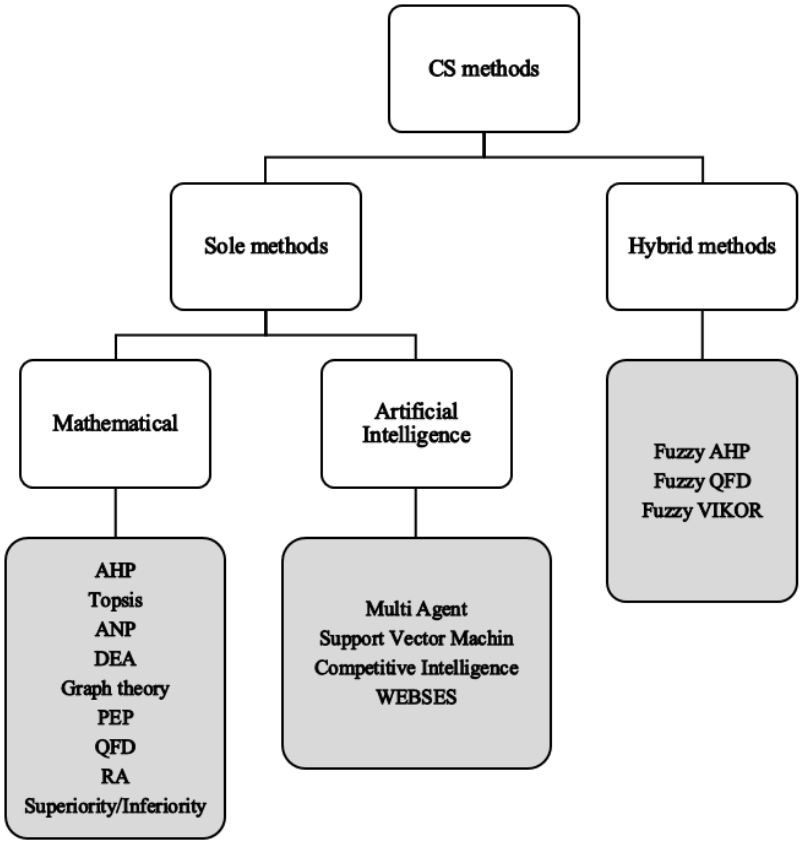

Figure 8- proposed categories for CS models

2.1.1.1.1 Mathematical

Mathematical Decision-Making (MDM) is a process which deals with numerical measures to make comparisons between different alternatives (Jaskowski, Biruk, & Bucon, 2010). In MDM, the process of integration of the desirability and probability in the different phases of decision-making is less complicated than AI and Hybrid approaches. However, the MDM approaches are applicable only after setting up the preferred goals, identify various alternatives and setting up the domain of the decision (Jaskowski et al., 2010). In other words, changes in the decision variables required repeating the procedure.

During the past decades, several MDM methods have been developed. The reviewed articles illustrated that AHP is the most published method from 2007 to 2018. From 2007, AHP was the most often used approach (27%) followed by TOPSIS (10%) and Fuzzy VIKOR (7%). Wang et al. (2013), Abdelrahman (2008), Chiang et al. (2017), have reviewed the application of AHP method in CS (Chiang et al., 2017; Wang et al., 2013; Abdelrahman et al., 2008). Their results indicate that the AHP method applies to support group decision-making and can increase group satisfaction in the process.

Due to their simplicity, AHP-based approaches are becoming more popular (G. D. Holt, 1998; Książek & Ciechowicz, 2016). When decision making involves interdependencies between attributes in complicated decision-making problems, the hierarchical structure may need to be remodelled (Pan, 2008). Although in most of the researches, attributes are assumed independent, Fong et al. (2000) demonstrated that selection criteria are interrelated to a certain extent and should be evaluated by generic analytic methods such as analytic network process (ANP). On the other hand, ANP requires a lot of calculations and pair-wise comparison metrics to demonstrate a meaningful result (Baykasoğlu, Özbay, Göğüş, & Öztaş, 2009).

To explore the impacts of the consistency limits of AHP on CS Martin et al. (2018), determined whether the traditional AHP (CR 0.1) and weakly consistent AHP (CR 0.5-0.1) produce the same result (Martin, Koylass, & Welch, 2018). The importance of the TOPSIS method in CS decision-making is evident from the works of San Cristobal (2012), Zavadiskas (2010) and Alptekin (2017) (Orkun Alptekin & Alptekin, 2017; San Cristóbal, 2012; Zavadskas, Vilutiene, Turskis, & Tamosaitiene, 2010; O. Alptekin, 2014; Zavadskas et al., 2008). The basic principles of this method are that the chosen alternative should have the shortest distance from the ideal solution and the farthest distance from the negative- ideal solution (Orkun Alptekin & Alptekin, 2017; O. Alptekin, 2014)

El-Abbasy et al. (2013) have provided the ANP method to prioritise CS criteria for a highway project in Egypt. ANP is the general form of AHP. However, unlike AHP, this method provides inner and outer dependencies between assessment criteria (El-Abbasy, Zayed, Ahmed, Alzraiee,

& Abouhamad, 2013) Yang et al. (2016) have developed a systematic method to support CS, utilising Data Envelop Analysis (DEA) to facilitate the assessment of each contractor during the short-listing stage (Yang, Wang, Wang, & Ma, 2016). DEA is a non-parametric method that can measure the efficiency of the alternatives (Emrouznejad & Yang, 2018; Ramezani-Tarkhorani, Khodabakhshi, Mehrabian, & Nuri-Bahmani, 2014). In CS problems, DEA can develop a function to determine the most efficient contractor.

Based on three case studies related to service procurement projects, Yang et al. (2016) demonstrated that the DEA method is an effective tool to evaluate and select contractors (Yang et al., 2016). The study conducted by Darvish et al. (2009) shows that how the graph theory and matrix can be applied as an analysis method for CS, specifically suitable when interdependency of the attributes are of the interest. This method can convert variables and their interdependencies into a mathematical form that can help DMs to determine the numerical index (Darvish et al., 2009)

In addition to the above-mentioned methods, four more mathematical CS methods have been identified in the reviewed literature namely, Price Elasticity of Performance (Yu et al. 2012), Quality function development (Jafari 2013), Regression Analysis (Doloi 2009) and superiority and Inferiority ranking model (Jafari, 2013; Doloi, 2009; Marzouk, 2008).

Table 2- Assessment of identified CS methods published from 2007 to 2018

Selection method	No. of publications	Relative percentage of the method	Global percentage of all publications in CS
Mathematical	17	65	40
AHP	7	27	16.5
TOPSIS	3	12	7.5
ANP	1	4	2.5
DEA	1	4	2.5
GRAPH THEORY	1	4	2.5
PEP	1	4	2.5
QFD	1	4	2.5
RA	1	4	2.5
SUPERIORITY/INFERIORITY	1	4	2.5
AI	5	19	12
MULTI AGENT	1	4	2.5
SVM	1	4	2.5
CI	1	4	2.5
WEBSES	2	8	5
Hybrid	3	12	7
FUZZY VIKOR	1	4	2.5
FUZZY AHP	2	8	5
FUZZY QFD	1	4	2.5

2.1.1.1.2 AI:

AI refers to the machine's ability to replicate the cognitive functions of a human being. It can learn and solve problems (Ghahramani, 2015). Various scholars suggested that AI will substantially raise the value of human judgement in the decision-making process (McGovern et al., 2017; Power, Sharda, & Burstein, 2015).

AI methods in CS are trying to predict the future performance of the potential contractors by evaluating a large amount of data from their previous performance. Prediction is useful because it helps improve decisions. However, even the best AI systems make mistakes (Tshilidzi, 2015), and since all the results have been measured and generated by machines, it is very difficult to interpret the reasons for disqualifying a contractor.

To automate tender evaluation procedures, Kog et al. (2016), introduced Multi-Agent Systems (MAS), which is the next generation of knowledge-based systems (Kog & Yaman, 2016). MAS interacts with its environment, learns upon obtaining new data and act to achieve the objectives of the construction project. To explore the prospective potential of using robust Support Vector Machine (SVM) method for CS, Lam et al. (2009) compared the performance of SVM with Artificial Neural Network (ANN) outcomes (K. C. Lam, E. Palaneeswaran, & C. y. Yu, 2009).

In this study, initially, a pilot modelling with hypothetical datasets has been explored. In the second phase, the applicability of the framework was examined by considering the suitability of three non-linear Kernel functions and validation for generalisation by using further practical datasets. Their results demonstrate encouraging the potential for SVM application in procurement problems such as CS. Arslan et al. (2012) and Safa et al. (2015) developed a web-based system and Competitive Intelligence (CI) system respectively, to improve the process of assessing and selecting contractors (Safa et al., 2015; Arslan, 2012).

2.1.1.1.3 Fuzzy Hybrid:

CS problems may have to be solved in the absence of precise information (Nieto-Morote & Ruz-Vila, 2012). Various scholars suggested that to achieve this goal, the evaluation process could you Fuzzy logic to model uncertainty and imprecision (Plebankiewicz, 2014; Nieto-Morote & Ruz-Vila, 2012) Fuzzy set and probability theory introduced by Lotfi Zadeh in 1965 attempts to predict future performance based on previous events (Hosseini Nasab & Mirghani Ghamsarian, 2015; Chan, Chan, & Yeung, 2009). Although, because of temporary nature and uniqueness of each project, it is difficult to predict the exact events, Fuzzy Sets can model human judgements and reduce the imprecision and uncertainty (Chan et al., 2009).

Hosny et al. (2013) and Jaskowski et al. (2010) have provided Fuzzy AHP method to the process of group decision-making in CS procedure (Hosny, Nassar, & Esmail, 2013; Jaskowski et al.,

2010). Their results show that a Fuzzy extension of AHP method enables the user to analyse the CS problems in details in terms of precision of estimation and evaluation consistency. However, it allows the user to find a solution even if some DMs are unable to provide a complete set of pairwise comparisons. The fuzzy extension of mathematical decision-making models is suitable for dealing with imprecision and uncertainty of the input data.

In a universal set of discourse X, a fuzzy subset A of X is defined by a membership function $\mu_A(x)$ which maps each element x in X to a real number in the interval (M Sönmez et al., 2001a) (Nieto-Morote & Ruz-Vila, 2012). The concept of these fuzzy sets plays a fundamental role in those decision-making problems, in which it is difficult to provide exact numerical values for the decision variables. Juan et al. (2009) and Vahdani (2013) studied the Fuzzy extension of QFD and VIKOR to design a framework to solve CS problems (Vahdani, Mousavi, Hashemi, Mousakhani, & Tavakkoli-Moghaddam, 2013; Y. K. Juan, Y. H. Perng, D. Castro-Lacouture, & K. S. Lu, 2009). A comprehensive review of the advantages and disadvantages of CS methods are illustrated in table 4.

Results illustrated that AHP and TOPSIS methods could be useful methods to solve MCDM problems. Thus, a combination of these two methods has been used in this research to design a tender evaluation framework later in the study. The primary reason for selecting the AHP method was that it is an appropriate method for solving complex decision problems, particularly for weighting multiple variables. The rationale to choose TOPSIS is that it has been proven that it is a reliable tool to clarify a solution from several alternatives by considering multiple dimensions of the problem. The following sections contain the definition and steps of applying AHP and TOPSIS techniques in decision-making problems.

2.1.1.1.1.1 AHP

The AHP is a systematic procedure to determine the relative importance of various decision criteria to help DMs select the best alternative among different alternatives (Saaty, 1978). This approach is based on decision theory and can be advantageous for weighting numerous attributes and selecting a lead concept among alternatives. This method has been applied to many areas of construction management such as the selection of the projects, ranking of the projects, facility location and improving construction productivity (Wang et al., 2013; Doloi, 2009)

This study explores the application of AHP in CS. By breaking CS problems down into a structured gradual step, users can connect through paired comparison judgements of DMs. Initially, the list of potential criteria should be identified by DMs. To determine which of these criteria are more important in the targeted project, the next step of AHP is to organise a pairwise weighting matrix (PWM).

$$\text{PWM} = \begin{bmatrix} 1 & s_{12} & \cdots & s_{1n} \\ \frac{1}{s_{12}} & 1 & \dots & s_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{s_{1n}} & \frac{1}{s_{2n}} & \cdots & 1 \end{bmatrix}$$

Given n elements at a hierarchical level, PWM is an nxn matrix. The importance of criteria is pair-wisely compared to each DMs to determine criteria weights. The ranking system for pairwise comparison proposed by AHP is 1-9, which represents the user's judgement of the relative importance of the criteria c_i over c_j (See Table 5).

Table 3 - A proposed ranking system for pairwise comparison

Numerical rating	Verbal judgments of preferences
1	Equally preferred
2	Equally to moderately
3	Moderately preferred
4	Moderately to strongly
5	Strongly preferred
6	Strongly to very strongly
7	Very strongly preferred
8	Very strongly to extremely
9	Extremely preferred

If c_i and c_j considered to be equally important, the proposed value S_{ij} would be equal to 1. If c_i considered to be more important than c_j, then S_{ij} Would be >1. Thus, the PWM is a reciprocal matrix obtained by pairwise comparison of each pair of criteria. To generate the vector of weights, users should determine the principal eigenvector V' corresponding to the maximum Eigen value λ_{max} to obtain the V' each column should be normalised and then taking the average of each resulting rows.

$$V' = \begin{bmatrix} V_{11} \\ V_{12} \\ \vdots \\ V_{1n} \end{bmatrix} = \frac{1}{n} \sum_j \left(\frac{s_{ij}}{\sum_i s_{ij}}\right)$$

However, DMs judgement may not be consistent with one another, and the aggregation weight vector may be invalid. Thus, a minimum level of consistency ratio should be demonstrated in the matrix. The consistency value will be determined by eigenvalue, λ, to calculatethe consistency index of the matrix.

$CI = \frac{\lambda_{max} - n}{n-1}$

In the next step, Consistency Ratio (CR) will be determined by dividing CI by the average Random consistency Index (RI) (See Table 6).

$CR = \frac{CI}{RI}$

Table 4- Average Random Consistency (RI)

Size of matrix (n)	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
Random consistency	0.0	0.0	0.58	0.90	1.12	1.24	1.32	1.40	1.45	1.49	1.51	1.48	1.56	1.57	1.59

RI is a constant value for an nxn reciprocal matrix, which results from a computer simulation. If CR>1, the reassessment cycle of assigning numerical values to pairwise comparison is required until CR<0.1.

2.1.1.1.1.2 TOPSIS:

Developed by Hwang & Yoon (Yoon & Hwang, 1995), TOPSIS is one of the effective Multi-Criteria Decision-Making (MCDM) techniques to identify the priorities among alternatives. TOPSIS selects the alternative which is the closest to the positive ideal alternative (one which has the best alternative value) and farthest from negative ideal alternative (one which has the worst attributes value). The TOPSIS procedure includes the following steps:

1) In the first step, the user should construct the mxn decision matrix D, where m is the number of alternatives and n is the number of criteria.

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array}$$

2) The second step is to calculate the normalisation value (r_{ij}) of the decision matrix D.

$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$, i= 1,…,m ; j= 1,…,n

Where x_{ij} is the value of the alternative i for the criteria j. The resulted normalisation matrix R would be as follows:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \ldots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

3) In the third step, the weighted normalised decision matrix should be formed as

$V_{ij} = w_i r_{ij}$, i=1,…,m ; j=1,…,n

Where w_i is the weight of the criterion j.

4) To determine the positive ideal solution (A^*) and negative ideal solution (A^-), maximum and minimum values of the ……. Should be identified.

$A^* = \{V_1^*, V_2^*, \ldots, V_n^*\} = \{(max_j V_{ij} | i \epsilon I'), (min_j V_{ij} | i \epsilon I'')\}$

$A^- = \{V_1^-, V_1^-, \ldots, V_1^-\} = \{(min_j V_{ij} | i \epsilon I'), (max_j V_{ij} | i \epsilon I'')\}$

Where I' is associated with non-price attributes, and I'' is associated with price attributes.

5) The distance of each alternative from the ideal solution and the negative ideal solution should be calculated as follows:

$$D_i^* = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^*)^2} \quad , i=1, 2, \ldots, m$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^-)^2} \quad , i=1, 2, \ldots, m$$

6) The next step is to calculate the closeness coefficient (C_i^*) of each alternative

$$C_i^* = \frac{D_i^*}{(D_i^* + D_i^-)}$$

7) In the final step, the user can rank the preference order of the alternatives by sorting their closeness values C_i^* and identify the best-ranked alternative by the measure.

A comprehensive review of the advantages and disadvantages of CS methods are illustrated in table 2. This literature was identified via online selected research databases. Academic journals were more emphasised since they represent the most important wealth of literature. The decision regarding a paper relevance to this study was a subjective one based entirely on the author's experience. Also, it should be mentioned that Articles published before the year 2000 were eliminated to only consider contemporary issues. It is hoped that this review will draw DM's

attention to the area of different CS methods and provide a basis for new ideas on group decision-making techniques in construction.

Table 5 - Advantages and disadvantages of the identified methods

METHOD	ADVANTAGES	DISADVANTAGES	REFERENCES
Analytical Hierarchy Process (AHP)	• Deal with qualitative data as well as quantitative data • Hierarchical structuring of the CS to simplify the problem • Relatively accurate method in identification of criteria relative weights • Ability to measure DMs consistency • Deal with group decision-making • Process multiple criteria simultaneously	• Low score in one attribute can be neglected by a high score in another attribute • Does not allow to review cluster priorities • The pairwise comparison might not be the ideal comparing method for DMs comparing to other methods such as ranking etc. • Resulted consistency index might challenge the DMs to reconsider inputs	(Wang et al., 2013; Jaskowski et al., 2010; Abdelrahman et al., 2008; Chiang et al., 2017; Martin et al., 2018; Hajek, Vrbova, & Kolis, 2017; Ksiazek & Ciechowicz, 2016)W.-C. Wang et al., 2013; Jaskowski et al., 2010; Abdelrahman et al., 2008; Chiang et al., 2017; Martin et al., 2018; Hajek, Vrbova, & Kolis, 2017; Ksiazek & Ciechowicz, 2016)(M. SÖNmez, J. B. Yang, & G. D. Holt, 2001 23-25, 45, 46)
Analytic Network Process (ANP)	• ANP is a generalisation of AHP • Find interconnections and multi-directional relation among attributes • Allows for feedback connections and loops	• Low score in one attribute can be neglected by a high score in another attribute • Need a lot of complex calculations • Very time-consuming • Require specific software's	(El-Abbasy et al., 2013)
CI	• Integrates knowledge management and helps to gather and applying information • Reduces DM bias because it provides third-party assessment	• There is no standard definition of CI and experts have different views on CI • Cannot be used as a sole method and requires the use of strategic analytical tools • Highly dependent on the quality of the integrated sources • Due to the one-off nature of construction projects, not all the steps of CI models apply to every project	(Safa et al., 2015)
DEA	• Non-parametric model • Avoid the subjectivity issue of the problem • Help to reduce uncertainty • Can deal with both linear and nonlinear data	• It does not find the best contractor, but just produces a list of potential winners who are all ranked the same • Acquire an extensive knowledge of mathematics • Long learning process to understand	(Yang et al., 2016)

		• Has the problem of so-called equal-weight effect • When the number of considered criteria increases, the DEA process can get very sophisticated • Cannot operate properly as a sole method and should be combined with other methods • Cannot deal with missing data • Require specific software's	
Fuzzy AHP	• Helps to make quantitative predictions • Can cope with DMs subjective judgment • Help to reduce uncertainty • Consider nonlinear relation between attributes	• Long learning process to understand • Acquire an extensive knowledge of mathematics and probability models	(Jaskowski et al., 2010; Hosny et al., 2013)
Fuzzy QFD	• considers project's requirement in addition to contractor's attributes • Can deal with qualitative and quantitative data • Can cope with DMs subjective judgment • Help to reduce uncertainty	• Does not allow to review cluster priorities • Long learning process to understand • Acquire an extensive knowledge of mathematics and probability models	(Y. K. Juan et al., 2009)
Fuzzy VIKOR	• Deal with qualitative data as well as quantitative data • Deal with group decision-making • Process multiple criteria simultaneously • Help to reduce uncertainty	• Does not allow to review cluster priorities • Does not calculate the consistency of the DMs • Complex nature • Long learning process to understand	(Vahdani et al., 2013)
Graph theory and matrix (GTM)	• Incorporate interdependencies between attributes • Can deal with qualitative and quantitative data • Visualize various criteria and their interrelations	• Does not consider all the possible factors and their effects on the result • Long learning process to understand • Does not allow to review cluster priorities	(Darvish et al., 2009)
Multi-Agent System (MAS)	• Learns upon obtaining new data • Ability to update stored data and improve • Can cope with DMs subjective judgment • Help to reduce uncertainty	• Cannot operate as a sole method and should be combined with other methods, ie. Regression analysis as learning mechanism • Depends on negotiation models, ie. MASCOT • Heavily rely on controlling parameters and historical data	(Kog & Yaman, 2016)

PEP	• Measure the heterogeneity of the market • Avoid the subjectivity issue of the problem • Help to reduce uncertainty	• Need a supportive method, ie. SAW • Just dealing with quantitative data • Price information and performance information are assumed available before the decision is made • Require lots of calculations	(Yu & Wang, 2012)
QFD	• considers project's requirement in addition to contractor's attributes • Can deal with qualitative and quantitative data • Visualize various criteria and their interrelations	• Does not allow to review cluster priorities • Does not consider all the possible factors and their effects on the result • Long learning process to understand	(Jafari, 2013)
Regression Analysis	• Dealing with entire variables simultaneously • Can estimate the probability of dependent variable based on one or more independent variables • Can deal with different statistical distributions • Provide an early warning of contractor likely performance	• Just dealing with linear variables • Cannot operate properly as a sole method and should be combined with other methods • Cannot deal with missing data • Just dealing with quantitative data • Complexity of framework • Fail to check inconsistency and inaccuracy of data	(Doloi, 2009)
Superiority (SIR)	• Deal with qualitative data as well as quantitative data • Deal with group decision-making • Process multiple criteria simultaneously	• Cannot operate as a sole method and should be combined with other methods to obtain Superiority and Inferiority flows • Require computer software • Long learning process to understand • Does not allow to review cluster priorities	(Marzouk, 2008)
Support Vector Machine (SVM)	• Minimising the risk of choosing an inappropriate contractor • Can deal with both linear and nonlinear data • Ability of accurate prediction • Can cope with DMs subjective judgment	• Construction projects are one-off and not easy to adopt new solutions based on previous problems • System needs training and testing of data • User knowledge level is highly important •	(K. C. Lam et al., 2009)
TOPSIS	• Deal with qualitative data as well as quantitative data • Deal with group decision-making	• Low score in one attribute can be neglected by a high score in another attribute • Does not allow to review cluster priorities	(Orkun Alptekin & Alptekin, 2017; Zavadskas et al., 2010; San Cristóbal, 2012)

	• Process multiple criteria simultaneously	• Does not calculate the consistency of the DMs	
Web-based system	• Speed up the process • Facilitate information transfer effectively • User-friendliness of the system	• Low score in one attribute can be neglected by a high score in another attribute • Does not allow to review cluster priorities • Require specific software's • Uses SAW method which has been considered inefficient by many scholars	(Arslan, Kivrak, Birgonul, & Dikmen, 2008; Arslan, 2012)

2.4 Common criteria for CS

Although there are various methods for CS, these techniques are inapplicable without a well-defined collection of decision criteria (Jafari, 2013). Tender evaluation procedures, when addressed by an appropriate set of criteria, can offer more rational construction projects where clients can effectively employ the contractor with the better potentials and increase the probability of delivering the project successfully.

The efficiency of the CS process is often associated with the appropriate choice of CS criteria. Hatush 1996 categorized the information required to evaluate the contractor's ability into five groups, include general information, financial viability, technical capability, management, and health and safety information.

- General information defines the administrative details related to the legal standing of the company, trade association membership, litigation tendency, size, age, etc.
- Financial viability is one of the most notable information required for construction projects. This category signifies the ability of the contractor to manage capital crises and exposure of the company for different contracts by considering financial statements and other information (Hatush 1996, Watt 2009, Elsayah 2016). Elsayah 2016 divided financial credibility further into four subcategories of tender price, banking arrangements, financial statue and positive credit rating.
- Technical capability is the category that evaluates the contractor's capacity to achieve project objectives. It usually considers current commitments of the contractor, human resources and equipment and ability to handle the type, quality and size of the project (Hatush 1996, Elsayah 2016).
- Management is highly important because it can increase the chances of successful delivery of the project (Watt 2009). Clients consider the contractor's ability to manage risk, strategy, organization, resources and documentation.

- Health and safety is a priority in the construction industry since this sector has the highest accident-related records comparing to other industries. Construction clients evaluate the contractor's health and safety protocols to support the desired performance of the project and reduce costs. Elsayah 2016, divided health and safety to four sub-categories of safety records, company safety policy, experience in noise control and the Occupational Safety and Housing Administration (OSHA).

The topic of identifying the most effective set of price/non-price attributes for CS has been an active area of research for decades. Hajek et al. (2017) evaluated 1,292, construction projects contract notices, assessed according to economic advantageousness of the tender. They identified five core criteria of "quality", "time", "financial aspects", "terms and conditions", and "guarantees" to be considered as CS criteria (Hajek et al., 2017). An invaluable study belongs to Watt et al. (2009), who included critical literature and an exploratory survey to identify a suite of representative tender evaluation criteria. Their results demonstrated that attributes that measure the contractor's ability in terms of past performance, technical expertise, reputation and proposed methodology are the preferred criteria for CS (Watt et al., 2009). In one of the most cited articles on CS, Jaskowski et al. (2010) determined the divergence of five decision criteria used by Polish tender evaluation DMs namely: "Manpower & equipment", "Financial capacity", "previous performance", Organizational experience", and "Certified management systems" (Jaskowski et al., 2010).

This stage of the study sought to investigate the targeted articles to establish a comprehensive list of CS criteria which reflects specific needs of construction projects. Reviewing the targeted publications, 28 papers (66%) identified reporting decision criteria for tender evaluation problems. Eventually, 140 criteria were recorded which assigned to 13 categories namely; "Appreciation of the task", "Client-supplier relations", "Financial viability", "Health, safety and Environment (HSE)", "Management systems and skills", "Methodology", "Organization and relevant experience", "Past performance and track records", "Price", "Reputation", "Resources and workload", "SME location" and "Technical skills". Similarly described criterions listed into a category that best represent their characteristics. Table 7 illustrates the identified list of criteria.

Table 6- Identified criteria published from 2007 to 2018

CRITERIA	CRITERION	DEFINITION	REFERENCES
Organisation and Relevant experience	Age(years from establishment), size, Number of related	General information about the contractor's organisation such as age, size, and previous	(Ksiazek & Ciechowicz, 2016) (Watt et al., 2009) (Watt et al., 2010) (Arslan, 2012) (Vahdani et al., 2013) (Li, Chen,

	Experience, Size and Type of Projects Completed, Role of the tenderer, duration of the project, Years in Similar Projects, Understanding of Regulations, Market Familiarity, Previous experiences with the project contract form	experiences in similar or different industries needs to be evaluated in this category. Historical experiences have less value than recent experiences.	& Nie, 2005; Shukery, Amirudin, & Sofield, 2016)(Li, Chen, & Nie, 2005; Shukery, Amirudin, & Sofield, 2016)(Ahmed, El-Adaway, Coatney, & Eid, 2016; Doloi, 2009; M. SÖNmez et al., 2001) (Marzouk, 2008) (Hosseini Nasab & Mirghani Ghamsarian, 2015) (Wang et al., 2013) (E. Plebankiewicz, 2010) (San Cristóbal, 2012; Singh & Tiong, 2006; El-Abbasy et al., 2013; Zavadskas et al., 2008; E. W. L. Cheng & Li, 2004; Rashvand, Majid, & Pinto, 2015; Semaan & Salem, 2017; Baykasoğlu et al., 2009; Darvish et al., 2009; Olaniran, 2015; Yang et al., 2016)
Financial Viability	Financial Soundness (Asset, profits, debts status), Financial Capacity, Financial stability, Insurances, return on net worth ratio, Business Turnover-Cash Flow, Analysis of Accounts, Bank Reference or Arrangements, Credit Rating, Liquidity Ratio, Profitability, Debit ratio, Flexibility in payment terms and conditions, profit growth rates,	This category focuses on issues surrounding financial stability and capacity of the contractor. The inadequate financial capability of a contractor may lead to unsatisfactory project outcome. Contractor's assets and profits, insurances, bank statements and previous arrangements will be assessed in this category.	(Ksiazek & Ciechowicz, 2016) (Arslan, 2012) (Vahdani et al., 2013) (Marzouk, 2008) (Hosseini Nasab & Mirghani Ghamsarian, 2015) (Doloi, 2009) (Wang et al., 2013) (E. Plebankiewicz, 2010) [San Cristóbal, 2012;Singh, 2006 ;El-Abbasy, 2013 ;Cheng, 2004 ;Rashvand, 2015 ;Enshassi, 2013 ;SÖNmez, 2001 ;Baykasoğlu, 2009 ;Darvish, 2009 ;Cheng, 2012 ;Yang, 2016 ;Kog, 2016]
Appreciation of the task	Desire for Business, Competitiveness, Contractor's view of Relative Importance in Providing Services	It has been proven that companies with a low interest in the job are more difficult to negotiate with and may increase the risk of failure. This category evaluates the desire of the contractor to compete and provide the required services.	(Watt et al., 2009)
Past performance and Track records	Time overruns, Cost overruns, Number of claims for variations, Satisfaction of previous clients, History of tendered price variations and final cost, Demonstrated Performance, History of Flexibility (Ability to accommodate design changes during	Contractor's performances in completing the previous projects and fulfil the requirements needs to be assessed. This assessment guides clients to forecast the likely future performance of the contractor.	(Lesniak, Plebankiewicz, & Zima, 2012; Ksiazek & Ciechowicz, 2016) (Watt et al., 2009) (Watt et al., 2010) (Vahdani et al., 2013) (Shukery et al., 2016) (Marzouk, 2008) (Hosseini Nasab & Mirghani Ghamsarian, 2015) (Doloi, 2009) [Wang, 2013] (E. Plebankiewicz, 2010) (Singh & Tiong, 2006, 2005; El-Abbasy et al., 2013; Zavadskas et al., 2008; E. W. L. Cheng

	design and construction period), Reliability, Past Failures, Performance History, records of cost reduction during past projects, History of post-delivery support		& Li, 2004; Enshassi et al., 2013; Walraven & de Vries, 2009; Baykasoğlu et al., 2009; M. Y. Cheng & Kang, 2012; Yang et al., 2016)
Management systems and skills	Management knowledge, Management Systems Implemented, ISO and other management certificates, Management structure, Documentation and reporting systems, Waste management and minimization systems, Onsite plant maintenance systems, Human resource planning systems, MIS level (Management Information System), Risk management method, Quality Control (QC) Policy, Implemented Quality Systems, R&D ability, Investment on R&D, Number of patents owned or transferred by the organization, Staff training program, Strategies for human resource developments, Reward and benefit distribution system, Professional qualification grade for managerial staff, Enterprise culture compatibility, Management cooperative desire, Level of investment in management systems	This category evaluates contractor's ability to manage the issues and considers possession of appropriate management personnel with required knowledge such as project development environment, quality management and risk management.	(Watt et al., 2009) (Vahdani et al., 2013) (Rashvand, Majid, et al., 2015) (Shukery et al., 2016) (Marzouk, 2008) (Doloi, 2009) [Wang, 2013] (E. Plebankiewicz, 2010) [San Cristóbal, 2012 ;Singh, 2006 ;Singh, 2005 ;Rashvand, 2015 ;Enshassi, 2013 ;SÖNmez, 2001 ;Wong, 2001 ;Semaan, 2017 ;Darvish, 2009 ;Cheng, 2012 ;Olaniran, 2015 ;Yang, 2016 ;Kog, 2016]
Technical skills	Project Management organisation and Skills, Project management tools, Qualifications, Cost control system, Project Management Ability, Management Competencies, Scope and Risk Control, Level of investment in training of staff, Experience of	Contractor's ability to project management skills and cost control needs to be assessed with emphasis on technical areas. The competence and experience of key technical and professional personnel and their availability should be evaluated.	(Watt et al., 2009) (Watt et al., 2010) (Arslan, 2012) (Vahdani et al., 2013) (Shukery et al., 2016) (Marzouk, 2008) (Hosseini Nasab & Mirghani Ghamsarian, 2015) [Wang, 2013] (E. Plebankiewicz, 2010) [Waara, 2006 ;Singh, 2005 ;Rashvand, 2015 ;Enshassi, 2013 ;SÖNmez, 2001 ;Wong, 2001 ;Darvish, 2009 ;Cheng,

	Technical Personnel, Technical Competence and Ability, Qualification of key staff, Availability and Experience of Technical Design Experts		2012 ;Yang, 2016 ;Kog, 2016 ;Arslan, 2012]
Resources/ Workload capacity	Current workload, Level of current resources (labour and equipment), Contractor Capacity, Current commitments, Equipment's technology	Sufficient and suitable human resources, technical equipment and intellectual properties help contractors to fulfil the requirements of the project. Clients should assess the resources (labour and equipment) that contractor proposed to use on the project.	(Watt et al., 2009) (Watt et al., 2010) (Rashvand, Majid, et al., 2015) (Shukery et al., 2016) (Hosseini Nasab & Mirghani Ghamsarian, 2015) [Singh, 2006 ;Singh, 2005 ;El-Abbasy, 2013 ;Cheng, 2004 ;Rashvand, 2015 ;Enshassi, 2013 ;Wong, 2001 ;Semaan, 2017 ;Baykasoğlu, 2009 ;Cheng, 2012]
Methodology	Understanding of objectives and key issues, Proposed Design, Technology Base, Functionality, Innovative ideas suggested, Reporting and recording systems suggested, Key performance indicators suggested, Division of works into subcontracts, Identification of risks (predict it, cost it, manage it, minimise it), quality plan, Life Cycle Requirements, Growth Capability, Cost-effectiveness, Compliance with Stated Needs or Requirements, Proposed System Solution, Plant/Equipment Type, adaptability and knowledge about new environment, Viability of Technical Solution, Waste reduction plan, Site safety assurance plan	The contractor should illustrate its capability to deliver the project on time, on budget and with satisfactory quality by describing the detailed methodology of approach. Any solutions, innovative ideas and risk allocations will be considered in this category.	(Watt et al., 2009) (Watt et al., 2010) (Rashvand, Majid, et al., 2015) (Singh & Tiong, 2006; Wong, Holt, & Harris, 2001; Walraven & de Vries, 2009; Y. K. Juan et al., 2009)
Price	Fixed capital Price, Labour Rates, Operating Costs, Variable tender costs during	This refers to the details of costs that the client would be required to pay to the contractor to bring the project	(Lesniak et al., 2012) (Ksiazek & Ciechowicz, 2016) (Watt et al., 2009) (Marzouk, 2008) (Doloi, 2009) [Wang, 2013] (San Cristóbal,

	project period, Maintenance costs, operating costs, Return and Benefits, Rationality of Estimates, Through Life Cost Program Methodology	to a satisfactory outcome. Depending on the contract, payments could include fixed capital cost or variable costs during the contract period or other payment methods.	2012)}(Waara & Bröchner, 2006; Singh & Tiong, 2005; El-Abbasy et al., 2013; Zavadskas et al., 2008; E. W. L. Cheng & Li, 2004; Enshassi et al., 2013; M. SÖNmez et al., 2001; Semaan & Salem, 2017; Walraven & de Vries, 2009; Y. K. Juan et al., 2009; Baykasoğlu et al., 2009; Yang et al., 2016)
Reputation	Amount of Past Business, Company Image and Size, Trade Union Record, Litigation Tendency, Organisational Maturity or Stability, References, Responsiveness, Business Ethics	An organisation with a good reputation will try to keep its good image in the business by delivering satisfactory results for the clients. In this section, clients assess contractors based on their trade records, references, responsiveness and their image in the industry.	(Watt et al., 2009) (Watt et al., 2010) [Wang, 2013] (E. Plebankiewicz, 2010) [Singh, 2006 ;Rashvand, 2015 ;Enshassi, 2013 ;SÖNmez, 2001 ;Darvish, 2009 ;Kog, 2016]
SME location and geographical familiarities	Business Location (location of home office), Area of Catchment (Local/National), Facilities Location, Familiarity with area and weather conditions, Familiarity with local labour, familiarity with local suppliers	One of the factors that clients usually consider is how close the contractor's company to the project site is. Local companies are usually more familiar with the area of the. Also, they can manage to employ local labour and identify local suppliers in a way, which can generate opportunities to increase employment rate in the region.	(Watt et al., 2009) (Arslan, 2012) (E. W. L. Cheng & Li, 2004; Wong et al., 2001; Darvish et al., 2009)
HSE (Health and Safety)	OHS&R management system, Corporate Environment Policy, Safety Plan, History of Safety Incidents, Occupational Health Safety Assurance (OHSA), Environmental Compliance, Safety Performance and standards, level of investment in HSE	Poor safety awareness and policies may result in serious injuries, huge costs or project delays. Thus, nowadays clients put more emphasis on Health and Safety management systems and plan to ensure the satisfactory implementation of safety standards.	(Watt et al., 2009) (Arslan, 2012) (Vahdani et al., 2013) (Shukery et al., 2016) (Marzouk, 2008) (Hosseini Nasab & Mirghani Ghamsarian, 2015) [Wang, 2013] (E. Plebankiewicz, 2010) [San Cristóbal, 2012 ;Singh, 2006 ;Singh, 2005 ;El-Abbasy, 2013 ;Cheng, 2004 ;Rashvand, 2015 ;Enshassi, 2013 ;SÖNmez, 2001 ;Semaan, 2017 ;Baykasoğlu, 2009 ;Kog, 2016]

Client-supplier relations	Client/Customer Attitude and Relations, Commitment to Support, Responsiveness Ability to Work as Team, Stakeholder Management, Customer Focus/Relationship, Post-contract attitude, Sub-contractor relations, Sub-contractor management systems	This category evaluates impacts of previous working relations among parties of the project. Any disputes and disagreements among different parties may cause deterioration in mutual trust and reduce the willingness to any compromise during the project.	(Watt et al., 2009) (Watt et al., 2010) (Vahdani et al., 2013) (Shukery et al., 2016) (Doloi, 2009) (Singh & Tiong, 2006, 2005; El-Abbasy et al., 2013; E. W. L. Cheng & Li, 2004; Rashvand, Abd Majid, Baniahmadi, & Ghavamirad, 2015; Baykasoğlu et al., 2009; Arslan, 2012)

Figure 7 plotted the number of observation of each category in the targeted literature, to identify the priority of each criterion in the proposed set.

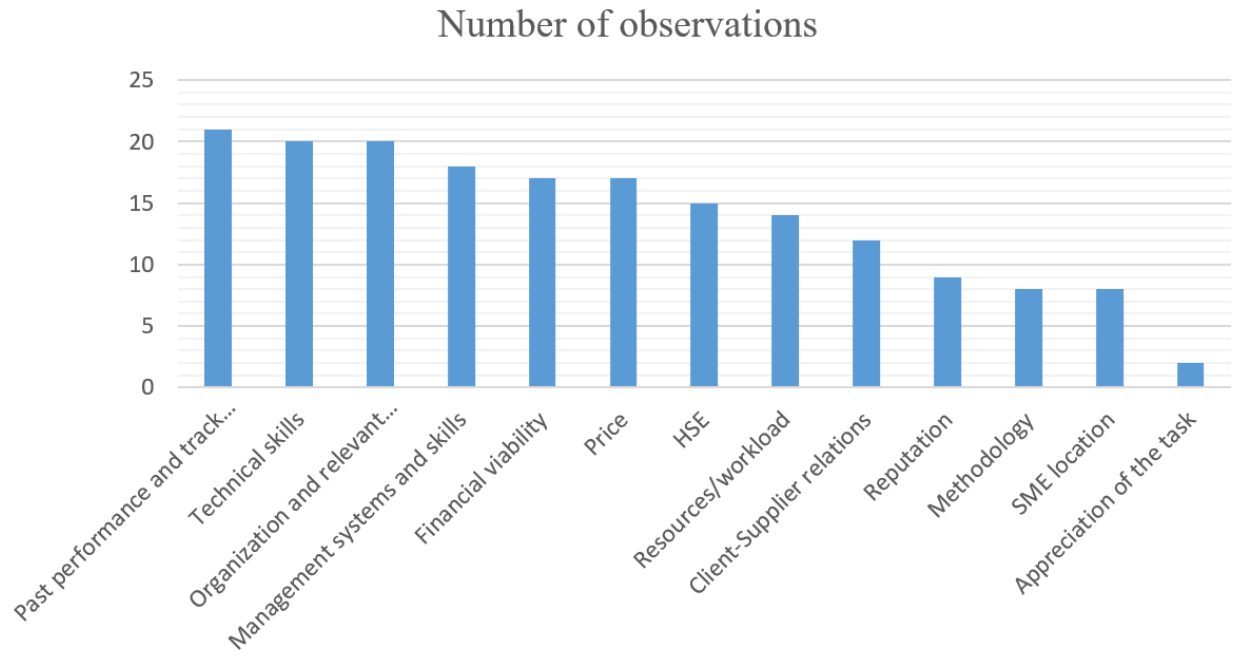

Figure 9- Number of observation of identified criteria in the reviewed literature

The results demonstrate greater importance is placed on “Past performance”, “Technical skills”, “organisation and relevant experience”, “Management systems” “Financial Viability “ and “Price”, indicating that clients and DMs are likely to assign more weight to these attributes during tender evaluation procedures. These results intended to offer DMs an opportunity to broaden their horizon by considering various sets of non-price attributes, specifically, “Past performance” and “Technical skills” in addition to the price attributes.

Some similarities and differences identified between these results and previously published articles. One of the notable findings is that similarly to the previous study by Watt et al. (2010),

"Past performance' and "Technical skills" are the top two key attributes in tenders. However, while their results show that "Organizational experience" is the least important consideration in CS procedure, our review indicated that this attribute is among the top three criteria and identified as having relatively high importance. Comparing our results further, our findings do not support the conclusions from earlier studies, in term of "Price" and its importance. Many researchers identified "Price" as the most important and often dominant criteria (Chiang et al., 2017; Orkun Alptekin & Alptekin, 2017; Ahmed et al., 2016; Jafari, 2013; San Cristóbal, 2012). However, our results demonstrate that this criterion is not among the top 5 criteria, and it is similarly important as "HSE" in the sixth place.

2.1.1 Modern criteria

The literature shows that construction projects are facing a various range of problems in relation to the lack of integration, changing the environment and lack of effective communication between different parties (Naoum et al. 2016, Khosrowshahi et al. 2014, Heravi et al. 2012, Lam & Wong 2011). Although, for decades, the iron triangle of time, cost and quality are widely accepted factors to evaluate project outcome, it is imperative to say that, these old-fashioned performance criteria are now too simplistic to be the sole determinant of today's complex construction projects (Naoum et al. 2016, Watt et al., 2008; Singh & Tiong, 2006).

By reviewing the current construction issues, Naoum et al. (2016) illustrated that to efficiently manage project risks, the evaluation criteria should be updated to include modern concepts such as Building Information Modelling (BIM), Sustainability and Supply chain. These principles and their definition have been demonstrated in table 4. In this research, we tried to explore the application of these modern principles in construction of public tender evaluation procedures.

Table 7 - New selection principles

Principal	**Definition**
Supply Chain Management (SCM)	The successful construction project should be done under integrated project management, meaning it is centrally coordinated and that the relationship between clients, contractors and suppliers are maintained properly for the construction duration so that design and delivery are more closely linked. More collaborative and integrated approach. Suppliers should be considered at the strategic level and to be involved at an early stage of the project. Improving communication and minimising barriers to information flow. (Walker 2015)
Sustainability	The process whereby organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole life basis to generate real long-term benefits, not only to the organisation, but also to society and the economy while minimising damage to the environment. (Berry et al. 2011)

BIM	BIM is a digital tool for sharing and updating the construction project information (Gould). Benefits of using BIM includes early identification of collisions, reducing errors and having a reliable source to understand field conditions. It requires early interaction to ensure that expertise and knowledge are shared. Moreover, it can improve productivity by managing the information generated through the lifecycle of buildings.

The priority of these new principles will be evaluated from interviews and questionnaires. Within the suggested framework, the parameters that can help DMs to evaluate the level of achievement of each contractor in each principal will be explained, and these elements will be considered as criterions of this section.

a. SCM: Egan (1998) identified the need to adopt more integrated approaches in construction. That research projected that SCM should be involved in at least 50% of construction projects by the year 2007. These results illustrate the necessity of adopting proper SCM methods by contractors in their projects. Clients should evaluate and award contractors who are capable of creating a seamless supply chain whereby the various phases of the project are integrated with one another (Naoum, 2016). Contractors who can minimise the barriers to information flow and can improve communication with other supply chain companies have a better chance of success in their projects (Dainty 2001; Albizri 2010).
b. Sustainability: Clients should award contractors who can meet the project's needs for materials, services and utilities in a way to achieve long-term benefits, not only to the organisation but also to the society while minimising damages to the environment. Contractors who implemented sustainable practices and had the experience of finding innovative ways to achieve sustainability targets while satisfying the client's objectives in their previous projects have a better opportunity to deliver the project within sustainable standards.
c. BIM: One of the largest problems of complex construction projects is the difficulty in implementing widespread collaboration between different teams in a project (Naoum, 2016). Clients should choose project team members (contractors, designers, etc.) who can solve collaboration barriers by developing BIM model in the project. A contractor who can implement BIM model can considerably improve productivity, minimising any re-work and make it possible to manage the information through the lifecycle of the building.

2.5 Research gaps

The literature on the subjects of construction CS and its key components has been reviewed in this chapter. The literature has also highlighted the significance of evaluation tools in tendering procedures. It has been demonstrated that some project failures are associated with a lack of effective tools to measure the contractor's ability to deliver the job successfully. This is due to the fact that selecting an appropriate contractor is a multi-criteria decision-making problem. Thus, evaluating contractor's characteristics is a priority for construction clients.

Although numerous selection methods have been developed in recent years, the way those procedures are carried out may vary substantially due to different procurement requirements in each country (B. Liu, Huo, Liao, Gong, & Xue, 2015). In the New Zealand context, different approaches have been introduced to construction clients for their CS procedures. However, procurement reports from both public and private sector demonstrate that construction of New Zealand suffers from the absence of a comprehensive CS framework that can properly evaluate and select the best contractor (NZCIC, 2004; Mastering Procurement Guide, 2011). The New Zealand Construction Industry Council (NZCIC, 2004) highlighted that the practice of selecting consultants, designers and contractors based on the lowest bid is among the greatest obstacles to improvement. Project construction delays, poor construction performance, cost overruns and abandonment of projects are among the problems of selecting the lowest bidders (Enyinda, Ogbuehi, & Udo, 2011).

In recent years, several reports demonstrated that a significant number of failings in construction projects such as Fletchers massive losses, Hawkins which almost left the high-rise market and most recent examples such as City Rail Link which had massive cost overruns, are related to public sector procurement (NZ institute of architects 2018, NZ construction Industry Council 2013). Lots of major public projects seem to have cost and time overruns. Our interest was to see whether the way in which contractors are involved could be improved.

A recent research published by Singer 2018, suggests that NZ public sector procurement suffers from multidimensional systemic failure relates to over concentrating on driving down the costs of public projects and ignoring the performance of the project participants and economic, social and environmental values. The report concludes that the public clients are often try to avoid these weaknesses in their procurement system by inappropriately managing the risks.

Results illustrated that the five mandatory principles introduced by MBIE do not seem to be governing the procurement practices of many public sector agencies. The information requested on initial stages of the suggested procurement strategies, often are irrelevant to the projects' type or scale, which requires several changes later in the tendering stages.

Moreover, the researcher found that even with the public entities who follow the public guidelines, there is a disconnect between the suggested standard models which are lowest price, filtering method and additive weight that leads to inefficiency. A comprehensive review of advantages and disadvantages of these models has been reviewed in chapter four of this thesis. Consequently, one of the objectives of this research was to propose a more efficient method of evaluation procedures.

Various researchers pointed out that the construction industry has significant problems concerning choosing the most suitable contractors for projects (Holt, 1998; Darvish, 2009; Taylan, 2014). However, contractor selection has not attracted significant attention from construction practitioners and researchers in New Zealand. To date, only three publications since the year 2000. This is much less than 23 publications in China, 20 publications in the US and 15 publications in Australia, which indicates that CS procedures do not receive proper attention in New Zealand (See figure 1). This research is oriented to improve tender evaluation methods and develop a framework that can lead to higher quality and lower costs for the construction. It is intended that the research published here, encourage construction sector of New Zealand to use modern CS methods and be a pioneer in this industry.

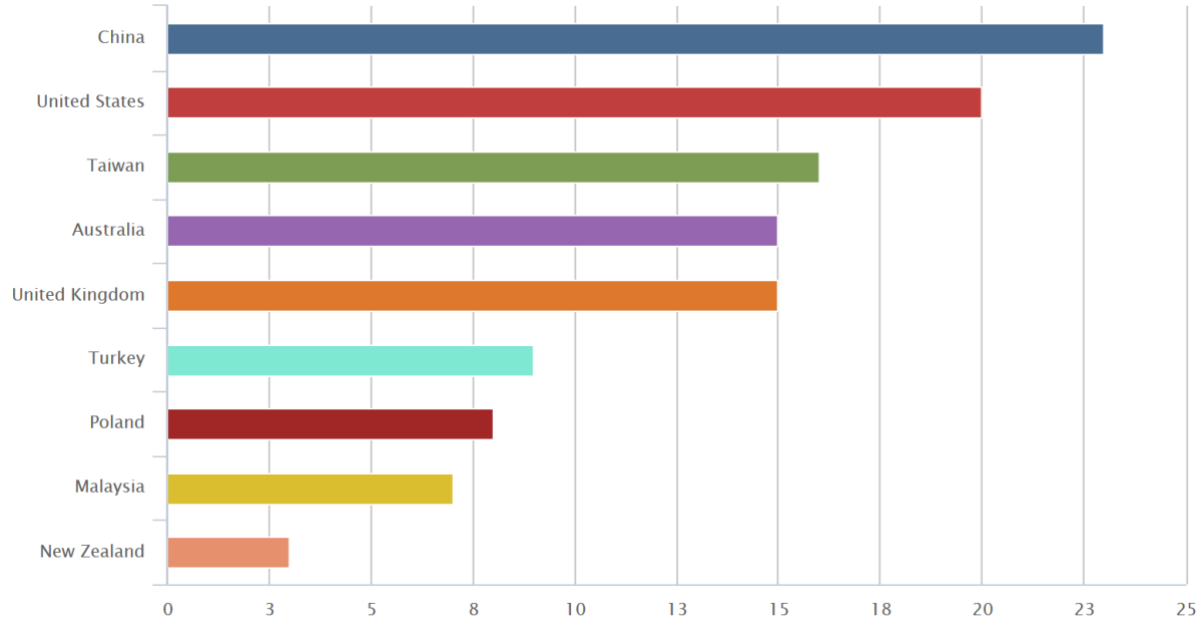

Figure 10 - Publication counts in terms of "Construction CS" and "Contractor pre-qualification" from 2000 – 2017 in nine countries

In previous studies on the construction of New Zealand, much effort has been centred on attempts to develop construction procurement routes and procurement selection models (Rajeh, Tookey, & Rotimi, 2015; Jelodar, Yiu, & Wilkinson, 2016; T. Liu & Wilkinson, 2011). However, the

standard level of CS methods and criteria is still inadequate as significant elements of modern CS procedures are not taken into account by clients and DMs. Identifying an appropriate list of criteria and applying different decision-making tools such as AHP to construction CS can be particularly useful to ensure the successful delivery of the project. Developing a comprehensive list of criteria and a practical CS framework has not been studied in the context of New Zealand before.

It is not our purpose here to evaluate alternative procurement methods. The main purpose of this study is to provide a grounded understanding of the elements involved in New Zealand tender evaluation procedures, as a contribution to improving construction sector. In this study, different CS methods and criteria will be identified from literature review results, and interviews with experts and their significance will be determined from questionnaires to establish a decision-support model for construction clients of New Zealand.

This framework can be used as a guideline for New Zealand clients to select local and international contractors in general construction projects such as buildings, hospitals, infrastructures, etc. in both the private and public sector. It is expected that this research contributes to construction field in two ways: first, by extending the understanding of CS methods, criteria and their degree of importance, and second, by implementing MCDM approaches to build a new method for analysing and selecting construction contractors.

2.6 Summary

In this chapter, the concepts and key factors of CS have been reviewed. The background of the CS procedures and objectives of tender evaluation processes have been reviewed. Moreover, different pre-tender, pre-qualification and tendering protocols have been defined. The key methods of tender evaluation and their advantages and disadvantages have been discussed. In addition, different sets of criteria were explored, and their criterions were demonstrated. The research methodology and the empirical study will be illustrated in the next chapter.

4. Chapter four - Research methodology

2.1 Introduction

From the literature review, it is evident that little research has been conducted to explore the public tendering procedures in New Zealand. Thus, a knowledge gap exists in current research. Therefore, this study seeks to evaluate different tendering protocols used by New Zealand public entities to design a conceptual framework to improve the current processes.

Chapter four will highlight the methodological arguments used in this research process. The chapter begins by clarifying research followed by an attempt to understand the definition of research methodology. It further presents the establishment of a research problem and study design. Subsequently, the research means for data collection and data analysis will be discussed, followed by information on the reliability, validity, generalizability and ethical issues of the study. Finally, the chapter presents the scopes and limitations of the research process.

2.2 Definition of research

There are numerous ways range from fairly informal to the strictly scientific approaches to obtain answers for different questions (Kumar, 2011). Scientific research is one of the ways to answer questions. Research can be defined as simply the logical and systematic search to discover hidden truths about a particular topic (Rajasekar et al. 2006). Although, there is a various range of definitions of research have been suggested, this study will use the definition suggested by Cavana et al. (2001) as a process of studying and analysing elements surrounding a problem to find solutions. Thus, the rationale of this study is to explore new approaches to improve the performance of the construction CS in New Zealand public projects. Various researchers identified different characteristics for good research (Amaratunga et al. 2002; Saunders et al. 2011; Higgs et al. 2009). Firstly, research should undertake a systematic and methodical approach to develop knowledge. Secondly, it should have a process of enquiry and investigation. Finally, it should increase human knowledge. Kumar (2011) stated that a research study process should follow three main rules:

1. It should have a set of philosophies as a framework.
2. Uses research methods that can be tested for their validity and reliability.
3. Should be unbiased and objective.

Higgs et al. 2009 illustrated that there are some key aspects that need to be clarified before designing a research study. First is to understand the research questions. Second is to define the nature of knowledge that is being looked for. Next one is to understand the reasons for doing research on these questions. Forth is to specify the objectives of the research. Finally, the

contextual factors that can influence the research should be clarified. Thus, it is highly important to explore the possible research methods and paradigm that can properly address the research questions. The procedures of the research study will be described in the following sections.

2.3 The research process

As it has been mentioned, research is a process which involves collecting, evaluating and interpreting information to answer questions (Kumar, 2019). Research should follow a logical process to find appropriate solutions for a problem. The basic procedure of the research has been shown in figure 11. Kumar 2011 illustrated that the process should have the following characteristics:

- Controlled: In a research study, it is important to define the links between effects and the causes. To explore the causality in the relations to two variables, it is important to minimise the effects of other factors affecting the relationship.
- Rigorous: The research procedures should be relevant, appropriate and justified.
- Systematic: The procedures should follow a certain logical sequence.
- Valid and verifiable: The findings of the research should be correct and can be verified by the others.
- Empirical: The results and conclusions should be established on hard evidence collected from real-life experiences.
- Critical: The research procedure should be free from any drawbacks and must be able to withstand critical scrutiny.

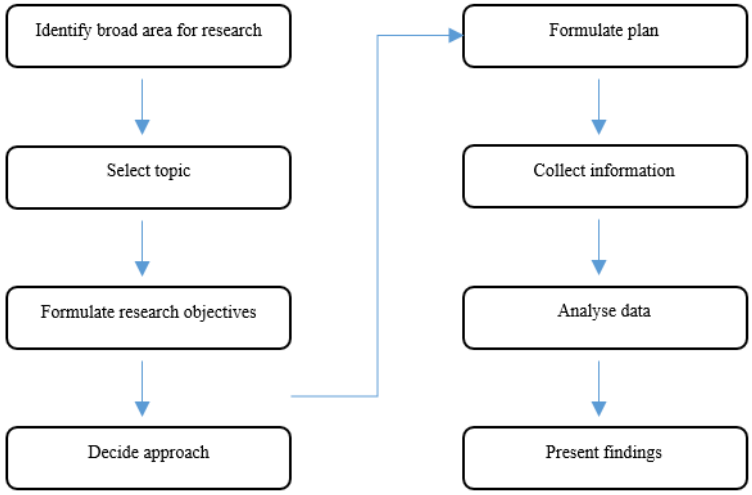

Figure 11 - Overview of the research process (Gray, 2009)

This research followed a systematic approach to defining the research problems based on a comprehensive literature review. Thus, firstly the subject area has been exploring to complete a

foundation for the study. Thereafter, qualitative information has been gathered by conducting semi-structured interviews with highly experienced construction industry professionals. The quantitative questionnaire approach has been adopted the, to extend the knowledge absorbed from the qualitative phase. To validate the findings, interviews with experts approach have been used. Finally, the results have been analysed to draw meaningful conclusions and recommendations. Figure 12 summarises the study procedures of this research.

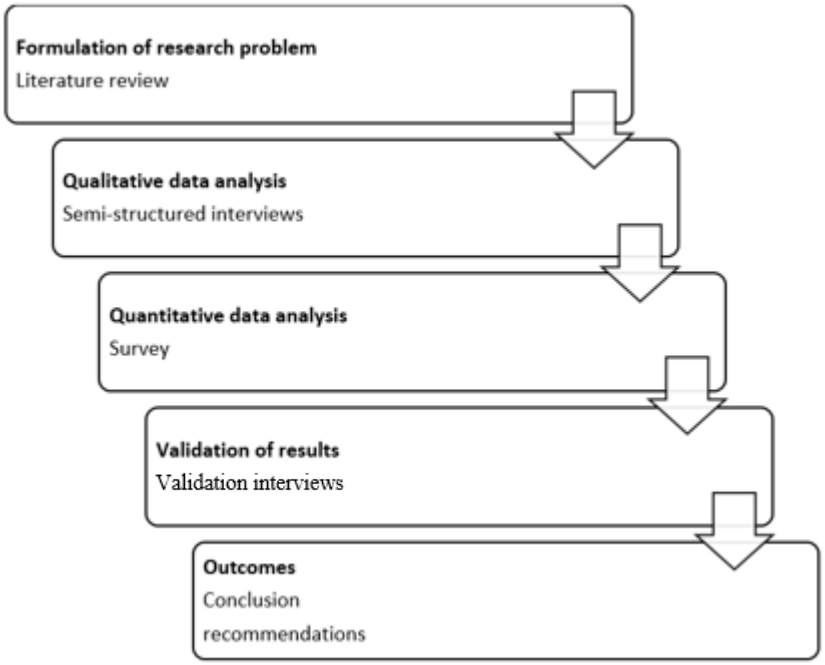

Figure 12 - Research process

2.4 Types of research

Research can be reviewed from three perspectives of application, objectives and mode of enquiry (Kumar, 2011) figure 13. From the application of the finding's viewpoint, there would be two categories of pure research and applied research. Pure research involves developing theories concerned with the development and examination of the research methods and procedures that may not have practical application the present time or in the future. Applied research utilizes research techniques to collect information about practical phenomenon and problem.

From objectives perspective, research can be descriptive, correlational, exploratory or explanatory (Bernard, 2012). The descriptive study explores a problem or phenomenon systematically as it naturally occurs to describe what is prevalent concerning the issue. A study is classified as a correlational study attempts to establish the existence of interdependency between two or more phenomenon (Kumar, 2011). Exploratory research is used when there is a little knowledge exists about the topic of the research or to investigate the possibility of undertaking a study. When the research topic is clear, explanatory research attempts to illuminate why a relationship exists between two or more phenomenon.

Research can also be categorised considering the process the researchers adopt to find the answers to the research questions. The two approaches to the enquiry are structured and unstructured. In the structured approach that also classified as quantitative research, all of the elements of the research process such as objectives, designs and samples are predetermined. This approach is established to determine the extent of a phenomenon or problem. On the other hand, the unstructured approach (qualitative approach) allows more flexibility in the process, which is useful to explore the diversity and nature of the problem.

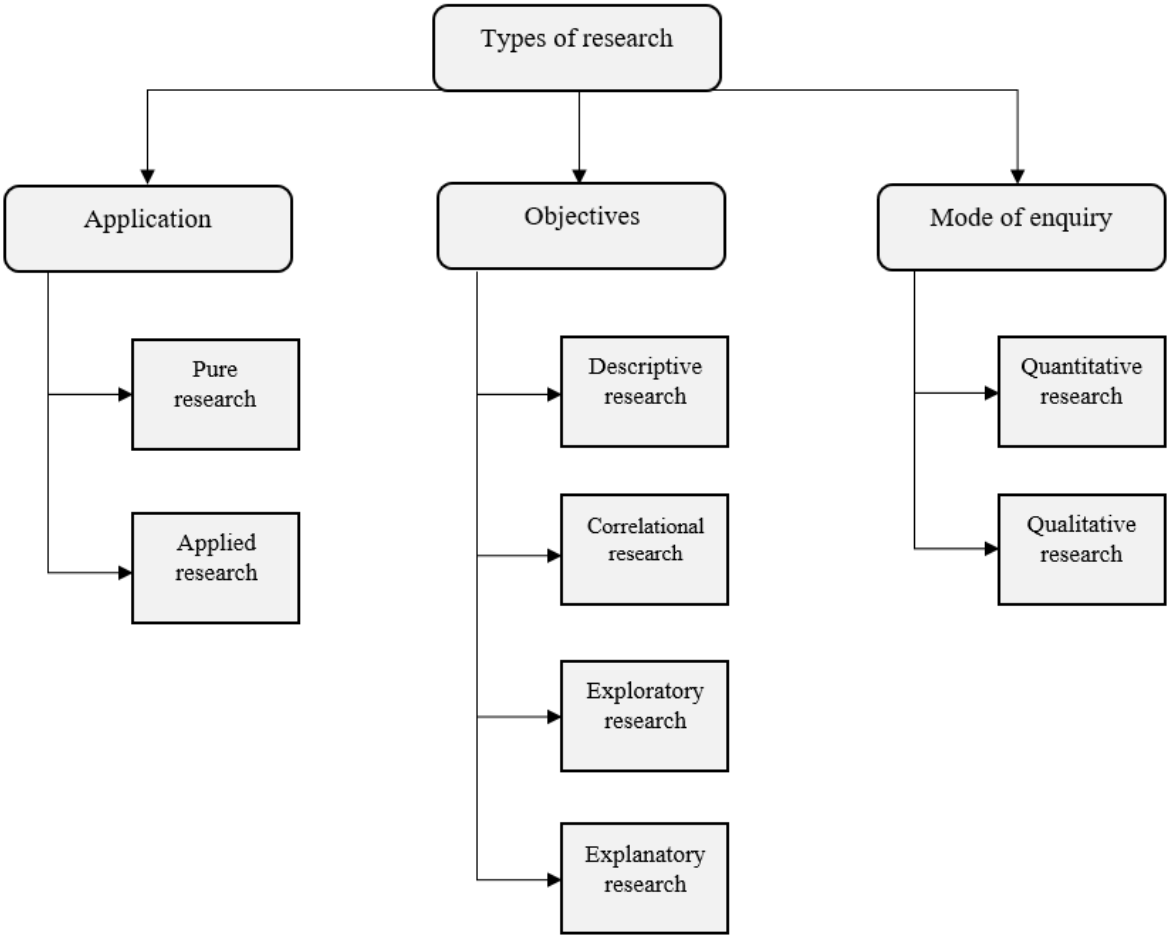

Figure 13 - Types of the research (Kumar 2011)

This research tries to explore the ways to improve the processes that construction of New Zealand evaluate contractors by establishing the current state of knowledge of this sector and provide a framework to transfer from traditional evaluation procedures to modern selection methods. To define the nature of the construction CS in both international and New Zealand context, a comprehensive literature review has been conducted. Moreover, to gain a better understanding of the tender evaluation procedures in New Zealand, semi-structured exploratory interview approach has been adopted. This is followed by an explanatory survey approach to extend the research results. Thus, it is apparent that this research employs a combination of both exploratory and explanatory research.

2.5 Research philosophy

Philosophy explores theories which enable researchers to build scientific knowledge (Gray, 2009). The research philosophy is the development of the nature of knowledge. It is also a foundation for a research design that can provide a better quality of the research project (Thorpe, 2002). The proper understanding of the research philosophy is a key factor in doing research

(Collis, 2009). Thus, it is vital to establish the philosophical position of the study, which can help the researcher to define the nature of the problem and select an appropriate approach. Ontological, epistemological, axiological and rhetorical assumptions of the study indicate the selection of the study methods and formulating the research philosophy.

2.1.1 Ontology

Ontology explains the nature of the knowledge and tries to understand 'what' knowledge is (Tan 2002, Creswell 2007, Pathirage 2008). It assists researchers in understanding how the world operates and how things work. Two views have been defined for the nature of the knowledge, objectivism and subjectivism. (Saunders et al. 2011, Tan 2002). Objectivism emphasises that social entities exist outside of the social actors, while subjectivism considers social actors as part of the social phenomena (Bryman & Bell 2007).

2.1.2 Epistemology

This aspect is related to the nature of 'knowing'. Epistemological assumptions are concerned with how a researcher knows and how knowledge can be created and communicated (Creswell 1994). This consideration is mostly concerned with finding a proper research approach to generate reliable findings and increase the validity of the results (Alsulamy, 2014). It has been suggested by various researchers that following both qualitative and quantitative methods can satisfy epistemological consideration properly and the study and eliminate their disadvantages (Creswell, 1994; Smith, 1983).

2.1.3 Axiology

The term axiology explains the nature of the values that can be brought to the research (Caroll, 2008). Qualitative research methodology can contribute to the study from both researcher's values, and the knowledge exists. In contrast, quantitative research is solely based on the hard evidence gathered in the study (Creswell, 1994).

2.1.4 Rhetoric

The characteristics of the language used in the research are referred to as rhetoric. The language of qualitative research methods is often informal and personal, while quantitative approaches usually adopt formal language (Creswell, 1997). This study adopted a mix method approach to benefit from both methods advantages and eliminate potential disadvantages.

2.6 Research paradigms

A paradigm is a conceptual framework that can provide a system to determine different views and their approaches to questioning and discovery (Fellows, 2006). Easterby-Smith et al. 2002

considered positivism and interpretivism as the main research paradigms. Although various researchers have defined other paradigms such as constructivism, pragmatism and post-positivism, positivism and interpretivism are the two main extremes. Thus, here, these two paradigms will be discussed to assist this research in establishing an appropriate philosophical position for this study.

2.1.1 Positivism

Established in the thinking of Comte (1798-1857), positivism is a paradigm that only accepts non-metaphysical and observable facts (Fellows, 2006). Although, positivism can cover qualitative approaches, clearly quantitative approach has a predominant relation to this paradigm. The ontological assumptions of positivism indicate that reality is external and objective. It is closely related to rationalism and objectivism (Saunders et al. 2011, Fellows 2006). It emphasises that reality should be evaluated without intuition and sensation. Thus, to guarantee that the research results are unbiased, researchers should act independently from the research environment.

2.1.2 Interpretivism

Interpretivism, also called 'idealism' or 'subjectivism' which is the dominant paradigm for management and social sciences has the ontological assumption that reality is constructed by the human behaviour and does not have a prearranged structure (Fellows 2006, Gummesson 2000, Saunders 2007). Thus, researchers should determine the reality from a participant's collective perspective, which requires extensive discussions with numerous participants. The acceptance of multiple reality exists in ontological perspectives of interpretivism (Hussey, 2009). In contrast to positivism, the interpretive paradigm is the dominant feature in qualitative researchers, which increase the risk of influence by individuals or groups of participants (Fellows, 2006). The main features of positivism and interpretivism are shown in table 8, and the philosophical assumptions of these paradigms are given in figure 14.

Table 8 - A comparison of positivism and interpretivism - Source: (Amaratunga et al., 2002; Easterby-Smith et al., 2002)

	Positivist paradigm	**Phenomenological paradigm**
Basic Beliefs	• The world is external and objective • Observer must be independent • Human interest should be irrelevant	• The world is socially constructed and subjective • Observer is part of what is observed • Human interest is the driver of the science
Researcher should	• Demonstrate the explanations casually	• Demonstrate the explanations aims to increase the general understanding of a phenomenon

	• Look for causality and fundamental laws • Formulate hypotheses and then test them • Generalize by statistical probability	• Try to understand what is happening • Develop ideas through induction from data • Generalize by theoretical abstraction
Preferred methods include	• Operationalising concepts so that they can be measured • Sampling techniques requires large numbers selected randomly	• Using multiple methods to establish different views of phenomena • Small number of cases investigated in-depth or over time

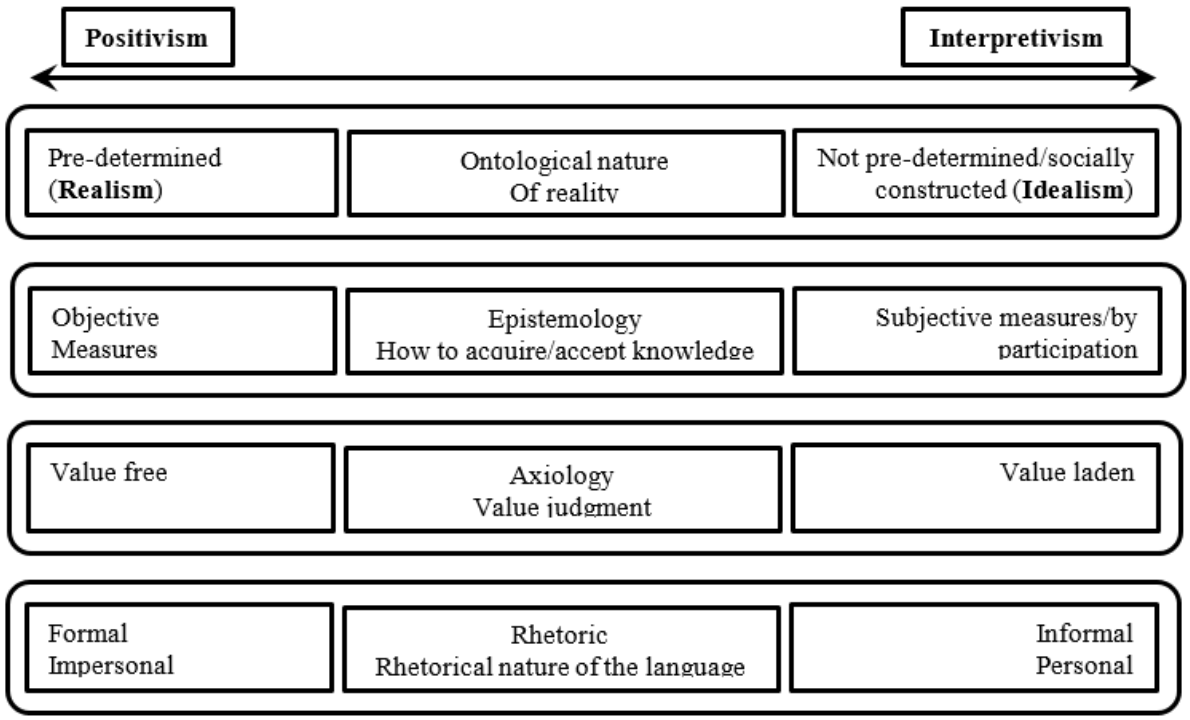

Figure 14: Philosophical assumptions and paradigm spectrum (Kulatunga, 2008)

2.7 Research logic

Two main paradigms of research logic are deduction and induction (Amaratunga, 2008). Here the features of these two approaches will be discussed.

2.1.1 Deduction

Deduction approach moves from general knowledge to more specific and detailed. This approach of reasoning is a systematic method of deriving true conclusions when the premises are accepted (Jenson, 2006). Deductive research progresses from theory to data (Amaratunga, 2008). It starts from thinking up a theory and then narrow it down to a specific hypothesis, collect observations, test the hypothesis, and finally get confirmation or rejection of the original theory. Thus, prior to testing the empirical observation, deductive research entails the development of a new theoretical structure in the hope that it provides a better framework than its preceded theories (Elzahrani, 2013). Figure 15 illustrates the four main stages of deductive research progress.

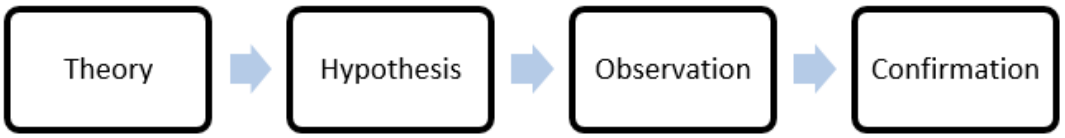

Figure 15 - Deductive research stages

2.1.2 Induction

Induction researchers are moving from observations to generalizations and theories. This scientific reasoning approach tries to draw general conclusions from a set of premises that rely on observations and experimental evidence (Amaratunga, 2008). In contrast to deductive reasoning, in induction researches, the theory would follow the data. It has been argued by Jensen 2006, that since inductive conclusions go beyond the information, it may lead from true premises to a false conclusion. Figure 16 shows the four key steps of an inductive research process. The inductive approach begins with a specific measurement and then tries to detect patterns, formulate hypotheses and finally develop a general theory. Table 9 demonstrates the main features of deduction and induction approaches.

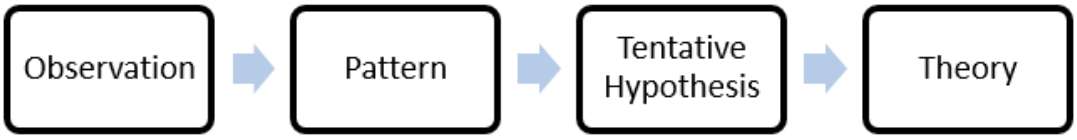

Figure 16 - Induction research stages

Table 9 - Main features of deductive and inductive approaches

Deduction	Induction
• Highly structured • From theory to data	• Flexible structure • From data to theory

• Dominant in natural sciences • Required sufficient sample size for generalisation	• Dominant in social sciences • Less concerned with the need for generalization

In this study, a deductive approach will be followed to align with the positivist paradigm. Thus, for the first step, the problem has been defined that there is a lack of a comprehensive framework with appropriate tools for evaluating public tenders in New Zealand. The research questions have been identified in the next step that can assist researchers in developing the framework by clarifying the areas for improvement in current procedures. This is followed by the establishment of the research design and means of data collection. Semi-structured interviews with experts and quantitative survey approach have been selected to collect rich and in-depth data. The data were collected and analysed, and the validity and the reliability of the results were tested to assist researchers in developing a tender evaluation framework for public projects in New Zealand.

2.8 Establishment of the research problem

Establishing the research problem is the first and most vital phase in scientific research (Kumar 2009). The research problem clarifies the destination and formulates the decision of what you want to find about (Kumar 2009). Researcher's motivation, literature review and discussion with experts were the initial steps toward establishing the research problems for this study. It has been concluded that with better public tender evaluation practices, public entities can confer more benefits to the public.

2.1.1 Initial motivation

The subject area for the research project selected should be initiated by the significant interest, competencies and complete engagement of the researcher (Saunders, 2011). The preliminary impetus for this thesis emerges from interest and previous experiences since the researcher of this doctoral study has industrial engineering and construction management background with years of working experience in a contractor company.

2.1.2 Literature review

Once the research topic has been identified, an essential preliminary task is to search for potentially relevant theory and literature to acquaint researcher with the available body of knowledge in the research area (Fellows 2006, Creswell 2013, Kumar 2009). Literature is the results of previous studies and existing knowledge provided by other scholars. It is vital because

it ensures that the researcher has current knowledge and can enable the establishment of research gaps. Creswell 2013 stated several purposes of the literature review includes a share of the results of the previous related researches, serves to ongoing dialogue for filling the gaps and extending the knowledge, and establishing a benchmark for comparing results. A literature review assists the researcher to establish the theoretical roots and develop research methodology (Kumar 2009).

The means of the solution is first established by exploring the research problem (Tookey 1998, Punch 2000). By reviewing the literature, it has been clarified that the CS problem is rooted in several types of research and have developed from different perspectives. The knowledge obtained were sorted and reviewed under different themes, unanswered questions identified, and the aspects that have a direct bearing on this research were highlighted.

This research initiated with exploring the broader aspects of tender evaluation and narrowed down later by reviewing theories and literature on construction CS. Initial results indicated that tender evaluation had not attracted adequate attention in the construction context. Therefore, the literature review process continued to investigate the application of decision-making methods in the construction sector. Moreover, tender evaluation methods and assessment criteria themes were generated to explore the functions of tendering protocols in the New Zealand context to ensure that the elements of construction CS have been systematically studied. The literature review process then continued to examine the public tendering approaches in New Zealand's construction sector to address the following categories:

1. CS protocols and methods
2. Key CS assessment criteria
3. Main challenges of public tendering in New Zealand
4. Improving the CS performance in the New Zealand construction sector
5. Designing a framework to move from traditional approaches to modern selection principles

To clarify the research problem of this study, the above categories were studied further. The primary objective of the research is to develop a framework that can assist New Zealand public clients in their tender evaluation procedures. One of the vital first steps of scientific research is to define the features that can influence the extent to which the study can contribute to research problem-solving. Thus, the following sections illustrate information on scope and nature of the research problem.

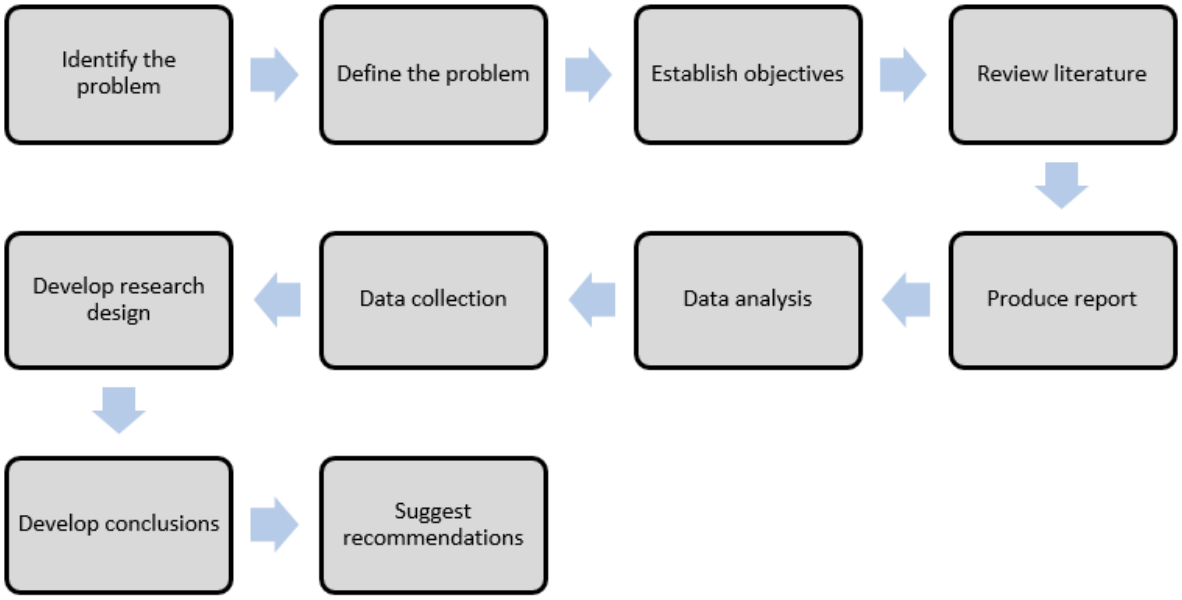

Figure 17 - Research steps

2.1.3 Scope, nature and complexity of the problem

The scope in scientific researches is referred to as the generalisability and applicability of the study objectives in the targeted sector. Generalisability is an application of results to the cases that have not been examined in the study (Collis, 2009). CS challenges are regular and generalizable issues in the construction sector. One of the significances of this study is that this specific problem has not been addressed properly before in the New Zealand context. It has been established during the literature review. To date, only three researches have been done on CS in New Zealand, which mainly focused on identifying the decision domains to gain competitive advantages in the market. It has been identified that there is a gap in integrating CS procedure for New Zealand public projects. However, it is essential to select a research methodology that would be able to deliver generalizable results.

Nature of the research is one of the essential elements that influences the selection of the research methodology (Collis 2009). Since descriptive research aims to describe a phenomenon, it should answer 'what' is happening and 'why' (Currall et al. 1999). Moreover, the descriptive approach obtains knowledge on the nature of the problem (Collis 2009). The qualitative and quantitative aspects should be considered while establishing the nature of the problem. The main descriptive research questions in this study are:

1. What are the challenges of current tendering protocols in New Zealand construction?
2. Why these challenges exist?
3. How can these challenges be minimised and the whole performance improve?

Various activities need to be understood to clarify what is going on in the construction CS. In this study, qualitative interviews were conducted to obtain rich information that can assist in understanding the procedures. Thus, in this research qualitative approach has been selected as the initial step toward discovering the nature of the problem. However, to obtain meaningful and generalizable results, the significance of this stage has been quantified through survey approaches.

2.9 Research approaches

Research approaches provide specific direction for the study process and guide the researcher to select a proper research strategy. The selection of the structure and the approach of the research is highly determined by the aim of the study and the difference of perspective in each paradigm (Kumar 2009). Subsequently, the selection of the research design and data collection and analysis methods are influenced by the research approach (Creswell 2013, Easterby-Smith 2012). The strategies available for to the researchers have grown but classified based on forms of data, collecting and testing methods and research objectives, three main research strategies have been identified as qualitative, quantitative and mixed methods approaches (Creswell 2013, Kumar 2009, Williams 2007). The following sections discuss the application and features of these three approaches.

2.1.1 Qualitative

The purpose of the qualitative approach is to understand people's perceptions of the world. It attempts to understand the meanings of human's lives and social world (Fossey 2002). As discussed earlier, it is a common approach in the interpretivist paradigm that explores attitudes, behaviours and non-numeric data (Burns 2001). Researchers who use qualitative strategy seek to gain insight into a phenomenon by gaining subjective information from participants (Amaratunga 2002, Fellows 2006). It is an inductive procedure that enables understanding of a phenomenon rather than objective quantification of the problem. However, analysis of such data is usually more difficult than quantitative approaches. Qualitative strategies often use to describe the comprehension of the study and help to develop theories (Dey 1993; Fellows 2006). Comparing to the quantitative approach, qualitative methods provide in-depth data and rich analysis of the situation. The validity of the results depends on the logical integration of data rather than numbers. This approach is not very specific and precise and usually is not well-structured. The distinction between methods of data collection and design of the study is less clear (Kumar 2009).

2.1.2 Quantitative

The purpose of qualitative approaches is to seek for factual data and find the relationships between them and previous theories. Highly related to the positivism paradigm, quantitative strategies use

scientific methods to analyse quantified data and derive conclusions from numerical results (Fellows 2006).

The results of the quantitative approach are more likely to lead to theory development because it mainly focuses on classifying features and constructing statistical models (Leedy 2005). The common features of quantitative research approaches are that they are well structured, explicitly defined and very specific and can be tested for their reliability and validity. By using approaches such as questionnaires, quantitative strategies tend to generate statistics using a large scale of participants.

That tends to have a clear distinction between study design and methods of data collection (Kumar 2009). Moreover, due to the less flexibility and more control in the research design, it is easier to check the researcher bias in quantitative studies. The main purpose of this approach is to gather quantitative terms such as frequencies, numbers, trends, and relationships for data analysis.

Research designs in each paradigm have different philosophical assumptions and are targeted to find different things. In the quantitative approach, the reality is singular and objective while qualitative researches consider reality as multiple and subjective. Epistemological assumptions of quantitative researches indicate that the researcher is independent of the research subject. On the other hand, qualitative approaches consider the researcher as part of the research environment and believe that the researcher interacts with the research subject. In quantitative approaches, the study is value-free and unbiased while axiological assumptions of qualitative researches consider research as biased. In quantitative approaches, the theory is largely deductive while in qualitative approaches theory can be inductive and non-casual. Quantitative researches use formal language. On the other hand, the language of qualitative researches are often informal and allows the researcher to develop voices that reflect the interests of the research subject.

The key characteristic differences between qualitative and quantitative approaches have been illustrated in table 10.

Table 10 - Key differences of qualitative and quantitative approaches

Characteristics	**Quantitative**	**Qualitative**

Goal of investigation	▪ Hypothesis testing ▪ Confirmation ▪ Prediction	▪ Hypothesis generation ▪ Understanding ▪ Description
General framework	▪ Seeks to confirm hypotheses ▪ Instruments use more rigid style of eliciting and categorizing responses to questions	▪ Explores phenomena ▪ More iterative style of eliciting and categorizing responses to questions
Design	▪ Well Structured ▪ Predetermined	▪ Semi-structured ▪ Flexible ▪ Evolving
Analytical objectives	▪ To quantify variations ▪ To predict causal relationships ▪ To describe characteristics of populations	▪ To describe variations ▪ To describe and explain relationships ▪ To describe individual experience ▪ To describe group norms
Question format	▪ Close-ended	▪ Open-ended
Sample size	▪ Large ▪ Random	▪ Small ▪ Purposeful
Data format	▪ Numerical (obtained by assigning numerical values to responses)	▪ Textual (obtained from audiotapes, videotapes, and field notes)
Flexibility in study design	▪ Study design is stable from beginning to end ▪ Participants' responses do not influence or determine how and which questions researchers ask next	▪ Some aspects of study are flexible (for example, the addition, exclusion, or wording of particular interview questions) ▪ Participants' responses affect how and which questions researchers ask next

2.1.3 Mixed method approach

Various scholars illustrated that despite the differences between these two approaches, there is an essential common ground exists and researchers can benefit from employing a combination of these approaches (Creswell 2013, Bryman 2012, Yin 1994). As table 11 shows, both of these approaches have advantages and disadvantages. For instance, one of the weaknesses of the quantitative approach is its tendency to measure 'snapshots' of a situation (Amaratunga 2002). However, the qualitative method can assist quantitative approach by aiding with conceptual development (Creswell 2013). Moreover, a quantitative approach can help the qualitative process by finding a proper representative sample. Therefore, the knowledge derived from both methods can be linked together to enable researchers gain benefits of both methods while lessening their

weaknesses (Tashakkori 2003). The philosophical stance of the mixed-method approach is pragmatism that can provide different opportunities for the researcher to use narrative and numeric data and analyse a wide range of information. It is hoped that by using a mixed method approach, these weaknesses would be balanced and minimised.

Table 11 - advantages and disadvantages of qualitative and quantitative approaches

	Qualitative	**Quantitative**
Advantages	• Good to determine to interpret construct of participants • Helpful to explore complex phenomena • Data are often naturalistic setting • Good to evaluate limited number of cases	• Provides generalizable results • Good to compare different groups of variables with quantitative description
Disadvantages	• Difficult to generalise • Hard to use when large number of participants involved • Slow in data collection • Requires long time for data analysis • Results can be influenced by researcher	• Difficult to explore dynamic phenomena • Does not study natural sciences • Context of the study is often ignored

Literature review revealed that construction tender evaluation is a significant part of construction procurement. The importance of methods used to ensure the selection of an appropriate contractor that can deliver the job successfully is not widely understood within the construction industry. With this in mind, this research tries to identify an effective method to discover and explain the logic that lies behind CS procedure and suggest answers by using analytic processes flexibly and innovatively. Thus, it is essential to select a research method that can achieve the research objectives.

Considering the nature of different research approaches, the descriptive, sequential mixed-method approach is going to be used in this research to collect both qualitative and quantitative information to carry out the most parsimonious and advantageous means for arriving at theory. This method involves initiating with a qualitative approach for exploratory purposes and following up with a quantitative method with a large sample to generalise the results (Creswell

2013). As Creswell (2013) stated, the rationale to choose mixed-method approach is the concept of the research problem. Neither qualitative nor quantitative approach is adequate to best understand the problems and gaps in CS procedures of New Zealand construction. Thus, the first aim of this research is to develop a detailed view of the current practices in New Zealand and learn what variables to study and then study those variables with a large sample of individuals and generalise the findings to the industry.

Mix method research is an approach that combines both qualitative and quantitative forms (Creswell, 2013; Strauss et al. 2008; Silverman, 2016). It involves the use of both forms in tandem so that the overall strength of the study is greater than either qualitative or quantitative research (Jackson, 2015). In this research, qualitative and quantitative results will be used side by side to reinforce each other. This study involves beginning with qualitative interviews for exploratory purposes and following up with a quantitative survey method with the large sample so that the researcher can generalise results to construction population. This study benefits from this mixed approach in a manner that the qualitative information direct and evolves the quantitative process with each method contributing to the theory in the ways they can.

This approach is also referred to as a triangulation technique. In these methods, it is vital that the importance of the validity and applicability of results be appreciated (Fellow 2009). Thus, the limitations of the research should be demonstrated and understood. Since this approach contains both qualitative and quantitative approaches, it is time-consuming. One of the vital challenges of the mixed methods is the integration of the quantitative and qualitative data collected throughout the study (Bryman 2012). Table 12 summarises the research methodology steps of this study. As can be seen, in this research, an initial qualitative approach (Semi-structured interviews) has been conducted to understand the nature of the tender evaluation procedures in New Zealand. This is then followed by a quantitative approach to generalise the results with a wide range of participants around New Zealand. Finally, validation interviews have been conducted to validate the findings and the developed framework. The mixed-method approach used in this research has been illustrated in figure 18.

Table 12 - Research methodology steps

Methodology step	**Content**
Literature review	1. Study the universal characteristics of construction CS 2. Compare different selection methods 3. Develop a comprehensive list of price/non-price attributes and their priority 4. Establish the current state of knowledge of construction CS in New Zealand industry

Qualitative interviews and survey's pilot study	1. Investigate the development of CS methods in New Zealand (Qualitative data collection) 2. Investigate the development of CS criteria in New Zealand (Qualitative data collection) 3. Illustrate the priority of CS criteria in New Zealand context and compare it with the results of the literature 4. Analyse the qualitative data 5. Validate qualitative data 6. Interpret data and develop a conceptual framework of New Zealand construction CS
Quantitative questionnaire	1. Investigate the relative importance of different criteria in New Zealand industry 2. Investigate the level of achievement of New Zealand industry in different criteria 3. Investigate the level of importance of different modern construction principles in New Zealand industry 4. Analyse the quantitative data 5. Check validity and reliability 6. Interpret data
Design a framework for construction CS of New Zealand	1. Compare data from previous stages and design a framework 2. Test the validity of the proposed framework

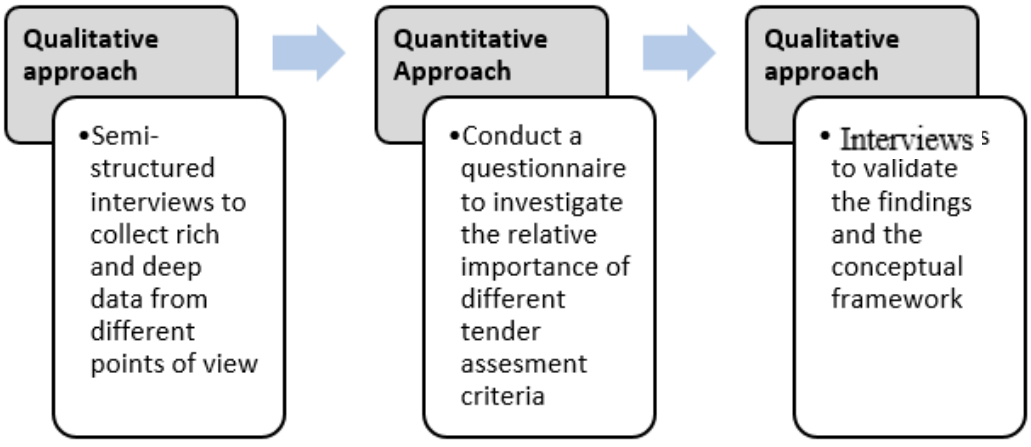

Figure 18 - Mixed method approach of this study

2.10 Selection of research strategy

Three main conditions were identified by Yin (1994) for selecting the research strategy, type of the questions, control over independent variables and degree of focus on events. Some scholars demonstrated that the main conditions of selecting research strategy are research problem, personal experience of the researcher and the audience (Creswell 2008). Considering these requirements, Saunders et al. (2011) categorised research strategies into the survey, experiment/quasi-experiment, archival analysis, history and case study. Table 13 illustrates the requirements of the application of different research strategies based on types of questions, level of control and focus on events.

In this research, a survey strategy deemed to be appropriate where there is no requirement to have control over independent variables and the research questions can include who, what, where, how many and how much. Moreover, Survey strategy suits the descriptive, explanatory and exploratory nature of the research. However, in this approach, the limited number of research questions and the reduced accuracy of the data are the key limitations for the study. In this research, two approaches of survey strategy have been employed, semi-structured interviews and quantitative questionnaire.

Table 13 - Requirements of application of different research strategies

Strategy	**Research questions**	**control over independent variables**	**Focuses on contemporary events**
Experiment	How, Why	Yes	Yes
Survey	Who, What, Where, How many, How	No	Yes
Archival analysis	Who, What, Where, How many, How	No	Yes/No
History	How, Why	No	No
Case study	How, Why	No	Yes

The researcher views this as a three-stage study. Semi-structured interviews with the leaders of New Zealand construction was adopted as a first stage to collect rich and deep data about this phenomenon. This preliminary qualitative stage helps us to better establish where the gaps were. Stage two consists of a further quantitative survey with a wider group of individuals to understand the proper weighting of identified attributes. This stage assisted the researcher to establish a

consistent definition and comparison between literature review results and qualitative and quantitative results.

The findings from previous stages then led us to generate a model which could be used for public tendering procedures in New Zealand. Thus, a qualitative interview approach was adopted as the third stage, to validate the suggested model and extend the research findings. In this stage, two interviews were conducted with very high-level practitioners from both client sides and contractor sides to view the problem from different perspectives.

2.11 Research design

Research design is a structured blueprint for investigating and obtaining valid, objective and accurate answers to the research questions. It is a complete scheme that the researcher outline from writing the hypothesis to the final analysis of data (Kumar 2009). Through the research design, the researcher communicates different aspects of the study to others, such as the purpose of the research, data collection methods, participant selection techniques and methods for data analysis. Selection of an appropriate research design is fundamental to both the contribution of the study and the philosophical background of the research (Dainty 2008). The research design of the study has been demonstrated in figure … The research process of this study initiates with semi-structured interviews and then followed by a questionnaire conducted from a wider range of participants. The following sections data collection process of this research.

2.1.1 Data collection for the current study

One of the vital considerations of any study that goes beyond the literature review is to find proper means for the collection of data (Fellows 2006). The limitations of data collection that needs to be appreciated include the availability of data, confidentiality, cost time, etc. This research uses a sequential mixed method approach to collect and analyse both qualitative and quantitative data. After reviewing the literature, semi-structured interviews will be conducted to collect rich and in-depth information about public tendering in New Zealand. Due to limitations of time and funds, these interviews were limited to the Auckland region. In the next phase, quantitative questionnaires were conducted to measure the significance of different CS assessment criteria. To validate the results and the suggested framework, interviews with construction experts were conducted. These phases of the research were further discussed in the following sections.

2.1.2 Secondary data collection

This phase of the study focused on the background and previous theories developed by other scholars and also examined the theoretical challenges and methodologies. By reviewing the literature, the previous knowledge was summarized, synthesised, and inconsistencies and gaps

were identified. In this study, a literature review started from investigating broader aspects of tender evaluation and then narrowed down to explore the theories in the construction sector. Multiple resources include journal paper, books, articles, guidelines, etc. have been reviewed to find and compare insights from various scholars on tender evaluation methods and their application in the New Zealand context. Furthermore, to review the function of CS procedures in New Zealand, two themes, including tender evaluation methods and assessment criteria, were generated and systematically studied.

2.1.3 Semi-structured interviews

This study will adopt a semi-standardised interview approach as a first step to collect rich and deep data from different points of view. Respondents have a great ability to express their opinions in their own words. Most of the further explanation that has been provided by the respondents would be nominal in scale (Jackson, 2015). Interviews can provide in-depth understanding of people's opinion, and they often have a higher response rate (Punch 2005, Kumar 2009). However, comparing to other methods, interviews are more time-consuming, expensive and have the possibility of bias in the researcher (Saunders 2007).

Thus, the qualitative analysis would be utilised to look for patterns in the collected data to design a reliable survey later in the study. Three types of questions are going to be used in these semi-structured interviews. First, theoretical questions that help the researcher to see the process and find connections among concepts. Second, practical questions that provide directions to develop the structure of the evolving theory. And finally, guiding questions which are open-ended and tend to become more specific as the research moves along (Corbin & Strauss, 2008).

Establishing a proper sampling approach is a vital step that enables the researcher to plan the data collection phase. Probabilistic and non-probabilistic sampling are the two main sampling approaches. Probabilistic sampling ensures that all the members of the population have the chance to be included in the study. Nonprobability sampling methods are purposeful sampling that allows the researcher to select the participants according to the research objectives and availability of the population (Patton 2002, Kumar 2009). Selection of the sampling approach is dependent on the scope and the nature of the research study. In this research, a nonprobability approach was used in the interview phase and the questionnaire phase of the study.

As Dworkin (2012) suggested, 5-50 respondents are adequate for interviews in mix methods. This research administered ten semi-structured interviews selected by "snowball sampling". This method is an effective and purposeful sampling method to reach the most knowledgeable people in the industry. In this method, available informants will be asked to use their social networks and refer the researcher to the most informative person who can effectively contribute to the study

(Palinkas et al., 2015; Guest, Bernard, & Gravlee, 2014; Emerson, 2015; Hasanzadeh, Esmaeili, & Molenaar, 2015). This procedure continues until the data saturation point is reached.

Population for this phase of the study were major construction clients (universities, hospitals and health care districts and government), construction engineers, builders, architects and researchers. Minimum requirement of at least five years of experience in New Zealand CS and procurement procedures have been considered to achieve a rich and in-depth information. Face-to-face interviews were conducted since it provides better perception from both verbal and visual points (Jackson, 2015; Creswell, 2013; Marshall, 1996).

These semi-structured interviews would be conducted to achieve two results. First, to gain proper information about the CS process in New Zealand due to a lack of publications. Then, to pilot testing the questionnaire, establish the question bank and also allow interviewees to review the questions about clarity and applicability to research objectives. To protect the anonymity of the participants, all the personal information of interviewees will be coded.

To eliminate unnecessary and reduce large amount of qualitative data collected through interviews to more manageable pieces of information and carry out the steps of current CS practices in New Zealand, conceptualization (defining categories and grouping similar items to each category (Corbin & Strauss, 2008) and specification (compare categories and identify patterns(Corbin & Strauss, 2008)) techniques were utilized. For qualitative data analysis, NVIVO 12 software was adopted. The reason to choose this software is that it is the latest in a series of Computer Assisted Qualitative Data Analysis (CAQDAS) that supports the analysis of qualitative and mixed data (Silver & Lewins, 2014). NVIVO 12 is a powerful tool that supports different types of documents. Its recent development focuses on improving coding and data management for mixed-method studies.

Figure 19 illustrates the processes of qualitative data analysis in this study based on Creswell, 2013.

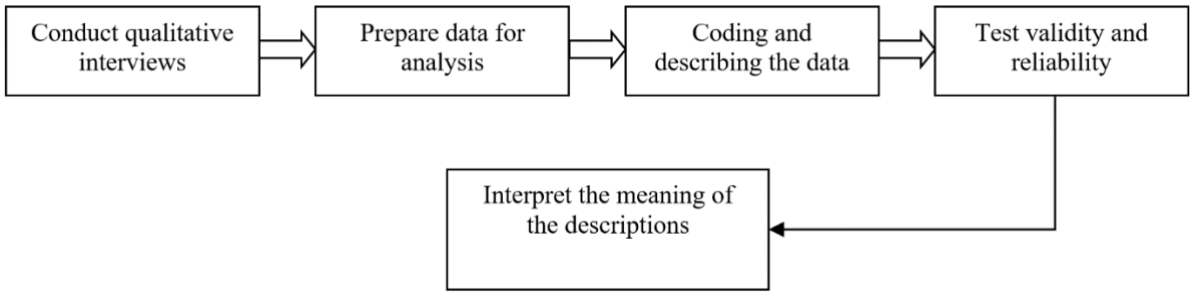

Figure 19 - Processes of qualitative data analysis (Creswell, 2013)

In the semi-structured interview stage, a sample set of four appropriate individuals were initially selected. These high-level experts were then asked to refer other information professionals about this topic. This procedure continues until the data saturation point is reached. After a certain point of 9-10 interviews the interview results were started to show similarities between the responses.

Each interview was approximately one hour. The time and place of the interviews were decided by prioritising the convenience of the participants. At least one week before the interview, an email has been sent to the interviewee includes the required document such as the information sheet and consent form. The interviews were recorded for transcribing purposes. Later all the interviews were transcribed using NVIVO software. To test the reliability and stability of the interviews, multiple coders will analyse transcript data separately and in an iterative process to check and identify mistakes and avoid any shifts in the coding procedure (Creswell, 2013).

2.1.4 Questionnaire

One of the data collection techniques of the survey research strategy is conducting questionnaires. Jackson (2015) indicated that the questionnaire is one of the most popular methods of descriptive approaches. This method is meant to collect data from a large group of individuals and describe their responses. One big concern about this method is whether the sample group who take participate in the study is a good representative of the people whom the research is meant to generalise. This issue can overcome by random sampling.

After conducting interviews, the quantitative questionnaire carried out to establish a consistent definition and comparison between literature review results and qualitative and quantitative results. It assisted this research in extending knowledge gained from previous phases of data collection. Data were sought from major construction clients (universities, hospitals and health care districts and government), construction engineers, builders, architects and project managers who are registered members of their association, i.e. New Zealand Institute of builders, New Zealand Institute of Architects, New Zealand registered master builders Federation and New Zealand specialist trade contractor's Federation. The minimum requirement is at least five years of involvement in CS procedures in the New Zealand construction industry.

Depending on the research budget and level of confidence required, the sample size may vary from small group to a very large number of participants. Since smaller samples are more likely to be different from the targeted population, they have more sampling error and lower reliability (Dworkin, 2012; Alreck & Settle, 1994). However, obtaining data from a large sample requires additional time, money and effort.

Since smaller samples are more likely to be different from the targeted population, they have more sampling error and lower reliability (Dworkin, 2012; Alreck & Settle, 1994). Figure 20 shows

the relation between sample size, sample error and sample reliability (Trieman, 2014; Alreck, 1985). Thus, previous literature that used quantitative survey method in the construction of New Zealand were examined to identify the approximate response rate in the industry.

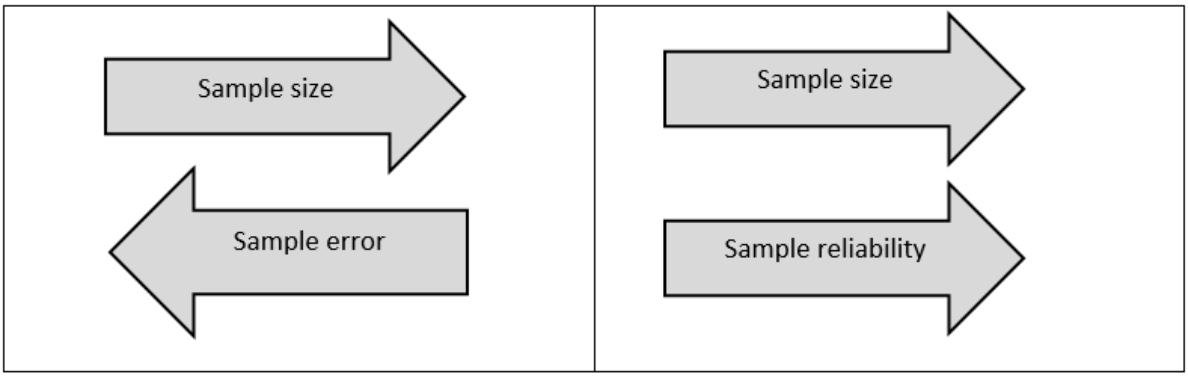

Figure 20 – Relation between sample size, sample error and sample reliability (Alreck, 1985)

Scopus database was selected to identify the following terms; "Construction" AND "Questionnaire" OR "Survey" AND "New Zealand". Moreover, the search has been limited to find papers from 2010 to 2017. Fifteen journal papers were identified, but four of them were directly usable for the objectives of this study.

Considering the purpose, time, and budget, purposeful sampling was used in this phase of the research. The sample size was calculated by considering the key member of the public tender evaluation process in New Zealand. Population for this phase of the study were major construction clients (universities, hospitals and health care districts and government), construction engineers, builders, architects and researchers who have been involved in New Zealand's construction CS processes.

Questionnaires are an appropriate method to collect data from a large number of participants. Numerous researches used a questionnaire approach to collect data in the New Zealand construction sector. Adafin et al. 2016, targeted architects of New Zealand for their study. They received 102 responses with the response rate of 60%. In 2015, Rotimi et al. used random sampling to collect 216 questionnaires with response rate of 21%. Rajeh et al. 2015, received 96 responses from 320 project managers with a response rate of 23%. 128 responses with a response rate of 30% were the result of Mbachu, who targeted project managers, contractors and cost managers in 2011.

The average response rate in these four studies obtained from the New Zealand construction sector was approximately 34%. Thus, it is expected that we receive a similar response rate in this research. However, due to the size of the New Zealand construction industry and the fact that there is a small number of decision-makers involved in the public tender evaluation process, the number of participants was limited further.

Although there are different techniques exist to estimate the sample size required, it is difficult to estimate the right sample size when the population proportion is unknown. Especially in this study where the demographics are construction experts with more than five years of working experience involved in New Zealand public tendering procedures. Researchers often suggest 100 participants as the minimum sample size when the population is large. However, the nature of the study and the estimated response rate determines the effective sample size (Creswell & Creswell, 2017). It has been argued by some scholars that in some cases, a sample size of more than 30 might be adequate (Kumar, 2019; Creswell & Creswell, 2017; Treiman, 2014). Small sample size means that non-parametric tests can be used to test the results, which have less statistical power (Kumar, 2019). Thus, to increase the confidence level of the results, validation interview method has been used after the survey phase.

In this study, the web survey "Qualitrics" has been being used. The reason is that web surveys are easier to complete than paper and pencil questionnaires and have the advantage of permitting different filters (Trieman, 2014). To identify the relative importance and level of achievement of each criterion in the New Zealand context, four-point Likert scale (not important, of little importance, important, very important) will be adopted. It does not contain a "neutral" to encourage respondents to provide more biased answers. Demographic information was obtained from participants at the end of the survey includes designation, academic and professional qualifications and work experience.

When the survey design has been completed, before distributing to the sample, pilot testing was conducted. Experts who participated in interviews were asked to check the designed survey to check if they can easily understand the questions, the scales, the instructions and to see how long it takes them to complete it (Alreck, 1985). Moreover, to find errors and changes to improve the performance of the survey, they were asked about their reactions and suggestions.

At the first section of the questionnaire, we asked respondents to rate the level of importance and level of achievement of the New Zealand construction industry on each CS criteria for tier 1 projects. The results will help us to test if there is any significant difference between the relative importance of each selection criteria and level of achievement in the New Zealand context. At the second stage, we asked respondents to rate the level of importance and level of achievement of the New Zealand construction industry on each CS criteria for tier 2 and three projects. This two-stage survey study was carried out to obtain the initial parameters of the model proposed and to design and develop the most appropriate framework for the New Zealand construction industry.

Considering the research purpose, budget and timeframe, purposive sampling method has been identified to be appropriate to this study. The population of this research were highly skilled practitioners with at least five years of working experience in tendering process for major public

projects which is a small fraction of the construction professional. Throughout New Zealand, we have roughly less than a hundred governmental departments district councils, universities, district health boards and their representatives including architects and quantity surveyors who have been involved in tendering procedures for major public projects. The number of high-level contractors who are capable of carrying out these types of projects are probably less than that. The researchers best estimate would be at most 60 contractors.

After identifying the population, the researcher considered the proper sample size for the study. Sample size is a part of the population that has been chosen for the survey (Creswell, 2013). The survey sample size was calculated by considering the key decision makers in New Zealand public tendering process who belonged to the participant group. To calculate the sample size, Cochran's formula was used for the identified population (Creswell, 2013).

Minimum sample size (n) $$n = \frac{(t^2 \times s^2)}{d^2}$$

Where t = 1.96 is the value for the selected alpha level, s = 1.25 is estimated standard deviation in the population for 4 point scale, and d = 5% acceptable margin of error. A total of 120 questionnaire surveys were sent out to the public clients, clients' representatives including architects, quantity surveyors, project managers, etc. and contractors involved in major public construction projects.

2.1.5 Validation interviews

The nature of tender evaluation in New Zealand public construction has been examined in this research and potential areas for improvement have been suggested. To validate and extend the research findings from previous stages of the study (Semi-structured interviews and online survey), validation interviews with industry experts have been employed. One of the aims of this research is to design a practical, tender evaluation framework. Thus, the applicability of the overall framework has also been assessed by the experts during interviews to check whether suggested solutions could be applied in practice. Furthermore, this method also helped to enhance research triangulation with qualitative and quantitative approaches.

This method of validation has been suggested by various scholars (Wass et al. 1994, King, 1994). In this research, two industry experts were selected based on their experience in New Zealand public tendering processes to participate in the validation process. The selected industry experts were construction industry experts with management roles such as managing director, general manager and chief executive officer. The information of the participants was further discussed in chapter seven.

To arrange interviews with these experts, a similar procedure to the arrangement of semi-structured interviews was followed. An information sheet with the outline of key research findings from previous stages was sent to the experts before the interview sessions. The information collected from these validation interviews further strengthened the research findings and designed framework.

2.12 Data analysis

Data analysis is one of the crucial steps of scientific research which involves methods for interpretation of data gathered to determine patterns, develop explanations, test hypothesis through the use of analytical and logical reasoning. Whether the research strategy is qualitative or quantitative, the general process of data analysis is the same, but the procedures of each step are different (Kumar, 2009). Figure 21 illustrates the core data analysis processes. The following sections present the data analysis procedures used to analyse qualitative data collected through semi-structured interviews and validation interview session and quantitative data collected through questionnaires.

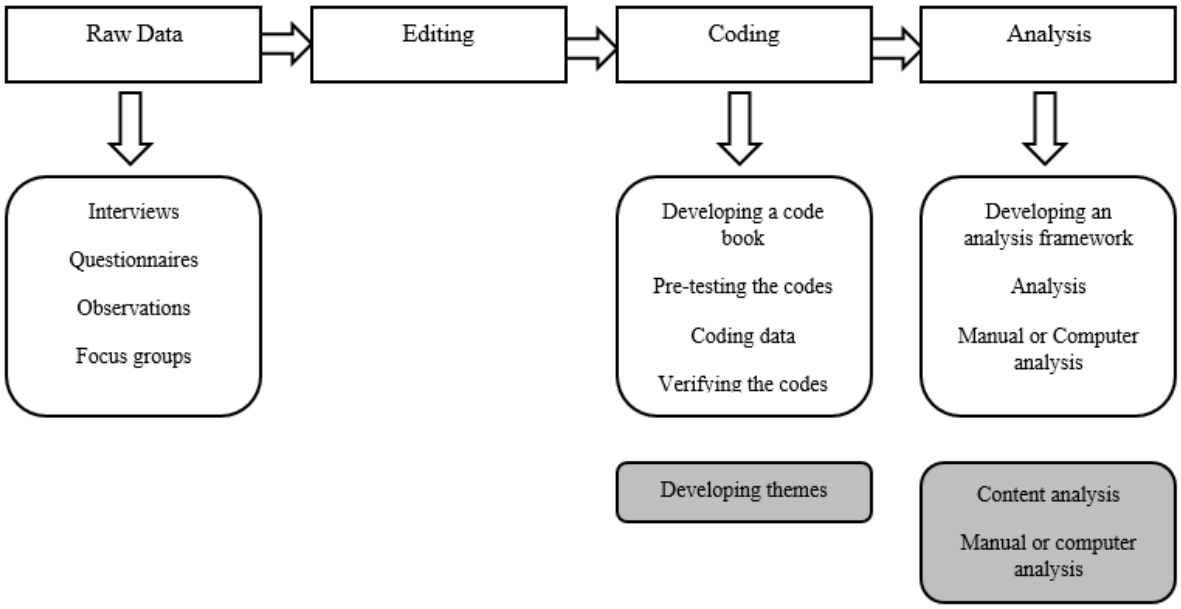

Figure 21 - Data processing steps (Kumar 2009)

2.1.1 Qualitative data analysis

In this research, 10 semi-structured interviews were conducted with construction practitioners to explore the nature of public tender evaluation procedures in New Zealand. There are three main ways to analyse qualitative data and communicate the findings (Kumar, 2009). The first approach is to develop a narrative to determine the phenomena. The second way is to identify the main themes from the in-depth interviews and quoting from them. The third approach is to quantify the main themes to find significant results.

The data collected from semi-structured interviews in this study were analysed to find key themes that emerged from interviewees. This includes four key steps. At the first step, the descriptive responses of the interviewees were determined to understand the responses and develop broad themes. These themes are the basis of qualitative analysis. This step continued until we reached a saturation point. In the second step, specific codes assigned to the main identified themes using keywords. This step assists in counting the number of times a theme has occurred in an interview (Kumar 2009). In the next step, the responses were classified under their related themes. Content analysis using NVivo 11 software was employed to systematically explore and classify participant's perceptions. Content analysis is a method for making inferences by systematically determine specific characteristics of messages (Holsti, 1969). Finally, the responses from different themes were integrated into the text for reporting the results.

Various range of computer software has been developed over the past decades to display and facilitate qualitative data analysis. This software applications assist researchers in managing a large volume of data. Thus, they provide more comprehensive, transparent and reliable data (Mayring, 2000). Considering the amount of data, researcher's available time and the knowledge of data, NVivo 11 software was used to analyse the qualitative results. The reason to choose this software is that it is the latest in a series of Computer Assisted Qualitative Data AnalysiS (CAQDAS) that supports the analysis of qualitative and mixed data (Silver & Lewins, 2014).

NVivo 11 software assist researchers by providing data management tools that support the creation and storage of the nodes and texts. In this research, NVivo software helped researchers to manage data that was too large to manage manually (more than 20 hours of semi-structured interviews), provided comprehensive data analysis tools to find patterns and increased transparency and reliability of the findings by improved analytical processes.

After transcribing all of the interviews, they were formatted to reflect answers separately from the questions. The transcribed interviews were then saved in MS Word format and copied to NVivo 11. To shape data and clarify the responses, different word process features were engaged. Transcripts were determined independently to find patterns and to reflect the participant's perspectives on the research questions and objectives. This process involved reading and summarising the interviewee's comments on the research. The text was further analysed to create themes, subthemes and assign codes in the NVivo 11. Figure 22 shows a screenshot from NVivo data analysis process. When a new concept was identified in the text, a new code was assigned based on the interviewee's perspective or from the knowledge gained from the literature review.

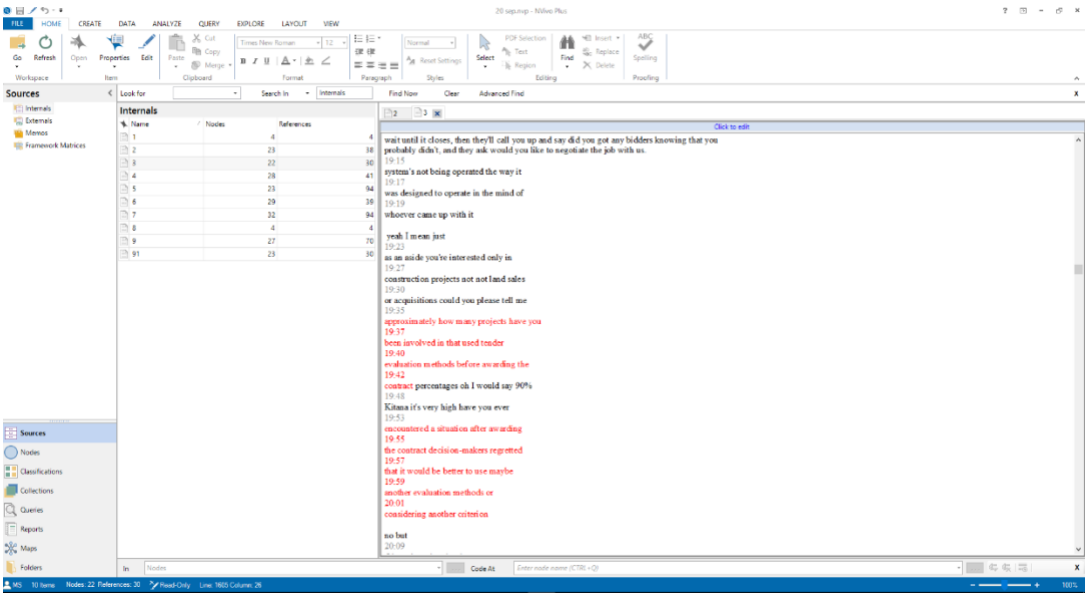

Figure 22 - NVivo data analysis of the study

By reviewing transcripts, participant's ideas were gathered to create nodes and evaluate similarities and differences in the perspectives of the interviewees. Figure 23 shows a portion of nodes created while analysing qualitative data. Nvivo provided better openings to draw meaningful themes from semi-structured interviews. It strengthened the internal validity, robustness and dependability of the analysing procedure. However, in this study, several criteria were considered when interpreting the transcripts to comprise identification, recognition and construction of the themes (Love, 1992). The ideas and issues discussed repeatedly across the interview were considered significant. Non-verbal cues such as emotions and other body movements were noted to determine the significance of the content or theme. Stories of the past that clarifies present meanings were noted. The interpretations of the activities, thoughts and meanings were observed and considered. Finally, the ideas, concerns and expressions that were different from what researchers expected based on the previous readings were considered significant since they allow the researcher to recognise new perspectives of the research problem.

Nodes

Name	Sources	References
Q	0	0
Q1	0	0
Current key issues of	8	59
Capacity	4	9
Client issues	3	3
Competition issues	1	1
Contractor Fails	2	2
Contractor fails ev	2	9
Design issues	2	3
Difference	5	11
Lawyers	2	7
Post completion re	1	1
Procurement issue	4	6
Productivity	2	12

Figure 23 - Sample of nodes created with NVivo 11 for this study

2.1.2 Quantitative data analysis

In recent years, the data analysis is far less burdensome with systems becoming increasingly user-friendly. Statistical analysis software is making statistical analysis relatively easy, but it's very important that the researcher understand the content and meaning of the research purpose and select the right statistical tools. In this research, descriptive analysis methods were used to analyse quantitative data. Descriptive analysis is a common tool to summarise the quantitative data obtained from questionnaires and draw conclusions from it. SPSS software has been used in this study to analyse quantitative data and performing factor analyses, normality and correlation tests, and display results in different graphical formats. This software is a powerful tool to analyse data conducted from social science researches.

The first step of quantitative data analysis is to ensure that the raw data is free from any inconsistency or incompleteness (Kumar, 2009). This process consists of identifying and minimising any possible errors, misclassification and gaps in the information. In this step, all the raw data were transferred to SPSS software, and their variable measures (scale, ordinal or nominal) were identified. The reason to choose SPSS is that it is a comprehensive and flexible statistics package that can also generate tabulated reports, plots of distribution and more complex statistical analysis.

After that, the content was checked for completeness and internal consistency. To analyse incomplete and blank responses, the method suggested by Sekaran (2005) was used, which includes assigning a mid-point value to the missing number. Furthermore, normality check and missing data screening methods were conducted in this step. The normal probability was examined by plotting the residual and stem-and-leaf diagram. The normality of the distribution

was further tested by determining the Skewness and Kurtosis of the data which confirmed the normality of the studied variables.

Various researchers explained that the acceptable range of kurtosis index and Skewness index for the normal distribution are less than or equal to 10 and 3 respectively (Kline 2005; George & Mallery, 2003; Leech, Barrett, & Morgan, 2008). To test the Kurtosis index and Skewness index of the variables used in the analysis of the survey, SPSS software was used and the results indicated that they were in the range of the acceptable values.

The next step is to code data. It is a procedure to convert raw data into meaningful results. This process is often dictated by the consideration of the measurement scale, and the way the researcher wants to communicate the findings. In this research, different numbers were allocated to the survey responses to facilitate the transferring of the survey results into SPSS software. To pre-test the coding procedure, a few questionnaires were selected and coded to ascertain any problem in coding. The coding structure used in this study was further discussed and verified by social research methodology professor at AUT. The steps of applying survey analysis methods in this research are summarised in figure 24.

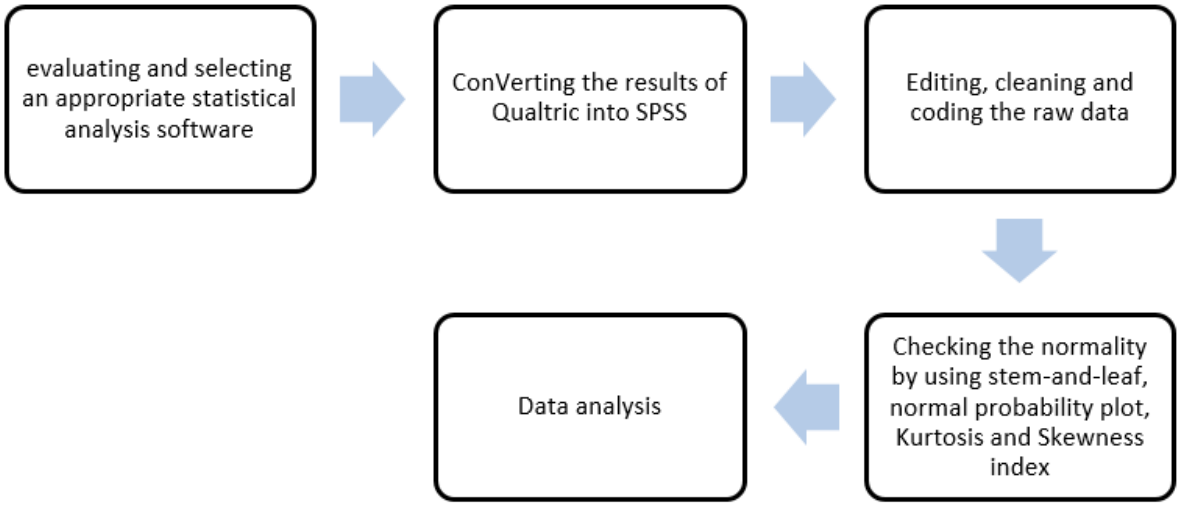

Figure 24 - Steps of applying survey analysis method in the study

Before starting the quantitative data analysis, it is vital to identify the appropriate statistical test that can satisfy the requirements of the study objectives. However, various statistical tools require raw data to meet specific conditions (Alreck, 2004). Statistical tools that can be used in the research will be dictated by the type of scale and data. The first step is to determine the method of measurement. The process of data analysis depends on the method of measurement. Four types of measurement have been suggested by the researchers, nominal, ordinal, interval and ratio (Creswell & Creswell, 2017; Treiman, 2014).

- In a nominal scale, different numbers will be used to categorise the object or value, even if those values are numbers. For instance, we can categorise male and female participants by assigning number 1 to male participants and number 2 to female participants. These variables cannot be used to perform much statistical analysis.
- The ordinal scale consists of values that have a meaningful order, and the numbers show the relative position of the variable. The ordinal scale is somewhat more powerful than the nominal scale. Ordinal scales show relationships among the variables. However, these variables do not represent the magnitude of the difference between the variables. The frequencies, percentages and some of the non-parametric tests can be used with ordinal variables.
- A scale with numeric values equidistant from one another is an internal scale (Alreck, 2004). Interval scales can make assumptions about the degree of difference between the objects. For example, the difference between 60 and 50 degree Celsius temperature is a measurable 10 degree.
- Ratio scales tell us about the order, the exact degree of difference an absolute zero point. It consists of the characteristics of all the properties of nominal, ordinal and interval scales. Height and weight are some of the examples of ratio scale variables.

Both continuous variables and Categorical variables were used in the questionnaire survey phase. Categorical variables only take on values that are names or labels such as gender. But continuous variables represent a measurable quantity like "number of years of working experience". Considering the types of answers in the questionnaire, in this study, ordinal scales were used. It involves the ranking of data in either ascending or descending order. The numbers assigned to the answers are merely numerical labels and do not indicate equality of intervals between the scales. In the questionnaire phase of this research, the participants were asked to classify the level of importance and level of achievement of various criteria in the New Zealand public construction sector.

2.1.1.1 The Likert scale

Selecting an appropriate scaling for the study is more a matter of researcher's choice than the invention of scaling device (Alreck, 2004). In this study, the purpose of the survey questions are to obtain an expert's position on certain criteria. Thus, open-ended questions might not fit that purpose since they might come up with different analysis and interpretation issues. To overcome this challenge, the Likert scale was used in the questionnaire phase of this study. First proposed by Dr Likert in 1932, the Likert scale states the criteria and obtains the participant's degree of agreement or disagreement. One of the main advantages of this approach is that it provides coded

data that can be easily compared and manipulated. Other advantages of the Likert scale includes flexibility, power and simplicity of the format (Alreck, 2004).

Since interval data are required in this phase of the study, the Likert scale values have been modified to have scale points from 1 to 4 with equal distance between them. Based on the Four points Likert scale has been chosen to push respondents to select a nonneutral option. Various scholars treat 4, 5 and 7 Likert scale as an interval scale in which parametric statistics can be used to analyse the data (Jöreskog et al. 2001, Lubke et al. 2004).

2.1.1.2 Descriptive statistics

Statistical analysis requires understanding data which could consist of different groups of data sets (Knapp 2018). Descriptive statistics assist researchers to understand and summarise a data set of any size using figures and graphs. Different data sets can be summarised using descriptive statistic tools such as number, mean, median, standard deviation, variance, etc. The mean is referred to as the average of the data sets. The calculation is similar to the average: add up the numbers and divide the total amount by the number of numbers involved (Knapp 2018). Standard deviation illustrates the dispersion of the numbers within a variable. A variable has low SD when the numbers are similar to each other, and it has high SD when more variety exists in the numbers. The number of times that an event or number occurs in a variable will be indicated by frequency. In this research, frequencies mostly will be represented graphically.

This study engaged descriptive statistics such as mean, standard deviation and frequency analysis to analyse the biographic responses and key research questions of the questionnaire. These data are required to define the participant's general characteristics regarding years of working experience in constriction, their role, types of projects they were involved in, etc. Moreover, descriptive analysis tools were used to explore the participant's perceptions of the tender evaluation criteria.

2.1.1.3 Plotting data

Once the quantitative data collected, the graph of the data was produced to indicate the nature of the distribution of the data and relationship among variables. The main purpose of this approach is to determine the appropriate statistical methods to be employed in data analysis (Fellows).

The following statistical analysis utilising IBM SPSS 20 would be used to analyse the results of this section.

- Kolmogorov-Smirnov test for normality: Kolmogorov-Smirnov test is a statistical analysis to test whether the observation represents a completely specified continuous distribution (Lilliefors 1967). One of the main advantages of this test over other

normality tests is that it can be used with small sample sizes. This test will be used to test the null hypothesis of "The sample data are not significantly different than a normal distribution".

- Wilcoxon Signed-rank test: It is a non-parametric statistical test to compare two related samples. It can be used as an alternative to the paired sample t-test (Algina, 1999). In this research, the Wilcoxon Signed-rank test was used to identify significant differences between the level of importance and level of achievement of the New Zealand construction in terms of different categories. Moreover, it has been used to find significant differences among the groups of survey participants. It has been further discussed in chapter six of the research.
- Spearman rank correlation: To test the validity of each criterion and validity of the questionnaire as a whole Spearman rank correlation with P-value 0.05 will be tested. If P-value is no greater than Alpha level, it can be interpreted that the questionnaire is consistent and valid to measure what it was set for (Algina, 1999).
- Cronbach's alpha test: This test will check the reliability of the questionnaire. The normal range of Cronbach's alpha coefficient is between 0.0 and 1.0. The alpha coefficient higher than 0.7 indicates the internal consistency of the questionnaire.

2.13 Validation of the framework

The primary objective of this research is to develop a conceptual framework to improve public CS procedures in New Zealand. To validate the framework, its characteristics have been presented to the experts in the construction sectors involved in public tendering procedures in an interview session, and their feedbacks were reviewed. The main reason for choosing this approach is that the interview provides a good environment for sharing, comparing and characterizing structural issues related to the experiences of the participant about a phenomenon.

The interview method was used in this research to confirm the results obtained in previous phases and to reach a consensus on the conceptual framework designed to improve the performance of public constriction CS protocols in New Zealand. Thus, several highly professional construction practitioners involved in public tender evaluation procedures were selected to conduct the interview. The interview meetings were audio recorded and transcribed later.

2.1.1 The credibility of the research findings

With the rapid pace of technology, people have more access to new information and research results. However, numerous information and results available are misleading and incorrect. This puts extra pressure on researchers to improve the credibility of their findings. Guba et al. 1994 indicated that the research credibility ensures the trustworthiness of the study results. Validity,

reliability and generalisability of the findings determine the credibility of the study (Saunders et al. 2011).

In scientific studies, in addition to the results of the study, consideration should be given to the extent which the researcher worked to enhance the quality of the research. This can be achieved by evaluating the validity, reliability and generalisability of the research.

2.1.2 Validity

The primary objectives of determining research validity are to assess the accuracy of the instrument employed as well as how fulfilled the study findings are. Moreover, it should be judged how the results may be used in future researches (fellows, 2011). Research validity contains two aspects of internal validity and external validity. Internal validity ensures that the research truly measures what it was intended to measure and external validity examines the degree of generalisability of the results (Amaratunga et al. 2002).

Thus, two types of threats can affect the validity of the research outcomes: internal validity threats and external validity threats. Internal validity threats are related to the research participant's experiences that may threaten the researcher's ability to draw correct conclusions about the study populations. On the other hand, potential threats to external validity should be considered when the researcher is drawing inferences from the sample data to other settings or situations (Creswell 2013). Table 14 summarised the main potential threats to internal and external validity.

Table 14 - Potential threats to the internal and external validity of the research (adopted from Creswell 2008)

Internal validity threats	• Participants with extreme scores are selected for the experiment. • Participants may mature or change during the experiment. • Events can occur during an experiment that can influence the outcome of the study. • Participants can be selected who have certain characteristics that may lead to having certain outcomes.
External validity threats	• Because of the narrow characteristics of participants in the experiment, the researcher cannot generalise to individuals who do not have the characteristics of participants. • Because of the characteristics of the setting of participants in an experiment, a researcher cannot generalise to individuals in other settings. • Because results of an experiment are time-bound, a researcher cannot generalise the results to past or future situations.

The internal validity can be determined by considering content validity, construct validity and criterion-related validity (Saunders et al. 2011). Content validity measures the coverage of the research problems from the questionnaire survey. In this study, the research questions were established to address the problems identified through a comprehensive literature review and semi-structured interviews. The research methodology has been verified by the help of supervisors who are experts in the subject area. Attitude and aptitude scales measured by the survey phase are referred to as construct validity. Criterion-related validity evaluates the effectiveness of a survey in measuring what it purports to measure.

Various researchers illustrated that it is improbable to have a 100% valid survey (Horn 2008, Lund 2012). Thus the validity is generally measured in degrees. Mora 2014 stated that the validity of a questionnaire is often determined by asking a group of experts to check the relevance of the survey content to the research problems. Therefore, the pilot survey was tested by construction experts to ensure that the survey could answer the research questions in sufficient complexity and improve the validity of the results.

2.1.3 Reliability

Reliability is the second tool to measure the accuracy of an instrument in quantitative studies. It can be defined as the extent to which the research instrument produced similar results on repeated occasions. It can be assessed through retesting, considering internal consistency and having alternative data collection methods (Saunders et al. 2011). Although giving the exact calculation of reliability is not possible, we can estimate reliability by using different measures (Heale et al. 2015). Internal consistency (homogeneity) and stability are the two common measures of reliability.

Internal consistency is the extent to which measure the consistency of the responses across the questions of the questionnaire. It can be evaluated using item-to-total correlation, split-half reliability, Kuder-Richardson coefficient and Cronbach's α. Stability can be tested using test-retest. It can be evaluated when an instrument is given to the same respondents more than once. Considering the research time frame and budget, repeating and retesting the interviews and questionnaires was not feasible. Instead, the results have been presented to construction experts in validation interview sessions to check the consistency and reliability of the findings.

2.1.4 Generalizability

In this research, the sample was selected carefully to guarantee the generalizability of the study results. The semi-structured interviews were conducted using snowball sampling to ensure that the decision-makers and participants of public tendering have been selected and different points

of views have been considered. However, considering the research timeframe and budget, these interviews were limited to the Auckland region only.

The response rate of the questionnaire phase was 30%. The survey was distributed around the whole country. The results indicated that the participants were from construction practitioners with different majors from construction clients to consultants, designers and contractors. Thus, it can be argued that the research results are generalizable throughout New Zealand public construction sector.

2.14 Research Scope and Limitations

One of the main limitations of this research is that there were just 10 semi-structured interviews which only limited to the Auckland region. Considering the research time frame and budget, it was not possible to conduct more interviews in other cities. However, it has been tried to select a sample that can properly represent the population of the study. For both semi-structured interviews and validation procedures, the elite interview sampling method was used. This is a method of using interviews to study those at the top of the system to gain rich and in-depth information about an issue (Kumar, 2019; Creswell & Creswell, 2017; Treiman, 2014). Moreover, the results of the quantitative phase may be subject to the accuracy and trustworthiness of the information obtained from the respondents.

Another challenge of this research was an appropriate use of a mixed method approach. Using a sequential mixed method approach requires a series of steps to check the reliability and validity of both qualitative and quantitative results. The limitation here is that the issues in one method might have effects on another. It is difficult to determine the influences of the issues impacted on the current research and the outcomes. Thus, it should be noticed that the research results should not be treated as a methodological effect the free outcome.

5. Chapter five – Semi-structured interviews

2.1 Introduction

This chapter presents the results of interviews with major construction clients, construction engineers, builders and architects involved in public construction tendering procedures in the Auckland region. The main focus of this phase was to better understand the current CS methods being used in the New Zealand public construction sector and to compare these practices with the methods utilised in other countries. The interview questions were prepared based on the study findings obtained from the literature review to guide the semi-structured interviews in accordance with the research objectives.

The chapter begins with demographic information of the participants and key themes obtained from the interviews. Then each question will be reviewed, and subcategories identified will be further discussed.

2.2 The semi-structured interview approach

When prior knowledge regarding the phenomenon is limited, and the main objective of the research is to gain familiarity with the problem and generate new insights for future studies, the inductive qualitative methodology has been considered to be appropriate (Elo and Kyngäs 2008, Haussner 2018, Sacilotto 2018, Scott 1965; Eisenhardt 1989). Moreover, this enables us to deeply engage with respondents to understand the various elements that can influence perceptions of public CS in New Zealand.

This necessitated the use of a qualitative interpretivism approach (Sacilotto, 2018). Thus, semi-structured interviews using open-ended questions were conducted with leaders of the New Zealand public construction sector to evaluate the cognitive mechanisms which are shaping perceptions of CS problems in New Zealand.

The data were obtained from 10 semi-structured interviews with experienced practitioners based in Auckland who was involved in public construction tender evaluation procedures in New Zealand. The following criteria were considered before select the interviewees: (1) interviewee was voluntarily willing to participate, (2) interviewee had at least 5 years of working experience in New Zealand construction sector, (3) interviewee was currently involved in public tender evaluation procedures. The participation in this study requires a high level of knowledge and experience in public construction tendering procedures, which limits the number of potential candidates (See Appendix 3 (A-C)).

Each interview lasted approximately one hour and was conducted in a location that the interviewee suggested. Details of the research objectives and interview procedure were emailed to interviewees before conducting the interviews. Interviews were structured around four key research questions to better understand the CS situation in New Zealand.

1. What are the perceived challenges of selecting best-value contractors in New Zealand?
2. What are the routine CS methods and criteria that New Zealand public clients use?
3. What are the strength and weakness of each method?
4. What improvements can be made?

The semi-structured interview questions have been further extended (as shown in Table 15) to meet the overarching objectives of the research.

Table 15 - The research objectives and questions addressed in the Semi-structured interviews

Research objectives	**Semi-structured interviews questions**
1. To review the nature of the public CS in New Zealand and identify potential areas for improvement	1. What are the perceived challenges of selecting best-value contractors in New Zealand?
2. To find the advantages and disadvantages of CS methods used in New Zealand and establish a proper set of Price/Non-Price Attributes	2. What are the routine tender evaluation methods that New Zealand public clients use? 3. What are the strength and weakness of each method? 4. What are the key criteria that New Zealand public clients consider? 5. What other criteria should be added to the public tender assessment documents?
3. Demonstrate solutions to transfer from traditional iron triangle criteria of time, cost and quality to modern industrial principles.	6. Should modern construction principles such as BIM/Sustainability/Supply chain management be considered in public construction tenders?
4. Develop a framework for CS that satisfy the requirements of New Zealand construction industry.	7. Do you think a standard CS framework can improve New Zealand construction? 8. What would be the main barriers of introducing a new framework? 9. What is the role of government in implementing improvement projects to increase the performance and efficiency of the construction sector

Semi-structured interview approach selected for data collection phase due to various important reasons. First, respondents have a great ability to express their opinions in their own words. Second, since relatively few construction practitioners have been involved in public tendering strategies, this method has been used to overcome a potentially poor response rate we might have by using other approaches such as questionnaires (Blackstone 2012, Haussner 2018). Finally, semi structured interviews allow the researcher to collect rich and detailed insights into different aspects of the problem. Three types of questions have been used in these semi-structured interviews. First, theoretical questions that help the researcher to see the process and find connections among concepts. Second, practical questions that provide directions to develop the structure of the evolving theory. And finally, guiding questions which are open-ended questions and tend to become more specific as the research moves along (Corbin & Strauss, 2008).

Due to limited time-frame and budget of the research, a sample of 10 participants has been selected by "snowball sampling". This is a non-probabilistic method which is a purposeful sampling approach to reach the most knowledgeable people in the industry. In this method, available informants will be asked to use their social networks and refer the researcher to the most informative person who can effectively contribute to the study. (Palinkas et al., 2015; Guest et al., 2014; Emerson, 2015); Hasanzadeh et al. (2015). As it has been suggested by various researchers, it is a very effective method, especially, in hidden populations, as this study, when it is difficult for the researcher to identify and access the members of the population (Morgan 2008; Hasanzadeh, Esmaeili, & Molenaar, 2015).

One of the identified disadvantages of this approach is that people tend to suggest like-minded participants be interviewed (Emerson, 2015). To reduce the impacts of this issue, researchers started the sampling from four different informants who held senior executive positions in different organisations. Snowball sampling continued until researchers reached theoretical saturation where the data collection procedure no longer offered any new and relevant information related to the main questions.

2.3 Demographic data of participants

At the end of the procedure, ten interviews were conducted. It should be noted that the results of this study can be further evolved by considering wider samples. However, in the semi-structured interview method, validity cannot be measured solely by the sample size as it does not reflect the seniority and knowledge of our respondents (Sacilotto 2018; Dworkin 2012). Detailed information of the participants is withheld due to privacy requirements. Summary of the participants' profiles, including their current position and responsibility, working experience, working experience related to CS, and education level is illustrated in Table 16.

Table 16 - Sample structure

Respondent	Position	Experience	Related to CS	Education
1	Construction manager	30-35 years	20-25 years	Bachelor of construction
2	Construction group director	+40 years	30-35 years	PhD
3	Client advisor	+40 years	35-40 years	Postgraduate diplomas in quantity surveyor
4	Project manager	30-35 years	20-25 years	Diploma in built environment
5	Chief executive	35-40 years	20-25 years	Master's in construction engineering
6	Design manager	+40 years	25-30 years	Postgraduate qualification in architecture
7	Project manager	25-30 years	15-20 years	Bachelor of project engineering
8	Construction manager	25-30 years	15-20 years	Civil engineer honours degree
9	Project manager	35-40 years	15-20 years	Bachelor of project engineering
10	Property business manager	10-15 years	5-10 years	Master's degrees in Urban and Regional Planning

Population for this phase of the study was major construction clients (universities, hospitals and health care districts and government), construction engineers, builders and architects in the Auckland region. From the demographic table, it can be noted that all of the interviewees were experts with a good level of knowledge and responsibility, which indicates their suitability for participation in this research and validity of the research results.

Interviews were recorded and transcribed, and qualitative data were analysed using content analysis. NVIVO 11 software was used to eliminate unnecessary information and reduce a large amount of qualitative data collected through interviews by coding and describing the data.

Instead of representing data with quantitative counts of variables, it has been decided to summarise information in narrative form supported by selected quotes (Clandinin and Connelly 2000, Sacilotto 2018). The primary reason to adopt this method is due to the lack of prior research on this topic and the fact that researchers didn't look for patterns of relationships between dependent and independent variables. The second reason is to retain the richness of insight contained in the narratives we had (Sacilotto 2018). Instead of recounting everything participants said, we decided to present the main themes emerging from the data using typical quotes and numerical analysis of codes in the data to demonstrate these themes.

2.4 Key themes

In this section, the main themes identified in the semi-structured interviews will be demonstrated. The identified themes are in line with the research problems and objectives presented in previous chapters. All of the questions used in semi-structured interviews can be found in Appendix … Table 17 presents a summary of the identified themes. The next sections illustrate the results of the semi-structured interviews categorised based on the main themes identified.

Table 17 - Key themes of semi-structured interviews

Number	Theme
01	Challenges of selecting best-value contractors in New Zealand
02	Routine CS methods in New Zealand public construction sector
03	Key assessment criteria used in New Zealand public tendering
04	Current challenges of public construction procurement in New Zealand
05	Importance of using modern construction principles
06	Main barriers of implementing improvement projects in the New Zealand construction sector
07	The role of government in implementing improvement projects to increase the performance and efficiency of the construction sector

2.5 Discussion of results

The results have been discussed in seven parts. The first part illustrates the challenges of selecting an appropriate contractor in New Zealand. The second part reports current evaluation methods associated with public tendering in New Zealand. The third part reviews the assessment criteria that are being used in New Zealand public tendering procedure. Section four explores the challenges of public procurement in New Zealand. Next part evaluates the importance of using

modern construction principles in public tendering. Part six demonstrate the main barriers of implementing improvement projects in the New Zealand construction sector. And finally, the last part explores the role of government in improving the performance of the construction sector.

2.1.1 Part 1 - Challenges of selecting best-value contractors in New Zealand

The research explored a range of potential challenges that New Zealand clients face while they are trying to select a proper head contractor for their projects included: over workload and capacity issues, low productivity of contractors and subcontractors, misunderstanding of the concepts of team work by different project participants, failed procurement strategies, timely and costly tendering procedures, and risk allocation issues.

Our results demonstrated that one of the most common challenges of selecting an appropriate contractor, especially for major construction projects in New Zealand is capacity issues.

R7: "New Zealand market is relatively small. There's not a lot of choices. So clients are forced into a situation and got to go down the path. Especially for projects above $100 M, it's not many options. There are one or two major main contractors, and then there's a huge gap. Other places in the world, Australia, UK, US and Asia, you could go to 30 different contractors who can handle that size."

Due to the small market, these large projects can also cause huge capacity challenges in that area. New Zealand occasionally has periods of very substantial construction that are core infrastructure (Hospitals, conventions centres, etc.) which are sucking up the capacity. In these periods of peak activity, the market struggles to provide the capacity, either in terms of a number of skilled people and sub-trades and ultimately of major contractors and designers. During the past few years, it has been observed that the market has stretched resources from both the main contractor's project management teams and also the subcontracting resources and their ability to deliver complex jobs. These views support reports published by New Zealand government entities and New Zealand Specialist Trade Contractors Federation (New ZealandSTCF) that both postulate the importance of reforms in the system to avoid future financial failures in the market.

R1: "... Over the past years, some clients have gone out to tender with big projects and haven't received any response from builders because everyone is just too busy."

R6: "The scale of work that we have underway is over stressing on our consultancy and design groups."

R2: "A few years back, we had very successful projects which contractors had all the expert resources on-site and designers who could look after the design development from 60% and get them up to 100% so the subcontractors could build. However, for recent projects that had similar

scales, contractors and designers don't have available resources. So clients had to employ a professional design manager to control the design development."

Another major concern of the clients is linked to the contractor's productivity. Productivity is one of the reasons that construction jobs in New Zealand are taking more time today. These delays will cost contractors extra costs, and they are going to push it back to the clients or passing it down to subcontractors who probably don't have the size or scale to take it. Our results reflect the views of Durdyev et al. (2011) who illustrated that the unproductivity and poor performance are some of the factors constraining the achievement of the project objectives in the New Zealand building and construction industry.

R9: "Productivity is low, and there is very little sign to suggest that it's going to get better. We have a lot of efforts that go into wastage. It's unproductive. So public resources are going into unproductive things. Hours of productive works need to increase. When you walk around the city, you see lots of cones and barriers, and you don't see anyone working. All the equipment is there. They cost public money, but the hours of work have been a constraint. From the people who live along there, from their point of view, it would be better if we can do our job as soon as possible and leave because while there is a construction job going on, they cannot get to their homes, they can't park their cars."

The respondents also perceived several issues related to the participants of the construction projects. One of the main issues that contractors mentioned is that in recent years, clients don't spend enough time and money getting the design to the point that a contractor can bid. Drawings are issues 60% or 70%, which is not adequate. Contractors put a bid on these vague designs, and clients get their quantity surveyors to allow for provisional sums.

R3: "…So the industry is run on a diet of provisional sums which account for not just unknown risks but vague designs."

On the other hand, some interviewees mentioned that this fewer details from designers are due to the fact that they are faced with decreasing fees and percentages.

R1: "They [designers] don't go into as many details as they used to. They are leaving more gaps behind and depending on the contract conditions."

One of the challenges that designers have is with D&C contracts. Clients are going for D&C, but they still want to have control over the design. So they have a little subcontract with the designers on the side. These results align with broader evidence presented by (Osei-Kyei 2015; Chen 2015, Liu 2017) that the D&C has been widely used in different countries and the results indicated that over-control by the clients on D&C projects might lead to time-overruns, cost-overruns and poor performance.

R10: "That's not a real D&C. If you go overseas, you can see that the design team become purely a subcontractor to the main contractor. However, in New Zealand, the designers still rely on the client for the next project. They are not loyal to the contractors."

One of the main challenges that our respondents mentioned is that the subcontracting market in New Zealand is not sophisticated enough. So architects have to do more design than they have to in other countries. Interestingly, our results reflect the views of (Ulubeyli et al. 2016; Abbasian Jahromi et al. 2018; Kocak et al. 2018) who indicated that since a huge proportion of the construction project is conducted by subcontractors, their ability to develop the concept design to IFC can be the difference between success and failure of the project.

R5: "In New Zealand, Subcontractors don't even have the qualified supervision to manage their staff, so essentially our head contractors have to supervise their works to ensure that they build the building."

On the other hand, sometimes head contractors had failed to appreciate the fact that due to New Zealand workload issues, they cannot get the good subcontractors they want.

R1: "Main contractors assume that they're going to get the good subcontractors to do the work when they want them and for the price they want them. But these days the market can change rapidly where subcontractors are more expensive, or they are not interested or not available, and suddenly the lead contractor has got a problem."

In the past few years, New Zealand construction market observed major head contractors going bust and goes into liquidation, despite the fact that the industry is booming, not just in housing, but also in vertical commercial and infrastructure development. Interviewees mentioned multiple reasons for this issue. One of the common answers our participants mentioned is in regard to an incomplete understanding of the project risks in the market.

R2: "Contractors had failed to appreciate what risks they were signing up to and therefore have ended up losing money."

However, contractors mentioned multiple reasons for their risk management failure. Their primary reason was about New Zealand tendering procedures.

R8: "New Zealand competitive tendering processes drive down the margins of it and increase the risk we should take"

Contractors also mentioned that client's team doesn't define the risks properly from risk assessment workshops. They just try to close any post-contract claim opportunity in the contract instead. These new contractual forms have probably increased the level of legalese being used.

Contractors and designers were very disappointed in seeing too much involvement of lawyers in reforming construction contracts.

R9: "Planning is extremely important in construction. Therefore the individuals who are involved in the planning phase need to know how the execution would be. Now clients and their boards are getting more legal advice around contract reform from the lawyers who have no idea how construction work is going to be done. They just try to shift any risks to contractors. That is truly causing problems because, in their mind, they're doing their job for the client by writing a very complex contract to eliminate any risks from client-side. That's not going to have the right results."

One of the contractors mentioned that he recently had seen an NZS 3910 contract with more than 100 pages of special conditions on the items that contractors cannot claim for.

R8: "We already have a standard 3910 and 3916 (D&C) contracts that respect the specifics of the job. We should be using that more, not heavily modified contracts. We need a fair contract, a fair assessment of the risks and fair special conditions."

From the contractor's point of view, clients are using the competitive tendering process to dump massive complex contracts on the main contractor. Now if contractors foresee that risks, they may price it in their bids, other may not price it, and through the current tendering process chances are the one that didn't price it will get the job because they may have a lower price. Thus, in recent years, it has been observed that the main contractors are not very keen on participating in competitive bids. They are more interested in negotiations which they can increase their margins.

R9: "Contractors need to wake up and be going for more margin if they want to survive. They should be going for eight to ten percent, not five or six percent margins."

Almost all of the interviewees believed that this is the primary reason for the failure of the major contractors, which left a huge gap in the market, especially for Tier 1 projects. Since most of the big sub-contractors are hooked to the major contractors, the problem has passed to the rest of the market. In recent years, some subcontractors tried to fill the gap and play the main contractor's role in the market. However, due to the lack of management experience and capabilities, they usually fail to deliver the optimum results. One of the interviewees mentioned that a good subcontractor is not necessarily a good main contractor.

R5: "We experienced it. There was a very good subcontractor working through the main contractor for us. It has been decided that the subcontractor had reached a stage where they could be the lead contractor and allowed to bid. They had a good performance as a subcontractor, so they got the job. However, after a while, they struggled with their Health and

Safety, they struggled with their performance and it has been realised that they just don't have management capabilities."

Due to the small market of New Zealand, it cannot afford to have major contractors go bust and people been taken out of business. Different parties should work together to overcome these issues.

R5: "It's a privilege that contractors have put their money and their resources to take risks and do our projects. They should be able to get a fair reward for the effort they put. As a public client, rule number one for us is that if my contractor is unsuccessful, my business is unsuccessful. Because construction is not similar to other markets that you have lots of customers. In construction, if the contractor fails, the business is bad. We need to change our mind set and go through more team work. We need to work with designers to develop a proper design. We need to work with contractors to find risks and properly manage it instead of firing it at each other. We need to understand that we are not dealing with entities; we are dealing with human beings. Because contractors don't want to fail. They want a good reputation to get the next projects. Just because it's the public sector project and there is a need to demonstrate to the public that it's a fair process, that doesn't mean that there's a need to run down the contractors and squeeze them when they are down. We should cooperate as one team."

In addition to the following challenges, the maturity of procurement systems is another major issue of New Zealand construction. While other countries are more leaning toward using Design-Build, this procurement system has not attracted adequate attention in New Zealand.

R2: "The market overseas is more mature. Builders are more likely to take on D&B projects whereas here builders shy away from those, because of the expertise to manage them. In Australia, within the last nine years, they did probably more than 70% of their jobs D&B. From a client perspective, they like that because the risk was more attributed to the builder with the right price. But in New Zealand, clients and designers, design a concept and they go to the market. Then the market says it's going to cost this much and they say oh that's more than what we thought. Then they're looking how we are going to make it fit, and that's when the squeeze comes on the contractor."

Recently, the construction market also observed some challenges with ECI procurement model as well. Due to the over workload and the amount of work that the contractors have out there at the moment, they cannot be fully committed and give the value that one would expect from an ECI phase. Some clients recently came to a conclusion that the best way to procure and to tender projects is to actually do the detailed IFC design with a committed design team and selected key subcontractors on board to inform the buildability of the design, so that when it comes out to tender, it's fully documented and fully coordinated detailed drawings.

2.1.2 Part 2 – What are the routine CS methods in New Zealand public construction sector?

In terms of "tender evaluation methods" in New Zealand, our results indicated that there is no formalised guideline that been used by public entities. Different public organisations in New Zealand have different sets of rules for their assessments. For instance, the Ministry of Business (MB), Ministry of Foreign Affairs and Trades, NZTA and Department of Corrections have different guidelines. This disunity of the procedures might be confusing to both contractors and clients. Most of our interviewees mentioned that since some of the guidelines in New Zealand public departments are not clear, it pushes clients to choose the lowest-bid rather than best-value contractors.

However, it has been mandated by the government that all the public bodies have to procure and tender by publishing an advertisement in the Government Electronic Tenders Service (GETS) website. Especially for major projects, they have to demonstrate to the public that they have achieved the best value for the public money by having a fair opportunity for everyone in the market to participate.

R6: "The routine process is that first an expression of interest will be published on GETS including very basic documents about the project timeline how they want to procure and maybe some basic drawings. Then the contractors are asked to register their interest. Then there's an interview process that the project manager as the clients representative will discuss the project with contractors. Then project manager goes back to the client to shortlist and get rid of the hopeful lot and hopeless lot and leave three to five contractors that they believe can deliver the job."

New Zealand, public entities approach, is generally to use pretender process as a filtering stage as it has been suggested by various scholars (Kashiwagi 2002; Darvish 2007) that would allow them to reduce the number of contractors who are going through a bidding process. Our respondents mentioned multiple reasons for their filtering stage. Their primary reason was that they appreciate that it costs significant money for contractors to bid (evaluate the project, document preparation and finally bid). Moreover, contractors who are going to pay it to bid need to understand what is their chances of winning. So if clients inform the market that they want to shortlist four contractors in pre-tender process, contractors know that when they are putting the effort to bid they have a 25% chance to get the job.

As it has been mentioned, after pre-tender procedures which is usually a filtering stage to scan and eliminate contractors that might not be able to deliver the job, tenderers will go through Price/Non-Price evaluation metrics. Depending on the nature of the project and clients sensitivity

to price, time and quality, one envelope or two envelopes (brook's law) approaches may be selected.

Where non-price attributes are the most important factors and clients want to ensure that price does not influence the evaluation panel, they use two envelope approach. In this approach, contractors have to submit their bids in two sealed envelopes. The first envelope should only contain responses to non-price attributes, and the second envelope contains all the pricing information. First, the non-price envelopes would be opened and assessed. The contractors who can fully deliver the project will be ranked based on their capabilities, then the highest-ranked contractor will be invited to negotiate the price.

R8: "… In the public sector, I would say it's mostly one envelope with two different evaluation methods. First is the lowest price, another is a simple additive weight (SAW)."

The lowest price is the most basic evaluation method. The contractors who have been shortlisted either through pretender or pre-qualification will be compared by their total price. This approach is not appropriate when quality or other non-price aspects are important as it does not offer greater value for public money.

Simple additive weight is the most common method used in public projects. Construction projects are unique, and each attribute has a different level of importance in different projects. Thus, evaluation panels start with ranking the attributes in order of their importance. Then decide a weight for each one. The weight of these attributes is somewhat dependent on the nature of the contract and vary from project to project, depending on what are the main concerns of the client. However, the big question is whether the price is still the predominant factor in public projects or not. Our interviewees had different points of view on this topic. While clients believed that non-price attributes and best value is their primary objective when evaluating tenders, contractors and designers believed that price is still the main factor for choosing construction contractors in New Zealand.

R3: "As a client, I think the price is always important, but generally non-price attributes are weighted higher than the price in our recent projects. In RFP, each section is broken down with marks, and sometimes we had 80% non-price attributes, especially for projects that need a high level of innovations."

R9: "… for government projects I would say evaluation would be mainly on price because government institutions should answer back to the public and they don't want to try and justify why they took the higher price over a lower one. Recently, we had a bid on a public project that we thought we had an 80% chance to win, but they chose the lowest price at the end."

By reviewing different governmental guidelines, it has been observed that the weightings published in NZTA instructions for tendering is the most common one with the price as the dominant attribute (50% to 70%), relevant skills (20% to 40%), methodology (20% to 30%), relevant experience (5% to 15%), track records (5% to 15%), and resources (5% to 10%).

Different methods have different strengths and weaknesses. Lowest price can give a financial gain to the client at that point in time, but the weakness is that you don't necessarily get the best quality provider. SAW can force both parties to consider the project in more details and what constitutes a quality project and rank contractors consistently. However one of the major weakness of SAW that some of our interviewees shrewdly observed is that it can drive you to accept a contractor with poor performance on the basis that they got a good mark on other attributes.

R3: "my personal view has always been to have a go/no-go criteria than weighting. Because in SAW, a low score is in one criterion can be neglected by a high score in another. For instance, if Health and Safety are important to us and someone scores very low in that and got full scores in everything else, well I might not want that contractor because Health and Safety are very important. Another weakness of SAW is that it doesn't allow you to use what you know about the people and their performance and their attitude."

2.1.3 Part 3 - Key assessment criteria used in New Zealand public tendering

The efficiency of the tender evaluation process is also associated with the appropriate choice of criteria. Participants were asked to describe the main criteria that have been used in public tendering procedures in New Zealand during the past years. Moreover, they have been asked what criteria should be considered. This theme further explored in a questionnaire aimed to identify the level of importance and level of achievement of the New Zealand construction sector in each identified criteria. Our interviewees had different opinions about what criteria should be considered in tenders.

R4: "although it depends on the project I think clients should be asking contractors around their performance there are key subcontractors their supply chain and the previous relationship between client and contractor, but they end up looking just at price because it's hard for them to find metrics for non-price attributes."

R6: "Price has to be part of any competitive bid I think it should be at least half of it however in today's market clients should also be concerned with the main contractor's workload clients should also understand what team are they going to get on the project and who would be the subcontractors."

One of the main concerns of the clients was about the team that the contractor wants to put on the job due to the lack of experienced professionals in New Zealand it has been observed by our interviewees that some construction experts have been assessed assigned to three different projects at the same time to help the company gets more jobs.

R5: "We have seen a rise in the bonding of key people as part of the terms of the contract because key personnel are that important in New Zealand I think public clients do not consider adequately the team involved."

R2: "We have to train more professionals in the whole construction management area currently we don't have enough depth of expertise in New Zealand, and we struggle with it in recent years there is another concern around supply chain there is a fear of getting inferior products through China without a proper quality guarantee.

Most of the respondents mentioned that the attributes considered in NZTA guideline are the most common criteria that are being used in New Zealand public CS. It contains 50-70 percent price and 30-50 percent non-price attributes. The main non-price attributes that has been identified in NZTA guideline are relevant experience [6%-9%], track records [9%-15%], relevant skills [10%-15%], resources [5%-10%], and methodology [20%-30%]. This result indicate that price is the dominant criteria in New Zealand's public tendering. However, almost all of the participants agreed that these criteria and associated weight might be different from project to project, especially, there might be a huge difference between Tier 1 projects and Tier 2&3 projects.

R1: "Price is a big one for public clients especially for tier 2 and tier 3 projects but in Tier 1 projects price is not the most important criteria for big contractors we are more interested to see their financial capabilities their balance sheets guarantees and insurances their track records organizational experience similar contractual arrangements their key personnel their workload and other things is that very important are their methodology innovation and their risk management experience."

Figure 25 and 26 plots the number of observation of each criterion from the literature review results and semi-structured interview results, to identify the priority of each criterion in the proposed set.

Figure 25 illustrates the criteria mentioned by our interviewees and the number of observation of each criterion in the semi-structured interviews. Although the number of observation cannot be interpreted as the importance of each criterion, it can provide general information to understand the main concerns of the participants in terms of tender assessment criteria in New Zealand public projects.

Some similarities and differences identified between these results and the results from the literature review illustrated in figure 26. The semi-structured interview results confirm the high importance of "price" related attributes as it has been suggested in NZTA guideline. However, it puts a high emphasis on "key personnel" and "financial capacity" of the contractor as the second and third most important criteria. The results demonstrate great importance is placed on "risk management". As it has been mentioned in part one of the semi-structured interview results, one of the main challenges of the current market in New Zealand is the lack of proper management skills to identify, analyse, treat and control the construction risks. The results illustrate that it is necessary to consider risk management as one of the main criteria in public tendering.

Various scholars identified "Price" as the most important and often dominant criteria (Chiang et al., 2017; Orkun Alptekin & Alptekin, 2017; Ahmed et al., 2016; Jafari, 2013; San Cristóbal, 2012). Our literature review results rejected this conclusion and showed that this attribute is not among the top 5 criteria. However, the results from semi-structured interviews confirm the conclusion of those scholars and illustrated that "price" is the dominant attribute in New Zealand public CS.

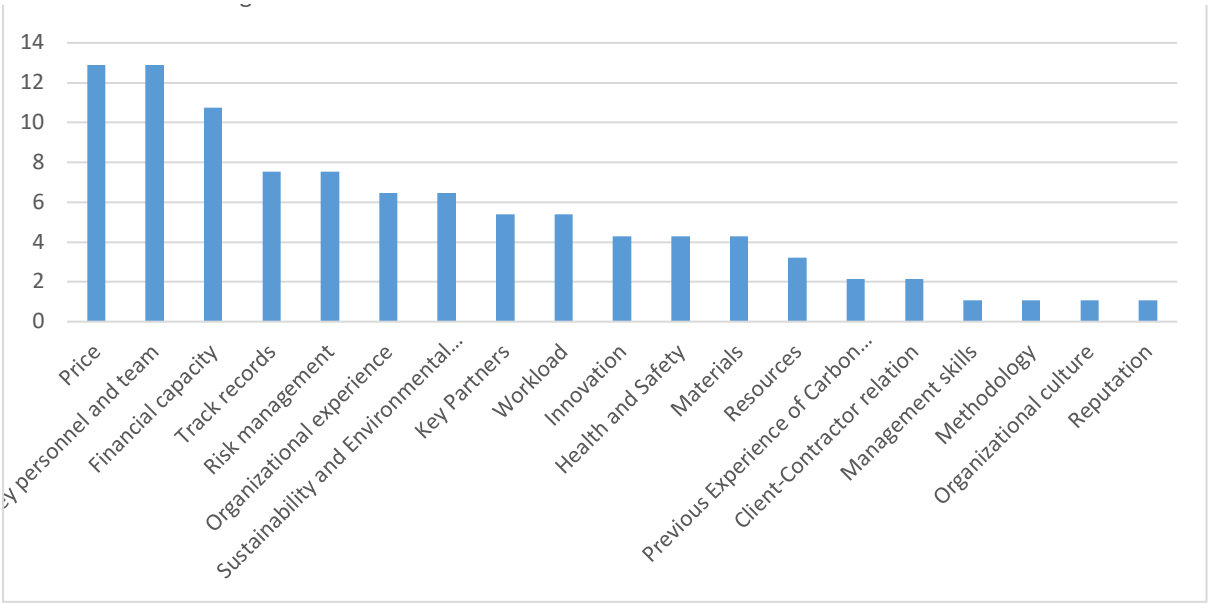

Figure 25 - Percentage of observation of each criterion in the semi-structured interview approach

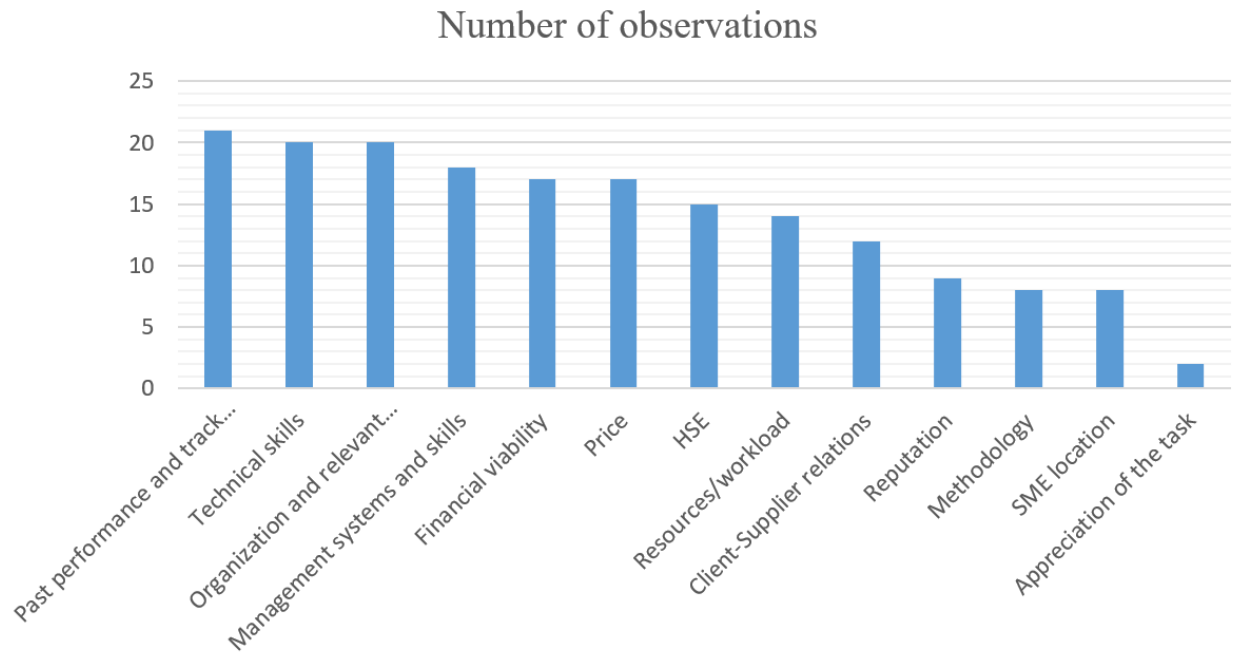

Figure 26 - Number of observation of identified criteria in the reviewed literature

2.1.4 Part 4 - Current challenges of public construction procurement in New Zealand

Most of the participants agreed that the procurement strategy is an important part of a construction project. However, they stressed that the integrated procurement systems had not developed properly in New Zealand as they are developed in other countries such as Australia, UK and US. Participants mentioned the various reason for this issue. For instance, interviewee R08 stated:

"One of the main reasons is that our public clients are not informed about the benefits, and they don't do a proper risk assessment at the beginning. Most people don't understand the benefits of a proper risk workshop. They should have expert consultants that can identify risks, understand the proper treatment for those risks and find the best procurement model that will go with it. There are good procurement models that go well with different outcomes, but first, we should understand what exactly the client wants and what the reasons are."

Some of the interviewees were concerned that design and build (D&B) had not attracted adequate attention in New Zealand. They believed this procurement strategy is one of the best approaches that we can use more often in New Zealand. Some of the clients and contractors had experience working in major design and build projects in Australia. They mentioned that the primary reason that design and build projects are very successful in Australia is that the clients were very clear about what they want at the concept design stage. Moreover, the subcontractor is more experienced in Australia and can properly develop the design with expert teams of engineers.

R2: "Australians do a loose design and build they do more the design build finance maintenance (DBFM) because builders are probably better in maintaining buildings than clients."

Participants agreed that Public Private Partnership (PPP) is one of the procurement strategies that can be efficiently used in construction projects. During the past few years, PPP has mostly been used in New Zealand by the Department of Corrections and Department of Education for projects with higher values.

R9: "PPP is generally for high commercial risk projects that have a more complex form of contracting with a usually guaranteed maximum price. However, it has not been raising proper attention in New Zealand from the contractor's perspective. The main reason is that the client wants to be involved in everything which is very unusual and very restrictive, and we (contractors) lose control of our trades."

Over recent years due to the current challenges of the New Zealand market where there are capacity issues and designs not adequately completed, there has been a trend toward Early Contractor Involvement (ECI) in projects. Our interviewees mentioned that there had been a significant number of instances where clients had preferred contractor on board at early stages to work through some of the key issues at the start of the project. However, some clients have argued that in some ECI projects, they didn't get the targeted outcome they wanted from contractors. One of the reasons might be due to the fact that in New Zealand, most of the head contractors are

management contractors and in the early stages clients need to go quiet deep, so they actually need key subcontractors around the table at the time, to get good feedbacks from ECI. The real challenge is to get access to these key subcontractors who can evaluate and respond to the buildability issues in the early stages.

From the contractor's perspective, they were concerned that the client's expectation from ECI contracts would not be reasonable.

R6: "Clients are concerned about how poorly it's done with the main contractor. But I think clients should be clear about what they want out of ECI. I think they have this feeling that the contractor is going to come on board and solve all the problems. Well, it doesn't work that way. Clients should understand what they want. Do they want the contractor to take five percent of the cost out by value engineering it or do they want him to assist on some items from the key designing terms of what system structural forming going to be used."

Another issue that the contractors mentioned is that sometimes the ECI stage is too close to the start of the project.

R10: "In some ECI contracts, the contractor gets on board too late. It's not easy when you ask contractors to come to the meeting when the work on-site starts in two weeks. It needs to be six months out if you actually want some high-level design. The timing is really important in ECI."

As it has been mentioned, ECI has been used during the past few years to improve some of the dysfunctions of New Zealand procurement system. However, most of the interviewees believed that more integrated models such as design and build are better ways than traditional approaches to procure major construction projects with the builders and designers in the same team. It encourages them to cooperate rather than competing, and it is not a contractual interface between them. Moreover, in the public projects, the role of government entities would be challenge.

R4: "One barrier is that the government procurement methods shaped by people who determine procurement processes as photocopying machines and want to apply those in all of their construction and design industry. It is such a loose fit. They largely do that to drive costs down rather than having a long-term focus on these procedures. There is a mismatch between something that has been tailored to the construction industry and something common across the whole government."

2.1.5 Part 5 - Importance of using modern construction principles

To understand the level of achievement of New Zealand construction sector to modern construction principles specifically Building Information Modelling (BIM), Sustainability and Supply Chain, interviewees were asked to describe their experiences related to these topics and challenges they faced.

BIM modelling becoming more and more important in New Zealand construction projects. Clients are interested in using it, contractors and designers are looking for new approaches to

achieve that. However, as our interviewees mentioned, every player has a different purpose of BIM.

R9: "Regarding BIM, we are behind the rest of the world. BIM can allow us to get our staff to interact, engage and give proper feedbacks. During recent years, it has been an element of significant project design and implementation. However, there is still a lot of territories to be navigated and a lot of procedures to be put in place to come to a common understanding from different parties to realise what exactly we want out of it. The current problem with BIM is that our clients, designers, contractors and subcontractors are not sophisticated enough to ensure everyone has an understanding of what is going to be done in BIM."

If we want to get full value out of BIM, it must start with the planning phase and all parties should be involved. Another issue is that different parties have different BIM modelling system. To get proper results, different players involved should use one integrated construction information management system which has been coordinated centrally by an experienced BIM consultancy group.

R8: "When it comes to BIM, contractors and designers will say we know how to use it. That's not always true. As clients, we had difficulty getting our different consultants to use the same BIM system. Our engineers say we have our software, our architects say we have our software, and they fought a lot to use that software. But as clients, we think all of them should adopt our system."

R3: "As construction consultants, we recommend that the client team should own, maintain and run BIM and then the whole team comes on board. If that executed correctly, clients can use it for their fully documented project management and facilities maintenance."

Although contractors were positive about having previous BIM experiences as a criterion, they were concerned that most of the times clients do not properly understand what exactly they want out of

BIM.

R4: "Clients should be more mature about what they are asking from BIM. If they want to get full value, they should start paying the full fee of it, rather than trying to get something for free."

In terms of sustainability, the participants expressed the view that it has been a criterion in New Zealand Construction. New Zealand has a green environment, so sustainable designs and projects played an important role in the market. Different contractors and designers embodied sustainable principles in terms of waste minimisation and developed structures that will last for longer periods.

R8: "Sustainability was attaining thing before it was about green stars and was driven by consultants. However, in recent few years, it has become an important thing that most clients are interested in."

R1: "In recent projects, clients and their consultants are trying to have better procurement methods and looking for better materials around sustainability and trying to improve their

performance in terms of waste management and making sure that they are separating certain types of waste to minimize landfills."

Sustainability is certainly an objective of current responsible development. When interviewees been asked that if they think sustainability factors should be considered in tender evaluation procedures they were mostly positive. Most of the interviewees responded that they think sustainability is an important factor to be considered in contractor selection processes.

R3: "It would be good to check contractors on how do they manage their sustainability in terms of waste minimisation and waste management. We want to know about their logistics management, efficient delivery, site management and packaging in their previous experience. If we can make it more practical, it can easily become a new criterion to be considered in contractor selection."

Sustainability as criteria might be something where clients can ask contractors to demonstrate an understanding of it and their previous experience with sustainable approaches and energy efficiency. However, other interviewees believed that it should not be considered in contractor selection procedures because it's not a major criterion for evaluating contractors.

R10: "I think sustainability is generally a client-driven objective rather than driven by the contractor. Our contractors are generally responding appropriately to it, and I think it's not much difference in the capability of our contractors in that area."

As it has been mentioned in the criteria section, during the past few years, the supply chain has been an important issue in New Zealand. There are lots of products being imported to New Zealand, and there is a fear of getting inferior products through China. Most of our interviewees mentioned that the supply chain is one of their main concerns in construction projects.

R3: "I think one of our biggest challenges in New Zealand is that we are at the end of the world of the supply chain. We don't make a lot of things ourselves. We are shipping it in, and the supply chain is a complex issue. When people say we are not engaged with the world market, I think, on the contrary, we are heavily engaged with the supply chain. But our challenge is to get the proper supply chain that delivers the right products to meet the New Zealand environment."

Although the supply chain has been a controversial challenge in New Zealand, it has been used at basic levels in construction. During the interviews, it has been noticed that most of the parties involved in construction projects were not completely aware of the options they have around supply chain and the benefits they can get from implementing proper supply chain system. They were mostly focused on material standards. However, some interviewees were using it more broadly in logistics and material management.

R4: "About supply chain, I think it means not just buying discrete products or plants. I'm talking about managing inquiries, purchasing, shipping, delivering on-site and maintaining relations with suppliers. It should part of be part of the contractor's ability to manage a positive relationship with suppliers and have the right production time at the sites."

R9: "Supply chain should be considered. It's very important. I guess it's something that we haven't have paid enough attention to. We have assumed that it's always there. We should be asking exactly who is going to supply things and from where because it can also have effects on sustainability."

2.1.6 Part 6 - Main barriers to implementing improvement projects in the New Zealand construction sector

To understand the challenges of suggesting an improvement project, the interviewees were asked to express their views on barriers of implementing standard tender evaluation framework in New Zealand construction sector. They mentioned that one of the primary issues would again be the capacity of the market.

R9: "Size of the market again is a huge challenge. There is a relatively small number of available options in the market. Thus, the supply chain dictates terms to contractors and contractors dictate terms to clients."

Another barrier that the participants mentioned is a cultural aspect of the New Zealand market.

R4: "Sometimes the New Zealand culture is allergic to following procedures. We have a strong culture of Do It Yourself (DIY). We are sort of make it up as we go along. Besides, that resistance to changes is a natural barrier."

2.1.7 Part 7 - The role of government in implementing improvement projects to increase the performance and efficiency of the construction sector

Governments play an important role in the market as a legislative body. The fact that they can introduce new laws and impose controls give them huge leverage on the market. Due to this vital responsibility, we asked interviewees about the government's role in improving construction sector. One of the main concerns of our interviewees was about the role of government in training experts that can solve the capacity issues and lack of professionals in the industry.

R5: "Government needs to get involved with training, not leaving it up to the private sector. It needs long term commitment, and the government needs to be more involved in giving grants and scholarships to the people who are coming into the industry. We are so short of expertise, and nobody wants to invest in the training properly."

However, with the high level of power of the governments, there is always the risk of over controlling the free market. Our interviewees had different opinions about the level of involvement of the government in the construction market. Some believed that more control from the government side could move us to better improvements.

R2: "I think effectively, it would be more controlled from the government side because, in public projects, it would be the government is saying that the project should look like this. Government is the only one that can impose improvements which require all the parties to use them. So I think their involvement is a key factor."

On the other hand, those who believe that the government should have less control over the market argued that a high level of involvement from the government side might have some negative impacts on our free market concepts.

R6: "Government is a big entity in terms of procurement. Recently, Minister of Transport of New Zealand announced publicly that he has some concerns about the recent procurement methods used by some government departments. It might hurt the market. We are in a capitalist world, and we need to make sure that always there is a market."

In terms of public tender evaluation procedures, most of our interviewees believed that currently, government departments have got so much bureaucratic process that it is so time and cost consuming.

R3: "I would like to see government in a framework that they feel comfortable. A framework that they cannot put their weights up in terms of favouring one contractor. They should have controls to make sure quality is right and put good standards. But don't dictate who gets the job as the contractor. We would like to see more flexibility from the government to reward good performance on to the next project by negotiating. We know that bureaucrats make it quite difficult for them to do so. However, if at least they standardised the process that would be better."

2.6 Discussion

In light of various tendering procedures and mechanisms being used by construction clients to reduce the project cost and time and improve the performance, this phase of the study examined the main aspects of tendering in New Zealand public construction market. At a theoretical level, these results can assist future researchers to better understand the challenges faced by different participants involved in New Zealand public construction projects and underlie important elements of different decision-making techniques in construction. In practical terms, this study aimed to explore cognitive CS mechanism in the New Zealand public sector and identify areas for improvement that can assist clients in their tendering procedures.

The data were collected utilising inductive qualitative methodology approach. This method has been considered appropriate when prior knowledge regarding the phenomenon is limited, and the objective is to gain more familiarity into the problem (Lewis 2015). The collected data were examined and coded by qualitative content analysis methods using NVivo 11 software which resulted in seven main categories of (1) challenges of selecting best contractors in New Zealand public sector, (2) methods being used to evaluate bids, (3) Key assessment criteria that are being used in New Zealand public tendering, (4) challenges of public procurement methods in New

Zealand, (5) importance of using modern construction principles, (6) barriers of implementing improvement projects in New Zealand and (7) role of government in improving the performance of public construction CS.

Our analysis revealed that the over the workload of contractors, low productivity of the workforce and misunderstanding of the concepts of teamwork in this sector are among the main reasons for failed attempts of selecting best value contractors in New Zealand. Furthermore, the New Zealand construction sector has witnessed numerous failures of its major contractors in recent years, which raises the question of how they are going into liquidation while there is economic growth in the market. The content analysis illustrated that the most common answer to this question from our interviews is in regard to an incomplete understanding of the project risks from project participants.

Our results also indicate that there is no formalised guideline for public tendering assessment procedures in New Zealand. Different public entities use their protocols, which sometimes might be vague for contractors to understand and comprehend. Responses demonstrated that disunity of the procedures is one of the reasons that sometimes, contractors avoided to bid on some projects. In terms of assessment methods, our results indicated that despite the recent development in New Zealand construction procedures, lowest-price and SAW are still the dominant methods to select contractors in New Zealand public projects. Although these techniques can be utilised for some projects, it has been suggested by different researchers that the construction market can highly benefit from a transition to modern MCDM evaluation methods (Darvish 2009; Semaan 2017; Chaing 2017; Holt 2010; Kashiwagi 2002).

In terms of assessment criteria, some similarities and differences identified between semi-structured interview results and literature review results. Responses illustrated that price, project team and financial capacity are the top three criteria that construction clients consider in public tenders. This rejects our results from a literature review, which showed that the price was not among the top five most important criteria in construction tender evaluation procedures. The results demonstrate greater importance is placed on financial capacity than literature review results. This might be due to the recent challenges of the New Zealand construction sector and failures of the major construction contractors.

Most of the participants stressed that the integrated procurement systems had not developed properly in New Zealand as they are developed in other countries such as Australia, UK and US. They mentioned the main reason for that is that the public clients are not fully aware of the benefits of integrated procurement models. They also mentioned that another reason is that clients in New Zealand are not very clear about the project objectives at the early stages of the project. However, results illustrate that in recent years, clients are more interested in employing ECI contracts to improve some of the dysfunctions of New Zealand procurement system.

Moreover, the importance of developing modern construction principles such as BIM, sustainability and supply chain has been discussed. Participants demonstrated that these

principles are currently being considered in different projects. However, if we can find appropriate elements for them, these principles can become non-price attributes in public tendering. To identify the proper steps after designing the framework, the barriers of implementing improvement projects and the role of government in imposing these developments were discussed with the interviewees.

It should be noticed that the findings of this phase of the research are not intended to provide statistical distribution of the issues and methods. The primary objective of this research was to evaluate current procedures and introduce new potential approaches to the identified problems. The authors emphasise that most of the findings presented in this paper were generally consistent with the results in the existing literature. However, some of the findings were not identical due to the fact that a different context has been explored which has unique characteristics.

6. Chapter six - Questionnaire survey

2.1 Introduction

Although there are various methods for CS, these techniques are inapplicable without a well-defined collection of decision criteria (Jafari, 2013). Tender evaluation procedures, when addressed by an appropriate set of criteria, can offer more rational construction projects where clients can effectively employ the contractor with the better potentials and increase the probability of delivering the project successfully. This chapter presents the findings of the survey phase administered across the New Zealand construction sector. Table 18 illustrates the key questions of the survey to meet the research objectives of the current study.

Table 18 - The research objectives and questions addressed in the survey

Research objectives	*Research questions*
5. To establish an appropriate set of criteria for public construction CS in New Zealand	7. What are the different tender assessment criteria? 8. Which criteria do New Zealand clients consider to assess public tenders?
6. To identify the priority and level of achievement of each criterion in the New Zealand construction sector	9. Which criteria are more important in Tier 1 projects? 10. Which criteria are more important in Tier 2&3 projects? 11. Which criteria requires more attention in Tier 1 projects? 12. Which criteria requires more attention in Tier 2&3 projects?
7. To explore the differences between Tier 1 projects and Tier 2&3 projects in regard to CS criteria	13. What are the main differences between Tier 1 projects and Tier 2&3 projects?
8. To find the gaps and suggest an improved framework with the use of important criteria	14. What are the key criteria that would improve public construction CS in New Zealand?

The survey results are presented in four sections. The first section illustrates the questionnaire administration. This is followed by a discussion of the response rate. The next section explores the demographics of the participants. Finally, the analysis of the findings will be illustrated and discussed.

2.2 Questionnaire administration

In this study, the web survey "Qualitrics" has been being used. The reason is that web surveys are easier to complete than paper and pencil questionnaires and have the advantage of permitting different filters (Trieman, 2014). Also, it facilitates automatic data transmission into SPSS, which saves time and enhances the survey accuracy. To identify the relative importance and level of achievement of each criterion in New Zealand context, four-point scale (not important, of little importance, important, very important) was adopted as it allows respondents to state their opinions across a reasonable scale. A four-point scale does not allow the participants to give a neutral answer. This has been decided after discussing it with research supervisors. The primary reason to choose a four-point scale is that the participation in this study requires a high level of knowledge and experience in public construction tendering procedures, which limits the number of potential candidates. Thus, it was decided to exclude neutral answer to push respondents to choose more skewed answers (See Appendix 3).

The questionnaire survey was designed by considering the study objectives and required information, the nature of the respondents and their knowledge on the subject, the type of data required, the statistical analysis required to provide proper and meaningful output and the format of the survey to be clear and understandable. After the survey was designed, it was reviewed and revised by research supervisors and proofreader expert. Moreover, to increase the reliability of the survey, the survey and the statistical results have been discussed and confirmed with a survey analysis expert.

2.3 Pilot survey

Efficiency is one of the key factors of a survey study. To promote efficiency and enhance the content validity and reliability of the data, it is essential to conduct a pilot survey. It can be defined as a small study that can aide in the identification of poorly worded questions, test research protocols and data collection instrument (Saunders 2007). In this research, the designed questionnaire was pilot tested by 5 construction practitioners (3 of them involved in the semi-structured interview phase). The primary objectives of this pilot survey were to estimate the completion time and test understandability and functionality of the questionnaire. The survey has been revised based on the recommendations made by pilot study participants to reflect the clarity and avoid any vagueness.

2.4 Invitation to participate

The survey link was sent out to major public clients, contractors, consultants and architects with a brief message outlining the research objectives and an attached information sheet. Some of the respondents were temporarily unavailable, so after four weeks, the first reminder was sent out,

and the final follow-up which was sent during week 7 increased the total responses to 38. Figure 27 illustrates the nature of the received responses over the eight weeks of the survey.

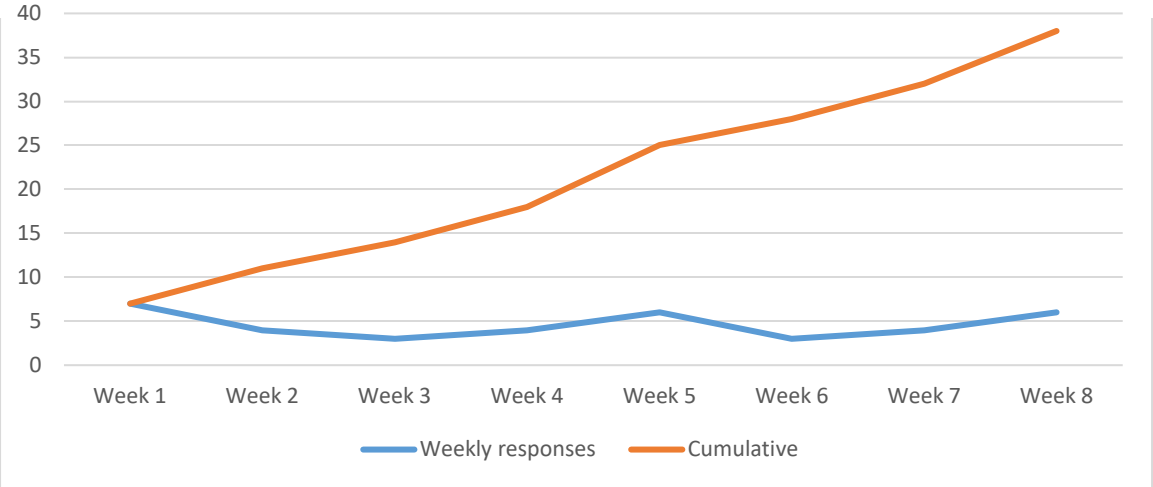

Figure 27 - Received survey responses over the 8 weeks period

2.5 Response rate

The online questionnaire was sent through a web-based survey tool Qualtrics to construction practitioners involved in public tendering procedures in New Zealand. A total of 38 responses were received over eight weeks period from an approximate 120 questionnaires sent out. Five questionnaires were dismissed because the respondents answered less than 50% of the survey. The overall response rate was 31.6%.

Although the response rate could be relatively low, it is similar to the response rate of previous studies in New Zealand. For instance, Rotimi et al. used random sampling to collect 216 questionnaires with response rate of 21%. Rajeh et al. 2015, received 96 responses from 320 project managers with a response rate of 23%. 128 responses with a response rate of 30% were the result of Mbachu, who targeted project managers, contractors and cost managers in 2011

2.6 The location of the questionnaire survey

This survey was carried out in New Zealand started in February 2019 and ended on April 2019. The invitation letter was sent to major construction companies including public entities, contractors, architects, consultants and quantity surveyors located mostly in Auckland, Wellington, Christchurch, Queenstown, Canterbury and Hamilton. However, in the invitation letter, the participants have been asked to forward the letter to other experts that they think would be interested in participating and could satisfy the participation requirements.

2.7 Demographics

The profile of the questionnaire participants was collected in the first section of the survey. It covers demographic information about their current role, highest educational qualification, years of experience in construction, years of experience related to public construction tendering and the types of the projects they have been involved in during the past 5 years. The analysis of the demographic results will be illustrated in the following sections.

2.1.1 Current role

The accuracy and reliability of the research findings are highly dependent on if the research could represent different participants of the construction market properly. Thus, the survey respondents were asked to indicate their role in the industry. Figure 28 shows that different construction participants have been represented in the study. However, the majority of the respondents were contractors, Architects and clients with 50%, 18.4% and 15.8% respectively. It allows us to check if there is any significant difference between criteria from different perspectives. However, it should be noticed that contractors represented a bigger proportion of the sample (n=19) than other groups. To avoid any bias findings, the survey results have also been analysed based on the role of participants to compare the opinions from different groups.

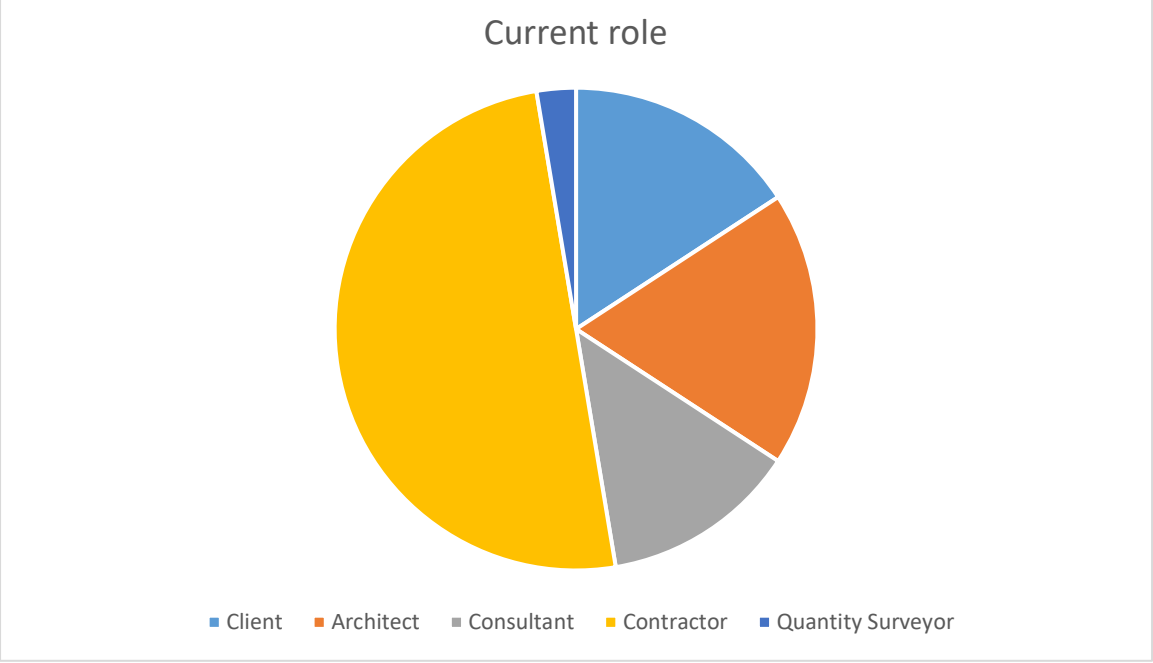

Figure 28 - Role of survey participants in the industry

2.1.2 Years of experience in the New Zealand construction industry

This survey aimed to collect data from construction practitioners with a minimum of 5 years of experience in the construction sector. Respondents were asked to indicate their years of experience in the construction industry. A summary of the results is demonstrated in Table 19. The majority (65.8%) of the respondents had 6-19 years of working experience in construction. 34.2% of the respondents had more than 20 years of working experience. This indicates that the participants have enough construction related experience to answer the survey questions properly.

Table 19 - Years of experience in the industry

Years	Frequency	Percentage
6-19	25	65.8
20+	13	34.2
Total	38	100.0

2.1.3 Years of experience related to public tender evaluation

To have reliable and accurate results, it is highly important that the respondents have adequate experience in public tendering procedures. Data presented in Table 20 shows the participant's years of experience related to public construction tendering in New Zealand. Table 20 shows that 68.4% of the participants had 6 to 19 years of working experience involved in a tendering procedure. Further, 28.9% of the respondents had more than 20 years of experience in this regard. Only one of our respondents had 1 to 5 years of experience in public tendering. The implication of these results is that the survey participants have adequate knowledge in New Zealand construction tendering to give us in-depth information about the research questions.

Table 20 - Years of experience related to contractor selection

Years	Frequency	Percentage
1-5	1	2.6
6-19	26	68.4
20+	11	28.9
Total	38	100.0

2.1.4 Education degree

Survey respondents were required to indicate their educational qualification. Figure 29 demonstrates the summary of the education degree results. It can be seen from the figure that the majority (45%) of the respondents had bachelor qualification. Bachelor honours and postgraduate were the other qualifications with 21% and 13% respectively. Moreover, 21% of the respondents selected "other" as their answer to the education level question. They might have a diploma or certificate level qualifications. From these results, it can be argued that the survey respondents have a good level of relevant academic knowledge to participate in this study. It can increase the degree of accuracy of the data collected from the questionnaire survey.

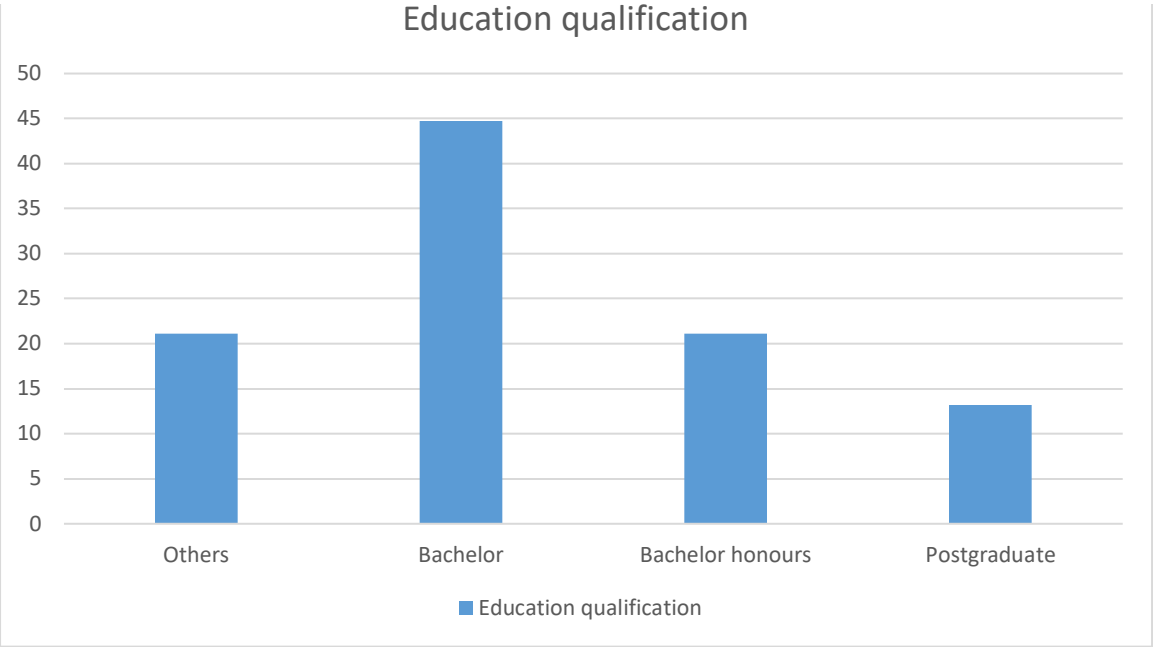

Figure 29 - Education degree of the participants

2.1.5 Experience in different types of projects

From the semi-structured interview results, it has been recognized that in terms of public CS criteria, there are differences between Tier 1 projects and Tier 2&3 projects. Thus, it is highly important that survey participants have adequate experience and involvement in these types of projects. Table 21 shows the participant's experience in different types of construction projects in New Zealand. Most of the participants (76%) were currently involved in Tier 1 projects, while 23% of the respondents were involved in Tier 2&3 projects. One of the main reasons might be due to the fact that since public projects are usually high-end commercial projects (usually Tier 1 projects), only major project participants satisfied the requirements to participate in the study.

Table 21 - Participants involvement in different types of projects

Project type	Frequency	Percentage
Tier 1	29	76.3
Tier 2&3	9	23.7
Total	38	100

2.8 Survey questions

The primary objective of this phase of the study is to understand the importance of CS criteria in different types of projects and to recognise if there is any significant difference between them. By reviewing the semi-structured interview results and comparing it with the literature review results, eventually, 178 criteria were recorded and assigned to 20 categories namely; Organization and Relevant experience, Financial Viability, Appreciation of the task, Past performance and Track records, Management systems and skills, Technical skills, Resources/ Workload capacity, Methodology, Price, Reputation, SME location and geographical familiarities, Health and Safety, Client-contractor relations, BIM experience, Sustainability, Supply Chain Management (SCM), Risk Management, Innovation, Key partners, Materials. Similarly described criterions listed into a category that best represent their characteristics. Table 22 illustrates the identified list of criteria.

Table 22 - List of criteria presented in the online survey

CRITERIA	CRITERION	DEFINITION
Organisation and Relevant experience	Age (years from establishment), size, Number of related Experience, Size and Type of Projects Completed, Role of the tenderer, duration of the project, Years in Similar Projects, Understanding of Regulations, Market Familiarity, Previous experiences with the project contract form	General information about the contractor's organisation such as age, size, and previous experiences in similar or different industries needs to be evaluated in this category. Historical experiences have less value than recent experiences.
Financial Viability	Financial Soundness (Asset, profits, debts status), Financial Capacity, Financial stability, Insurances, return on net worth ratio, Business Turnover-Cash Flow, Analysis of Accounts, Bank Reference or Arrangements, Credit Rating, Liquidity Ratio, Profitability, Debit ratio, Flexibility in payment terms and conditions, profit growth rates,	This category focuses on issues surrounding financial stability and capacity of the contractor. The inadequate financial capability of a contractor may lead to unsatisfactory project outcome. Contractor's assets and profits, insurances, bank statements and previous arrangements will be assessed in this category.
Appreciation of the task	Desire for Business, Competitiveness, Contractor's view of Relative Importance in Providing Services	It has been proven that companies with a low interest in the job are more difficult to negotiate with and may increase the risk of failure. This category evaluates the desire of the contractor to compete and provide the required services.
Past performance and Track records	Time overruns, Cost overruns, Number of claims for variations, Satisfaction of previous clients, History of tendered price variations and final cost, Demonstrated Performance, History of Flexibility (Ability to accommodate design changes during design and construction period), Reliability, Past Failures, Performance History, records of cost reduction during past projects, History of post-delivery support	Contractor's performances in completing the previous projects and fulfil the requirements needs to be assessed. This assessment guides clients to forecast the likely future performance of the contractor.

Management systems and skills	Management knowledge, Management Systems Implemented, ISO and other management certificates, Management structure, Documentation and reporting systems, Waste management and minimization systems, Onsite plant maintenance systems, Human resource planning systems, MIS level (Management Information System), Risk management method, Quality Control (QC) Policy, Implemented Quality Systems, R&D ability, Investment on R&D, Number of patents owned or transferred by the organization, Staff training program, Strategies for human resource developments, Reward and benefit distribution system, Professional qualification grade for managerial staff, Enterprise culture compatibility, Management cooperative desire, Level of investment in management systems	This category evaluates contractor's ability to manage the issues and considers possession of appropriate management personnel with required knowledge such as project development environment, quality management and risk management.
Technical skills	Project Management organisation and Skills, Project management tools, Qualifications, Cost control system, Project Management Ability, Management Competencies, Scope and Risk Control, Level of investment in training of staff, Experience of Technical Personnel, Technical Competence and Ability, Qualification of key staff, Availability and Experience of Technical Design Experts	Contractor's ability to project management skills and cost control needs to be assessed with emphasis on technical areas. The competence and experience of key technical and professional personnel and their availability should be evaluated.
Resources/ Workload capacity	Current workload, Level of current resources (labour and equipment), Contractor Capacity, Current commitments, Equipment's technology	Sufficient and suitable human resources, technical equipment and intellectual properties help contractors to fulfil the requirements of the project. Clients should assess the resources (labour and equipment) that contractor proposed to use on the project.
Methodology	Understanding of objectives and key issues, Proposed Design, Scheduling and CPM, Technology Base, Functionality, Innovative ideas suggested, Reporting and recording systems suggested, Key performance indicators suggested, Division of works into subcontracts, Identification of risks (predict it, cost it, manage it, minimise it), quality plan, Life Cycle Requirements, Growth Capability, Cost-effectiveness, Compliance with Stated Needs or Requirements, Proposed System Solution, Plant/Equipment Type, adaptability and knowledge about new environment, Viability of Technical Solution, Waste reduction plan, Site safety assurance plan	The contractor should illustrate its capability to deliver the project on time, on budget and with satisfactory quality by describing the detailed methodology of approach. Any solutions, innovative ideas and risk allocations will be considered in this category.
Price	Fixed capital Price, Labour Rates, Operating Costs, Variable tender costs during project period, Maintenance costs, operating costs, Return and Benefits, Rationality of Estimates, Through Life Cost Program Methodology	This refers to the details of costs that the client would be required to pay to the contractor to bring the project to a satisfactory outcome. Depending on the contract, payments could include fixed capital cost or variable costs during the contract period or other payment methods.
Reputation	Amount of Past Business, Company Image and Size, Trade Union Record, Litigation Tendency, Organisational Maturity or Stability, References, Responsiveness, Business Ethics	An organisation with a good reputation will try to keep its good image in the business by delivering satisfactory results for the clients. In this section, clients assess contractors based on their trade records, references, responsiveness and their image in the industry.
SME location and geographical familiarities	Business Location (location of home office), Area of Catchment (Local/National), Facilities Location, Familiarity with area and weather conditions, Familiarity with local labour, familiarity with local suppliers	One of the factors that clients usually consider is how close the contractor's company to the project site is. Local companies are usually more familiar with the area of the. Also, they can manage to employ local labour and identify local suppliers in a way, which can generate opportunities to increase employment rate in the region.
Health and Safety	OHS&R management system, Corporate Environment Policy, Safety Plan, History of Safety Incidents, Occupational Health Safety Assurance (OHSA), Environmental Compliance, Safety Performance and standards, level of investment in HSE	Poor safety awareness and policies may result in serious injuries, huge costs or project delays. Thus, nowadays clients put more emphasis on Health and Safety management systems and plan to ensure the satisfactory implementation of safety standards.
Client-contractor relations	Client/Customer Attitude and Relations, Commitment to Support, Responsiveness, Ability to Work as Team, Stakeholder Management, Customer Focus/Relationship, Post-contract attitude, Sub-contractor relations, Sub-contractor management systems	This category evaluates impacts of previous working relations among parties of the project. Any disputes and disagreements among different parties may cause deterioration in mutual trust and reduce the willingness to any compromise during the project.
BIM experience	Scale of the previous projects that used BIM, Level of BIM used in previous projects (Level1, L2, L3), Purpose of BIM used in previous projects (Documentation, Communication, Project scheduling, Project costing and estimation, Life cycle analysis, Logistics, Demolition, BIM education level (Level of BIM education of key BIM personnel, Company's yearly investment on BIM, Trainings undertaken, How do they keep their key BIM personnel updated Annual workshops, 6 months workshops)), BIM certificates achieved, BIM softwares used in previous projects	This criteria evaluates contractor's ability to support the continual updating and sharing of project information by utilizing Building Information Modelling (BIM) technology. In fully utilizing BIM technology, the design information can be modelled in real time with the full consideration of cost and scheduling information to increase project productivity and performance.

Sustainability	Previous experience in Green building projects, Previous experience in Sustainability management (Logistics management, Efficient delivery, Site storage management, Labour management, Site disruptions, Community disturbance, Disposal costs, Reusable/Recyclable/Renewable elements, Energy consumption management, Pollution generation), Investments in Sustainability innovations, Yearly investment in sustainable construction management training, Implementation of ISO 14001 (Level of achievements in 5 major area of releases to land, releases to air, releases to water, natural resource usage and energy consumption), Sustainability certificates achieved	With raising awareness of environmental, economical and social issues, sustainable construction have become a growing concern of the clients. This category evaluates contractor's ability to apply sustainable development principles in different phases of construction.
Supply Chain Management (SCM)	Percentage of previous projects that used SCM, Scale of the previous projects that used SCM, Level of development of SCM in the organization (Financial accounting, Controlling, Asset management, Project System, Human Resource planning, Site maintenance, Quality Management, Material Management, Logistics), Previous delays on receiving materials, Frequency of communication with suppliers, Centralised system used in previous projects, SCM education level (Level of SCM education of key SCM personnel, Company's yearly investment on SCM, Trainings offered, How do they keep their key SCM personnel updated, Annual workshops, 6 months workshops)), SCM certificates achieved	Buildings are becoming more complex that requires understanding of the breakdown and traceability of materials, services, organizations, logistics, people, activities and information. Clients have taken an increasing interest in establishing supply chain relationships among different participants involved in the construction projects.
Risk Management	Previous successful experience in risk management, previous failures in risk management, Level of development in risk management processes (Planning, Identification, Assessment, Treatment and Monitoring), Suggested Risk planning (Objectives, Methodology, Roles and Responsibility, Budgeting, Time management, Risk interpretation, Risk identification method, Risk breakdown structure, Risk Probability-Consequences matrix, Suggested risk treatments)	Because of the poor record of completion to cost and time, high levels of disputes, low margins and profits, risk management have become a growing concern of the clients. In this category, decision makers evaluate contractor's ability to plan, monitor and control the risks involved in construction project.
Innovation	History of innovation in previous projects (Financial, Project time and scheduling, Risk management, Procurement system, Supply chain issues, On site decision making, improving HSE), Registered inventions, Yearly investments on R&D, Any structured lessons learned programme that captures project results, Any structured employee suggestion system, Any structured assessment of innovation in annual personal evaluation	Since construction industry is constantly facing new challenges, clients are showing more interest in contractors with the ability to manage project issues with innovative ideas.
Key partners	Information of key subcontractors, Information of key material suppliers, Information of key equipment suppliers, Previous experiences with the key subcontractors, Previous experiences with the key material suppliers, Previous experiences with the key equipment suppliers	A project may have a talented, innovative and sophisticated head contractor, but without good partners, there is a high risk of failure. In this criteria, clients assess key partners of the contractor and their ability to deliver the unique characteristics of the project.
Materials	List of key materials, Information about material characteristics and methods of material assembly, Certificates, standards and stamp of approvals for key materials, Previous experience of using any defective materials	Contractor's choice of materials and their performance, durability and aesthetic appeal will be evaluated in this criteria.

2.9 Criteria for CS in New Zealand – Descriptive statistics and Non-parametric tests

2.1.1 Comparison between Tier 1 and Tier 2&3 projects

This analysis aims to identify the most important criteria for public tender evaluation procedures in New Zealand. In order to rank the importance of each criteria in different types of projects, the respondents were asked to select the level of importance of each criteria in two types of projects (Tier 1 and Tier 2&3). The list of identified criteria was presented to the participants. Response options were ranged on a scale of 1 to 4, with 1 representing the lowest score "not and 4 the highest score "very important". By discussing the appropriate scale with construction experts in New Zealand, it has been decided to eliminate "Neutral". The main reason is that previous studies

illustrated that when "Neutral" is one of the options, the participants are more likely to select it without properly reading the questions.

The data obtained were analysed in SPSS. The descriptive statistical analysis was used to obtain the mean scores of each criterion. Table 23 and 24 shows the descriptive statistics of the importance of each criterion for Tie 1 and Tier 2&3 projects. The standard deviation can assist us in identifying the standard error of the study. It is a measure of how representative a sample is likely to be to the population of the study (Field 2005). The sample can be considered more accurate of reflecting the population when the standard error associated with the mean is closer to zero. Various scholars stated that the standard deviation of less than 1.0 indicates a higher degree of consistency in the survey responses (Treiman, 2014).

Table 23 - Descriptive statistics of the importance of Tier 1

Descriptive statistics						
	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation
Tier 1 - Importance - Organization and Relevant experience	38	3	4	3.21	.067	.413
Tier 1 - Importance - Financial Viability	38	3	4	3.66	.078	.481
Tier 1 - Importance - Appreciation of the task	38	1	4	2.74	.09	.554
Tier 1 - Importance - Past performance and Track records	38	3	4	3.92	.044	.273
Tier 1 - Importance - Management systems and skills	38	2	4	3.71	.084	.515
Tier 1 - Importance - Technical skills	38	3	4	3.82	.064	.393
Tier 1 - Importance - Resources/ Workload capacity	38	3	4	3.68	.076	.471
Tier 1 - Importance - Methodology	38	3	4	3.37	.079	.489
Tier 1 - Importance - Price	38	2	4	2.68	.114	.702
Tier 1 - Importance - Reputation	38	1	4	2.74	.09	.554
Tier 1 - Importance - SME location and geographical familiarities	38	1	3	2.05	.065	.399

Tier 1 - Importance - Health and Safety	38	2	4	3.53	.09	.557
Tier 1 - Importance - Client-Contractor relations	38	2	4	3.39	.096	.595
Tier 1 - Importance - Sustainability and Environment	38	2	4	3.26	.082	.503
Tier 1 - Importance - Risk Management	38	3	4	3.76	.07	.431
Tier 1 - Importance - Key Partners	38	2	4	3.00	.075	.465
Tier 1 - Importance - Innovation	38	2	4	3.08	.079	.487
Tier 1 - Importance - Materials	38	2	4	3.39	.089	.547
Tier 1 - Importance - BIM experience	38	1	3	2.32	.085	.525
Tier 1 - Importance - Supply Chain Management	38	2	4	3.05	.092	.567
Valid N (listwise)	38				.	

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation
Tier 2 - Importance - Organization and Relevant experience	38	3	4	3.05	.037	.226
Tier 2 - Importance - Financial Viability	38	3	4	3.32	.076	.471
Tier 2 - Importance - Appreciation of the task	38	2	4	2.82	.099	.609
Tier 2 - Importance - Past performance and Track records	38	2	4	3.82	.074	.457
Tier 2 - Importance - Management systems and skills	38	2	3	2.95	.037	.226
Tier 2 - Importance - Technical skills	38	3	4	3.92	.044	.273
Tier 2 - Importance - Resources/ Workload capacity	38	2	4	3.74	.082	.503
Tier 2 - Importance - Methodology	38	3	4	3.29	.075	.460
Tier 2 - Importance - Price	38	2	4	3.32	.101	.620
Tier 2 - Importance - Reputation	38	2	3	2.63	.079	.489
Tier 2 - Importance - SME location and geographical familiarities	38	1	4	2.45	.0111	.686
Tier 2 - Importance - Health and Safety	38	3	4	3.42	.081	.500
Tier 2 - Importance - Client-Contractor relations	38	2	4	3.00	.038	.232
Tier 2 - Importance - Sustainability and Environment	38	2	4	3.13	.067	.414
Tier 2 - Importance - Risk Management	38	2	4	2.97	.070	.434
Tier 2 - Importance - Key Partners	38	2	4	3.05	.065	.399
Tier 2 - Importance - Innovation	38	2	4	2.89	.083	.509
Tier 2 - Importance - Materials	37	2	4	3.70	.102	.618
Tier 2 - Importance - BIM experience	38	1	3	1.74	.082	.503
Tier 2 - Importance - Supply Chain Management	38	2	3	2.61	.080	.495
Valid N (listwise)	37					

Table 24 - Descriptive statistics of the importance for Tier 2&3

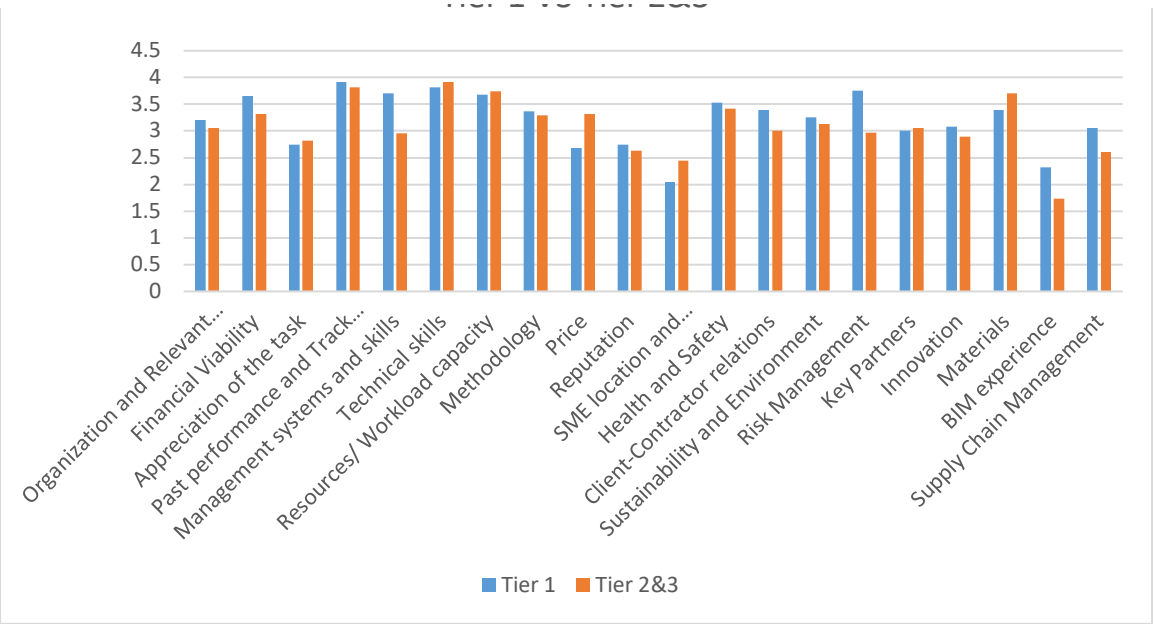

Figure 30 - Comparison of importance of Tier 1 and Tier 2&3

The survey participants were asked to rate the level of importance of each CS criteria in Tier 1 and Tier 2&3 projects. This section of the analysis aims to highlight the most important criteria for tender evaluation procedures in New Zealand for Tier 1 projects and Tier 2&3 projects. The most important criteria for Tier 1 projects was "Past performance and track records" with a mean of 3.92 out of 4. However, the most important criteria for Tier 2&3 projects has been "Technical skills" with a mean of 3.92 out of 4. The top 6 criteria for Tier 1 projects are "Past Performance and Track records", "Technical skills", "Risk management", "Management systems and skills", "Resources/Workload capacity" and "Financial viability".

These results confirm the previous results we got from our literature review that "Past Performance and Track records", "Technical skills", "Management systems and skills" and "Financial viability" were among the top 6 criteria. However, the results demonstrate greater importance is placed on "Risk management" and "Resources/Workload capacity" in New Zealand. Interestingly, this confirms the results from our semi-structured interviews in the previous phase of the research when participants argued that there is a challenge in New Zealand construction sector with allocating risks properly in the contracts and also capacity challenges in the market.

On the other hand, the most important criteria for Tier 2&3 projects were "Technical skills", "Past performance and track records", "Resources/Workload capacity", "Materials", "Health & Safety" and "Price". The results confirm our previous findings that "Price" is a more important criteria for Tier 2&3 projects than Tier 1 projects.

Least important criteria for Tier 1 projects are "SME location and geographical familiarities", "BIM experience" and "Price". "BIM experience" being among the least important criteria is in contrast to our findings from semi-structured interviews where the majority of interviewees mentioned that "BIM experience" can be one of the important criteria in CS. This might be due to the fact that the majority of survey respondents were contractors who consider BIM implementation as extra work in projects. This results will be discussed later in this chapter to see if there are any difference between different groups of participants in this regard.

The least important criteria for Tier 2&3 projects were "BIM experience", "SME location and geographical familiarities" and "Supply chain management". It has been mentioned by our interviewees in the previous phase that these criteria are not very significant attributes for projects with less complexity.

One of the notable findings is that "Price" is more important in Tier 2&3 projects where there are more potential bidders to compete in the tender. Moreover, "Appreciation of the task", "Technical skills", "SME location and geographical familiarities", "Key partners" and "Materials" got higher scores for Tier 2&3 projects than Tier 1 projects.

However, to generalise these findings, Wilcoxon Signed matched-pairs test was performed on the data to check if there is any statistically significant difference in criteria between two types of projects with $p<.05$. Nonparametric analysis was believed to be the most appropriate form of test for this study due to the sample size and distribution of the data. Table 25 illustrates the average positive and negative ranks for two types of projects.

Table 25 - average positive and negative ranks for different types of projects

Wilcoxon Signed rank test					
		N	Z	Asymp. Sig. (2-tailed)	Positive and Negative ranks
Organization and Relevant experience	Negative Ranks	7	-2.12	0.34	Tier1>Tier 2&3
	Positive Ranks	1			
	Ties	30			
	Total	38			
Financial Viability	Negative Ranks	16	-2.98	0.003	Tier1>Tier 2&3
	Positive Ranks	3			
	Ties	19			
	Total	38			
Appreciation of the task	Negative Ranks	8	-0.688	0.491	Tier 2&3 >Tier1
	Positive Ranks	11			
	Ties	19			
	Total	38			
Past performance and Track records	Negative Ranks	5	-1.63	0.102	Tier1>Tier 2&3
	Positive Ranks	1			
	Ties	32			
	Total	38			
Management systems and skills	Negative Ranks	30	-5.20	0.000	Tier1>Tier 2&3
	Positive Ranks	1			

	Ties	7			
	Total	38			
Technical skills	Negative Ranks	2	-1.41	0.157	Tier 2&3 >Tier1
	Positive Ranks	6			
	Ties	30			
	Total	38			
Resources/ Workload capacity	Negative Ranks	6	-0.53	0.593	Tier 2&3 >Tier1
	Positive Ranks	8			
	Ties	24			
	Total	38			
Methodology	Negative Ranks	9	-0.77	0.439	Tier1>Tier 2&3
	Positive Ranks	6			
	Ties	23			
	Total	38			
Price	Negative Ranks	0	-4.34	0.000	Tier 2&3 >Tier1
	Positive Ranks	21			
	Ties	17[a]			
	Total	38			
Reputation	Negative Ranks	9	-1.06	0.285	Tier1>Tier 2&3
	Positive Ranks	5			
	Ties	24			
	Total	38			
SME location and geographical familiarities	Negative Ranks	1	-3.44	0.001	Tier 2&3 >Tier1
	Positive Ranks	15			
	Ties	22			
	Total	38			
Health and Safety	Negative Ranks	8	-1.15	0.248	Tier1>Tier 2&3
	Positive Ranks	4			
	Ties	26			
	Total	38			
Client-Contractor relations	Negative Ranks	17	-3.44	0.001	Tier1>Tier 2&3
	Positive Ranks	2			
	Ties	19			
	Total	38			
Sustainability and Environment	Negative Ranks	7	-1.66	0.096	Tier1>Tier 2&3
	Positive Ranks	2			
	Ties	29			
	Total	38			
Risk Management	Negative Ranks	27	-4.97	0.000	Tier1>Tier 2&3
	Positive Ranks	0			
	Ties	11			
	Total	38			
Key Partners	Negative Ranks	5	-0.57	0.564	Tier 2&3 >Tier1
	Positive Ranks	7			
	Ties	26			
	Total	38			
Innovation	Negative Ranks	8	-2.33	0.020	Tier1>Tier 2&3
	Positive Ranks	1			
	Ties	29			
	Total	38			
Materials	Negative Ranks	4	-2.52	0.012	Tier 2&3 >Tier1
	Positive Ranks	15			
	Ties	18			
	Total	37			
BIM experience	Negative Ranks	23	-4.49	0.000	Tier1>Tier 2&3
	Positive Ranks	1			
	Ties	14			

	Total	38			
Supply Chain Management	Negative Ranks	18	-3.90	0.000	Tier1>Tier 2&3
	Positive Ranks	1			
	Ties	19			
	Total	38			

The results indicates that there are 10 criteria that have statistically significant difference for two types of projects. Figure … presents these 10 criteria. Participants tended to favor "Financial viability" ($z = 2.98$, $p < .05$), "Management systems and skills" ($z = 5.2$, $p<.05$), "Client-contractor relations" ($z = 3.44$, $p<.05$), "Risk management" ($z = 4.97$, $p<.05$), "Innovation" ($z = 2.33$, $p<.05$), "BIM experience" ($z = 4.49$, $p<.05$) and "SCM" ($z = 3.9$, $p<.05$) in Tier 1 projects than Tier 2&3 projects.

On the other hand, "Price" ($z = 4.34$, $p<.05$), "SME location and geographical familiarities" ($z = 3.44$, $p<.05$) and "Materials" ($z = 2.52$, $p<.05$) are the three criteria that are significantly more important in Tier 2&3 projects than Tier 1 projects. These findings confirm our results from the qualitative analysis that there are differences between CS criteria in Tier 1 projects and Tier 2&3 projects.

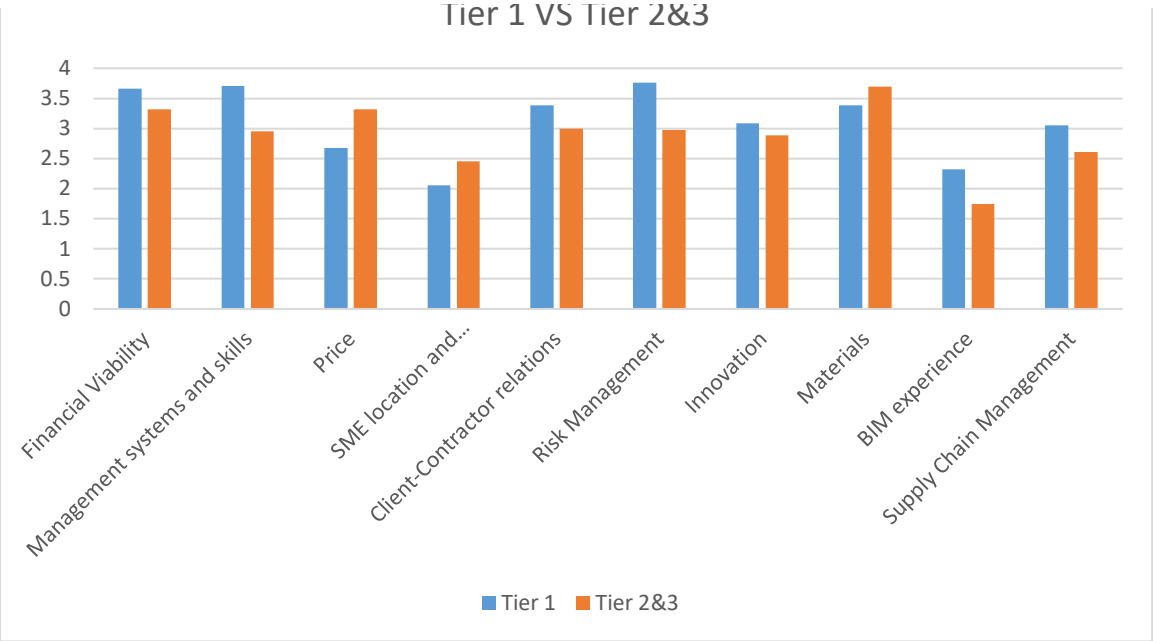

Figure 31 - Criteria with significant difference in their importance between different types of projects

2.1.2 Achievement Tier 1

The primary objective of this analysis is to identify gaps between different criteria in New Zealand public tendering processes. Of the given criteria derived from the literature review and semi-structured interview analysis, the participants have been asked to select the significance of each criterion in making a decision and to what extent New Zealand construction sector have achieved those criteria. The results give us important information which assists us in designing an

appropriate guideline that can help DMs in considering the best list of criteria in their public tenders.

Figure 32 illustrates the comparison between the level of importance and level of achievement of each criterion for Tier 1 projects. From the figure, it can be seen that the scores for "Price", "Appreciation of the task" and "Reputation" are relatively equal. But there are differences among other criteria. Figure 33 shows the matrix with colour codes to identify gaps for each criteria. The area with the importance mean of more than 3.25 and the achievement mean of less than 2.75 has been considered as the extreme points.

There are seven criteria in the extreme range of the matrix, namely; Resources/Workload capacity, Risk management, Past performance and track records, Technical skills, Materials and client-contractor relations. These results indicate that there is a gap between the importance of these criteria and the level of achievement in New Zealand public construction CS. It highlights that DMs for Tier 1 public projects need to put more attention on these criteria in their future tenders.

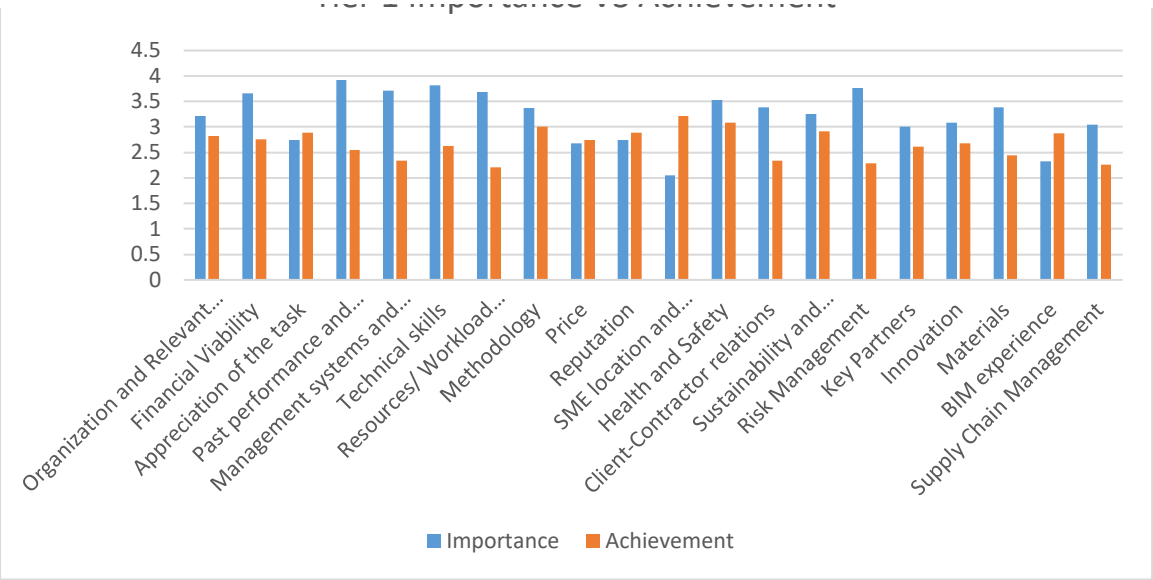

Figure 32 - Comparison between level of importance and level of achievement of each criteria in Tier 1 projects

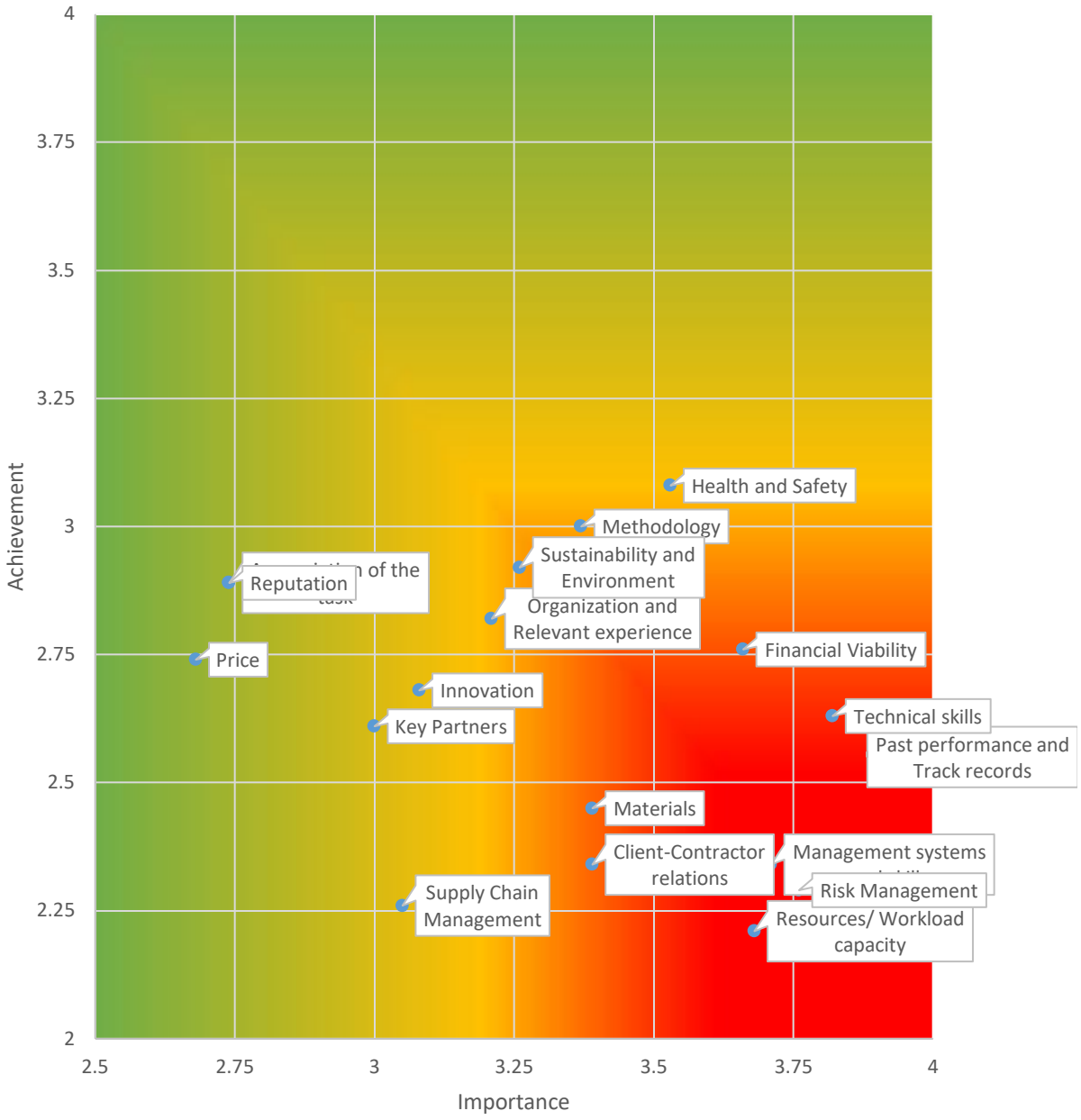

Figure 33 - Identified gaps between the level of importance and level of achievement of different criteria in Tier 1

2.1.3 Achievement Tier 2

This section of the analysis covered the gaps between the level of importance and level of achievement of each criterion for Tier2&3 projects. As it can be seen in Figure 34 some criteria such as "Past performance and track records", "Technical skills" and "Resource/Workload capacity" are highly important in Tier 2&3 projects, but have not received adequate attention in the public tenders. Figure 35 shows the matrix with colour codes to identify gaps for each criterion. The area with the importance mean of more than 3.25 and the achievement mean of less than 2.75 has been considered as the extreme points.

There are four criteria in the extreme range of the matrix, namely; Resources/Workload capacity, Technical skills, Materials and Past performance, and track records. Moreover, "Price" and "Financial viability" are very close to the extreme area. These results indicate that there is a gap between the importance of these criteria and the level of achievement in New Zealand public construction CS. It highlights that DMs for Tier 2&3 public projects need to put more attention on these criteria in their future tenders.

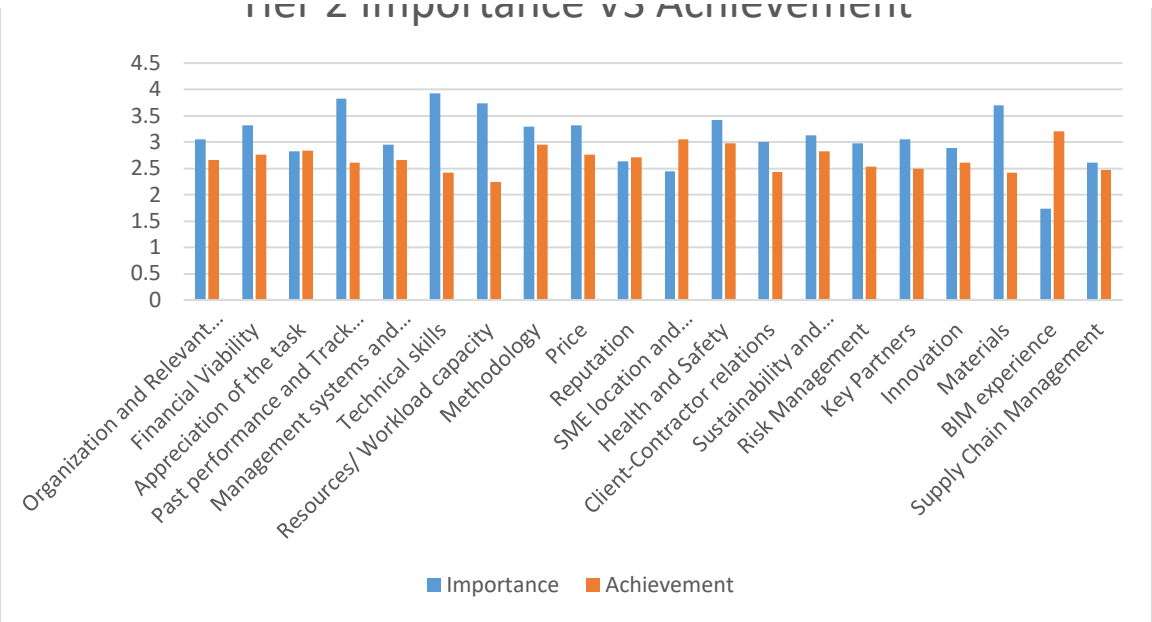

Figure 34 - Comparison between level of importance and level of achievement of each criteria in Tier 2&3 projects

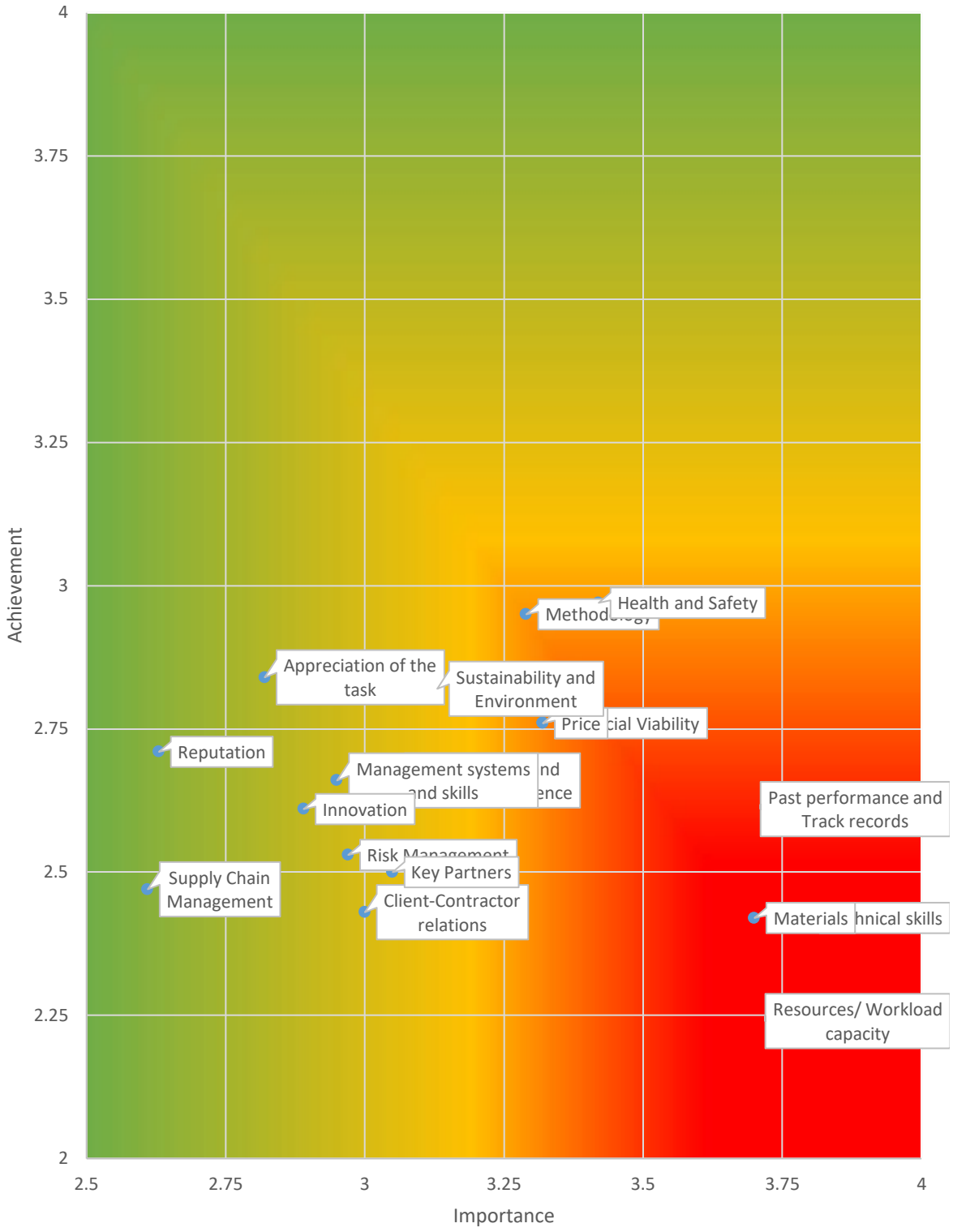

Figure 35 - Identified gaps between the level of importance and level of achievement of different criteria in Tier 2&3

2.1.4 Comparing the results between groups of participants

Descriptive statistics analysis was performed to identify the perceptions of the different groups of participants regarding the importance of each criterion in two types of projects. Since there was only one quantity surveyor participated in the study, these results have been limited to "Clients", "Architects", "Consultants" and "Contractors". Four different tables have been generated by SPSS explaining the views of participants in each type of project. Table 26 and Table 27 illustrates the top 6 criteria in each types of projects based on the role of participants.

Comparisons were made between the groups to determine what the most important criteria for each group are. The most important criteria from a clients perspective are "Past performance and track records", while "Technical skills" is the number one criteria for contractors. However, all of the respondents agreed that "Past performance and track records" is among the most important criteria for Tier 1 projects. Similarly, "Risk management" is among the top three criteria for all groups. These results confirm our semi-structured interview findings that usually for Tier 1 projects, "Price" is not the dominant criteria.

Table 26 - The top 6 criteria in Tier 1 from different participants

Tier 1 - Importance				
Rank	**Clients**	**Architects**	**Consultants**	**Contractors**
1	Past Performance and Track record	Past Performance and Track record	Management systems and skills	Technical skills
2	Management systems and skills	Risk management	Past Performance and Track record	Past Performance and Track record
3	Risk management	Technical skills	Risk management	Risk management
4	Health & Safety	Financial Viability	Sustainability and Environment	Resources/Workload capacity
5	Resources/Workload capacity	Resources/Workload capacity	Client-contractor relations	Management systems and skills
6	Financial Viability	Health & Safety	Financial viability	Financial Viability

On the other hand, “Resources/Workload capacity” is the most important criteria for clients in Tier 2&3 projects while “Past performance and track records” is the third most important criteria. Interestingly, all four groups confirmed that “Technical skills” is among the two top criteria for Tier 2&3 projects. “Past performance and track records” is still among the top three criteria for Tier 2&3 projects. It worth mentioning that while “Materials” was not among the top six criteria for Tier 1 projects, it is among the most important criteria for Tier 2&3 projects. Furthermore, from a contractor’s perspective, “Price” is important criterion for Tier 2&3 projects.

Table 27 - The top 6 criteria in Tier 2&3 from different participants

Tier 2&3 - Importance				
Rank	**Clients**	**Architects**	**Consultants**	**Contractors**
1	Resources/Workload capacity	Technical skills	Health & Safety	Technical skills
2	Technical skills	Past Performance and Track record	Technical skills	Past Performance and Track record
3	Past Performance and Track record	Materials	Past Performance and Track record	Resources/Workload capacity
4	Materials	Resources/Workload capacity	Materials	Materials
5	Health & Safety	Methodology	Resources/Workload capacity	Price
6	Methodology	Health & Safety	Key partners	Financial Viability

2.1.5 A statistically significant difference between groups

Wilcoxon Signed Rank test was used to determine if there is any significant difference in criteria between Tier 1 projects and Tier 2&3 projects from different groups of participant's perceptions. The statistically significant differences have been shown in Table 28.

There was no significant difference between Tier 1 and Tier 2&3 projects for "Organization and relevant experience" from all groups. Similarly, no significant difference exists for "Appreciation of the task", "Past performance and track records", "Technical skills", "Resources/Workload capacity", "Health and safety" and "Sustainability and Environment" criteria between Tier 1 and Tier 2&3 projects. It indicates that if the criterion is highly important in Tier 1 projects, it is also highly important in Tier 2&3 projects and if the criterion is less important in Tier 1 projects, it is similarly, less important in Tier 2&3 projects as well.

On the other hand, clients believed that "Financial viability" is significantly more important in Tier 1 projects than Tier 2&3 projects. However, other groups believed that "Financial viability" is highly important criteria for both types of projects. Our results indicate that clients, consultants and contractors believed that "Management systems and skills" is significantly more important in Tier 1 projects than Tier 2&3 projects.

Almost all of the groups (except architects) indicated that "Price" is more important in Tier 2&3 projects rather than Tier 1 projects. One of the notable findings is that all of the groups agreed that both "Risk management" and "BIM experience" are the criteria that are more important in Tier 1 projects than Tier 2&3 projects.

Table 28 - Statistically significant differences between groups of participants in terms of importance of criteria among different projects

Tier 1 VS Tier 2 (Importance)				
	Client	Architects	Consultant	Contractors
Organization and Relevant experience				
Financial Viability	×b			
Appreciation of the task				
Past performance and Track records				
Management systems and skills	×b		×b	×b
Technical skills				
Resources/ Workload capacity				
Methodology				×b
Price	×c		×c	×c
Reputation				×b
SME location and geographical familiarities	×c	×c		×c
Health and Safety				
Client-Contractor relations			×b	×b
Sustainability and Environment				
Risk Management	×b	×b	×b	×b
Key Partners				
Innovation				×b
Materials	×c	×c		
BIM experience	×b	×b	×b	×b
Supply Chain Management	×b		×b	×b

a. Wilcoxon Signed ranked test

b. Tier 1 > Tier 2&3

c. Tier 1 < Tier 2&3

2.10 Summary

This chapter reports the results from the survey questionnaire analysis. The administration procedures of the survey have been initially explained, followed by the response rate of the

questionnaire. Then, the demographic data of the respondents were presented. This was followed by the survey results gathered from different project participants to explore their perspectives on the importance and level of achievement of different CS criteria in different types of projects. Descriptive analysis was used to discuss the results. Moreover, the Wilcoxon Signed rank test was performed to examine the differences in perceptions between different types of project and different groups of respondents. The following chapter illustrates the final framework and validation of the findings.

7. Chapter Seven: Proposed framework and validation

2.1 Introduction

This chapter presents the first version of the proposed conceptual framework for public construction CS in New Zealand generated from the analysis of the (1) literature review results on construction tender evaluation (2) Semi-structured interviews with construction practitioners involved in public CS in New Zealand (3) survey questionnaire to identify CS criteria. This framework can serve as a guideline of how contractors can be selected for public construction tenders. The findings from each objective illustrated in previous sections served as a basis for the development of this framework and also for justification of the need for this framework. The validation of the framework will also be provided in this chapter.

To validate the framework and identify areas for improvement, the first version of the framework is presented to industry experts. Different views of the participants were summarised in a set of recommendations and later used to improve the final version of the framework.

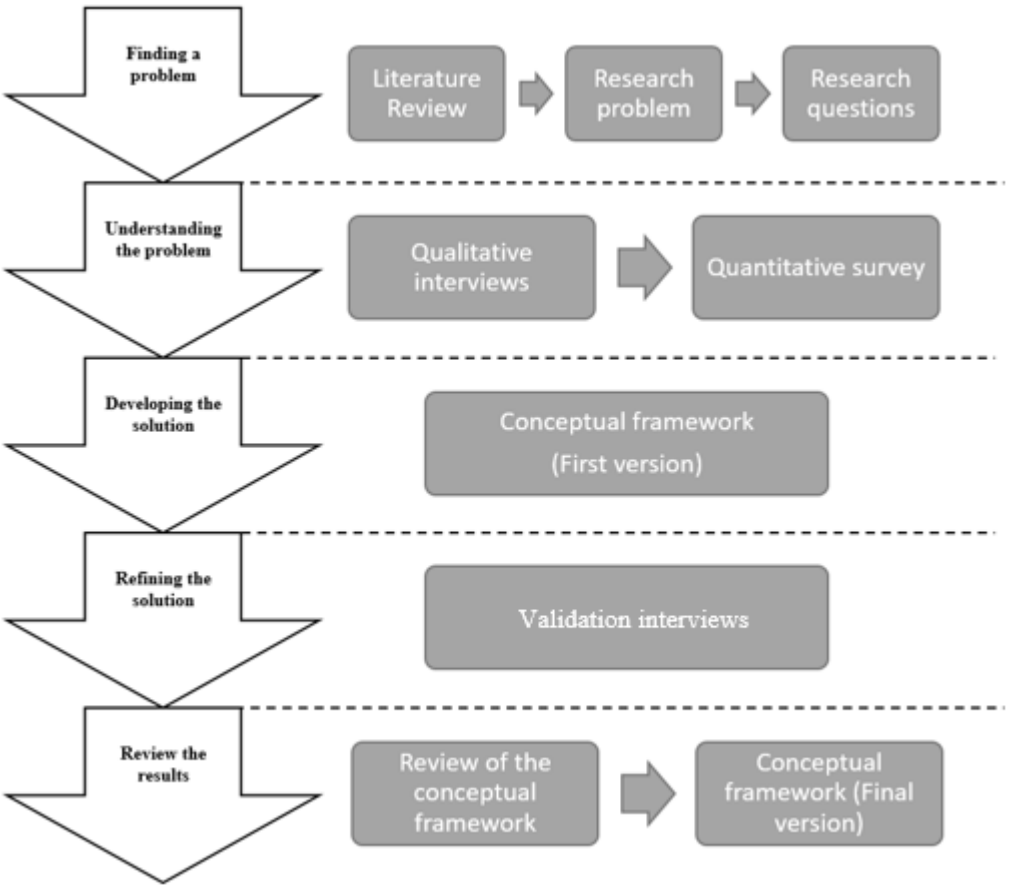

Figure 36 - Research processes steps

This framework has been designed to help decision-makers to (1) ensure that the best contractor has been selected, (2) ensure that the contractor can deliver the project successfully (3) Overcome the current limitations of the construction market.

2.2 Introduction to framework

The importance of adopting modern decision-making methods to manage tangible and intangible benefits of implementing innovative strategies in the current market is increasing. The drive for developing a CS framework for public construction tenders is to enable public construction clients to achieve better value for public money. The review of numerous tender evaluation frameworks necessitates the need for a more comprehensive guideline. The main focus of most of the existing frameworks is on developing a universal method of assessment using inefficient methods of evaluation with a limited number of criteria. Thus, this framework tried to design a more practical guideline with a comprehensive list of price and non-price attributes to improve the performance of public tendering in New Zealand construction.

CS procedures in New Zealand does not have a standard basis. Different public departments have different sets of rules and guideline to follow, which may lead to select a contractor with poor performance and lack of knowledge. This eventually may cause the failure of the projects due to time and cost overruns or significantly to affect quality. Public entities in New Zealand can use this framework to find suitable approaches in order to improve public tendering strategies. The framework has the following components:

- Market analysis
- Criteria selection
- Tender evaluation protocols

2.3 Market analysis

2.1.1 Key information for Decision-makers

This framework follows the structure of the strategic approach to public procurement introduced by Ministry of Economic Developments (Mastering Procurement). This section describes the required pre-tender information for DMs to implement a successful procurement strategy. If this step executes well, it brings increasingly valuable benefits. Before initiating the tendering procedures, DMs should have a full understanding of public needs and expectations. Without recognising the needs properly, it would not be possible to write a comprehensive specifications. Therefore, the selected criteria will not target the important factors of the project and the selected contractor may not have the proper capability to deliver the project successfully.

To understand the needs of the construction sector, our qualitative results obtained from semi-structured interviews with experienced construction practitioners can assist DMs to provide invaluable information on the current challenges and a possible solution that can be used in tendering procedures. To prepare a comprehensive framework, these qualitative results have been combined with the important information exists in the current public guidelines from multiple departments. The following section will discuss the existing construction challenges that can affect the CS processes in New Zealand and suggests solutions to improve the performance during CS procedures.

One of the main challenges in construction tendering is the low capacity of the New Zealand market. The DMs should be aware that due to the small market, for some of the major projects, there might not be a lot of choices. Hence, it is vital to have an initial consideration of whether a competitive approach would be appropriate or direct negotiation can satisfy the project requirements. This has a huge impact on the type and level of the analysis needed to be done before approaching the market.

Another common challenge in the market is that the current scale of work is over stressing both human resources and equipment. Due to over workload, design teams cannot usually develop the design to 100%, and the contractors don't have available expert resources to properly look after the project development. Low productivity is the other element of failures in previous projects. It is one of the main reasons that the construction jobs in New Zealand are taking more time, and these delays will eventually lead to cost overruns as well. To overcome these challenges, it is highly important that the DMs consider these challenges at the first steps of market analysis. By communicating these concern properly with the project participants and identifying proper KPIs, a significant number of issues may be avoided.

One of the main reasons for failure in previous projects was that DMs didn't put enough resources to get the design to the point that contractors can identify the specification properly and bid on the project. This issue often encourages contractors to prefer negotiation over competitive bids, which fails to secure the best value for public money. Moreover, as it has been mentioned before, due to over workload and lack of skilled resources, the subcontracting market is not sophisticated enough to develop the concept design to IFC drawings as the project goes forward. Therefore, DMs should develop the design and project specification to the point that the main concern of the contractors is unknown risks, not vague designs.

In the past few years, New Zealand construction market observed major head contractors going bust and goes into liquidation, even though the industry is booming, not just in housing, but also in vertical commercial and infrastructure development. One of the main reason is an incomplete understanding of the project risks from different parties. Construction clients don't define the project risks properly from risk assessment workshops and trying to reform contracts to close any

post-contract claim opportunity for contractors. Also, contractors had failed to appreciate what risks they were signing up to and therefore have ended up losing money.

It should be recognised by all of the project participants that a successful project can only be achieved by cooperation and teamwork. Due to the small market of New Zealand, it cannot afford to have major contractors go bust and people been taken out of business. Different parties should work together to overcome these issues. Contractors should be able to get a fair reward for the effort they put. If head contractors fail, they will pass it on to the subcontracting market or push it up to the client-side. Clients should work with the design team to develop a proper design and also work with contractors to find the risks and properly manage it instead of dumping massive complex contracts on the main contractor. They should cooperate as one team.

In addition to the following challenges, the maturity of procurement systems is another major issue of New Zealand construction. While other countries are more leaning toward using Design Build, this procurement system has not attracted adequate attention in New Zealand. Choosing an appropriate procurement strategy is one of the vital decisions that the client should make. An improper procurement plan will affect the CS procedures and can be a reason to project failure. The purpose of the procurement strategy is to (1) provide an appropriate plan for approaching to the market, evaluate tenders and select contractor, (2) to ensure that the selected contractor can deliver the project successfully, and the best value for public money has been achieved, (3) to set a realistic project schedule, assign roles and responsibility in the project team and control the implementation. Different elements of the procurement strategy should be understandable and defined before the CS processes. The key components of an appropriate procurement strategy have been illustrated in figure 37 (Government, 2011).

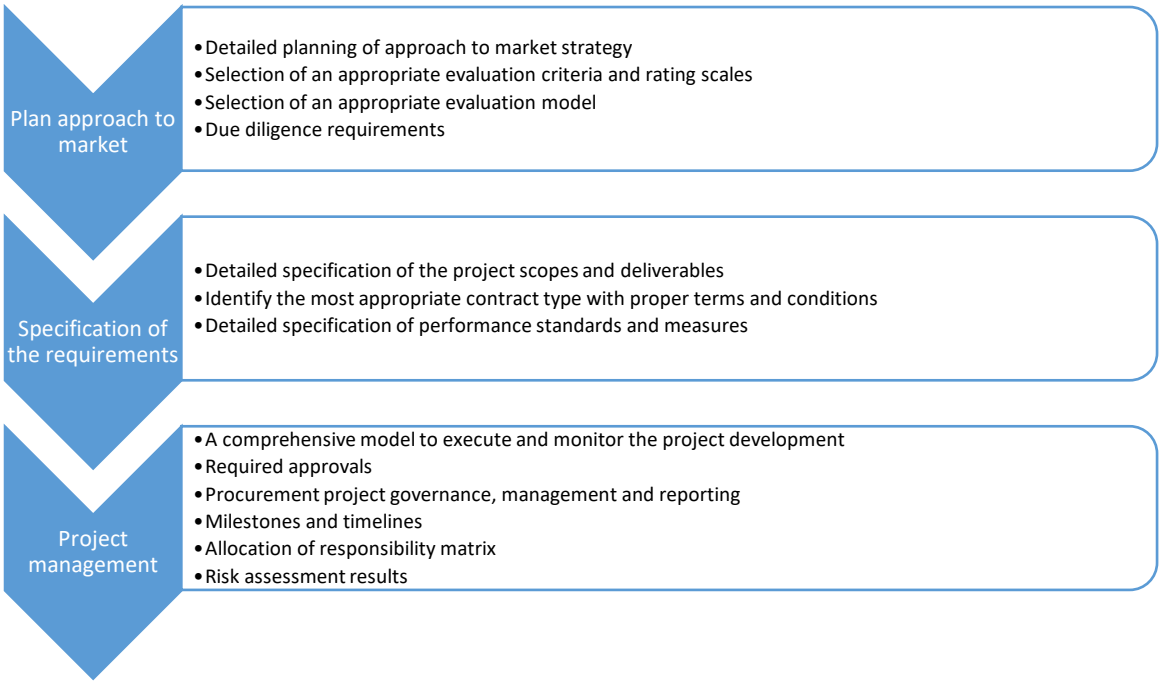

Figure 37 - Key components of procurement strategy

Before approaching the market, clients should develop the statement of need through consultation with stakeholders. It should include important information about the type of the market research, sustainability opportunities, risks and environmental objectives, defining nature and scope of the materials and services and development of evaluation criteria and scales. To define these elements, DMs should first discuss with key stakeholders to answer questions such as what are the objectives of the project, who will be impacted by it, who are the internal and external stakeholders and what are their expectations and to what level should they be involved in decision making.

The next step is to investigate previous projects and procurement strategies. It is a vital step that can inform the team how to proceed with the project. Since different public departments in New Zealand have a different set of rules, it could be very helpful to review the outcomes of other departments and their guidelines to identify the issues they encountered and the solutions they used.

Our previous results illustrated that one of the main challenges of the project team is to identify and communicate the risks of the project. Risk assessment is an important step to evaluate the risk and minimise disruptions. Different governmental agencies have different risk assessment tools, but here, a common analysis will be presented to be used as a standard tool.

Project risk can be defined as an uncertain condition that when it occurs, has impacts on the objectives of the project. The causes of the risk can be one, or it might have multiple causes. The main characteristics of the risk are that it focuses on future events and deals with probabilities. Risk management is a vital tool to minimise the risks of not achieving the project objectives and

to take advantage of the opportunities. It requires the project team to cooperate and set appropriate priorities and allocating resources to reduce the negative impacts of risks. There are three key activities that the project team should do to properly manage project risks:

1. Systematically analyse and identify the risks and develop risk plans
2. Each identified risk should be allocated to the party that can best handle an manage the risk
3. And to ensure that the cost assigned to manage each risk is commensurate with the importance and impacts of it.

Figure 38 shows the routine process of risk management. The first step is to develop a risk management plan. It requires meetings with project team members, stakeholders and others who might be involved in the project to develop a risk plan which includes methodology (defines how the risk management will be implemented for the project), roles and responsibility (defines the role of each project participant in risk management procedures), budget and timing (Includes the cost and time of the management processes), risk category (define the methods for identifying risks and their impacts), tolerance thresholds (information about to what extent the risks would be tolerated by the key stakeholders and project team) and tracking methods (includes how the risk procedures would be audited) (Larson & Gray, 2011; Burke, 2013).

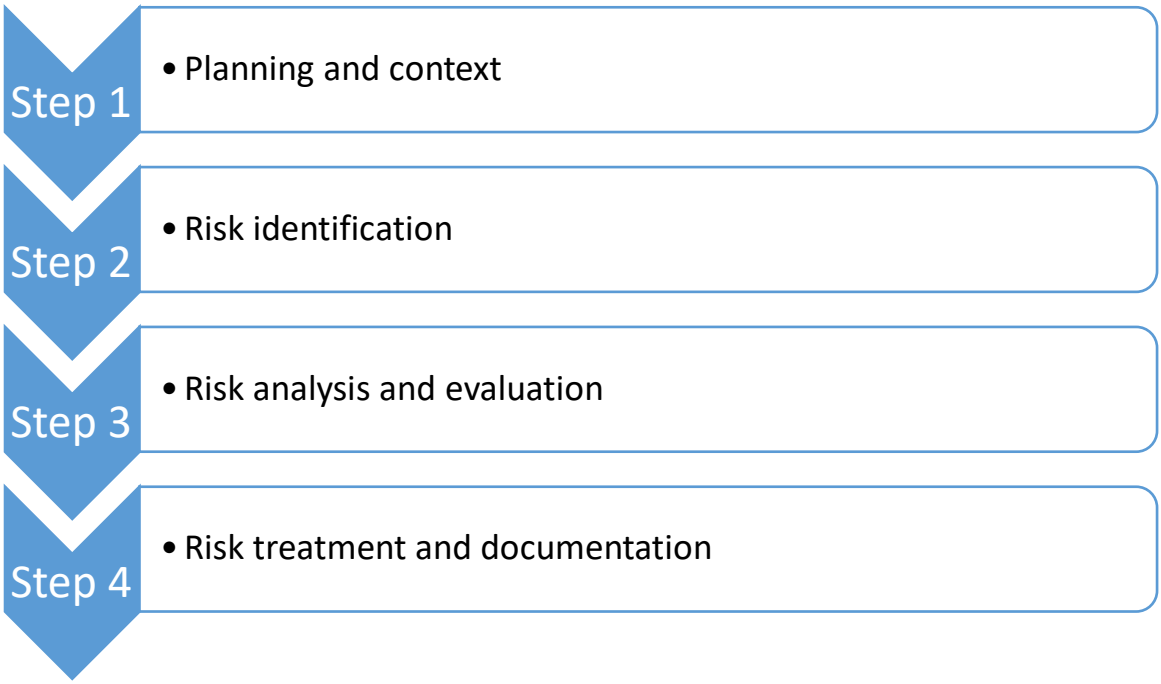

Figure 38 - Proper risk management steps

Step 2 is risk identification where all the project participants will gather to determine what risks might affect the project outcome. There are different methods to gather the required information about possible risks. Five methods of data collection for risk analysis will be presented here.

1. Review existing documents: By reviewing scopes and objectives of the project, some of the risks can be identified. Additional information can be obtained from lessons learned from previous projects, articles and other documents.
2. Brainstorming: This method is a popular group creativity tool to generate new ideas for problem-solving. It also provides other benefits, such as improving teamwork and work enjoyment. In this technique, different project participants will gather in a meeting to use their knowledge and experience to identify the possible risks and their impacts on the project.
3. SWOT analysis: This method is a strategic planning tool to assess the project in terms of Strengths, Weaknesses, Opportunities and Threats. This technique starts with reviewing project objectives and deliverables to specify the internal and external factors that can affect the successful delivery of the project.
4. Interviewing: This is a question and answers session to find possible risks based on the previous experiences of the interviewees. Interviewees can be current project participants or other project managers, construction experts, stakeholders and experts from academia who have experience on similar projects. To help them think in the right direction, it would be highly effective to show them the project assumptions and current Work Breakdown Structure (WBS) and ask them what risks might happen in the project.
5. Risk Breakdown Structure (RBS): This tool is being used in projects to provide a standard hierarchical presentation of risks and facilitate communication. David Hillson (2002) defined RBS as "A source-oriented grouping of project risks that organises and defines the total risk exposure of the project. Each descending level represents an increasingly detailed definition of sources of risk to the project." Some authors categorised project risks into four sections of Technical, External, Organizational and Project management ((Cooke & Williams, 2013; Burke, 2013). Figure 39 illustrates a standard RBS and its subcategories.

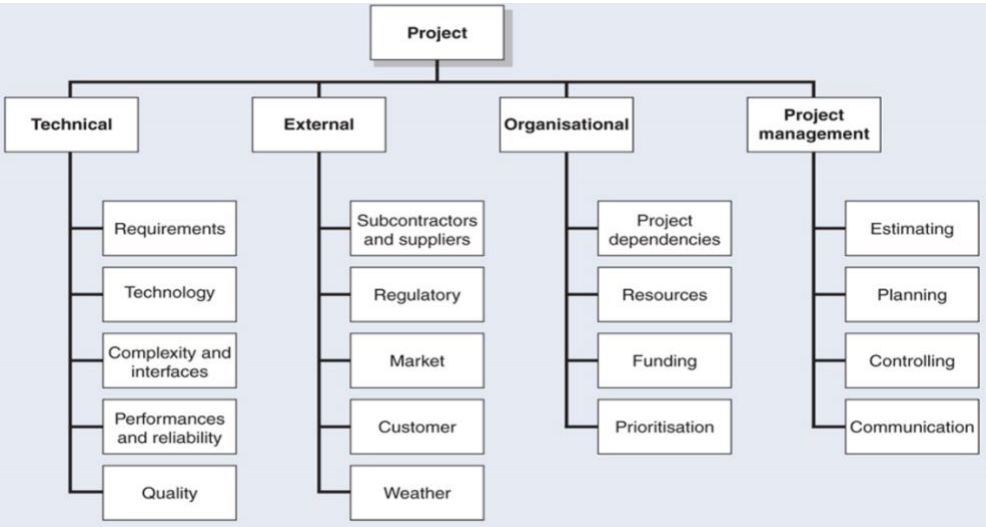

Figure 39 - Standard RBS and defined categories

2.1.2 Risk analysis and evaluation

Once the project team identified a list of potential risks, they should prioritise identified risks by undertaking a risk rating. Risk rating requires the identification of the likelihood of happening and the consequences to understand the level of important of each risk. The first step in risk rating is to evaluate the likelihood of the risk and place it on a scale ranging from "Rare" to "Almost certain". Then, the impacts that will follow if the risk happens should be considered and placed on a scale ranging from "Insignificant" to "Catastrophic". The final step is to use these two ratings to plot the risk on the risk matrix presented in Table 29. The project team should focus on risks with the "Extreme" and "High" overall rating and try to (1) mitigate the likelihood of the risk happening (2) minimise the impacts if the risk occurs.

Table 29 - Risk consequences and probability matrix

Risk rating	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Moderate	High	High	Extreme	Extreme
Likely	Moderate	Moderate	High	Extreme	Extreme
Possible	Low	Moderate	High	High	Extreme
Unlikely	Low	Moderate	Moderate	High	High
Rare	Low	Low	Moderate	High	High

2.1.3 Risk treatment and documentation

When the risk rating is done, the project team should identify and assess options for treating important risks and planning their implementation. Risk treatment is the action of reducing or

eliminating the impacts of risk. The options for responding to risk are avoidance, reduction, retention and transfer.

There is four known treatment for risks in construction projects:

- Risk avoidance: This means that the client or contractor investigating the risks pre-contract and try to avoid the risk by changing the plan and not performing activities that could carry risk. Although this might seems a good response to the risks, all of the risks cannot be avoided in a project since there might not be a reasonable alternative course of action. Some methods of risk avoidance strategies can include more detailed planning, improving designs, protection and safety systems, operations review and training.
- Risk reduction: This treatment tries to reduce the likelihood or consequences of the risk. For instance, outsourcing can be considered as a risk reduction. Some risks such as economic variations and weather conditions may not be avoided, but their impacts may be reduced by risk prevention strategies. Some methods of risk reduction include an alternative procurement strategy, changes in design, relocation of activity and resources and disaster recovery plan.
- Risk transfer: This method can be defined as shifting responsibility and consequences of the risk to those better placed and capable of managing or control the outcome. Risk sharing is when the portion of the risk transfers to another party, whilst some risk is retained. This is a common approach when the consequences of the risk are beyond one party. The important issue that the project team should consider is that when the risk is transferred, it does not eliminate and can impact the whole project.
- Risk-retention: This approach can be defined as accepting the risk and exposure with no further action. This treatment is a viable strategy for low risks where the cost of managing the risk is greater than the total losses of the risk. The risks that are not avoided or transferred are retained by default.

When the treatments of risks defined, each risk should be numbered and documented. The risk document should include the project name, risk, risk owner, description, key assumptions, source of information and risk treatment. This facilitates the storage and retrieval of information. At this stage, having defined the objectives of the project, needs, risks and requirements, the project team should plan approach to the market. Different public entities have their protocols to illustrate their fair and realistic approach strategy. Different approaching methods will not be discussed in

this research. The next sections will present the important elements of success in contractor selection.

2.4 Criteria selection

Contractor selection is a vital stage of a successful project. However, an evaluation process is incapable of choosing the best contractor without a well-defined collection of decision criteria. Tender evaluation procedures, when addressed by an appropriate set of criteria, can offer more rational construction projects where clients can effectively employ the contractor with the better potentials and increase the probability of delivering the project successfully. Thus, this section of the framework has focused on providing a comprehensive set of criteria to be used by DMs as a guide in CS procedures. Table 30 illustrates the set of criteria suggested by this framework. It includes 178 identified criteria assigned to 20 categories. Similarly described criterions listed into a category that best represent their characteristics.

Table 30 - Suggested list of evaluation criteria

CRITERIA	CRITERION	DEFINITION
Organisation and Relevant experience	Age (years from establishment), size, Number of related Experience, Size and Type of Projects Completed, Role of the tenderer, duration of the project, Years in Similar Projects, Understanding of Regulations, Market Familiarity, Previous experiences with the project contract form	General information about contractor's organisation such as age, size, and previous experiences in similar or different industries needs to be evaluated in this category. Historical experiences have less value than recent experiences.
Financial Viability	Financial Soundness (Asset, profits, debts status), Financial Capacity, Financial stability, Insurances, return on net worth ratio, Business Turnover-Cash Flow, Analysis of Accounts, Bank Reference or Arrangements, Credit Rating, Liquidity Ratio, Profitability, Debit ratio, Flexibility in payment terms and conditions, profit growth rates,	This category focuses on issues surrounding financial stability and capacity of the contractor. The inadequate financial capability of a contractor may lead to unsatisfactory project outcome. Contractor's assets and profits, insurances, bank statements and previous arrangements will be assessed in this category.
Appreciation of the task	Desire for Business, Competitiveness, Contractor's view of Relative Importance in Providing Services	It has been proven that companies with a low interest in the job are more difficult to negotiate with and may increase the risk of failure. This category evaluates the desire of the contractor to compete and provide the required services.
Past performance and Track records	Time overruns, Cost overruns, Number of claims for variations, Satisfaction of previous clients, History of tendered price variations and final cost, Demonstrated Performance, History of Flexibility (Ability to accommodate design changes during design and construction period), Reliability, Past Failures, Performance History, records of cost reduction during past projects, History of post-delivery support	Contractor's performances in completing the previous projects and fulfil the requirements needs to be assessed. This assessment guides clients to forecast the likely future performance of the contractor.
Management systems and skills	Management knowledge, Management Systems Implemented, ISO and other management certificates, Management structure, Documentation and reporting systems, Waste management and minimization systems, Onsite plant maintenance systems, Human resource planning systems, MIS level (Management Information System), Risk management method, Quality Control (QC) Policy, Implemented Quality Systems, R&D ability, Investment on R&D, Number of patents owned or transferred by the organization,	This category evaluates contractor's ability to manage the issues and considers possession of appropriate management personnel with required knowledge such as project development environment, quality management and risk management.

	Staff training program, Strategies for human resource developments, Reward and benefit distribution system, Professional qualification grade for managerial staff, Enterprise culture compatibility, Management cooperative desire, Level of investment in management systems	
Technical skills	Project Management organisation and Skills, Project management tools, Qualifications, Cost control system, Project Management Ability, Management Competencies, Scope and Risk Control, Level of investment in training of staff, Experience of Technical Personnel, Technical Competence and Ability, Qualification of key staff, Availability and Experience of Technical Design Experts	Contractor's ability to project management skills and cost control needs to be assessed with emphasis on technical areas. The competence and experience of key technical and professional personnel and their availability should be evaluated.
Resources/ Workload capacity	Current workload, Level of current resources (labour and equipment), Contractor Capacity, Current commitments, Equipment's technology	Sufficient and suitable human resources, technical equipment and intellectual properties help contractors to fulfil the requirements of the project. Clients should assess the resources (labour and equipment) that contractor proposed to use on the project.
Methodology	Understanding of objectives and key issues, Proposed Design, Scheduling and CPM, Technology Base, Functionality, Innovative ideas suggested, Reporting and recording systems suggested, Key performance indicators suggested, Division of works into subcontracts, Identification of risks (predict it, cost it, manage it, minimise it), quality plan, Life Cycle Requirements, Growth Capability, Cost-effectiveness, Compliance with Stated Needs or Requirements, Proposed System Solution, Plant/Equipment Type, adaptability and knowledge about new environment, Viability of Technical Solution, Waste reduction plan, Site safety assurance plan	The contractor should illustrate its capability to deliver the project on time, on budget and with satisfactory quality by describing the detailed methodology of approach. Any solutions, innovative ideas and risk allocations will be considered in this category.
Price	Fixed capital Price, Labour Rates, Operating Costs, Variable tender costs during project period, Maintenance costs, operating costs, Return and Benefits, Rationality of Estimates, Through Life Cost Program Methodology	This refers to the details of costs that the client would be required to pay to the contractor to bring the project to a satisfactory outcome. Depending on the contract, payments could include fixed capital cost or variable costs during the contract period or other payment methods.
Reputation	Amount of Past Business, Company Image and Size, Trade Union Record, Litigation Tendency, Organisational Maturity or Stability, References, Responsiveness, Business Ethics	An organisation with a good reputation will try to keep its good image in the business by delivering satisfactory results for the clients. In this section, clients assess contractors based on their trade records, references, responsiveness and their image in the industry.
SME location and geographical familiarities	Business Location (location of home office), Area of Catchment (Local/National), Facilities Location, Familiarity with area and weather conditions, Familiarity with local labour, familiarity with local suppliers	One of the factors that clients usually consider is how close the contractor's company to the project site is. Local companies are usually more familiar with the area of the. Also, they can manage to employ local labour and identify local suppliers in a way, which can generate opportunities to increase employment rate in the region.
Health and Safety	OHS&R management system, Corporate Environment Policy, Safety Plan, History of Safety Incidents, Occupational Health Safety Assurance (OHSA), Environmental Compliance, Safety Performance and standards, level of investment in HSE	Poor safety awareness and policies may result in serious injuries, huge costs or project delays. Thus, nowadays clients put more emphasis on Health and Safety management systems and plan to ensure the satisfactory implementation of safety standards.
Client-contractor relations	Client/Customer Attitude and Relations, Commitment to Support, Responsiveness, Ability to Work as Team, Stakeholder Management, Customer Focus/Relationship, Post-contract attitude, Sub-contractor relations, Sub-contractor management systems	This category evaluates impacts of previous working relations among parties of the project. Any disputes and disagreements among different parties may cause deterioration in mutual trust and reduce the willingness to any compromise during the project.

BIM experience	Scale of the previous projects that used BIM, Level of BIM used in previous projects (Level1, L2, L3), Purpose of BIM used in previous projects (Documentation, Communication, Project scheduling, Project costing and estimation, Life cycle analysis, Logistics, Demolition, BIM education level (Level of BIM education of key BIM personnel, Company's yearly investment on BIM, Trainings undertaken, How do they keep their key BIM personnel updated Annual workshops, 6 months workshops)), BIM certificates achieved, BIM softwares used in previous projects	This criteria evaluates contractor's ability to support the continual updating and sharing of project information by utilizing Building Information Modelling (BIM) technology. In fully utilizing BIM technology, the design information can be modelled in real time with the full consideration of cost and scheduling information to increase project productivity and performance.
Sustainability	Previous experience in Green building projects, Previous experience in Sustainability management (Logistics management, Efficient delivery, Site storage management, Labour management, Site disruptions, Community disturbance, Disposal costs, Reusable/Recyclable/Renewable elements, Energy consumption management, Pollution generation), Investments in Sustainability innovations, Yearly investment in sustainable construction management training, Implementation of ISO 14001 (Level of achievements in 5 major area of releases to land, releases to air, releases to water, natural resource usage and energy consumption), Sustainability certificates achieved	With raising awareness of environmental, economical and social issues, sustainable construction have become a growing concern of the clients. This category evaluates contractor's ability to apply sustainable development principles in different phases of construction.
Supply Chain Management (SCM)	Percentage of previous projects that used SCM, Scale of the previous projects that used SCM, Level of development of SCM in the organization (Financial accounting, Controlling, Asset management, Project System, Human Resource planning, Site maintenance, Quality Management, Material Management, Logistics), Previous delays on receiving materials, Frequency of communication with suppliers, Centralised system used in previous projects, SCM education level (Level of SCM education of key SCM personnel, Company's yearly investment on SCM, Trainings offered, How do they keep their key SCM personnel updated, Annual workshops, 6 months workshops)), SCM certificates achieved	Buildings are becoming more complex that requires understanding of the breakdown and traceability of materials, services, organizations, logistics, people, activities and information. Clients have taken an increasing interest in establishing supply chain relationships among different participants involved in the construction projects.
Risk Management	Previous successful experience in risk management, previous failures in risk management, Level of development in risk management processes (Planning, Identification, Assessment, Treatment and Monitoring), Suggested Risk planning (Objectives, Methodology, Roles and Responsibility, Budgeting, Time management, Risk interpretation, Risk identification method, Risk breakdown structure, Risk Probability-Consequences matrix, Suggested risk treatments)	Because of the poor record of completion to cost and time, high levels of disputes, low margins and profits, risk management have become a growing concern of the clients. In this category, decision makers evaluate contractor's ability to plan, monitor and control the risks involved in construction project.
Innovation	History of innovation in previous projects (Financial, Project time and scheduling, Risk management, Procurement system, Supply chain issues, On site decision making, improving HSE), Registered inventions, Yearly investments on R&D, Any structured lessons learned programme that captures project results, Any structured employee suggestion system, Any structured assessment of innovation in annual personal evaluation	Since construction industry is constantly facing new challenges, clients are showing more interest in contractors with the ability to manage project issues with innovative ideas.
Key partners	Information of key subcontractors, Information of key material suppliers, Information of key equipment suppliers, Previous experiences with the key subcontractors, Previous experiences with the key	A project may have a talented, innovative and sophisticated head contractor, but without good partners, there is a high risk of failure. In this criteria, clients assess key partners of the contractor and their ability to deliver the unique characteristics of the project.

	material suppliers, Previous experiences with the key equipment suppliers	
Materials	List of key materials, Information about material characteristics and methods of material assembly, Certificates, standards and stamp of approvals for key materials, Previous experience of using any defective materials	Contractor's choice of materials and their performance, durability and aesthetic appeal will be evaluated in this criteria.

Depending on the project's nature and scope, a different set of criteria can be used in tender evaluation. Selecting the most appropriate set is an important decision that the project team should make. To achieve this objective, our results from survey questionnaires can assist DMs to identify the most relevant criteria. Based on the survey results the most important criteria for Tier 1 projects were "Past Performance and Track records", "Technical skills", "Risk management", "Management systems and skills", "Resources/Workload capacity" and "Financial viability".

On the other hand, the most important criteria for Tier 2&3 projects were "Technical skills", "Past performance and track records", "Resources/Workload capacity", "Materials", "Health & Safety" and "Price". The results demonstrated that "Price" is a more important criterion for Tier 2&3 projects than Tier 1 projects. Figure 40 illustrates the comparison of the importance of different criteria in Tier1 and Tier 2&3 projects.

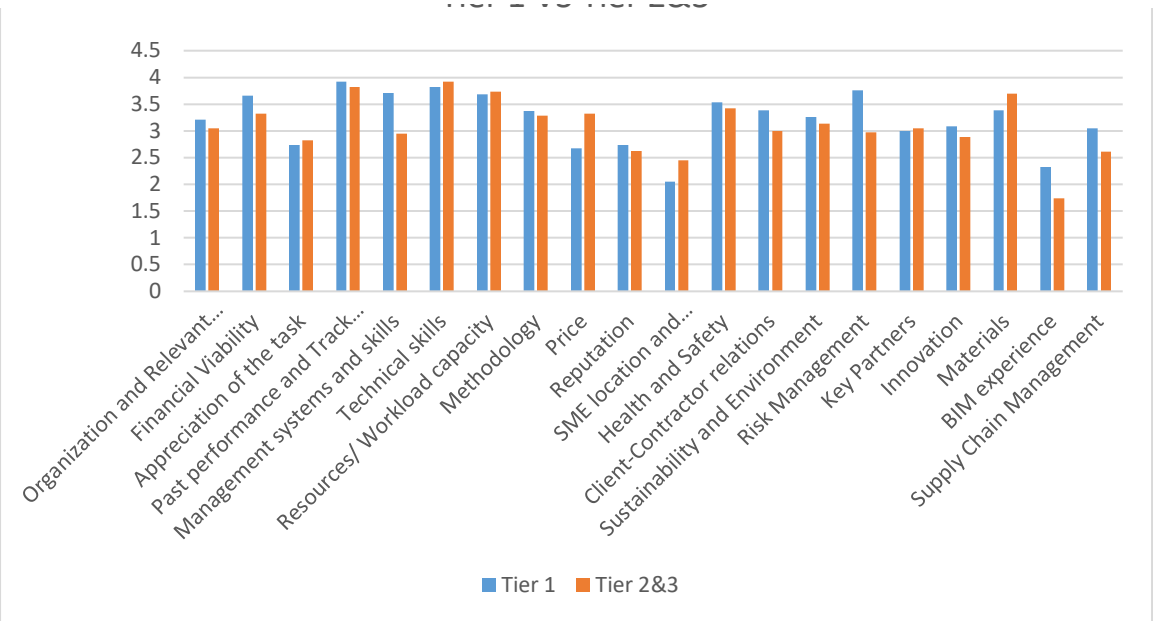

Figure 40 - comparison of the importance of different criteria in Tier1 and Tier 2&3 projects

Another important result we got from the survey phase is the gap between the level of importance and level of achievement of different criteria. Figure 41 presents this gap for Tier 1 projects. The

area with the importance mean of more than 3.25 and the achievement mean of less than 2.75 has been considered as the extreme points.

There are seven criteria in the extreme range of the matrix, namely; Resources/Workload capacity, Risk management, past performance and track records, Technical skills, Materials and client-contractor relations. These results indicate that there is a gap between the importance of these criteria and the level of achievement in New Zealand public construction CS. It highlights that DMs for Tier 1 public projects need to put more attention on these criteria in their future tenders.

Figure 42 illustrates the gap between the level of important and level of achievement of different criteria for Tier 2&3 projects. There are four criteria in the extreme range of the matrix, namely; Resources/Workload capacity, Technical skills, Materials and Past performance, and track records. Moreover, “Price” and “Financial viability” are very close to the extreme area. These results indicate that there is a gap between the importance of these criteria and the level of achievement in New Zealand public construction CS. It highlights that DMs for Tier 2&3 public projects need to put more attention on these criteria in their future tenders.

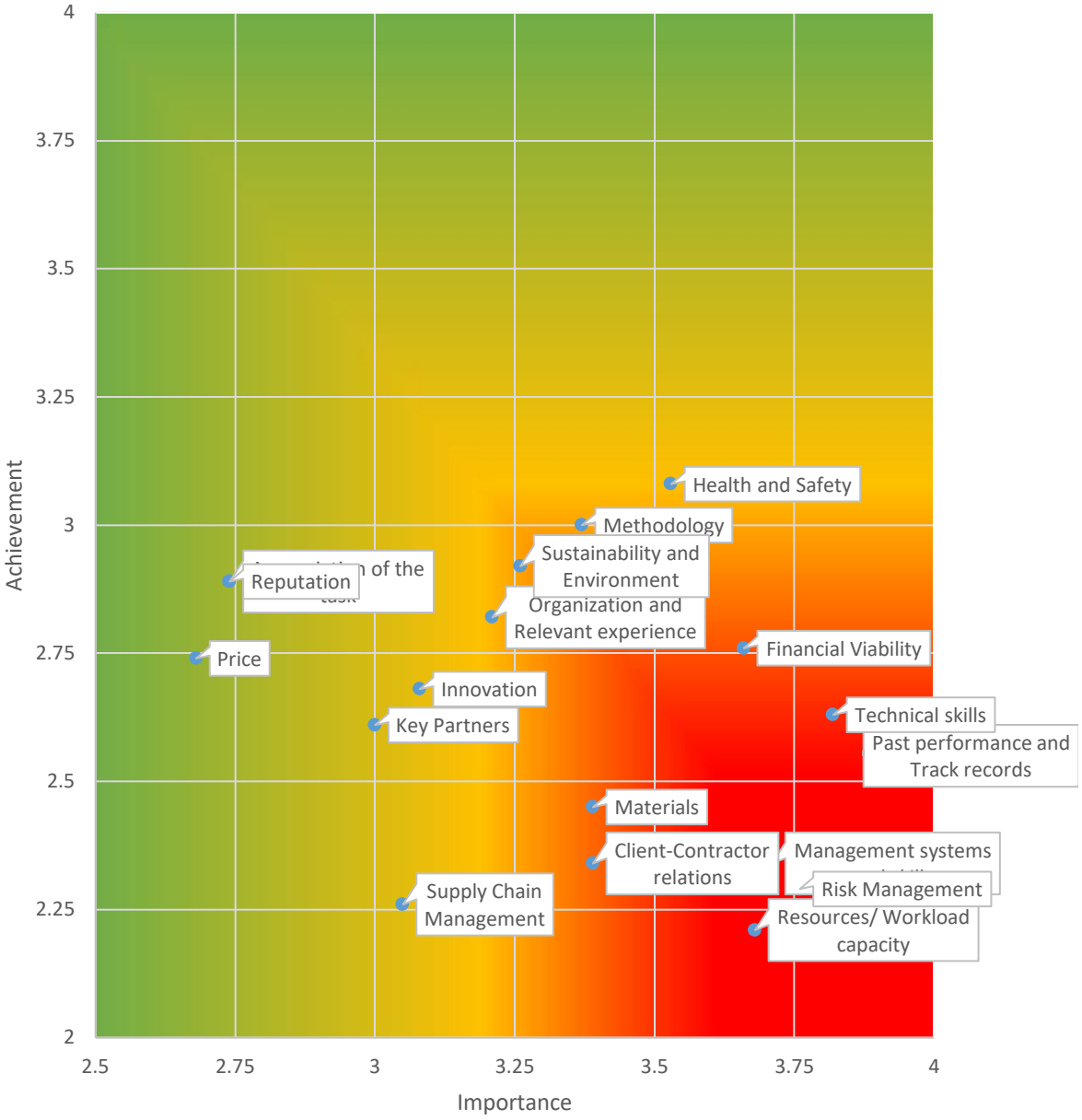

Figure 41 - Identified gap between level of important and level of achievement of different criteria for Tier 1 projects

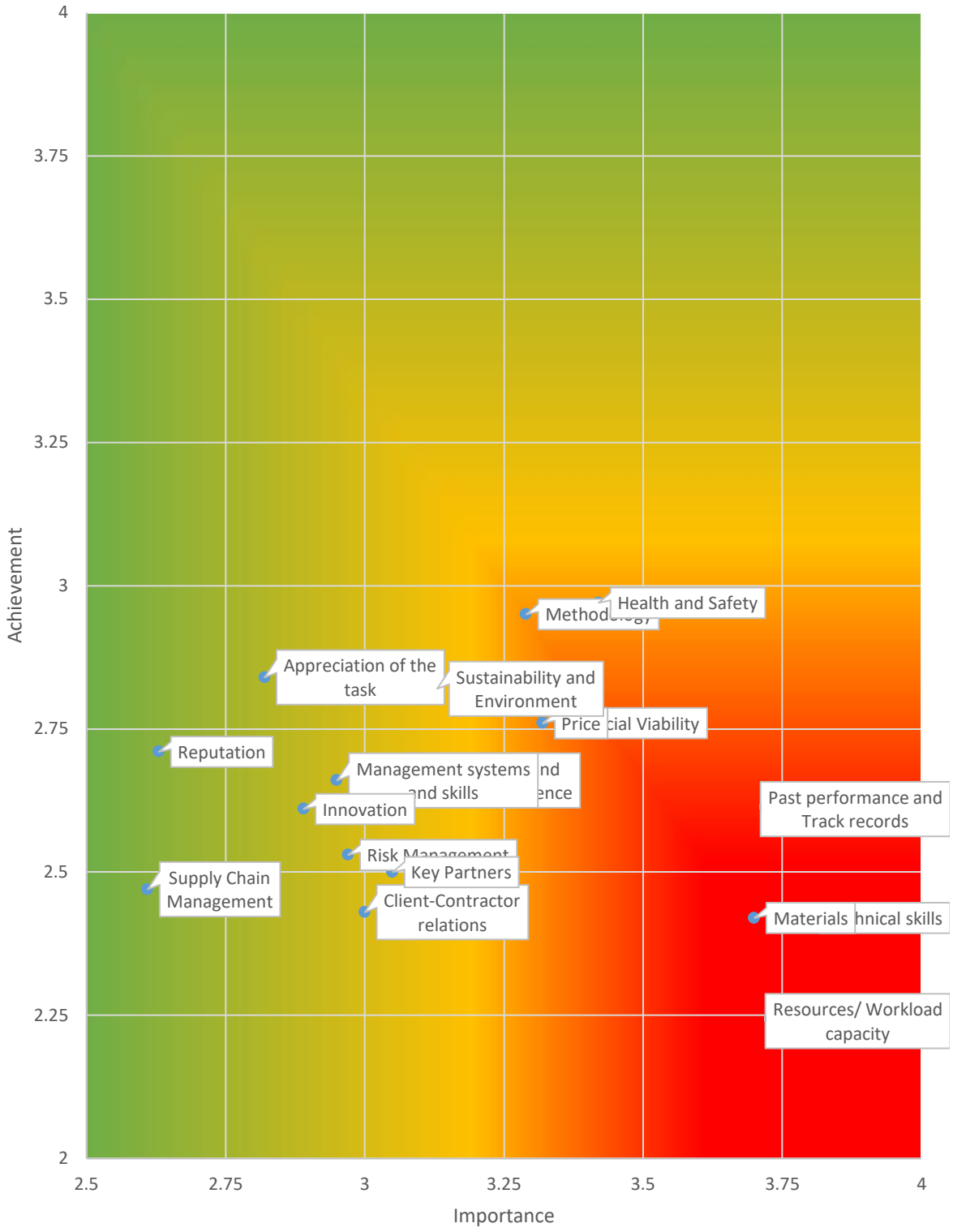

Figure 42 - Identified gap between level of important and level of achievement of different criteria for Tier 2&3 projects

2.5 Tender evaluation protocols

This section will discuss the proposed method of evaluation that has been established in this framework for analysing CS criteria. This method comprised of two decision-making techniques of AHP (Analytical Hierarchy Process) and TOPSIS (Technique for Order Performance by Similarity to Ideal Solution). The AHP-TOPSIS method will be used to determine the relative weight of each selected criteria and selecting the best contractor.

This combined method has been utilised by different scholars during the past few years. Percin (2009) utilised this combined method in the evaluation of third-party logistics. To assist designers in determining the customer needs, Lin et al. (2008) adopted AHP-TOPSIS method in an integrated framework. This approach has also been used by Elsayah (2016) in an invaluable study to evaluate construction contractors of Libya. The following sections will present the concepts of AHP-TOPSIS in CS processes and the designed formulas to be used by DMs.

2.1.1 AHP

The AHP is a systematic procedure to determine the relative importance of various decision criteria to help DMs select the best alternative among different alternatives (Saaty 1978). This approach is based on decision theory and can be advantageous for weighting numerous attributes and selecting a lead concept among alternatives. This method has been applied to many areas of construction management such as the selection of the projects, ranking of the projects, facility location and improving construction productivity (Doloi 2008; Wang et al. 2013)

This study explores the application of AHP in the CS framework. By breaking CS problems down in a structured gradual step, users can connect through paired comparison judgements of DMs. These steps have been generated in a Microsoft Excel sheet to demonstrate the applicability of the approach for DMs. Figure 43 illustrates the initial screen of the AHP approach in an Excel sheet with 13 criteria as an instance.

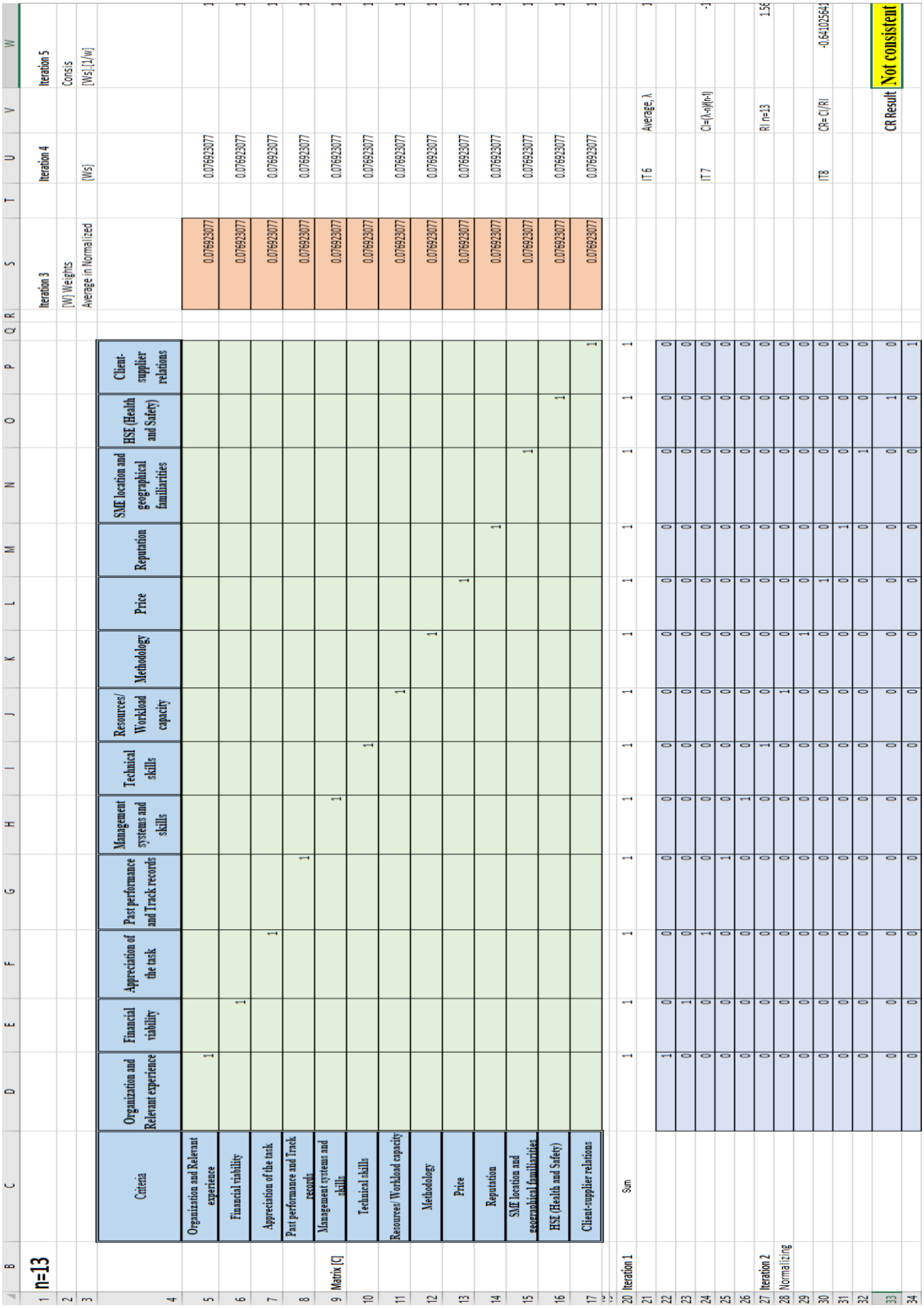

Figure 43 - initial screen of the AHP approach in an Excel sheet with 13 criteria

Initially, the list of potential criteria should be identified by DMs. To determine which of these criteria are more important in the targeted project, the next step of AHP is to organise a pairwise weighting matrix (PWM). It has been created in the Excel sheet as Matrix [C].

$$\text{PWM} = \begin{bmatrix} 1 & s_{12} & \cdots & s_{1n} \\ \frac{1}{s_{12}} & 1 & \dots & s_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{s_{1n}} & \frac{1}{s_{2n}} & \cdots & 1 \end{bmatrix}$$

Given n elements at a hierarchical level, PWM is an nxn matrix. The importance of criteria is pair-wisely compared to each DMs to determine criteria weights. The ranking system for pairwise comparison proposed by AHP is 1-9, which represents the user's judgement of the relative importance of the criteria c_i over c_j (See Table 31).

Table 31- a Proposed ranking system for pairwise comparison

Numerical rating	Verbal judgments of preferences
1	Equally preferred
2	Equally to moderately
3	Moderately preferred
4	Moderately to strongly
5	Strongly preferred
6	Strongly to very strongly
7	Very strongly preferred
8	Very strongly to extremely
9	Extremely preferred

If c_i and c_j considered to be equally important, the proposed value S_{ij} would be equal to 1. If c_i considered to be more important than c_j, then S_{ij} Would be >1. Thus, the PWM is a reciprocal matrix obtained by pairwise comparison of each pair of criteria. To generate the vector of weights, users should determine the principal eigenvector V' corresponding to the maximum Eigen value λ_{max} to obtain the V' each column should be normalised and then taking the average of each resulting rows.

$$V' = \begin{bmatrix} V_{11} \\ V_{12} \\ \vdots \\ V_{1n} \end{bmatrix} = \frac{1}{n} \sum_j \left(\frac{s_{ij}}{\sum_i s_{ij}}\right)$$

Three iterations have been defined of this stage. Iteration 1 calculates the sum of each column. Iteration 2 normalises the Matrix by dividing each cell of the Matrix [C] by the sum of the related column. Iteration 3 generates the average of each row, which can be considered as the relative weight of each criterion. The formula of each iteration has been presented below. The used cell numbers can be checked by the figure …

Iteration 1: (=SUM(D5:D17))

Iteration 2: (=D5/$D$20)

Iteration 3: (=AVERAGE(D22:P22))

However, DMs judgement may not be consistent with one another, and the aggregation weight vector may be invalid. Thus, a minimum level of consistency ratio should be demonstrated in the matrix. The consistency value will be determined by eigenvalue, λ, to calculate the consistency index of the matrix.

$$CI = \frac{\lambda_{max} - n}{n-1}$$

In the next step, Consistency Ratio (CR) will be determined by dividing CI by the average Random consistency Index (RI) (See Table 32).

$$CR = \frac{CI}{RI}$$

Table 32- Average Random Consistency (RI)

Size of matrix (n)	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
Random consistency	0.0	0.0	0.58	0.90	1.12	1.24	1.32	1.40	1.45	1.49	1.51	1.48	1.56	1.57	1.59

RI is a constant value for a nxn reciprocal matrix, which results from a computer simulation. If CR>1, the reassessment cycle of assigning numerical values to pairwise comparison is required until CR<0.1.

The AHP approach requires six additional iterations in the Excel sheet to evaluate the consistency of the results. The required formula for the next five iterations is as follows.

Iteration 4:
(=D5*$S$5+E5*$S$6+F5*$S$7+G5*$S$8+H5*$S$9+I5*$S$10+J5*$S$11+K5*$S$12+L5*$S$13+M5*$S$14+N5*$S$15+O5*$S$16+P5*$S$17)

Iteration 5: (=U5*(1/S5))

Iteration 6: (=AVERAGE(W5:W17))

Iteration 7: (=(W21-13)/(12))

Iteration 8: (=W24/W27)

Iteration 9: (=IF(W30>0.1;"Consistent";"Not consistent"))

2.1.2 TOPSIS:

Developed by Hwang & Yoon (Yoon & Hwang, 1995), TOPSIS is one of the effective Multi-Criteria Decision-Making (MCDM) techniques to identify the priorities among alternatives. TOPSIS selects the alternative which is the closest to the positive ideal alternative (one which has the best alternative value) and farthest from negative ideal alternative (one which has the worst attributes value). The research results highly recommend the implementation of TOPSIS method in CS procedures. Therefore, this technique has been utilised in this framework to better assess the contractors, reduce the tendering time and select the most appropriate candidate. The iterations of the TOPSIS method has been generated by Microsoft Excel and presented in figure 44.

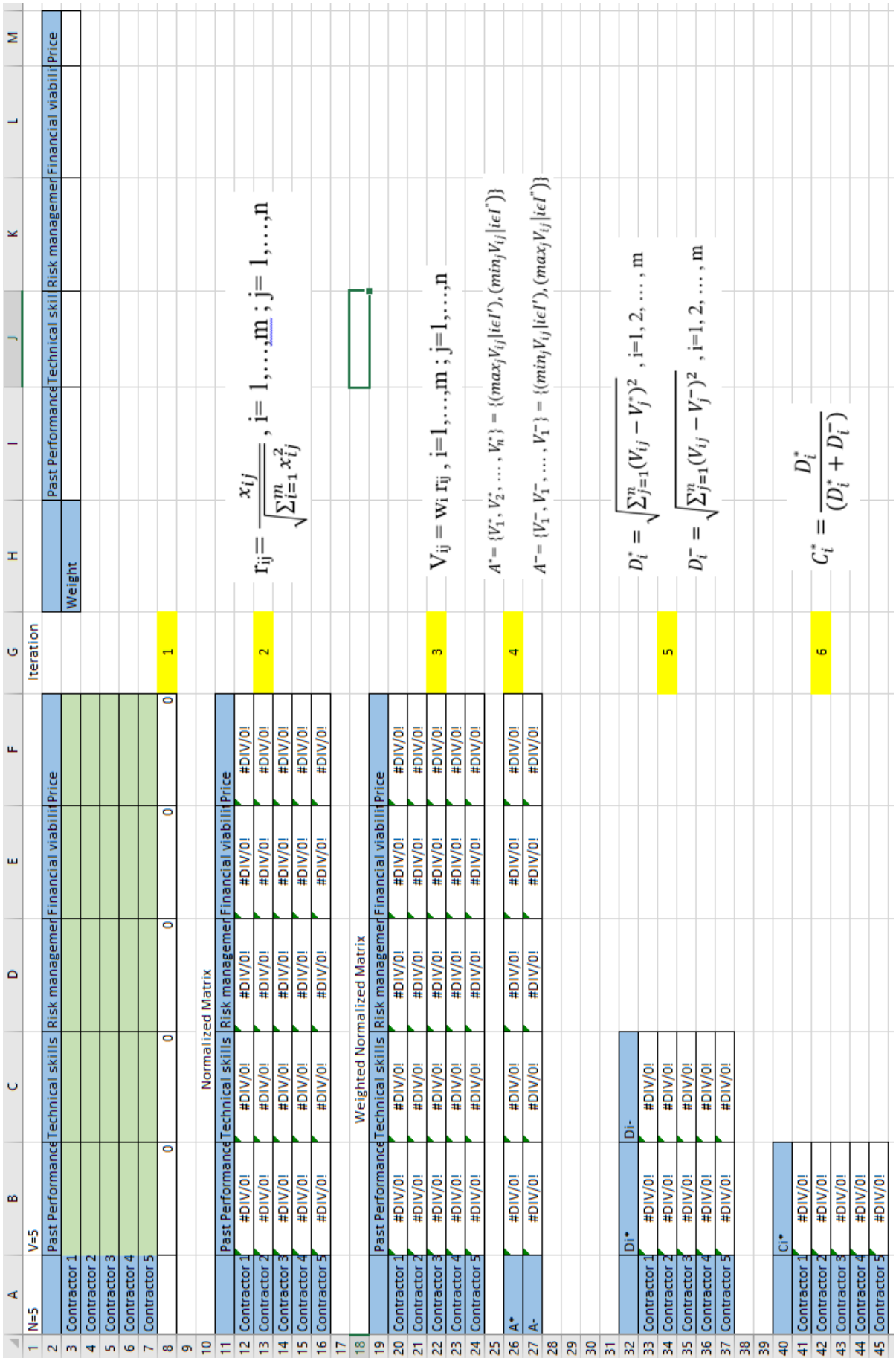

Figure 44 - Initial screen of TOPSIS method in Excel

The TOPSIS procedure includes the following steps:

8) In the first step, the user should construct the mxn decision matrix D, where m is the number of alternatives and n is the number of criteria.

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array}$$

9) The second step is to calculate the normalisation value (r_{ij}) of the decision matrix D.

$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$, i= 1,…,m ; j= 1,…,n

This step has been divided into two iterations. Iteration 1 calculates the denominator separately. In the second iteration, each cell of the original matrix will be divided by the related denominator.

Iteration 1: (=(B3^2+B4^2+B5^2+B6^2+B7^2)^0.5)

Iteration 2: (=B3/$B$8)

Where x_{ij} is the value of the alternative i for the criteria j. The resulted normalisation matrix R would be as follows:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

10) In the third step, the weighted normalised decision matrix should be formed as

$V_{ij} = w_i r_{ij}$, i=1,…,m ; j=1,…,n

Thus, iteration 3 multiplies the value of the normalized matrix to the assigned weight calculated by AHP approach.

Iteration 3: =B12*$I$3

Where w_i is the weight of the criterion j.

11) To determine the positive ideal solution (A^*) and negative ideal solution (A^-), the maximum and minimum values of the weighted normalised matrix should be identified.

$A^*= \{V_1^*, V_2^*, \dots, V_n^*\} = \{(max_j V_{ij} | i \epsilon I'), (min_j V_{ij} | i \epsilon I^{"})\}$

$A^-= \{V_1^-, V_1^-, \dots, V_1^-\} = \{(min_j V_{ij} | i \epsilon I'), (max_j V_{ij} | i \epsilon I^{"})\}$

To calculate the positive ideal solution (A^*) and negative ideal solution (A^-), it is important to recognise which criterion would benefit the project if the value of it increases and which criterion would benefit the objectives of the project if the value of it decreases. For instance, "Past performance and track records" is a value that should be maximised and "Bidding price" is the value that should be minimised throughout the evaluation. The iteration 4 illustrated below is an example of a criterion which should be maximised. For some criteria such as "Price" the A* is the MIN of the column and the A- would be MAX of the column.

Iteration 4:

- A*: (=MAX(B20:B24))
- A-: (=MIN(B20:B24))

Where I' is associated with non-price attributes, and $I^{"}$ is associated with price attributes.

12) The distance of each alternative from the ideal solution and the negative ideal solution should be calculated as follows:

$D_i^* = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^*)^2}$, i=1, 2, … , m

$D_i^- = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^-)^2}$, i=1, 2, … , m

The formula used in the Excel sheet to calculate the distances has been presented in iteration 5.

Iteration 5:

- Di*: (=((B20-$B$26)^2+(C20-$C$26)^2+(D20-$D$26)^2+(E20-$E$26)^2+(F20-$F$26)^2)^0.5)
- Di-: (=((B20-$B$27)^2+(C20-$C$27)^2+(D20-$D$27)^2+(E20-$E$27)^2+(F20-$F$27)^2)^0.5)

13) The next step is to calculate the closeness coefficient (C_i^*) of each alternative (Formula for Excel sheet demonstrated in Iteration 6)

$$C_i^* = \frac{D_i^*}{(D_i^* + D_i^-)}$$

Iteration 6: (=C33/(C33+B33))

14) In the final step, the user can rank the preference order of the alternatives by sorting their closeness values C_i^* and identify the best-ranked alternative by the measure. The alternative with the highest C_i^* is the best contractor in the evaluation.

2.6 Overall framework

The importance of adopting innovative strategies to evaluate construction contractors is increasing. To ensure the successful delivery of the project, advances in technology need to be matched by the processes that are used to procure buildings (Morledge & Smith, 2013; Masterman, 2003). Selecting the best contractor is an essential step toward successful implementation of construction projects.

The drive for developing a construction CS framework for the New Zealand public sector is to enable public entities to adopt modern evaluation methods to assess contractors. A thorough evaluation of candidates will provide a better chance for delivering the project successfully and achieve the best value for public money. The review of several guidelines developed for CS necessitates the need for a comprehensive framework specifically developed to satisfy the requirements of New Zealand construction characteristics. Most of the existing procedures focused mainly on the theoretical development of the approach and very few emphasised on the practicality of the framework implementation. Thus, this research tried to embrace the usefulness of modern decision-making techniques by considering the practicality of the processes in the New Zealand context.

The proposed CS framework consists of three stages, as illustrated in figure 45. In the first stage, the project team review the construction sector and plan the best strategy to approach the market. Moreover, they will determine the specifications of the project and provide a project management schedule to execute, monitor and control the project. Based on the project specifications developed in stage 1, related criteria will be chosen from the comprehensive list of criteria generated in this research. The criteria analysis presented earlier in this chapter can assist the project team in determining that the evaluation of which criteria can increase the chance of successful delivery of the project. Finally, stage 3 consists of the protocols to evaluate the

candidates. In this stage, the AHP pairwise comparison method will be used to determine the criteria weighting, and TOPSIS method will be utilized to find the ideal candidate.

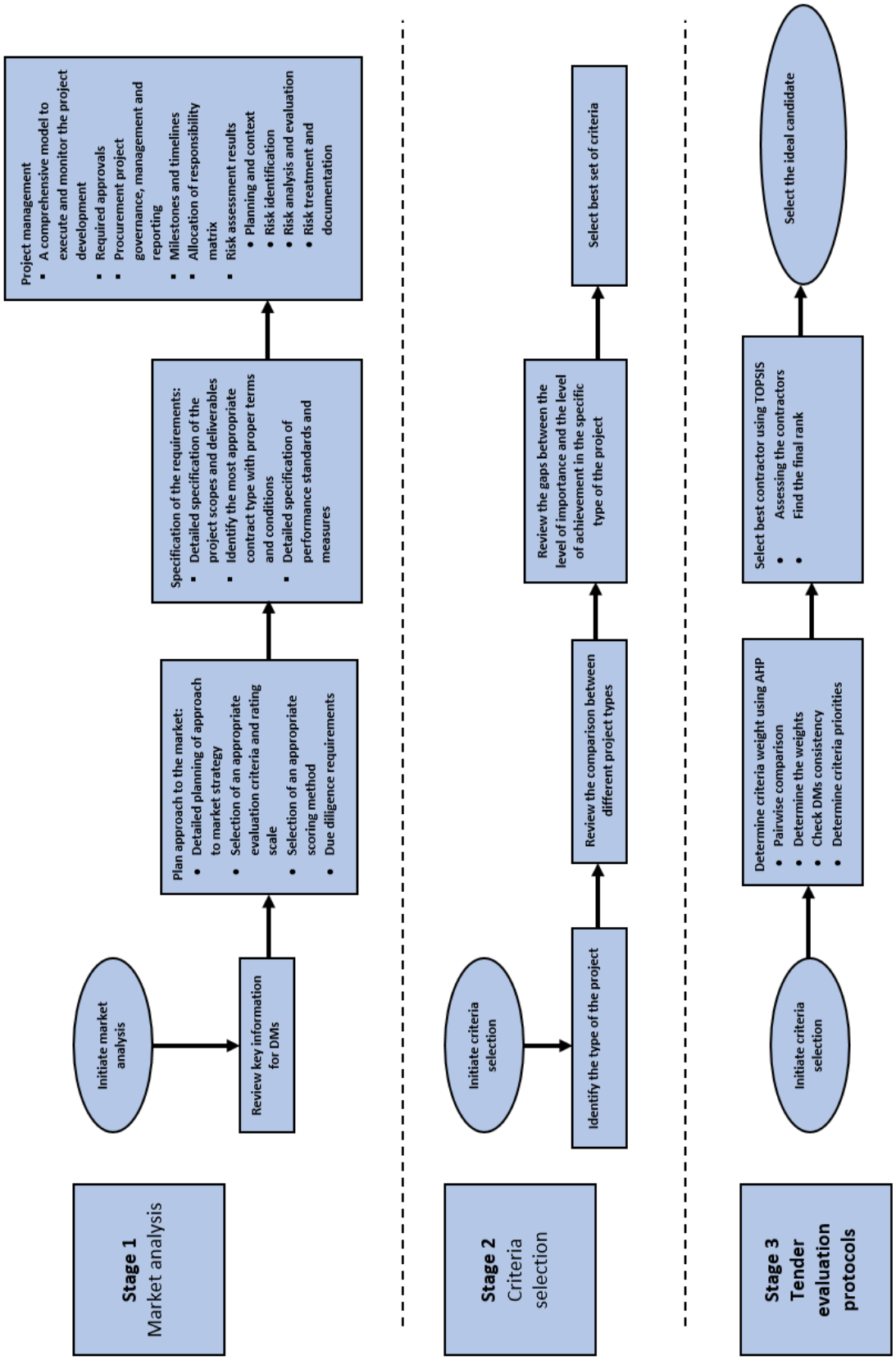

Figure 45 - Proposed public tender evaluation framework

2.7 Framework validation

This section presents the results of the research validation process conducted through interviews with New Zealand construction practitioners to test the reliability of the collected data from qualitative semi-structured interviews and a quantitative survey. Moreover, the validity and applicability of the proposed framework are also evaluated. The following sections will briefly explain the aims of the validation procedure, the general outline information about the validation interview participants, questions that have been asked from them and the feedback and comment received.

2.1.1 Aims of validation

Aim of the research validation is to refine and enhance the credibility of the research findings (Cronbach 1990; Patton 2002). The primary objective of this validation is to test the validity and credibility of the proposed framework. However, the findings from semi-structured interviews and survey questionnaires were also assessed and validated through this phase. Thus, the main objectives of this validation are as follows:

- To evaluate the validity and reliability of the research findings obtained from qualitative and quantitative stages
- To assess the applicability and effectiveness of the proposed framework
- To achieve expert validation and improve the performance of the framework
- To determine the probable advantages and challenges of implementing the framework
- To identify whether the proposed framework requires further amendments and refinements

2.1.2 Profile of participants

Two experts participated in the validation interviews. Both of them were experienced construction practitioners with more than 25 years of working experience in this sector. The first interviewee was the managing director of a major construction organisation with the experience of representing numerous public clients. The second interviewee was a senior manager of a professional membership association representing practitioners who are involved in construction projects. The objective of selecting these interviewees was to have an opportunity to investigate the research problem from both client-side and the contractor side (See Appendix 4 - 5).

Findings from the research validation

In this section, the main themes identified in the validation interviews will be demonstrated. Each theme contains agreements and disagreements on the discussed issue, with relevant quotes as appropriate. The following four themes were identified from validation interviews.

- Number of participants in qualitative and quantitative steps
- Validity and reliability of semi-structured interview and online survey results
- Validity and applicability of the proposed framework
- Suggestions for improving the proposed framework

Number of participants in qualitative and quantitative steps

During the validation interviews, the results obtained from semi-structured interviews and survey questionnaires were presented to the experts, along with the proposed framework. Both experts confirmed that the obtained data presents the current situation of the market properly. They agreed that the data collection methods used in this research were a good use of methodological triangulation. Both experts were asked to provide their insight into the adequacy of the number of participants in the study. The first expert mentioned that the depth of data gathered is more important than the number of participants. While it would be good to involve a big population in the study, the current number of participants in both qualitative and quantitative approaches were adequate. The second experts illustrated that comparing the size of the New Zealand construction market and the defined timeframe and the budget of the research, the number of participants is relatively good.

Validity and reliability of semi-structured interview and online survey results

The validation interviews started with the presentation of the semi-structured interview and online survey results. At first, the identified key challenges of public tender evaluation procedures in New Zealand were demonstrated to both experts and later they were asked to provide their insight on the identified issues.

Our semi-structured interview results illustrated that one of the primary challenges of construction works in New Zealand is its geographical aspects. Most of the interviewees in semi-structured interviews believed that due to seismic and weather challenges, New Zealand is a quite hard place to build. However, the first expert disagreed with this conclusion and believed that sometimes, construction practitioners use it as an excuse.

"Every country thinks it's different and construction think it's different than any other industry, it's not. It's about what has changed. If things changed, it becomes more difficult. But if it's the same, it doesn't matter if it rains or we have earthquakes. It always rained, and we always had earthquakes. I think that an attitude of mind rather than actuality."

Furthermore, both experts agreed with capacity issues identified in the research. Our results showed that capacity challenges are one of the critical issues in the market. The size of the market in New Zealand is relatively small, and for major projects, there are not a lot of choices. Especially during the periods of peak activities, the market struggles to provide capacity in terms of skilled human resources, equipment and sub-trades. The second experts have also added:

"It is a small market, but it's also very cyclic. And the ability of the clients and the contractors to line up capacity and delivery is key here. If it's a small market, that's ok. But it's the ability of the size of the market to change. The speed of the change and the ability of the supply side and the client side to line up. We either got over capacity or under capacity. And those things make some real material effect on pricing. It's one of the biggest changes. It's less about the ability to build it, but the ability to compete, either it's too much competition or too little completion, and that is the cyclic nature of the market.

The identifiedthe challenge of tendering with incomplete designs and specifications of the project was also confirmed by both experts. They believed that sometimes contractors have to bid on vague designs and leave more gaps behind because, in recent years, clients and their consultants don't spend enough time and budget getting the design to the point that contractors can bid properly. The second expert stated that:

"The responsibility for design has changed. In a traditional market, the contractor bids, on a full set of drawings. Or if it's D&B at 60 or 70% completed. But they are developed fully to the stage before being

handed over. What tends to be happening now, is while the capacity constraints, the ability of designers to exercise the responsibility of our coordination is poor. That means the design that goes through tender is not very good.

In regards to the issues with the procurement strategies, experts confirmed the results obtained from the semi-structured interviews. The first expert suggested that:

"The contractors don't like to do D&B at the moment, they are stepping away from that model because there are lots of risks for contractors in the design and build. Because they have to take responsibility for the incomplete design and they have to price those without getting subcontractor's prices."

The second expert was also agreed that with the D&B contracts, some clients still want control over the design and have sub-contracts with the designers, which are not the real D&B.

"That' right. And the risk is transferred it. Because in D&B the risk is transferred to the contractor and the contractor hate it in a rising market because construction inflation is eating their margins because they cannot award sub-contracts until later that they have bid on the D&B.

However, the first expert disagreed with the results we got that indicates that the designers in New Zealand have to design with more details than elsewhere because the sub-contracting market is not sophisticated enough to develop the design.

"I sometimes challenge that. So the subcontracting market is sometimes not very deep, it is also restricted. There are sometimes only a few good subcontractors. But I don't see the architects doing more design. I think the risk is the gap. The architects don't do adequate design, the subcontractors are sometimes thin. So somebody has to carry the risks. For instance, in windows and glazing, somebody would design secondary steel, somebody would design the windows, but the architects don't do the weather proof design. They just hope that either the secondary steel guy, the glazing guy or the window manufacturer will sort it out somehow. So it's kind of left out. Those details are usually left out, and it's very unclear who's responsible for that."

One of the issues that both experts agreed with and highly recommended was about the importance of cooperation and collaboration between construction participants. Due to the size of the New Zealand market, sometimes, it cannot afford to lose major players and the current role of the lawyers and legal advisors is not helping the situation. The second expert stated that:

"The lawyers specifically, are writing the contracts without the desire for the contracts to be collaborative or helpful. They, on behalf of clients or behalf of main contractors to the subcontractors, are writing very hard contracts which goes against the purpose of having collaboration and openness."

In terms of evaluation criteria, both experts agreed with the semi-structured interview results and questionnaire results. The first expert mentioned that:

"I agree with survey results and like the representation of it. Those are quite good. They tell the story very quickly, and I agree with that. My instincts say that they look about right."

However, he suggested another criterion for the Sustainability category that can develop the criteria list further.

"About the criteria, another term that can be considered and assessed further is localisation. So in the sustainability section, there are a couple of things about the sustainability of the marketplace. That's about buying local, training which means making the industry sustainable by using the project to generate training schemes, and it is also about supporting communities. For instance, pulling people in need and from the areas of high risk to have long term contracts and improving a whole community. A lot of social aspects can be added to sustainability. The reason I added that is that some of the major clients such as councils are starting to specify social goals for their projects and in the contract to develop a sustainable workforce.

Validity and applicability of the proposed framework

After illustrating the qualitative and quantitative results, the proposed framework was introduced to the experts. All three stages were discussed, and sample use of AHP and TOPSIS method was presented. Then, both experts were asked to provide their insights on the advantages and disadvantages of the proposed model. Both experts believed that it is a good framework which can provide a useful guide to clients and decision-makers. The first expert stated that:

"I believe your model works. I quite understand what you're trying to do, which is produce a tool that ranks the contractors that are closest to the good point and furthest from the bad point. It is good that the reason for selecting these methods for New Zealand has been rationalised properly by reviewing different evaluation methods from around the world. I think it is a big step forward than how it's currently done. One of the biggest issues in the marketplace for contractors and clients is that clients want to have 5 or 6 contractors to compare, but the contractors would like it to be a two-horse race to increase the chance and less waste of resource. So, it is good that your model works even with two contractors bidding on the tender.

The second expert was also agreed that the proposed framework can be applied to the New Zealand context and can probably improve the industry.

"I think, firstly, this model that you have provided, I think it was desperately needed by the industry. Because everybody does it differently, and everybody starts from scratch. Different departments and councils have their methods, but because of the lack of experience and lack of agreed model, they just default to price or very simplistic evaluation system. The industry needed such a model that recognises a sort of robust and have a scientific background to it.

Both experts confirmed that there are differences between the suggested framework and the approaches that the public departments such as NZTA and Ministry of Education are using. They argued that it seems that these differences can improve the performance of the tender evaluation procedures in New Zealand.

Suggestions for improving the proposed framework

The validation interview results identified several suggestions to improve the proposed public tender evaluation framework. One of the areas that both experts suggested which might improve the model is regarding the second stage of the framework. They mentioned that identifying an approach that can assist clients in selecting an appropriate set of criteria from the list provided in the second stage could be one of the areas for improvement in the model. The first expert stated that:

"What you should use for tender evaluation, and how you can build the criteria up and a methodology for scoring. That's good. But the future study should be how to get to those criteria from the criteria that are being used now."

The second suggestion identified is related to one of the issues that have also been mentioned by semi-structured interview participants as well. One of the natural barriers of implementing any improvement model is the resistance to change in the market. The first expert stated that:

"My recommendation for further studies is about change management. How do you initiate the change, who do you have to influence. For instance, some clients have better procurement models than others, and you can find people who are keen on change, talk to them and use them as a market influencer to prove that your model can work.

The second expert has also stated that:

For future study, it would be good to have a method that can reduce the subjective judgement of the decision-makers in stage two of the suggested framework, which is the selection of the project criteria.

Both experts agreed that while this research provides good information about the public tendering procedures in New Zealand, more research should be conducted continuously on this issue to help the contractor selection process. There should be a scope to conduct more research on various aspects of tender evaluation and procurement challenges because currently, there are not adequate studies conducted on these issues. The second expert believed that it could be good to have this topic being taught to undergraduate in the university to raise awareness about the current challenges in the market.

"What I would like to see is that if this becomes a subject at the university because I believe there should be more awareness and training on procurement in New Zealand."

As an additional comment on this section, finding a way to validate the documents provided by the contractors in the tender is also as important as the method of evaluation, as explained by the first expert:

"Another thing that can be added here is that the suggested model is good, but to use the model you have to have good data coming in. So the recommendation is about the quality of the data to supply at the tender to be able to do the evaluation. If future studies can find a way to validate the data that contractors provide, that can improve the quality of your model."

8. Chapter 8 - General discussion and conclusion

2.1 Introduction

This chapter outlines the findings and conclusion of the study and identifies the original contributions made by the research toward improving contractor selection protocols in the New Zealand public construction sector. Therefore, the research objectives will be reviewed, and the key findings of the research will be discussed. This is followed by an explanation on the originality of the research and its contribution to the science and the industry, along with the limitations of the research. Finally, the chapter provides a set of recommendations for future studies and a conclusion with the research summary.

2.2 Review of the research objectives

The primary objective of this research is to identify areas that reduce the efficiency of the public CS in New Zealand and find potential solutions to address these by providing a framework to transfer from traditional evaluation procedures to modern selection methods. Thus, the objectives of this research are four-fold:

1. To find the advantages and disadvantages of CS methods, establish a universal set of Price/Non-Price Attributes and identify their priorities.
2. Identify potential areas for improvement of CS procedures in New Zealand.
3. Demonstrate solutions to transfer from traditional iron triangle criteria of time, cost and quality to modern industrial principles.
4. Develop a framework for CS that satisfy the requirements of the New Zealand construction industry.

A mixed-method approach of Semi-structured interviews, survey questionnaires and validation interviews was adopted to achieve the research objectives. The nature of the problem and challenges of current CS methods was mainly revealed by semi-structured interview approach. To obtain a wider perspective from construction project participants, an online questionnaire survey was distributed among the aforementioned parties who had a good experience in participating in public tender evaluation procedures. In the final step, validation interview approach was used to review the research findings and validate the overall framework. The following section explains how each study objective was fulfilled in the research.

2.1.1 Objective 1

To find the advantages and disadvantages of CS methods, establish a universal set of Price/Non-Price Attributes and identify their priorities.

The researcher formulated the following research questions to address this objective:

1. What are the different tender evaluation methods?
2. What are the advantages and disadvantages of each method?
3. What are the different tender assessment criteria?
4. What are the priorities in the universal set of criteria?

These questions were mainly addressed through the review of the literature and semi-structured interviews. The research revealed that there are various tender evaluation methods exists. Different countries have adopted different procedures to evaluate their tenders. The research further investigated these methods and demonstrated the advantages and disadvantages of each CS method. The research illustrated that a series of decision-making methods had been developed to estimate the value of contractors in construction tenders. This research identified, collected and recorded 16 methods from reviewing 26 papers on the topic of CS evaluation models published from 2007 to 2018. These methods can be summarised into three categories of Mathematical models, Artificial Intelligence (AI) models and Hybrid models.

To identify an effective set of price/non-price attributes, the common tender assessment criteria and their priorities in different articles were reviewed. Eventually, 140 criterion were recorded which assigned to 13 categories namely; “Appreciation of the task”, “Client-supplier relations”, “Financial viability”, “Health, safety and Environment (HSE)”, “Management systems and skills”, “Methodology”, “Organization and relevant experience”, “Past performance and track records”, “Price”, “Reputation”, “Resources and workload”, “SME location” and “Technical skills”.

However, by reviewing the semi-structured interview results and comparing it with the literature review results, eventually, 178 criteria were recorded and assigned to 20 categories. Thus, 7 more categories were added to the potential set of criteria, namely; BIM experience, Sustainability, Supply Chain Management (SCM), Risk Management, Innovation, Key partners, Materials. These criteria were further examined in the survey questionnaire phase to illustrate their priorities in the New Zealand context.

2.1.2 Objective 2

Identify potential areas for improvement of CS procedures in New Zealand.

The researcher formulated the following research questions to address this objective:

14) What are the current challenges of the New Zealand construction sector in terms of public tender evaluation procedures?

15) Which methods and criteria do New Zealand clients use to assess tenders?

16) What are the benefits and barriers of current contractor selection practices in New Zealand?

These questions were addressed through semi-structured interviews. The literature review and semi-structured interviews initially addressed the second question, but a wider opinion was collected in survey questionnaire stage. These opinions were then validated through validation interview phase of the research.

The research explored a range of potential challenges that New Zealand clients face while they are trying to select a proper head contractor for their projects included: over workload and capacity issues, low productivity of contractors and subcontractors, misunderstanding of the concepts of team work by different project participants, failed procurement strategies, timely and costly tendering procedures, and risk allocation issues. The research results illustrated that different public organisations in New Zealand have different sets of rules for their tender assessments. However, the evaluation methods are limited to the lowest-price, and Simple Additive Weights (SAW) and the modern decision-making methods have not been adopted properly by public departments. To further understand the CS processes of New Zealand public projects, the strengths and weaknesses of the methods that are currently being practised in New Zealand were explored in Literature review and semi-structured interviews.

Appropriate choice of assessment criteria is a vital consideration that DMs should make during tender evaluation processes. Thus, the criteria that public New Zealand clients consider in their construction tender were explored during this stage. Four categories have been added to the criteria list in this step, which includes risk management experience, innovation, key partners and materials. Moreover, results illustrated that there might be a significant difference between the criteria that public New Zealand clients consider in Tier 1 projects and Tier 2&3 projects.

2.1.3 Objective 3

To create recommendations that evolve traditional criteria to optimal price and non-price attributes.

Objective 3 was formulated to identify the elements of a suitable list of attributes to direct the construction sector to more advanced techniques. The study developed three research questions to address this objective.

1) Which CS methods are more suited for this purpose?

2) Which criteria are more important for the New Zealand construction sector?

3) Which modern principles are more important to be added to CS?

The literature review illustrated that the industry could benefit by shifting from traditional assessment criteria to modern principles such as BIM, Sustainability and Supply Chain. It can assist DMs with various range of problems they are facing in construction projects about the lack of integration, changing the environment and lack of effective communication between different parties. By reviewing contractor's ability in these attributes, clients can ensure the continual updating and sharing of project information, application of sustainable development principles in different phases of construction and increased understanding of the breakdown and traceability of materials, services, organizations, logistics, people, activities and information

The research reviewed different evaluation methods to find appropriate methods that have the capability to address this objective. The first question was addressed through literature review and semi-structured interviews. Results illustrated that AHP and TOPSIS methods were suitable to be used for this purpose. The primary reason for selecting the AHP method was that it is an appropriate method for solving complex decision problems, particularly for weighting multiple variables. The rationale to choose TOPSIS is that it has been proven that it is a reliable tool to clarify a solution from several alternatives by considering multiple dimensions of the problem.

The study found that tender evaluation processes, when addressed by a proper price and non-price attributes, can increase the probability of delivering the project successfully. The main objective of the quantitative survey phase of this study was to address the second question and explore the importance of the identified criteria. The questionnaire results demonstrated that there are some significant differences among the level of importance of each category in different project type.

The top 6 criteria for Tier 1 projects are “Past Performance and Track records”, “Technical skills”, “Risk management”, “Management systems and skills”, “Resources/Workload capacity” and “Financial viability”. On the other hand, the most important criteria for Tier 2&3 projects were “Technical skills”, “Past performance and track records”, “Resources/Workload capacity”, “Materials”, “Health & Safety” and “Price”. The results confirm our previous findings that “Price” is a more important criteria for Tier 2&3 projects than Tier 1 projects.

The results indicate that there are 10 criteria that have a statistically significant difference for two types of projects. To further understand these differences, the key categories and their criterion that had significant differences in a different type of projects are listed below:

1. Financial viability: Financial Soundness (Asset, profits, debts status), Financial Capacity, Financial stability, Insurances, return on net worth ratio, Business Turnover-Cash Flow, Analysis of Accounts, Bank Reference or Arrangements, Credit Rating, Liquidity Ratio, Profitability, Debit ratio, Flexibility in payment terms and conditions, profit growth rates,

2. Management systems and skills: Management knowledge, Management Systems Implemented, ISO and other management certificates, Management structure, Documentation and reporting systems, Waste management and minimization systems, Onsite plant maintenance systems, Human resource planning systems, MIS level (Management Information System), Risk management method, Quality Control (QC) Policy, Implemented Quality Systems, R&D ability, Investment on R&D, Number of patents owned or transferred by the organization, Staff training program, Strategies for human resource developments, Reward and benefit distribution system, Professional qualification grade for managerial staff, Enterprise culture compatibility, Management cooperative desire, Level of investment in management systems

3. Client-contractor relations: Client/Customer Attitude and Relations, Commitment to Support, Responsiveness, Ability to Work as Team, Stakeholder Management, Customer Focus/Relationship, Post-contract attitude, Sub-contractor relations, Sub-contractor management systems

4. Risk management: Previous successful experience in risk management, previous failures in risk management, Level of development in risk management processes (Planning, Identification, Assessment, Treatment and Monitoring), Suggested Risk planning (Objectives, Methodology, Roles and Responsibility, Budgeting, Time management, Risk interpretation, Risk identification method, Risk breakdown structure, Risk Probability-Consequences matrix, Suggested risk treatments)

5. Innovation: History of innovation in previous projects (Financial, Project time and scheduling, Risk management, Procurement system, Supply chain issues, On-site decision making, improving HSE), Registered inventions, Yearly investments on R&D, Any structured lessons learned programme that captures project results, Any structured employee suggestion system, Any structured assessment of innovation in annual personal evaluation

6. BIM experience: Scale of the previous projects that used BIM, Level of BIM used in previous projects (Level1, L2, L3), Purpose of BIM used in previous projects (Documentation, Communication, Project scheduling, Project costing and estimation, Life cycle analysis, Logistics, Demolition, BIM education level (Level of BIM education of key BIM personnel, Company's yearly investment on BIM, Training undertook, How do they keep their key BIM personnel updated Annual workshops, 6 months workshops)), BIM certificates achieved, BIM software used in previous projects

7. SCM: Percentage of previous projects that used SCM, Scale of the previous projects that used SCM, Level of development of SCM in the organization (Financial Accounting, Controlling, Asset Management, Project System, Human Resource planning, Site maintenance, Quality Management, Material Management, Logistics), Previous delays on receiving materials, Frequency of communication with suppliers, Centralised system used in previous projects, SCM education level (Level of SCM education of key SCM personnel, Company's yearly investment on SCM, Training offered, How do they keep their key SCM personnel updated, Annual workshops, 6 months workshops)), SCM certificates achieved

8. Price: Fixed capital Price, Labour Rates, Operating Costs, Variable tender costs during the project period, Maintenance costs, operating costs, Return and Benefits, Rationality of Estimates, Through Life Cost Program Methodology

9. SME location and geographical familiarities: Business Location (location of the home office), Area of Catchment (Local/National), Facilities Location, Familiarity with area and weather conditions, Familiarity with local labour, familiarity with local suppliers

10. Materials: List of key materials, Information about material characteristics and methods of material assembly, Certificates, standards and stamp of approvals for key materials, Previous experience of using any defective materials

The third question was addressed through semi-structured interviews and survey questionnaires. The results indicated that although none of the identified modern construction principles of BIM experience, Sustainability and Supply Chain Management is among the most important categories for different

types of projects, clients can benefit from assessing the contractors ability to achieve these attributes, especially for Tier 1 projects.

2.1.4 Objective 4

Develop a framework for CS that satisfy the requirements of the New Zealand construction industry.

This objective was formulated to address the following questions.

1) How to develop the current methods of CS to fit into New Zealand industry?
2) Which criteria should be considered to optimise the framework?
3) What would be the challenges of implementing this framework in New Zealand industry?

The study found that the importance of adopting advanced decision-making tools to manage tender evaluation procedures in the current market is increasing. The industry has begun to move from traditional approaches to more integrated and modern methods. The review of numerous tender evaluation frameworks necessitates the need for a more comprehensive guideline. The research established the main benefits of a standard CS framework. Firstly, it can improve tendering efficiency by providing a better plan for approaching the market and specification of the project requirements. Secondly, it can build better teamwork and cooperation among project participants by increasing trust between different parties and avoid any vagueness of selection among the project team. Moreover, a proper framework can improve performance by developing a better criteria selection and evaluation method. Finally, by using more advanced decision-making techniques, clients can capture the expert's judgement when dealing with complex multi-criteria problems to have more realistic and rational decisions.

The literature review, semi-structured interviews and survey questionnaire results provided advanced knowledge of tendering methods, which led to the development of a CS framework. This framework combines the use of AHP and TOPSIS to evaluate public construction contractors. The AHP technique will be used to identify the relative weight of each criterion by considering the categorised structure, pair-wise comparison and consistency of the respondents. TOPSIS method can identify the most capable contractor by ranking the alternatives based on different attributes.

The proposed CS framework consists of three stages, as illustrated in figure 46. In the first stage, the project team review the construction sector and plan the best strategy to approach the market. Moreover, they will determine the specifications of the project and provide a project management schedule to execute, monitor and control the project. Based on the project specifications developed in stage 1, related criteria will be chosen from the comprehensive list of criteria generated in this research.

The criteria analysis presented earlier in this chapter can assist the project team in determining that the evaluation of which criteria can increase the chance of successful delivery of the project. Finally, stage 3 consists of the protocols to evaluate the candidates. In this stage, the AHP pairwise comparison method will be used to determine the criteria weighting, and TOPSIS method will be utilised to find the ideal candidate.

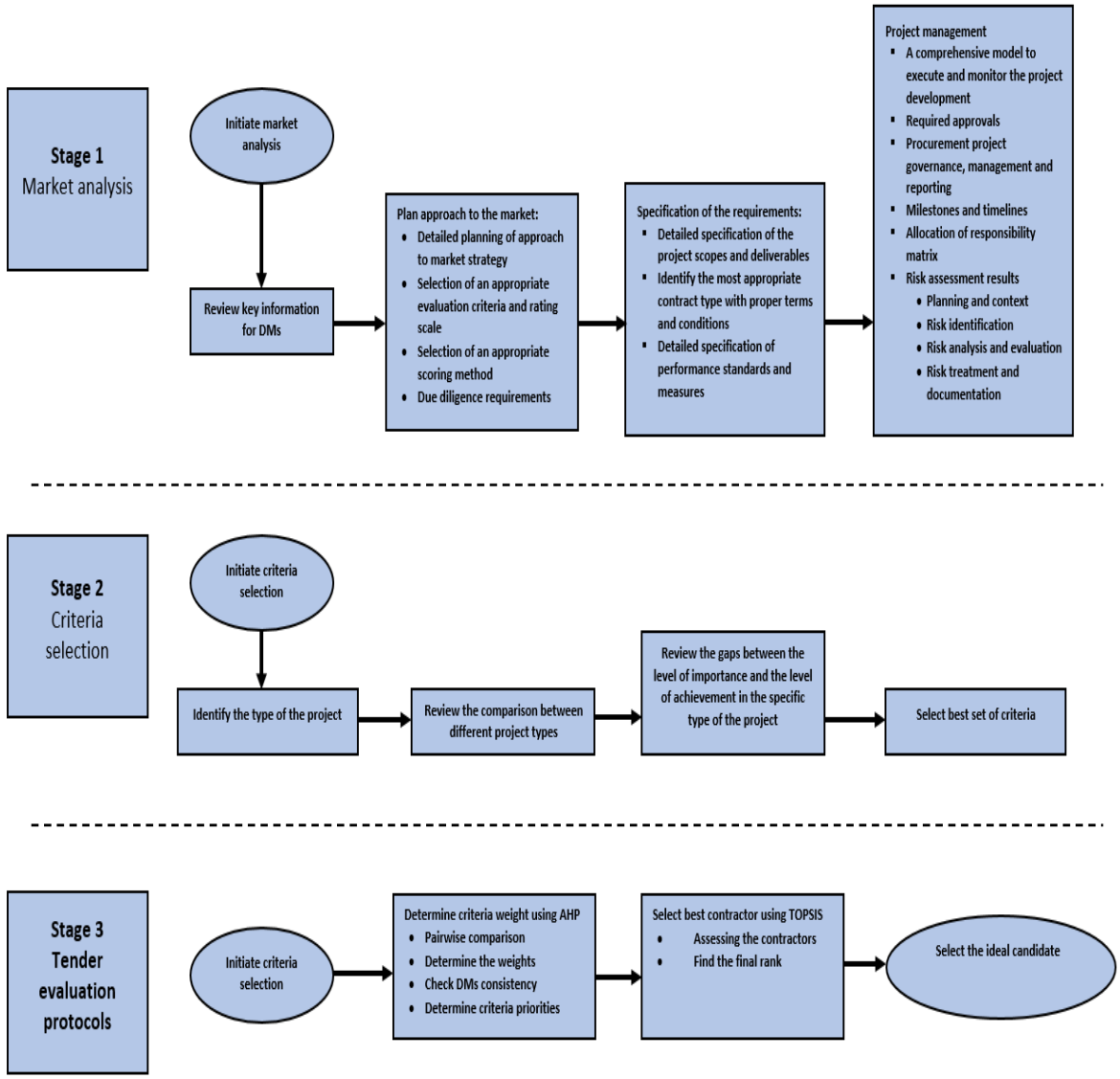

Figure 46 - Proposed framework

2.3 Key research findings and suggestions

In this section, both qualitative data from interviews and quantitative information from survey questionnaires are integrated to address innovative knowledge on the tender evaluation framework for the New Zealand public sector. Various issues, questions and findings emerged from different stages of this study. One of the main challenges was that there are no previous key studies of tender evaluation procedures in New Zealand. By obtaining rich information from experienced construction practitioners

of New Zealand, a framework was developed and validated to assist public clients in their tender evaluation procedures. The findings of this study resulted in the development of a hybrid approach based on AHP and TOPSIS methodology. The following sections demonstrate the key elements of the suggested framework, as well as research findings and recommendations.

2.1.1 Literature review phase

Our results illustrated the absence of a formalised framework that can evaluate and select contractors appropriately. Different public departments have their own sets of rules for their assessments. The review of literature related to the New Zealand construction sector revealed that tender evaluation had not attracted significant attention from construction practitioners and researchers in New Zealand. To date, only three publications since the year 2000, which mainly focused on the integration between the development of construction procurement strategies and selection models rather than tendering procedures and assessment criteria. Thus, this study mainly focused on providing a grounded understanding of the elements involved in New Zealand tender evaluation procedures, as a contribution to improving construction sector.

With this in mind, the literature review of this research explored the key components of tender evaluation processes. For the first step, different evaluation methods including mathematical, AI and hybrid approaches were reviewed, and a comprehensive list of advantages and disadvantages of each method was provided. This research identified, collected and recorded 16 methods from reviewing 26 papers on the topic of tender evaluation models published from 2007 to 2018.

Although there are various methods for CS, these techniques are inapplicable without a well-defined collection of decision criteria (Jafari, 2013). Hence, for the second step, the literature review focused on identifying a universal set of price/non-price attributes for CS procedures. Reviewing the targeted publications, 28 papers identified reporting decision criteria for tender evaluation problems. Eventually, 140 criterion were recorded which assigned to 13 categories namely; “Appreciation of the task”, “Client-supplier relations”, “Financial viability”, “Health, safety and Environment (HSE)”, “Management systems and skills”, “Methodology”, “Organization and relevant experience”, “Past performance and track records”, “Price”, “Reputation”, “Resources and workload”, “SME location” and “Technical skills”. Furthermore, the review of the literature illustrated that to efficiently manage project risks, the evaluation criteria should be updated to include modern construction concepts such as Building Information Modelling (BIM), Sustainability and Supply chain. Thus, these concepts have been explored and added to the list of potential assessment criteria to be studied further in the next phases of the research.

2.1.2 Semi-structured interview phase

In the semi-structured interview stage, open-ended questions were conducted with experts of the New Zealand public construction sector to evaluate the cognitive mechanisms which are shaping perceptions of CS problems in New Zealand. The data were obtained from 10 semi-structured interviews with experienced practitioners based in Auckland who was involved in public construction tender evaluation procedures in New Zealand. The participation in this study requires a high level of knowledge and experience in public construction tendering procedures, which limits the number of potential candidates.

Seven key themes emerged from semi-structured interview results namely; Challenges of selecting best-value contractors in New Zealand, Routine CS methods in New Zealand public construction sector, Key assessment criteria used in New Zealand public tendering, Current challenges of public construction procurement in New Zealand, Importance of using modern construction principles, Main barriers of implementing improvement projects in New Zealand construction sector, and the role of government in implementing improvement projects to increase the performance and efficiency of the construction sector.

The first theme explored a range of potential challenges that New Zealand clients face while they are trying to select a proper head contractor for their projects included: over workload and capacity issues, low productivity of contractors and subcontractors, misunderstanding of the concepts of team work by different project participants, failed procurement strategies, timely and costly tendering procedures, and risk allocation issues.

The second theme illustrated that there is no formalised guideline that been used by public entities. However, the New Zealand public entities approach is generally to use the pretender process as a filtering stage that would allow them to reduce the number of contractors who are going through the bidding process. Depending on the nature of the project and clients sensitivity to price, time and quality, one envelope or two envelopes (brook's law) approaches may be selected. However, the evaluation method is often limited to the lowest price and Simple Additive Weight (SAW).

The common choice of criteria that are being considered in the public CS procedures were explored in the third theme of the semi-structured interviews. The results illustrated that the main attributes that are being considered in public tenders include price, relevant experience, track records, relevant skills, resources, and methodology. This result indicate that price is the dominant criteria in New Zealand's public tendering. However, it has been demonstrated that these criteria and associated weights might be different from project to project, especially, there might be a huge difference between Tier 1 projects and Tier 2&3 projects.

Furthermore, the research assessed the challenges of implementing an efficient procurement strategy in the New Zealand construction sector. The study showed that the integrated procurement systems had

not developed properly in New Zealand as they are developed in other countries such as Australia, UK and US. One of the main reasons identified was that often public clients are not informed about the benefits of shifting to more advanced integrated approaches and rather to work with the systems that they have the previous experience with. Another reason that integrated approaches such as design & build have not developed properly in New Zealand includes the lack of proper development of the client's objectives at the concept design stage.

The importance of using modern construction principles and its challenges were explored in this theme. The results indicated that the industry could benefit from considering modern construction principles such as BIM, Sustainability and Supply Chain Management in tender evaluation processes. However, various challenges exist in the implementation of these principles. One of the main issues is that different project participants have different definition and purposes from adopting these principles. It has been suggested that if the project team wants to get full value out of these principles, they must start with the planning phase and all parties should be involved.

The sixth theme assessed the main barriers to implementing improvement projects in New Zealand construction. These challenges include the size of the market, cultural barriers and natural barriers such as resistance to changes in the market. The last theme explored the role of government in improving the efficiency of the construction industry. Governments play an important role in the market as a legislative body. Thus, they can highly affect the market by involving in the development of the market.

2.1.3 Survey phase

In the quantitative phase of the research, online questionnaires were sent through a web-based survey tool to construction practitioners involved in public tendering procedures in New Zealand to assess the importance of CS criteria. A total of 38 responses were received over 8 weeks period from an approximate 120 questionnaires sent out.

By reviewing the semi-structured interview results and comparing it with the literature review results, eventually, 178 criteria were recorded and assigned to 20 categories. The objectives of this phase of the study were to understand the level of importance of each criteria as well as the level of achievement of the public construction sector in each category. Moreover, since the semi-structured interviews illustrated that there are differences between the criteria for Tier 1 projects and Tier 2&3 projects, the differences of the level of importance of each category in two different types of projects (Tier 1 projects and Tier 2&3 projects) were reviewed.

The results show that the top 6 criteria for Tier 1 projects are "Past Performance and Track records", "Technical skills", "Risk management", "Management systems and skills", "Resources/Workload capacity" and "Financial viability". On the other hand, the most important criteria for Tier 2&3 projects

were “Technical skills”, “Past performance and track records”, “Resources/Workload capacity”, “Materials”, “Health & Safety” and “Price”. The results confirm our previous findings that “Price” is a more important criteria for Tier 2&3 projects than Tier 1 projects.

The survey questionnaire findings indicated that 6 criteria of Resources/Workload capacity, Risk management, past performance and track records, Technical skills, Materials and client-contractor relations requires higher attention of the decision-makers in Tier 1 projects since there are gaps exists between the level of importance and level of achievement of the New Zealand construction sector in terms of these categories. For Tier 2&3 projects, there are four criteria exist that requires greater attention from clients, namely; Resources/Workload capacity, Technical skills, Materials and Past performance, and track records.

To examine the significant differences between Tier 1 projects and Tier 2&3 projects, Wilcoxon Signed Rank test was used on the level of importance of the categories. The results demonstrated that there are significant differences exist in the level of importance of some criteria for Tier 1 projects and Tier 2&3 projects. For instance, all of the groups agreed that both “Risk management” and “BIM experience” are the criteria that are more important in Tier 1 projects than Tier 2&3 projects.

2.1.4 Framework phase

Research results illustrated the importance of adopting modern decision-making methods to manage public contractor selection procedures. The drive for developing a CS framework for public construction tenders is to enable public construction clients to achieve better value for public money. The suggested framework consists of three stages of (1) market analysis, (2) criteria selection and (3) tender evaluation protocols (Figure 46).

The information we obtained from semi-structured interviews of the research was gathered and presented in the first stage. This information can assist public clients and DMs in their pretender procedures including; plan approach to the market, specifying the project requirements and project management planning. Without recognising the needs properly, it would not be possible to write comprehensive specifications. Therefore, the selected criteria will not target the important factors of the project and the selected contractor may not have the proper capability to deliver the project successfully.

The second stage consists of the identification of the most suitable attributes to be evaluated in the tender. Tender evaluation procedures, when addressed by an appropriate set of criteria, can offer more rational construction projects where clients can effectively employ the contractor with the better potentials and increase the probability of delivering the project successfully. With this in mind, a

comprehensive set of criteria with 20 categories and 178 criteria was established. These categories were identified through different phases of the study.

Depending on the project's nature and scope, a different set of criteria can be used in tender evaluation. To assist DMs in selecting an appropriate set of criteria, the results from the survey phase of the study were presented. During these procedures, the most important criteria for different types of projects, their achievement in New Zealand industry and the gaps among them were illustrated.

The final stage of the framework is the evaluation process, which consists of a hybrid approach using AHP and TOPSIS methods. The development of this approach is the result of exploring different MCDM methods. The AHP-TOPSIS method will be used to determine the relative weight of each selected criteria and selecting the best contractor. Using this hybrid approach has numerous advantages. One of the main benefits is that both of these methods are the tools that have been used and suggested by various scholars to solve complex MCDM problems. Using a combination of these methods can provide a more realistic and rational decisions. Moreover, it can provide a good structure for the procedures and can check the consistency of the results. In addition, if any changes occur in the assessment criteria or allocated weights, it can easily illustrate the new results.

2.4 Contribution of the research to theory and practice

The research has contributed to the construction contractor selection management body of knowledge in both theory and practice. The major contribution of this research to knowledge is that it has explored different elements of tender evaluation procedures and provided a reference for tendering problems. The following is a list of specific contributions that this research has made.

- Rich information has been provided by this study on tender evaluation protocols and its applicability in the public construction sector of New Zealand. The study has identified critical factors involved in each stage of the assessment to assist decision-makers through evaluation processes. Moreover, useful information is now available for clients, policymakers and other stakeholders to have a better understanding of the contractor selection procedures in New Zealand.

- The study has established a comprehensive list of the advantages and disadvantages of each multi-criteria evaluation method. This research identified, collected and recorded 16 methods from reviewing 26 papers on the topic of tender evaluation models published from 2007 to 2018.

- The study has advanced the understanding of contractor selection procedures in terms of evaluation methods and assessment criteria. The outcome of the study can be considered an

important database for researchers in this area, assisting other investigators in understanding the elements that impact the tender evaluation in New Zealand.

- The study has provided a universal set of price/non-price attributes that can be used as a reference for decision-making teams. The identified list consists of 178 criteria were recorded and assigned to 20 categories, including modern construction principles such as BIM, sustainability and supply chain experience.

- The study explored the challenges of public construction tendering in New Zealand and found that various factors such as unproductivity, low capacity of the market and weak collaboration between project participants influence the efficiency of the public construction tender assessment processes.

- Another important contribution is that this is the first study that investigates public tender evaluation processes in New Zealand and can be considered an important reference for future studies.

- The study further investigated tender evaluation methods in New Zealand and found that lowest-price and SAW are the dominant evaluation methods in New Zealand. The study illustrated that the New Zealand construction sector could benefit from adopting modern MCDM tools in public tender evaluation processes.

- The study identified gaps between evaluation criteria and established a reference for DMs to select the most suitable set of criteria for their tenders.

- The study has developed a comprehensive framework consists of three stages that can assist construction clients and decision-makers in their tender evaluation procedures. This framework consists of three stages, namely; market analysis, criteria selection and evaluation methods including AHP and TOPSIS techniques. Moreover, this framework can encourage researchers to contribute and enter the arena and investigate elements of the framework more deeply.

- The research findings are expected to provide data for several academic papers that are planned to be submitted to construction engineering and project management journals.

2.5 Limitations of the study

Several constraints have affected the research. The main limitations of the study and suggested framework are summarised below:

- One of the main limitations of this study is associated with the accuracy of responses provided by the participants in the qualitative and quantitative phase of this research.

- As the study was based on semi-structured interviews and survey questionnaires, the validity of the results is subject to the accuracy of responses provided by the participants. The semi-structured interviews were limited to 10 interviewees because of time and resource constraints.

- The response rate of the survey was around 30%. Thus, it should be noted that the perceptions offered by the respondents will form only part of the real problem.

- There was no previous theoretical or practical research on public tender evaluation processes in New Zealand. Thus, the lack of available information and literature on the subject was one of the main limitations of this research.

- The scopes of this research are limited to public tender evaluation for Tier 1 and Tier 2&3 projects.

- For the validation interviews, the researcher would have preferred to have had additional validation interviews to check validity of the findings. However, limitations of time and fund prevented wider survey.

2.6 Recommendations for further research

The study recommends further researches in the following areas that could expand the study findings.

- Our results indicate that evaluation of more tools and implementation of these methods in real-world projects could provide a more comprehensive understanding of challenges faced by construction practitioners in the market.

- It is important to notice that a broader sample which includes a wider range of construction professionals can provide new insight into more mature stages of the problem.
- This study provided current elements of public tender evaluation procedures in New Zealand from a wider perspective. To examine the findings with more depth, further studies are required to extend the current knowledge of the construction CS.

- The scope of the study lies within the boundaries of public-funded projects in New Zealand. Further studies investigating the tendering procedures in private funded projects can provide a better understanding of the construction contractor selection strategies in New Zealand.

- Further research in the construction procurement routes in New Zealand and its impacts on tendering strategies would help to develop an information database that can contribute to both theory and practice.

- The research suggests the employment of more in-depth interviews with construction experts to address the challenges of tendering in New Zealand, which can better assist in generalising the findings to the industry.

- The study designed and developed a framework to evaluate and select the most suitable contractor in New Zealand public construction sector. More specific case study research projects can further extend the current study results as applicable in the industry.

2.7 Summary

This chapter provided a general discussion and conclusions of the thesis. Firstly, the research objectives have been presented, and the approaches to achieving these objectives have been illustrated. The second section of the chapter includes the key research findings and study suggestions. The research findings have summarized the results from the literature review, semi-structured interviews and survey questionnaires, which formed the basis for the suggested framework. The chapter further outlined the contribution of the research to theory and practice. Moreover, the limitations of the study and recommendations for further research have been demonstrated. It is hoped that this research has contributed to the existing body of knowledge and practice to improve the performance of tender evaluation processes.

9. REFERENCES

Abbasianjahromi, H., Rajaie, H., & Shakeri, E. (2013). A framework for subcontractor selection in the construction industry. Journal of Civil Engineering and Management, 19(2), 158-168.

Abdelrahman, M., Zayed, T., & Elyamany, A. (2008). Best-value model based on project specific characteristics [Article]. Journal of Construction Engineering and Management, 134(3), 179-188. doi:10.1061/(ASCE)0733-9364(2008)134:3(179)

Ahmed, M. O., El-Adaway, I. H., Coatney, K. T., & Eid, M. S. (2016). Construction bidding and the winner's curse: Game theory approach [Article]. Journal of Construction Engineering and Management, 142(2). doi:10.1061/(ASCE)CO.1943-7862.0001058

Algina, J., & Keselman, H. J. (1999). Comparing squared multiple correlation coefficients: Examination of a confidence interval and a test significance. Psychological methods, 4(1), 76.

Alptekin, O. (2014). Multi-criteria decision making approach in contractor selection. International Journal of Natural and Engineering Sciences (IJNES) E-ISSN: 2146-0086, 5(2), 06-09.

Alptekin, O., & Alptekin, N. (2017). Analysis of Criteria Influencing Contractor Selection Using TOPSIS MethodIOP Publishing. Symposium conducted at the meeting of the IOP Conference Series: Materials Science and Engineering

Alreck, P. L., & Settle, R. B. (1994). The survey research handbook: McGraw-Hill.

Amaratunga, D., Baldry, D., Sarshar, M., & Newton, R. (2002). Quantitative and qualitative research in the built environment: application of "mixed" research approach. Work study, 51(1), 17-31.

Arslan, G. (2012). Web-based contractor evaluation system for mass-housing projects in Turkey [Article]. Journal of Civil Engineering and Management, 18(3), 323-334. doi:10.3846/13923730.2012.698892

Arslan, G., Kivrak, S., Birgonul, M. T., & Dikmen, I. (2008). Improving sub-contractor selection process in construction projects: Web-based sub-contractor evaluation system (WEBSES) [Article]. Automation in Construction, 17(4), 480-488. doi:10.1016/j.autcon.2007.08.004

Baykasoğlu, A., Özbay, E., Göğüş, M. T., & Öztaş, A. (2009). Contractor selection with multi criteria decision support tools [Article]. International journal of industrial and systems engineering, 4(2), 174-197. doi:10.1504/IJISE.2009.022371

Black, M., Guy, M., & McLellan, N. (2003). Productivity in New Zealand 1988 to 2002. New Zealand Economic Papers, 37(1), 119-150.

Burke, R. (2013). Project management: planning and control techniques. New Jersey, USA, 26.

Chan, A. P., Chan, D. W., & Yeung, J. F. (2009). Overview of the application of "fuzzy techniques" in construction management research. Journal of Construction Engineering and Management, 135(11), 1241-1252.

Chan, A. P., Lam, P. T., Chan, D. W., Cheung, E., & Ke, Y. (2010). Critical success factors for PPPs in infrastructure developments: Chinese perspective. Journal of Construction Engineering and Management, 136(5), 484-494.

Chan, A. P., Scott, D., & Lam, E. W. (2002). Framework of success criteria for design/build projects. Journal of Management in Engineering, 18(3), 120-128.

Cheng, E. W. L., & Li, H. (2004). Contractor selection using the analytic network process [Article]. Construction Management and Economics, 22(10), 1021-1032. doi:10.1080/0144619042000202852

Cheng, M. Y., & Kang, S. T. (2012). Integrated fuzzy preference relations with decision utilities for construction contractor selection [Article]. Journal of the Chinese Institute of Engineers, Transactions of the Chinese Institute of Engineers,Series A/Chung-kuo Kung Ch'eng Hsuch K'an, 35(8), 1051-1063. doi:10.1080/02533839.2012.708510

Chiang, F.-Y., Vincent, F. Y., & Luarn, P. (2017). Construction contractor selection in Taiwan using AHP. International Journal of Engineering and Technology, 9(3), 211.

REFERENCES

Cooke, B., & Williams, P. (2013). Construction planning, programming and control: John Wiley & Sons.

Corbin, J., & Strauss, A. (2008). Basics of qualitative research: Techniques and procedures for developing grounded theory.

Creswell, J. W. (2013). Research design: Qualitative, quantitative, and mixed methods approaches: Sage publications.

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches: Sage publications.

Darvish, M., Yasaei, M., & Saeedi, A. (2009). Application of the graph theory and matrix methods to contractor ranking [Article]. International Journal of Project Management, 27(6), 610-619. doi:10.1016/j.ijproman.2008.10.004

Development, M. o. E. (2011). Mastering procurement.

Doloi, H. (2009). Analysis of pre-qualification criteria in contractor selection and their impacts on project success [Article]. Construction Management and Economics, 27(12), 1245-1263. doi:10.1080/01446190903394541

Durdyev, S., & Mbachu, J. (2011). On-site labour productivity of New Zealand construction industry: Key constraints and improvement measures. Construction Economics and Building, 11(3), 18-33.

Dworkin, S. L. (2012). Sample size policy for qualitative studies using in-depth interviews. Archives of sexual behavior, 1-2.

Egan, J. (1998). Rethinking construction: Department of Environment, Transport and the Region.

El-Abbasy, M. S., Zayed, T., Ahmed, M., Alzraiee, H., & Abouhamad, M. (2013). Contractor selection model for highway projects using integrated simulation and analytic network process [Article]. Journal of Construction Engineering and Management, 139(7), 755-767. doi:10.1061/(ASCE)CO.1943-7862.0000647

Ellis, T. J., & Levy, Y. (2010). A guide for novice researchers: Design and development research methods Symposium conducted at the meeting of the Proceedings of Informing Science & IT Education Conference (InSITE)

El-Sawalhi, N., Eaton, D., & Rustom, R. (2008). Forecasting contractor performance using a neural network and genetic algorithm in a pre-qualification model. Construction Innovation, 8(4), 280-298.

Elsayah, O. S. (2016). A Framework for Improvement of Contractor Selection Procedures on Major Construction Project in Libya. Edinburgh Napier University.

Emerson, R. W. (2015). Convenience sampling, random sampling, and snowball sampling: How does sampling affect the validity of research? Journal of Visual Impairment & Blindness (Online), 109(2), 164.

Emrouznejad, A., & Yang, G.-l. (2018). A survey and analysis of the first 40 years of scholarly literature in DEA: 1978–2016. Socio-Economic Planning Sciences, 61, 4-8.

Enshassi, A., Mohamed, S., & Modough, Z. (2013). Contractors' selection criteria: Opinions of Palestinian construction professionals [Article]. International Journal of Construction Management, 13(1), 19-37. doi:10.1080/15623599.2013.10773203

Enyinda, C. I., Ogbuehi, A. O., & Udo, G. (2011). A decision support model for contractor selection in a government procurement supply chain: Evidence from an emerging market. Journal of Management Policy and Practice, 12(7), 9.

Essays. (2013). Types Of Tenders And Tendering Process Construction. Retrieved from https://www.ukessays.com/essays/construction/types-of-tenders-and-tendering-process-construction-essay.php?vref=1

Fellows, R. F., & Liu, A. M. (2015). Research methods for construction: John Wiley & Sons.

Fong, P. S.-W., & Choi, S. K.-Y. (2000). Final contractor selection using the analytical hierarchy process. Construction Management and Economics, 18(5), 547-557.

George, D., & Mallery, P. (2016). Descriptive statistics. In IBM SPSS Statistics 23 Step by Step (pp. 126-134). Routledge.

Ghahramani, Z. (2015). Probabilistic machine learning and artificial intelligence. Nature, 521(7553), 452.

Gibson, R. (2010). New Zealand public transport procurement strategies in a new legislative environment. Research in transportation economics, 29(1), 159-163.

Gould, F. E., & Joyce, N. E. (2009). Construction project management: Prentice Hall.

REFERENCES

Government, N. (2011). Mastering procurement A structured approach to strategic procurement.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. Handbook of qualitative research, 2(163-194), 105

Guest, G., Bernard, H., & Gravlee, C. (2014). Sampling and selecting participants in field research. Handbook of methods in cultural anthropology. Rowman & Littlefield, Lanham, MD, USA, 215-249.

Hajek, J., Vrbova, L., & Kolis, K. (2017). Hierarchical structure of criteria used for contractor selection for construction works. Empirical research from the Czech Republic [Article]. International Journal of Procurement Management, 10(4), 444-460. doi:10.1504/IJPM.2017.085035

Hasanzadeh, S., Esmaeili, B., & Molenaar, K. (2015). Exploring the behavioral pattern of stakeholders in construction projects which used best-value selection.

Hasnain, M., Thaheem, M. J., & Ullah, F. (2017). Best Value Contractor Selection in Road Construction Projects: ANP-Based Decision Support System. International Journal of Civil Engineering, 1-20.

Hatush, Z., & Skitmore, M. (1997). Evaluating contractor prequalification data: selection criteria and project success factors. Construction Management and Economics, 15(2), 129-147.

Heale, R., & Twycross, A. (2015). Validity and reliability in quantitative studies. Evidence-based nursing, 18(3), 66-67.

Holt, G. (2010). Contractor selection innovation: examination of two decades' published research. Construction Innovation, 10(3), 304-328.

Holt, G. D. (1998). Which contractor selection methodology? International Journal of Project Management, 16(3), 153-164.

Hosny, O., Nassar, K., & Esmail, Y. (2013). Prequalification of Egyptian construction contractors using fuzzy-AHP models. Engineering, Construction and Architectural Management, 20(4), 381-405.

Hosseini Nasab, H., & Mirghani Ghamsarian, M. (2015). A fuzzy multiple-criteria decision-making model for contractor prequalification [Article]. Journal of Decision Systems, 24(4), 433-448. doi:10.1080/12460125.2015.1081048

Horn, E. J., Lobosco, S. J., Fox, K. M., Stevens, S. R., & Lebwohl, M. (2008). Psoriasis treatment patterns: results of a cross-sectional survey of dermatologists. Journal of the American Academy of Dermatology, 58(6), 964-969.

Jafari, A. (2013). A contractor pre-qualification model based on the quality function deployment method [Article]. Construction Management and Economics, 31(7), 746-760. doi:10.1080/01446193.2013.825045

Jaskowski, P., Biruk, S., & Bucon, R. (2010). Assessing contractor selection criteria weights with fuzzy AHP method application in group decision environment [Article]. Automation in Construction, 19(2), 120-126. doi:10.1016/j.autcon.2009.12.014

Jelodar, M. B., Yiu, T. W., & Wilkinson, S. (2016). Relationship-quality judgment model for construction project procurement: A conjoint measurement. Journal of Construction Engineering and Management, 142(7), 04016012.

Jöreskog, K. G., & Moustaki, I. (2001). Factor analysis of ordinal variables: A comparison of three approaches. Multivariate Behavioral Research,, 36(3), 347-387.

Juan, Y. K., Perng, Y. H., Castro-Lacouture, D., & Lu, K. S. (2009). Housing refurbishment contractors selection based on a hybrid fuzzy-QFD approach [Article]. Automation in Construction, 18(2), 139-144. doi:10.1016/j.autcon.2008.06.001

Juan, Y.-K., Perng, Y.-H., Castro-Lacouture, D., & Lu, K.-S. (2009). Housing refurbishment contractors selection based on a hybrid fuzzy-QFD approach. Automation in Construction, 18(2), 139-144.

Kashiwagi, D., & Byfield, R. E. (2002). Selecting the best contractor to get performance: On time, on budget, meeting quality expectations. Journal of Facilities Management, 1(2), 103-116.

Kline, R. B. (2015). Principles and practice of structural equation modeling. Guilford publications.

Kog, F., & Yaman, H. (2016). A multi-agent systems-based contractor pre-qualification model [Article]. Engineering, Construction and Architectural Management, 23(6), 709-726. doi:10.1108/ECAM-01-2016-0013

REFERENCES

Knapp, H. (2018). Intermediate statistics using spss. SAGE Publications.

Ksiazek, M., & Ciechowicz, P. (2016). Selection of the General Contractor Using the AHP Method [Article]. Archives of Civil Engineering, 62(3), 105-116. doi:10.1515/ace-2015-0086

Książek, M., & Ciechowicz, P. (2016). Selection of the general contractor using the AHP method. Archives of Civil Engineering, 62(3), 105-116.

Kumar, R. (2019). Research methodology: A step-by-step guide for beginners: Sage Publications Limited.

Lam, K. C., Palaneeswaran, E., & Yu, C. y. (2009). A support vector machine model for contractor prequalification [Article]. Automation in Construction, 18(3), 321-329. doi:10.1016/j.autcon.2008.09.007

Lam, K. C., Palaneeswaran, E., & Yu, C.-y. (2009). A support vector machine model for contractor prequalification. Automation in Construction, 18(3), 321-329.

Larson, E. W., & Gray, C. F. (2011). Project management: The managerial process.

Latham, M. (1994). Constructing the team: final report of the government/industry review of procurement and contractual arrangements in the UK construction industry: Hmso, London.

Leech, N., Barrett, K., & Morgan, G. A. (2013). SPSS for intermediate statistics: Use and interpretation. Routledge.

Lesniak, A., Plebankiewicz, E., & Zima, K. (2012). Design and build procurement system - Contractor selection [Article]. Archives of Civil Engineering, 58(4), 463-476. doi:10.2478/v.10169-012-0025-9

Li, Y., Chen, S., & Nie, X. (2005). Fuzzy pattern recognition approach to construction contractor selection [Article]. Fuzzy Optimization and Decision Making, 4(2), 103-118. doi:10.1007/s10700-004-5867-4

Lilliefors, H. W. (1967). On the Kolmogorov-Smirnov test for normality with mean and variance unknown. Journal of the American statistical Association, 62(318), 399-402.

Liu, B., Huo, T., Liao, P., Gong, J., & Xue, B. (2015). A group decision-making aggregation model for contractor selection in large scale construction projects based on two-stage partial least squares (PLS) path modeling. Group Decision and Negotiation, 24(5), 855-883.

Liu, T., & Wilkinson, S. (2011). Adopting innovative procurement techniques: Obstacles and drivers for adopting public private partnerships in New Zealand. Construction Innovation, 11(4), 452-469.

Lobo, Y. B., & Wilkinson, S. (2008). New approaches to solving the skills shortages in the New Zealand construction industry. Engineering, Construction and Architectural Management, 15(1), 42-53.

Lubke, G. H., & Muthén, B. O. (2004). Applying multigroup confirmatory factor models for continuous outcomes to Likert scale data complicates meaningful group comparisons. Structural equation modeling, 11(4), 514-534.

Martin, H., Koylass, J., & Welch, F. (2018). An exploration of the consistency limits of the analytical hierarchy process and its impact on contractor selection. International Journal of Construction Management, 18(1), 14-25.

Marzouk, M. (2008). A superiority and inferiority ranking model for contractor selection [Article]. Construction Innovation, 8(4), 250-268. doi:10.1108/14714170810912644

Masterman, J. (2003). An introduction to building procurement systems: Routledge.

MBIE. New Zealand Manufacturing Sector Report 2018. doi:ISBN 978-1-98-853509-8 (online)

McGovern, A., Elmore, K. L., Gagne, D. J., Haupt, S. E., Karstens, C. D., Lagerquist, R., . . . Williams, J. K. (2017). Using Artificial Intelligence to Improve Real-Time Decision-Making for High-Impact Weather. Bulletin of the American Meteorological Society, 98(10), 2073-2090.

Ministry of Business, I. E. (2015). Constructive Market Engagement.

Morledge, R., & Smith, A. J. (2013). Building procurement: John Wiley & Sons.

Nieto-Morote, A., & Ruz-Vila, F. (2012). A fuzzy multi-criteria decision-making model for construction contractor prequalification [Article]. Automation in Construction, 25, 8-19. doi:10.1016/j.autcon.2012.04.004

REFERENCES

Council, N. Z. C. I. (2004). Best practice procurement in construction and infrastructure in New Zealand.

Olaniran, O. J. (2015). The effects of cost-based contractor selection on construction project performance [Article]. Journal of Financial Management of Property and Construction, 20(3), 235-251. doi:10.1108/JFMPC-06-2014-0008

Page, I. (2009). Residential construction and costs Symposium conducted at the meeting of the Paper for CHRANZ Housing workshop After the Boom–Where to from here

Palaneeswaran, E., & Kumaraswamy, M. M. (2000). Contractor selection for design/build projects. Journal of Construction Engineering and Management, 126(5), 331-339.

Palaneeswaran, E., Kumaraswamy, M., & Ng, T. (2003). Targeting optimum value in public sector projects through "best value"-focused contractor selection. Engineering, Construction and Architectural Management, 10(6), 418-431.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. Administration and Policy in Mental Health and Mental Health Services Research, 42(5), 533-544.

Pan, N.-F. (2008). Fuzzy AHP approach for selecting the suitable bridge construction method. Automation in Construction, 17(8), 958-965.

Plebankiewicz, E. (2010). Construction contractor prequalification from Polish clients' perspective. Journal of Civil Engineering and Management, 16(1), 57-64.

Plebankiewicz, E. (2010). Construction contractor prequalification from polish clients' perspective [Article]. Journal of Civil Engineering and Management, 16(1), 57-64. doi:10.3846/jcem.2010.05

Plebankiewicz, E. (2014). Modelling decision-making processes in bidding procedures with the use of the fuzzy sets theory [Article]. International Journal of Strategic Property Management, 18(3), 307-316. doi:10.3846/1648715X.2014.943332

Power, D. J., Sharda, R., & Burstein, F. (2015). Decision support systems: Wiley Online Library.

Rajeh, M. A., Tookey, J. E., & Rotimi, J. O. B. (2015). Developing a procurement path determination chart SEM-based approach. Construction Management and Economics, 33(11-12), 921-941.

Ramezani-Tarkhorani, S., Khodabakhshi, M., Mehrabian, S., & Nuri-Bahmani, F. (2014). Ranking decision-making units using common weights in DEA. Applied Mathematical Modelling, 38(15-16), 3890-3896.

Rashvand, P., Abd Majid, M. Z., Baniahmadi, M., & Ghavamirad, F. (2015). Contractor selection at prequalification stage: Current evaluation and shortcomings [Article]. Jurnal Teknologi, 77(16), 81-89. doi:10.11113/jt.v77.6403

Rashvand, P., Majid, M. Z. A., & Pinto, J. K. (2015). Contractor management performance evaluation model at prequalification stage [Article]. Expert Systems with Applications, 42(12), 5087-5101. doi:10.1016/j.eswa.2015.02.043

Saaty, T. L. (1978). Modeling unstructured decision problems—the theory of analytical hierarchies. Mathematics and computers in simulation, 20(3), 147-158.

Safa, M., Shahi, A., Haas, C. T., Fiander-McCann, D., Safa, M., Hipel, K., & MacGillivray, S. (2015). Competitive intelligence (CI) for evaluation of construction contractors [Article]. Automation in Construction, 59, 149-157. doi:10.1016/j.autcon.2015.02.009

San Cristóbal, J. R. (2012). Contractor selection using multicriteria decision-making methods [Article]. Journal of Construction Engineering and Management, 138(6), 751-758. doi:10.1061/(ASCE)CO.1943-7862.0000488

Saunders, M. N. (2011). Research methods for business students, 5/e. Pearson Education India.

Semaan, N., & Salem, M. (2017). A deterministic contractor selection decision support system for competitive bidding [Article]. Engineering, Construction and Architectural Management, 24(1), 61-77. doi:10.1108/ECAM-06-2015-0094

Shukery, N. M., Amirudin, R., & Sofield, T. (2016). Level of importance of performance-based tender evaluation indicators [Article]. Indian Journal of Science and Technology, 9(34). doi:10.17485/ijst/2016/v9i34/100842

Silver, C., & Lewins, A. (2014). Using software in qualitative research: A step-by-step guide: Sage.

REFERENCES

Singh, D., & Tiong, R. L. K. (2005). A fuzzy decision framework for contractor selection [Article]. Journal of Construction Engineering and Management, 131(1), 62-70. doi:10.1061/(ASCE)0733-9364(2005)131:1(62)

Singh, D., & Tiong, R. L. K. (2006). Contractor selection criteria: Investigation of opinions of Singapore construction practitioners [Review]. Journal of Construction Engineering and Management, 132(9), 998-1008. doi:10.1061/(ASCE)0733-9364(2006)132:9(998)

SÖNmez, M., Yang, J. B., & Holt, G. D. (2001). Addressing the contractor selection problem using an evidential reasoning approach [Review]. Engineering, Construction and Architectural Management, 8(3), 198-210. doi:10.1108/eb021182

Sönmez, M., Yang, J., & Holt, G. D. (2001a). Addressing the contractor selection problem using an evidential reasoning approach. Engineering Construction and Architectural Management, 8(3), 198-210.

Sönmez, M., Yang, J., & Holt, G. D. (2001b). Addressing the contractor selection problem using an evidential reasoning approach. Engineering, Construction and Architectural Management, 8(3), 198-210.

Treiman, D. J. (2014). Quantitative data analysis: Doing social research to test ideas: John Wiley & Sons.

Tshilidzi, M. (2015). Causality, correlation and artificial intelligence for rational decision making: World Scientific.

Vahdani, B., Mousavi, S. M., Hashemi, H., Mousakhani, M., & Tavakkoli-Moghaddam, R. (2013). A new compromise solution method for fuzzy group decision-making problems with an application to the contractor selection [Article]. Engineering Applications of Artificial Intelligence, 26(2), 779-788. doi:10.1016/j.engappai.2012.11.005

Waara, F., & Bröchner, J. (2006). Price and nonprice criteria for contractor selection [Article]. Journal of Construction Engineering and Management, 132(8), 797-804. doi:10.1061/(ASCE)0733-9364(2006)132:8(797)

Walraven, A., & de Vries, B. (2009). From demand driven contractor selection towards value driven contractor selection [Article]. Construction Management and Economics, 27(6), 597-604. doi:10.1080/01446190902933356

Wang, W.-C., Yu, W.-d., Yang, I.-T., Lin, C.-C., Lee, M.-T., & Cheng, Y.-Y. (2013). Applying the AHP to support the best-value contractor selection–lessons learned from two case studies in Taiwan. Journal of Civil Engineering and Management, 19(1), 24-36.

Watt, D. J., Kayis, B., & Willey, K. (2009). Identifying key factors in the evaluation of tenders for projects and services [Article]. International Journal of Project Management, 27(3), 250-260. doi:10.1016/j.ijproman.2008.03.002

Watt, D. J., Kayis, B., & Willey, K. (2010). The relative importance of tender evaluation and contractor selection criteria [Article]. International Journal of Project Management, 28(1), 51-60. doi:10.1016/j.ijproman.2009.04.003

Wong, C. H., Holt, G. D., & Harris, P. (2001). Multi-criteria selection or lowest price? Investigation of UK construction clients' tender evaluation preferences [Review]. Engineering, Construction and Architectural Management, 8(4), 257-271. doi:10.1108/eb021187

Yang, J. B., Wang, H. H., Wang, W. C., & Ma, S. M. (2016). Using data envelopment analysis to support best-value contractor selection [Article]. Journal of Civil Engineering and Management, 22(2), 199-209. doi:10.3846/13923730.2014.897984

Yoon, K. P., & Hwang, C.-L. (1995). Multiple attribute decision making: an introduction (Vol. 104): Sage publications.

Yu, W. D., & Wang, K. W. (2012). Best value or lowest bid? A quantitative perspective [Article]. Journal of Construction Engineering and Management, 138(1), 128-134. doi:10.1061/(ASCE)CO.1943-7862.0000414

Zavadskas, E. K., Turskis, Z., & Tamošaitiene, J. (2008). Contractor selection of construction in a competitive environment [Article]. Journal of Business Economics and Management, 9(3), 181-187. doi:10.3846/1611-1699.2008.9.181-187

Zavadskas, E. K., Vilutiene, T., Turskis, Z., & Tamosaitiene, J. (2010). Contractor selection for construction works by applying saw-g and topsis grey techniques [Article]. Journal of Business Economics and Management, 11(1), 34-55. doi:10.3846/jbem.2010.03

10. APPENDIX - 1

Auckland University of Technology Ethics Committee (AUTEC)

Auckland University of Technology
D-88, Private Bag 92006, Auckland 1142, NZ
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

5 June 2018

John Tookey
Faculty of Design and Creative Technologies

Dear John

Re Ethics Application: **18/152 Reengineering Contractor Selection (CS) processes for improved performance of New Zealand construction sector**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 5 June 2021.

Standard Conditions of Approval

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. You are reminded that it is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

For any enquiries, please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: msoltani@aut.ac.nz; Fei Ying

11. APPENDIX – 2 (A)

Consent Form (Semi-Structured Interviews)

Consent Form

For use when interviews are involved.

Project title: **Reengineering Contractor Selection (CS) processes for improved performance of New Zealand construction sector**

Project Supervisor: ***Prof. John Tookey***

Researcher: ***Mehrdad Soltanifar***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated dd mmmm yyyy.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I agree to take part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

Participant's signature: .....

Participant's name: .....

Participant's Contact Details (if appropriate):

.....

.....

.....

.....

Date:

Approved by the Auckland University of Technology Ethics Committee on type the date on which the final approval was granted AUTEC Reference number type the AUTEC reference number

Note: The Participant should retain a copy of this form.

12. APPENDIX - 2 (B)

Participant Information Sheet

For Interview

Date Information Sheet Produced:

12/02/2018

Project Title

Reengineering Contractor Selection (CS) processes for improved performance of New Zealand construction sector

An Invitation

Dear [insert name]

You received this document [email] as I would like to invite you to participate in an in-depth interview.

I currently work as a PhD researcher at School of Engineering, Computer and Mathematical Sciences, Built Environment Engineering Department, Auckland University of Technology. My supervisors are Prof John Tookey and Dr Fei Ying.

My research study aims to improve Contractor Selection (CS) procedures in New Zealand construction. The outcome of this research is to provide a comprehensive framework to transfer industry from traditional approaches to modern selection methods. It is hoped that eventually, both clients and consumers of the construction industry will benefit from this development. Clients and stakeholders will achieve better value for money and New Zealand residents will experience more satisfaction from their homes. Moreover, by clarifying the potential areas for improvement of selection procedures, the government can consider this information to improve their "Request for Proposal" (RFP) and tender evaluation protocols.

I would highly value your contribution but please do not oblige to participate. Your participation will be anonymised in my research results and will be organised as efficient as possible. Please note that this is voluntary and may withdraw at any time before completing the data collection. If there is any conflict of interest at any point of time, you are able to choose whether to proceed with the research or not, your decision will neither advantage you nor disadvantage you.

Looking forward to hearing from you.

Best regards,

Mehrdad Soltanifar

PhD research candidate

What is the purpose of this research?

Objectives of this research are four-fold:

To find advantages and disadvantages of CS methods, establish a universal set of Price/Non-Price Attributes and identify their priorities.

Identify potential areas for improvement of tender evaluation procedures in New Zealand.

Demonstrate solutions to transfer from traditional iron triangle criteria of time, cost and quality to modern industrial principles.

Develop a framework for CS that satisfy the requirements of New Zealand construction industry.

A summary of my intermediate research findings (hard copies and soft copies) could be sent to you in case you request for it.

How was I identified and why am I being invited to participate in this research?

You will have responded to the email sent by the researcher or by CCNZ /PrefabNZ/IPENZ/ACENZ/ADNZ/DINZ/NZIA or through one of your colleagues in your professional network were identified through your interest in the advertisement that was displayed on the CCNZ /PrefabNZ/IPENZ/ACENZ/ADNZ/DINZ/NZIA website. You have been identified as you fit the criteria of the research which is a client/contractor/civil engineer/architects/project manager involved in contractor selection procedure in New Zealand for at least 5 years for the interviews.

How do I agree to participate in this research?

If you choose to participate in the study, then you would need to sign a consent form stating that you have accepted to participate. You will be sent a consent form at the same time as I send you this information sheet. You will have the opportunity to ask any further questions before you sign the consent form and commence the interview.

Your participation in this research is voluntary and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time before data collection is completed. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

This project involves a researcher conducting a face to face interviews with you if you are in Auckland. Interviews can be in a mutually agreed public place, your work office or an office at AUT. If you are outside of Auckland we will interview you by phone. It is expected that interviews will last between 45 and 60 minutes and I will record the interviews.

What are the discomforts and risks?

It's very unlikely that you will experience any discomfort. If you do not feel comfortable answering a question you are not obliged to answer it.

How will these discomforts and risks be alleviated?

You have the right to refuse to answer any question you feel that you are not comfortable answering. You also have the option of withdrawing from the interview at any time within the data collection process.

What are the benefits?

For you: The results from the research could assist you in increasing the efficiency of decision making in tender evaluation procedures. The summary of the research results could be sent to you so that you could have deep insights about the current practices and developed framework for tender evaluation in New Zealand.

For the researcher: The study will be a qualification for my PhD degree. I also have a deep knowledge in improving construction CS procedures and benchmarking modern selection methods.

For the wider community: It is hoped that eventually, both clients and consumers of the construction industry will benefit from this development. Clients and stakeholders will achieve better value for money and New Zealand residents will experience more satisfaction from their homes.

The researchers will benefit from the project through completion of a Doctor thesis and academic journal article publications. You are able to get a chance to be able to contribute to the body of knowledge with your experience in your career development in the construction industry and may benefit from the resulting guidelines.

How will my privacy be protected?

The main issue that needs to be addressed is confidentiality. The research team can assure you that your identity will only be used to give you information on our project. This information will be only accessible to the researchers. The research findings will not disclose any personal information that could identify the participant or their organisation.

What are the costs of participating in this research?

You will contribute your time and your experience in this research. It is expected that the interview will last from 45-60 minutes.

What opportunity do I have to consider this invitation?

You will be given two weeks to consider this invitation.

Will I receive feedback on the results of this research?

You are able to receive feedback on the results of this research, and this will be obtained in the journal article upon your request of this document to which you can get an electronic copy of the journal article.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the

Project Supervisor: *Professor John Tookey,* ***Phone:*** *+64 9 921 9999 ext 9512,* ***Email:*** *john.tookey@aut.ac.nz*

Thesis supervisor: *Mehrdad Soltanifar, msoltani@aut.ac.nz, +64 020 412 49777*

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz*, 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Mehrdad Soltanifar, msoltani@aut.ac.nz, +64 020 412 49777

Project Supervisor Contact Details:

Professor John Tookey, ***Phone:*** *+64 9 921 9999 ext 9512,* ***Email:*** *john.tookey@aut.ac.nz*

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

13. APPENDIX – 2 (C)

Indicative Questions (Semi-Structured Interviews)

Demographics: • Could you please describe your current role in the industry? • How many years of working experience do you have in construction industry? • How many years of working experience do you have related to construction tender evaluation? • What is your education level?
1. Could you please tell me what is Contractor Selection (CS) in your opinion? 2. What major changes do you perceive in New Zealand's CS procedures during the past years?
3. Please, could you describe to me, what are the main differences of CS procedures between public projects and private projects in NZ?
4. How would you describe the current standard pre-tender processes (invitation to tender, tendering strategies, important clients)? 5. Is there a link between different procurement strategies and different tendering strategies? Can you give me an example?
6. What are your suggestions to improve pre-tender procedures?
7. Could you please tell me, how many projects have you been involved in that used CS methods before awarding the contract? 8. Have you ever encountered a situation where after awarding the contract, DMs regret that it would be better to use another CS method or considering another criterion? Which method/criterion? 9. From your previous experience, what were the main reasons for post-contract claims from NZ contractors?
10. Could you please tell me what are the current CS methods that NZ public clients use? 11. What are the current CS methods that NZ private clients use? 12. What are the strength and weakness of each method? 13. What improvements have been made?
14. Some clients might say that they are satisfied with the current CS procedures and it does not need any improvements. Do you think it is true? Why? 15. In your opinion, what are the best CS methods in the world that can be benchmarked in NZ?
16. What are the current main criteria that NZ public clients use in their projects? 17. What are the current main criteria that NZ private clients use in their projects?

After demonstrating our list of criteria from the literature ask them to identify 18. The level of importance of each criterion and The level of achievement of NZ in each criterion
19. Have you ever participated in a project that Decision Makers (DMs) considered modern construction principles such as BIM/Sustainability/Supply Chain in their CS? 20. Do you think these modern principles should be considered? 21. Any other Criteria you think should be added?
22. Do you think clients and DMs have an adequate understanding of the importance of CS in NZ? 23. How can their awareness be raised?
24. Do you think a standard CS framework can improve NZ construction? 25. How will CS improvement affect NZ construction?
26. Please could you describe to me, what would be the challenges of introducing a new framework? 27. What would be the solutions to mitigate those challenges? 28. What can be done to educate DMs about a new framework?
Thank you so much for answering all these questions. It has been really helpful. Before we end, I was just wondering if there were any other areas…

14. APPENDIX – 3

Reengineering Contractor Selection (CS) processes for improved performance of the New Zealand construction sector

Consent to Participate:
Dear Participant,
You are about to participate in a survey which is a part of research undertaken at AUT University. The primary objective of this research is to develop an empirical understanding of the critical factors influencing the Public Tender Evaluation procedures in New Zealand. Your participation in this survey is voluntary and your responses will be kept strictly confidential. By completing this questionnaire, you are indicating your consent to participate in this research.

There are only two pages after this. It will take you not more than **15 minutes** to complete the survey. Your kind cooperation is highly appreciated.

Any inquiries regarding this survey please contact
Researcher
Name: Mehrdad Soltanifar
Email: msoltani@aut.ac.nz

Research supervisors
Name: Professor John E. Tookey
Email: john.tookey@aut.ac.nz
Phone: +64 9 921 9999 ext 9512

Name: Dr Fei Ying
Email: fei.ying@aut.ac.nz
Phone: +64 921 9999 ext. 6635

The survey is completed anonymously, and all reasonable steps will be taken to ensure confidentiality. The participant is not identified. The research team can assure you that your identity will never be known if you choose to complete the online survey. The data you provided will be treated as confidential and used for the purpose of this research only. The research findings will not disclose any personal information that could identify you or your organisation. You will not be able to be identified by anything that is written in the text of the research paper.

STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY
I've read and understand this informed document, all my questions have been answered, and I freely and voluntarily choose to participate in this study.

- ○ Yes, I consent.
- ○ No, I do not consent.

Part 1. Background Information

1) What is your current role in the construction sector?

- ○ Client
- ○ Architect
- ○ Consultant
- ○ Contractor
- ○ Quantity Surveyor
- ○ Subcontractor
- ○ Others (Please specify)

2) How many years have you worked in New Zealand construction industry?

- ○ 0
- ○ 1-5
- ○ 6-19
- ○ 20+

3) How many years have you worked in New Zealand construction industry related to tenders and tender evaluation procedures?

- ○ 0
- ○ 1-5
- ○ 6-19
- ○ 20+

4) What is the highest education degree you have received?

- ○ Doctoral Degree
- ○ Master's Degree
- ○ Bachelor Honours Degree
- ○ Bachelor's Degree
- ○ High school Diploma
- ○ Others (Please specify)

5) What type of projects have you mostly been involved in during the past 5 years?

- ○ Tier 1
- ○ Tier 2
- ○ Tier 3
- ○ Others (Please specify)

1) In your opinion, what would be the level of importance and the level of achievement of these criteria in New Zealand public **Tier 1** projects?

	Level of Importance				Level of Achievement			
	Not Important 1	Low Important 2	Important 3	Very Important 4	Not Acceptable 1	Slightly Unacceptable 2	Slightly Acceptable 3	Perfectly Acceptable 4
Organization and Relevant experience	○	○	○	○	○	○	○	○
Financial Viability	○	○	○	○	○	○	○	○
Appreciation of the task	○	○	○	○	○	○	○	○
Past performance and Track records	○	○	○	○	○	○	○	○
Management systems and skills	○	○	○	○	○	○	○	○
Technical skills	○	○	○	○	○	○	○	○
Resources/ Workload capacity	○	○	○	○	○	○	○	○
Methodology	○	○	○	○	○	○	○	○
Price	○	○	○	○	○	○	○	○
Reputation	○	○	○	○	○	○	○	○
SME location and geographical familiarities	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○
Client-Contractor relations	○	○	○	○	○	○	○	○
Sustainability and Environment	○	○	○	○	○	○	○	○
Risk Management	○	○	○	○	○	○	○	○
Key Partners	○	○	○	○	○	○	○	○
Innovation	○	○	○	○	○	○	○	○
Materials	○	○	○	○	○	○	○	○
BIM experience	○	○	○	○	○	○	○	○
Supply Chain Management	○	○	○	○	○	○	○	○

2) In your opinion, what would be the level of importance and the level of achievement of these criteria in New Zealand public **Tier 2** and **Tier 3** projects?

	Level of Importance				Level of Achievement			
	Not Important 1	Low Important 2	Important 3	Very Important 4	Not Acceptable 1	Slightly Unacceptable 2	Slightly Acceptable 3	Perfectly Acceptable 4
Organization and Relevant experience	○	○	○	○	○	○	○	○
Financial Viability	○	○	○	○	○	○	○	○
Appreciation of the task	○	○	○	○	○	○	○	○
Past performance and Track records	○	○	○	○	○	○	○	○
Management systems and skills	○	○	○	○	○	○	○	○
Technical skills	○	○	○	○	○	○	○	○
Resources/ Workload capacity	○	○	○	○	○	○	○	○
Methodology	○	○	○	○	○	○	○	○
Price	○	○	○	○	○	○	○	○
Reputation	○	○	○	○	○	○	○	○
SME location and geographical familiarities	○	○	○	○	○	○	○	○
Health and Safety	○	○	○	○	○	○	○	○
Client-Contractor relations	○	○	○	○	○	○	○	○
Sustainability and Environment	○	○	○	○	○	○	○	○
Risk Management	○	○	○	○	○	○	○	○
Key Partners	○	○	○	○	○	○	○	○
Innovation	○	○	○	○	○	○	○	○
Materials	○	○	○	○	○	○	○	○
BIM experience	○	○	○	○	○	○	○	○
Supply Chain Management	○	○	○	○	○	○	○	○

15. APPENDIX - 4

Participant Information Sheet

For Interviews

Date Information Sheet Produced:

18/10/2018

Project Title

Reengineering Contractor Selection (CS) processes for improved performance of New Zealand construction sector

What is the purpose of this research?

This study is aimed to design a framework for selecting the most appropriate construction contractor. The researcher of this study is Mehrdad Soltanifar. He is a PhD candidate in construction engineering at AUT. He has more than 5 years of experience in project management, quality control and designing excellence models. The primary supervisor of this project is Prof. John Tookey. He is an experienced construction industry professional and director of the centre for Urban Built Environment in New Zealand (CUBE-NZ). The second supervisor of this project is Dr. Fei Ying. She is a qualified member of Institution of Professional Engineers of New Zealand (IPENZ) and has years of experience as a construction industry practitioner.

Since, this framework is specifically designed based on the New Zealand's construction characteristics, it can be used as a guideline to help clients improve their tender procedures to select local and international contractors in general construction projects such as buildings, hospitals, infrastructures, etc. Moreover, by clarifying the potential areas for improvement, the government can consider this information to improve their "Request for Proposal" (RFP) and tender evaluation protocols. Objectives of this research are four-fold:

- ***To find advantages and disadvantages of CS methods, establish a universal set of Price/Non-Price Attributes and identify their priorities.***
- ***Identify potential areas for improvement of tender evaluation procedures in New Zealand.***
- ***Demonstrate solutions to transfer from traditional criteria to modern industrial principles.***
- ***Develop a framework for CS that satisfy the requirements of New Zealand construction industry.***

A summary of my intermediate research findings (hard copies and soft copies) could be sent to you in case you request for it.

In order to obtain your views, I would like to invite you to participate in our research by attending our interview session. The interview session takes approximately two hour. In the session, our research results and proposed framework will be illustrated to you and you will be asked to express your views on validity and applicability of the results in the New Zealand construction sector.

The information provided by you in the interview will be anonymous and used only for the research purpose. The information provided will not be utilised in a manner that would identify your individual responses. If there is any conflict of interest at any point in time, you are able to choose whether to proceed with the research or not; your decision will neither advantage you nor disadvantage you.

The study has been considered by the Ethics Committee of Auckland University of Technology and has been given favourable review.

How was I identified and why am I being invited to participate in this research?

You have been identified as you fit the criteria of the research which is a client/contractor/civil engineer/architects/project manager involved in contractor selection procedure in New Zealand for at least 5 years for the interview.

How do I agree to participate in this research?

By participating in the interview session and signing our consent form.

Your participation in this research is completely voluntary and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time before the completion of interview session.

What will happen in this research?

The research results and overall framework will be demonstrated to you in a session and you will be asked to express your opinions on applicability and validity of the findings.

What are the discomforts and risks?

It's very unlikely that you will experience any discomfort. If you do not feel comfortable answering a question you are not obliged to answer it.

How will these discomforts and risks be alleviated?

You have the right to refuse to answer any question you feel that you are not comfortable answering. You also have the option of withdrawing from the interview at any time within the data collection process.

What are the benefits?

For you: The results from the research could assist you in increasing the efficiency of decision making in tender evaluation procedures. The summary of the research results could be sent to you so that you could have deep insights about the current practices and developed framework for tender evaluation in New Zealand.

For the researcher: The study will be submitted as a thesis for Mehrdad Soltanifar (only) in fulfilment of the requirement for the degree of PhD.

For the wider community: It is hoped that eventually, both clients and consumers of the construction industry will benefit from this development. Clients and stakeholders will achieve better value for money and New Zealand residents will experience more satisfaction from their homes.

The researchers will benefit from the project through completion of a Doctoral thesis and academic journal article publications. You are able to get a chance to be able to contribute to the body of knowledge with your experience in your career development in the construction industry and may benefit from the resulting guidelines.

How will my privacy be protected?

The research team can assure you that your identity will never be known if you choose to participate in the interview session. The data you provided will be treated as confidential and used for the purpose of this research only. The research findings will not disclose any personal information that could identify you or your organisation. You will not be able to be identified by anything that is written in the text of the research paper.

What are the costs of participating in this research?

You will contribute your time and your experience in this research. It is expected that the interview will take 1 hour.

What opportunity do I have to consider this invitation?

You will be given two weeks to consider this invitation.

Will I receive feedback on the results of this research?

You are able to receive feedback on the results of this research, and this will be obtained in the journal article upon your request of this document to which you can get an electronic copy of the journal article.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the

Project Supervisor: *Professor John Tookey,* ***Phone:*** *+64 9 921 9999 ext 9512,* ***Email:*** *john.tookey@aut.ac.nz*

Thesis supervisor: *Mehrdad Soltanifar, msoltani@aut.ac.nz, +64 020 412 49777*

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz*, 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Mehrdad Soltanifar, msoltani@aut.ac.nz, +64 020 412 49777

Project Supervisor Contact Details:

Professor John Tookey, ***Phone:*** *+64 9 921 9999 ext 9512,* ***Email:*** *john.tookey@aut.ac.nz*

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

16. APPENDIX – 5

Consent Form

For use when interviews are involved.

Project title: **Reengineering Contractor Selection (CS) processes for improved performance of New Zealand construction sector**

Project Supervisor: ***Prof. John Tookey***

Researcher: ***Mehrdad Soltanifar***

○ I have read and understood the information provided about this research project in the Information Sheet dated dd mmmm yyyy.

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.

○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.

○ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.

○ I agree to take part in this research.

○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

Participant's signature: .....

Participant's name: .....

Participant's Contact Details (if appropriate):

.....

.....

.....

.....

Date:

Approved by the Auckland University of Technology Ethics Committee on type the date on which the final approval was granted AUTEC Reference number type the AUTEC reference number

Note: The Participant should retain a copy of this form.