Comparative Analysis of Construction Procurement Systems Based on Transaction Costs

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of a university or other institution of higher learning, except where due acknowledgement is made in the acknowledgements.

Author's Signature Date

Dedication

To my late father, beloved mother, sisters, and my dear family

Acknowledgment

I am grateful to my supervisors for their help and support throughout this research. I would like to thank Professor John Tookey for making this project possible and for providing me with support and encouragement. John, your positive attitude and patience have been a tremendous help. Also, your suggestions in the practical aspects of my research were invaluable. Additionally, I would like to express my sincere thanks to my second supervisor Dr. James Rotimi. James, your support and thoughtful feedback was an immense help to the research. Your suggestions and editing have been very important in the structure of this thesis.

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Ethics Approval

The research undertaken here has received approval by the Auckland University of Technology Ethics Committee (AUTEC). Such approval was granted on 22 March 2013 under Ethics Application Number 13/33. For a study titled ' Impact of Procurement System on Transaction Cost Economics: Future Organizational Structure in the Construction Industry'.

Abstract

Within construction procurement, Transaction cost economics (TCE), offers a mechanism to understand 'unseen' costs associated with the pre and post-contract work. Pre-contract, these include costs related to information gathering and procurement. Post-contract they include activities of contract administration and enforcement.

This research investigates the relationship between procurement system and transaction costs (TCs) in the New Zealand construction industry, developing a theoretical model of relationship between procurement systems and TC. The model was operationalized and developed into a questionnaire. A cross-sectional sample approach was deployed, involving questionnaire survey, interviews, and research verification through 'real world' cases. Data was sought from professionals in management, design and operations (i.e. project managers, architects, engineers, quantity surveyors, and procurement officers). These professionals represented several construction organizations and NZ Councils (Auckland, Hamilton, Wellington, Christchurch, Dunedin). TCs were measured using time-spent conducting procurement related activities as a surrogate for cost. Professionals evaluated their time spent on procurement activities using a 5-point Likert scale, comparing the Traditional and Design-Build delivery systems.

96 responses (74 usable) were received from a sampled population of 360 (27% response). This data was triangulated with interviews to test and explain the model. The tests included Validity and Reliability Tests, Path Analysis, Regression Analysis, Factor Analysis, and Structural Equation Modeling (SEM). The primary analytical technique used was Structural Equation Modelling to yield information on Goodness-of-Fit, model development and comparison, and confirmatory

strategies. SPSS Amos 21 statistical software was used for data analysis and model development.

The data demonstrated univariate and multivariate normality assumptions underlying SEM testing of research hypotheses. Of 43 hypotheses tested, six null hypotheses were rejected, demonstrating a positive relationship between the costs of information, procurement, administration, and enforcement with TCs. Additionally environmental uncertainties have indirect significant impact on TCs. The results suggest procurement systems have indirect impact on TCs, which is fully mediated by costs of information, procurement, administration, and enforcement. Finally, for research results verification, the models were applied to real-life cases (four Traditional, two Design-Build). TCs were calculated using regression equations based on factor loadings in the Traditional and Design-Build models. It was found that TCs in the Traditional system amounts to 18.5% of the annual salary cost of a project manager (as an indicator quantum), while in the Design-Build system, it amounts to 14.5% of the annual salary cost of a project manager.

This study applies a new theoretical model for procurement selection based on TCs, investigating and empirically demonstrating the influence of procurement system on TCs in construction. It also offers a new plausible explanation for the factors influencing TCs in procurement. The findings have practical implications on construction business practice due to their robust empirical nature and theoretical framework, which might enhance the performance of the construction industry.

The study contributes to the procurement selection in construction, by introducing a new conceptual model for the link between procurement systems and TCs. It has extended the current practices for procurement selection by estimating TCs for different procurement systems, specifically for the Traditional and Design-Build systems for comparison.

This study emphasizes ‘in-house’ TCs from the perspective of the client, consequently the study recommends that the work be expanded to determine the ‘out-of-house’ TCs from the contractor perspective. Furthermore that to expand the relevance of the findings further work using the same methodology should be used to measure TCs for other procurement systems for comparison purposes. Finally, this study calculates TCs within projects, so it was recommended to further explore intra-organizational TCs in construction.

List of Publications

Conferences (Peer-Reviewed)

1. **Rajeh, M.**, Tookey, J., & Rotimi, J. (2013). Best procurement selection: development of a conceptual model based on transaction costs *Australasian Universities Building Education Association (AUBEA).* Symposium conducted at the meeting of the The 38th Australasian Universities Building Education Association, Faculty of Engineering, The University of Auckland, Auckland, New Zealand.

2. **Rajeh, M.**, Tookey, J., & Rotimi, J. (2013). Determining the magnitude of transaction costs in construction procurement systems: An exploratory study*World Building Congress.*

3. **Rajeh, M.** (2014). Impact of procurement systems on transaction costs: A structural equation modelling methodology. *Proceedings of the 4th New Zealand Built Environment Research Symposium (NZBERS).* Auckland, New Zealand. 14 November. ISSN 2324-1829

Journal Papers

1. **Rajeh, M. A.**, Tookey, J., & Rotimi, J. (2014). Procurement selection model: Development of a conceptual model based on transaction costs. *Australasian Journal of Construction Economics and Building – Conference Series, 2(2)*, 56-63.

2. **Rajeh, M. A.**, Tookey, J., & Rotimi, J. O. B. (2015). Estimating transaction costs in New Zealand procurement systems: A structural equation modelling methodology. *Engineering Construction and Architechural Management, 22(2)*, 242-267.

Glossary

AVE	Average Variance Explained
BOT	Build-Operate-Transfer
BOOT	Build-Own-Operate -Transfer
BRANZ	Building Research Advisory/New Zealand
CFA	Confirmatory Factor Analysis
CIOBNZ	Chartered Institution of Building/New Zealand
DB	Design-Build
EFA	Exploratory Factor Analysis
FA	Factor Analysis
IPENZ	Institute of Professional Engineers/New Zealand
MSA	Measure of Sampling Adequacy
Me	Mediation Effect
Mo	Moderation Effect
NZIA	New Zealand Institute of Architects
NZIOB	New Zealand Institute of Building
NZIQS	New Zealand Institute of Quantity Surveyors
PCA	Principal Components Analysis
PFI	Project Finance Initiative
PMINZ	Project Management Institute/New Zealand
PPP	Public-Private Partnership
QUAL	Qualitative

QUAN	Quantitative
RMBF	Registered Master Builders Federation
SEM	Structural Equation Modeling
TC	Transaction Cost
TCE	Transaction Cost Economics
TCT	Transaction Cost Theory

CHAPTER ONE

Introduction

1.0 Background

Transaction costs (TCs) are the price that market participants have to pay in order to reach an agreement, develop rules to implement this agreement, and establish the appropriate delivery systems as part of the agreement (Williamson, 1981). In the construction industry, TCs are mainly related to the information costs, procurement costs, administration costs, and safeguarding costs (Lynch, 1996; Rindfleisch & Heide, 1997; Williamson, 2010b; Li et al., 2013). These (i.e. TCs) can be seen as a waste of social resources and wealth (Wenan & Mengjun, 2010; Wenan & Tianhua, 2010), therefore, they are among the important factors that affect the construction projects' performance. So far, there have only been a few attempts to apply the transaction cost framework to the procurement selection in the construction industry. This is even more unknown within New Zealand's construction industry.

This study examines the relationship between procurement system and TCs, and determines its impact on TCs in the framework of New Zealand's construction industry. Three central issues are explored. First, what are transaction costs? Second, to what extent are the TCs in construction related to its procurement? Third, can a construction firm improve its procurement practices in New Zealand?

In addressing the first issue, a search for a robust conceptualization of TCs is required. Transaction costs might tentatively be associated with the professionals conducting procurement activities during the pre and post-contract phases. But is procurement activities described in terms of information search, negotiation and preparing bid documentation, contract administration, and contract enforcement? Evidently the definition of TCs in construction requires considerable thought and reflection.

The second issue lies in determining whether the TCs of a construction project relates to its procurement practices. Other affecting factors include uncertainties in the transaction environment and the importance of phases throughout the project lifecycle. An initial response from practitioners and academics might be that best practice procurement system is more likely to achieve superior project execution. Conversely, a project that is conducted in an uncertain environment might not be expected to execute smoothly. Owners and construction managers aim for their projects to be risk free because of uncertainties (external threats and internal opportunities) that may arise during the project execution (Cooper et al., 2005; Smith et al., 2013). The query is: To what extent procurement practice is risk free because of uncertainties in the transaction environment? Evidently including uncertainties (external and internal) in the procurement selection process needs to be considered.

Given that the most suitable procurement practice leads to improved productivity within construction, the third issue arises: Can a construction firm improve its procurement practices in New Zealand? Solely focusing on the design of formal procurement processes and procedures is not enough for cost savings, minimizing claims, and reducing conflict and dispute. There is a need to consider the interaction of uncertainties in the transaction environment, and the costs of information, procurement, contract administration, and contract enforcement.

There are relatively few studies that have attempted to apply the concept of TC across a wide range of construction centric topics. For example, Winch (2001) applied the concept of TC to evaluate the project organization and determine the appropriate governance structure. A study by Eccles (1981) used the TCs to evaluate construction market with a focus on sub-contracting. Lynch (1996) adopted TCs to determine the appropriate delivery systems for construction projects. A study conducted by Dudkin and Valila (2005) tried to measure and evaluate transaction costs in public private partnership projects (PPPs) in the U.K. Recently, a study conducted by Li et al. (2013) evaluated the project performance based on TCs.

The majority of these studies adopted different definitions of the TC concept, and focused on theoretical and qualitative aspects of the concept. Some researchers define TCs as contract cost while others call it procurement cost. Williamson (1985) in the organization theory (TCE) defines transaction costs to include the costs of drafting, negotiating, contract administration, and contract enforcement. However, some authors have suggested including other costs, for example the cost of acquiring information, legal costs, organizational costs (Joskow, 2002), and costs of breaching contractual agreements (Rahman & Kumaraswamy, 2002). In the context of a contractual arrangement TCE has traditionally examined the customer-supplier relationship. With the assumption, that this relationship is associated with TCs including costs of information, negotiation, competitive advantage, contract administration and management, market structure, enforcement and measuring/monitoring of performance (Heide & Stump, 1995; Artz, 1999; Melese & Franck, 2005).

In construction projects, Turner and Simister (2001) identified a different set of TCs throughout the project lifecycle such as specifying the product and the worked method in the tender documentation, managing variation to the project specification and process specification during project delivery. Moreover, Hughes et al. (2006) classified TCs in three project phases: - In the pre-tendering phase, mainly the costs of marketing and information search were included. In the tendering phase, it is the costs of bidding and negotiation. While in the post-tendering phase, it is the costs of dispute resolution, monitoring and control, and contract enforcement. Similarly, the study by Wittington (2008) included TCs from the costs of advertisement and bids preparation and award, to the cost of contract execution. Finally according to Lingard et al. (1998), one should distinguish between the pre and post-contract transaction costs. At the pre-contract phase it is the costs of information, communication, negotiation, bids documentation, and project preliminary design. While the post-contract phase includes the costs of dispute resolution, contract administration, and contract enforcement. Therefore, concepts related to transaction costs are inconsistent in definition and there is little agreement how the concept is constructed. This means inconsistency in data, and renders data analysis almost impossible (Farajian, 2010).

Throughout this research the term transaction cost refers to costs incurred because of construction professionals conducting procurement activities at the pre and post-contract stages. At the pre-contract stage, TCs include the costs of information search and project procurement, while at the post-contract stage TCs include the costs of contract administration and enforcement.

Procurement system has a significant impact on the associated transaction costs in the construction industry. The adopted procurement system may cause an increase in the cost of information, procurement, administration, and enforcement, which in turn increases TCs. The key sources of TCs are economic actors' behavioral assumptions (opportunistically and bounded rationality) and transaction characteristics; i.e. asset specificity, uncertainty, frequency, complexity, and contestability (Williamson, 1981). The opportunity costs because of renegotiation and delays in delivery may significantly undermine expected benefits of the project (Ho & Tsui, 2009). Similarly, outsourcing project activities could involve extra TCs such as negotiation, measuring, and monitoring costs because of opportunistic behavior of the actors involved (Frank et al., 2007).

More importantly transaction characteristics such as uncertainty affect the ability of contracting parties to fully define contingencies in the contract. Uncertainties in this study are external and internal factors of an organization that affects the success and performance of a project (Walker & Pryke, 2009; Jin & Zhang, 2011; Li et al., 2013). Political, legal, social, economical, technological and competition all refer to external environmental uncertainties. While corporate culture, project location, finance and ownership, and information systems all refer to internal environmental uncertainties (Ford & Slocum, 1977; Marcus, 2005; Grimm et al., 2006; Elliott et al., 2008; Foss & Foss, 2008). According to Li et al. (2012), the high level of uncertainty might force contractors to jack up their bids, file numerous claims, substantial extra work and rework, and antagonistic relationships with owners, which end up in dispute and conflict. Those in turn are more likely to increase TCs because of information incompleteness, the time-spent in contract documentation and negotiation, increased number of staff for contract administration and enforcement of the contract such as quality control etc.

Transaction costs minimization is constantly associated with the capability of contractual parties to fully define terms and conditions in the contractual agreements (Eccles, 1981a; Reve & Levitt, 1984; Winch, 1989; Bajari & Tadelis, 2001b; Aibinu et al., 2011). This results in better contractual agreements, enhances long-term strategic procurement approaches, improves cost estimation, and in defining the most feasible contractual approach under certain circumstances. This will help in improving the performance for construction projects. Construction projects are described as unique, complex, uncertain, and high-risk. In such an environment, questionable decisions on planning and design can be made in the pre-contract phase, and disagreements, change orders, claims, conflicts, and disputes can occur in the post-contract phase. In addition, because of the one-off production operation in construction, the procurement process has to begin from scratch every time the client purchases a good or service. These problems contribute to increase TCs in project procurement.

It is anticipated that reducing transaction costs may contribute to improved cost estimation of projects. Which could lead to an improvement of the procurement process through better contractual agreements, enhanced long-term strategic procurement approaches, improved cost estimation, and defining the most feasible contractual approach under certain circumstances. All of these factors combined will result in enhancing project performance in construction. However, measuring and evaluating TCs in construction projects is always difficult and often broad and subjective (Dudkin & Valila, 2005; Ho & Tsui, 2009; Solino & Gago de Santos, 2010).

Although, previous work on applying the TCs concept in construction provides useful information, but there have been only a few studies attempting to quantify

TCs in construction. There are very few studies that have explored links between TCs and procurement systems, and determining the impact of the adopted procurement system on the magnitude of transaction costs in construction. This research established through relevant literature a thorough compilation of the definition of client-borne TCs in project procurement by joining the views of previous researches, and an empirical study to find the impact of procurement systems on TCs. This study looks outside traditional construction practices to other fields of study especially organization theory. A better balance of best practices with insightful theories would benefit the construction industry. Also, the current research estimates client-borne TCs at the individual level of construction professionals conducting procurement activities, different from Dudkin and Valila (2005) in the UK (infrastructure projects) and Whittington (2008) in the US (infrastructure projects) who focused on costs incurred at the project level only. The research project is a unique study in New Zealand that quantifies TCs in construction procurement, and there has been no research before empirically estimate TCs of construction procurement.

1.1 Statement of the Problem

"Transaction cost economics is unknown, and the links between procurement systems and transaction costs is ambiguous in the New Zealand construction industry "

Build on this statement the following problems are addressed:

- There is a lack of understanding of transaction costs and their extent in New Zealand construction projects.
- There is a lack of understanding of the linkage between the procurement systems and transaction costs in New Zealand construction projects.

- There is a lack of understanding of the impact of procurement systems on the magnitude of transaction costs in New Zealand construction projects.
- There is a pressing need to improve New Zealand construction's productivity, which implies a reduction of input costs of which TCs are significant.

1.2 Research Aim and Objectives

Based on the research problem, the purpose of the study was to examine the relationship between procurement systems and transaction costs in the New Zealand construction industry.

Within the overall purpose, seven objectives were identified:

O1. Determine common transaction costs incurring at project procurement phase.

O2. Assess the extent to which transaction costs are influenced by the procurement systems.

O3. Investigate whether environmental uncertainties and project phases would interact to influence the client's procurement decision.

O4. Develop conceptual relationships between transaction costs, pre and post-contract costs, procurement systems, project phases, and environmental uncertainties.

O5. Construct a model that examines the links between transaction costs and procurement systems in construction.

O6. Estimate transaction costs for different procurement systems (Traditional and Design-Build) for the purpose of comparability, and applied the results to real life cases.

O7. Recommend methods of administering transaction costs in construction procurement in New Zealand.

1.3 Research Questions

There are two main questions raised in the current study:

R1. What is the link between transaction costs and procurement system in construction?

R2. How can transaction costs be minimized so that the productivity of the construction industry is enhanced in New Zealand?

However, the sub-questions raised in this research are:

Q1. What are common transaction costs in construction?

Q2. To what extent are transaction costs related to procurement in construction?

Q3. To what extent are transaction costs related to environmental uncertainties in construction?

Q4. Are there any links between procurement system and environmental uncertainties in construction?

Q5. How can the client's procurement selection procedures be improved in construction?

1.4 Justification for the Research

The construction industry is described as fragmented, uncertain, and complex. Risk is generated throughout the project lifecycle such as design and construction risk (Pryke, 2009). As a result, traditional management practices are not well suited to enhance construction productivity (Forbes & Ahmed, 2010). Since productivity is a function of cost versus revenues, developing and improved understanding of the basis of costs offers significant potential to affect construction productivity. Therefore, theoretical explanation of TCs estimates for different procurement systems is needed to raise the growth of practical arrangements, and to assess under which circumstances they are suited for certain purposes.

Practical importance — Procurement has a substantial effect on TCs in construction projects. Transaction costs, from the client perspective, relate to costs incurred in the pre and post contract stages. Pre-contract transaction costs include the costs of information search and drafting and negotiating agreements. While, post-contract transaction costs include the costs of contract administration and enforcement (Whittington, 2008b; Solino & Gago de Santos, 2010; Li et al., 2012). For example in the U.K., pre-contract TCs in Public Private Partnership Projects (PPPs) may amount to between 2% and 3% of the contract value (Dudkin & Valila, 2005). In the U.S. pre-contract TCs in the Traditional delivery system range from 0.4% to 8.8% of the contract value (Whittington, 2008b). Post-contract TCs are generally high in countries such as the U.S, U.K., and Australia because of disputes and litigation. For example, in the U.S. post-contract TCs in the Traditional delivery system range between 8.9% and 14.7% of the contract value. However, the figure of TCs is unknown for the New Zealand construction industry.

In this research transaction costs are generated because of professionals conducting procurement activities, and operations personnel in measuring and reporting through the control systems. The four main TCs incurred throughout the Project Lifecycle are procurement cost, information cost, contract administration cost, and enforcement cost. All these costs will eventually be borne by the client. As a result, TCs are seen as a waste of social resources and wealth (Wenan & Mengiun, 2010), so they are among the most important factors that affect the performance of construction projects. The biggest contributor to TCs are uncertainties in the transaction environment that occur during project procurement (Li et al., 2013). According to Winch (1989), the best option to reduce the problem of contracting uncertainty and to gain maximum flexibility is by sub-contracting construction activities. However, the decision to outsource construction activities is made to reduce the amount of the TCs through offsetting and/or mitigating risks and reducing capital employed in specialized sub-trades (Jin & Zhang, 2011). Accordingly, reducing the TCs of particular procurement systems will inherently affect the performance of the construction project, for example resulting in better tendering, procurement, and cost and risk profiles.

There is thus a practical need for research that might provide owners of construction projects with ideas for improving project procurement. Both public and private sector advisors need to be able to call upon relevant empirical research. However, the heterogeneity of construction projects in terms of uniqueness, complexity, and uncertainty, makes meaningful advice difficult. This research contributes to efforts to inform and aid clients on a board range of operational development issues. Ultimately, this study attempts to make a contribution toward improved procurement practice of construction projects in New Zealand.

Theoretical importance — Transaction cost economics (TCE), as an organization theory, is useful in explaining client-contractor relationships in the context of contractual agreements. In construction, the relationship between procurement strategy, contractual arrangement, and tendering procedures is often dictated by the procurement strategy (Hughes et al., 2006; Hackett et al., 2007). Increasingly, companies are recognizing that procurement is a profit-contributing activity, instead of a routine-order placing function (NZBCSD, 2009). The procurement decision depends on the degree of defined contract specifications and the frequency of the transactions.

Transaction Cost Theory (TCT) contends that there are costs in conducting transactions through the market. These costs can be reduced through mechanisms other than markets (Coase, 1988; Williamson & Ghani, 2012). Specifically there are costs in drafting contracts, negotiating, and safeguarding exchange that are impeding smooth transactions (Williamson, 1985). Transaction cost analysis emphasizes the need for formalized governance mechanisms (i.e., formal contracts, rules and regulations, reputation mechanisms, termination agreements, warranties, etc.) and an appropriate strategy, such as long-term agreements and alliances, to eliminate the risk associated with uncertainty, few numbers of bargaining/or opportunism and asset specificity. The rationale behind these strategies is eliminating coordination and motivation cost, which in fact reduces the TCs (Angelis et al., 2008). Accordingly, any mechanism that can evaluate TCs will allow clients to make more appropriate procurement decisions.

Procurement decision is hypothesized in this study to be related to TCs incurred because of information search, project procurement, contract administration, and contract enforcement. Also, the procurement decision is hypothesized to be influenced by uncertainties in the transaction environment. A concept of procurement selection based on TCs that allow for strategic intent within an evolutionary framework is proposed. The TCE theory has the potential to incorporate other organization theories such as resource-based view. In construction, this theory is more inclusive to be applied than other theories, and it fits perfectly with construction management. Thus, this study attempts to make a contribution to the emerging literature concerning applying transaction costs in construction, and also attempts to contribute to the integration of strategic management and evolutionary theory.

1.5 Potential Applications

There is increased interest in developing navigation and measurement tools that guide and assess TCs in project procurement in the New Zealand construction industry. Since productivity is a function of cost versus revenues, developing and improved understanding of the basis of costs offers significant potential to affect construction productivity. Therefore, theoretical explanation of TCs estimates for different procurement systems is needed to raise the growth of practical arrangements, and to assess under which circumstances they are suited for certain purposes. This is achieved by developing measurement models for TCs of different procurement systems. The developed models are expected to improve a firm's performance, such as procurement, through the minimization of costs, enhanced productivity, and overall project owner satisfaction.

To achieve the goals set out by the study, the methodology used included a series of developed questionnaires with weightings provided for the two procurement models (for Traditional and Design-Build). The models were then applied to six experimental cases, as well as developing a method for calculating TCs using regression equations. Transaction costs were decomposed into several categories of costs including information, procurement, contract administration, and contract enforcement. By identifying the cost impacts of different procurement systems, they may be more objectively compared. Thus, the models developed and the procedures for calculating TCs are relevant to individual projects.

Further application arises from the emphasis in this study on adopting TCE to examine customer-supplier relationships in the context of a contractual arrangement. In the construction industry, the relationship between procurement strategies, contractual arrangements, and tendering procedures are not always articulated and that contractual arrangement is often dictated by the procurement strategy. Thus, selecting the suitable procurement system is a strategic decision in construction. The procurement decision is grounded on the advantages, disadvantages, and success factors of each system. TCE was chosen to provide an understanding of underlying principles and reasons for procurement decision. By determining TCs for different procurement systems in construction projects, some practical issues that construction industry decision-makers in New Zealand and elsewhere should be considered.

1.6 Scope of the Research

Domain of investigation — TCs may exist at the pre and post contract stages of project procurement. The core problem is the costs of information and procurement at the pre contract stage and the costs of contract administration and enforcement at the post contract stage are the greatest contributors to higher TCs. Therefore, this study focuses on TCs incurred during the whole lifecycle of the project. The study covers the construction industry within New Zealand. Including the main councils, Auckland, Hamilton, Wellington, Christchurch, and Dunedin, top 50 construction firms in New Zealand, and construction institutions that operate within New Zealand.

Unit of analysis — This study is conducted from the clients' perspective. Transaction cost theory has been found to be applicable to differentiate among alternative procurement systems. TCs are estimated on the basis of the professionals' time in conducting procurement activities. Therefore, the unit of analysis is at the project level for the current study.

Unit of observation — In this study, information is sought from project managers, architects, engineers, surveyors, and procurement officers. To evaluate the time spent in conducting procurement activities such as information search, project procurement, contract administration, and contract enforcement relative to other project activities. The Traditional and Design-Build delivery systems were used in during the evaluation for comparison.

1.7 Research Methodology

The research methodology adopted for this study utilizes a framework method approach. Given the nature of the research problem the methodology is considered appropriate. A framework will illustrate the linkages between the procurement system and TCs. It is an explanation of the key factors, variables, and the presumed relationships among them. These relationships may be presented in graphical or narrative form.

The research method is designed to determine the magnitude of TCs for different procurement systems. This will be achieved through evaluating daily time spent by professionals at conducting procurement activities relative to other project activities during the project phases. These include phases such as concept, development, early implementation, full implementation, and project close. Two different types of procurement systems are deployed for assessment; the Traditional and Design–Build. Professionals such as Project managers, Architects, Civil engineers, Surveyors, and Procurement officers participate because of their role in procurement processes. A questionnaire survey is used for data collection, which supported by data from other sources such as interviews or focus groups. This is because questionnaires alone leave the researchers too remote from their data sources, and to ensure that the data is sound and well understood.

For this study, the methods used to collect data include interviews and surveys. The chosen methods will utilize the strength of both qualitative and quantitative research techniques. The first set of data was collected through an interview survey (pilot survey) with the aid of a structured questionnaire. Project managers who are currently working in ongoing projects in the Auckland Region were selected to respond. Participants were required to respond to the questions based on their experience with project management. The objective of this questionnaire was to validate the terminologies used and practicality of questions in the wider questionnaire survey in the definition of TCs in construction projects.

The second set of data was collected from construction professionals through the administration of a wide questionnaire survey to the construction industry in New Zealand. The questionnaire is designed for response over a web link (Survey Monkey) and administered to professionals with direct experience with construction projects. The potential respondents were selected from several construction organizations and institutes. Including the main councils, Auckland, Hamilton, Wellington, Christchurch, and Dunedin, top 50 construction firms in New Zealand, and construction institutions that operate in New Zealand, for example New Zealand Institution of Building (NZIOB), New Zealand Institute of Architects (NZIA), The Institution of Professional Engineers in New Zealand (IPENZ), Registered Master Builders Federation (RMBF), New Zealand Institute of Quantity Surveyors (NZIQS), and Project Management Institute/New Zealand (PMINZ). Respondents were asked to evaluate, using a 5-point Likert scale, the time-spent daily in conducting procurement activities relative to other project activities. Also, respondents were required to evaluate, using a 5-point Likert scale, the impact of environmental uncertainties on the cost of information, procurement, administration, and enforcement. Comparing two delivery systems: the Traditional and Design–Build. A comparison of the results was shown in graphs that illustrate the relative values of TCs for different procurement systems.

The third set of data was collected through an interview survey with the aid of a structured questionnaire. Six real-life cases, four procured in Traditional delivery system and two in Design-Build system, in the Auckland Region were selected. Project managers who are currently working in these projects were chosen to respond. Respondents were required to respond to the questions based on their experience with project management. To estimate the daily time-spent, (in hours) in conducting specified procurement activities. The objective of this questionnaire was to validate the results by applying the developed models to real-life cases. Also, to estimate the percentage of TCs in a project manager cost salary. Transaction costs were calculated using regression equations based on the factor loadings in the developed models.

Since the research required the canvassing of opinions from live subjects, anterior to commencing the investigation, ethics approval was sought from the AUT Ethics Committee (AUTEC) to guarantee the privacy and confidentiality of all research participants.

Data was analyzed via coded entry into Excel as appropriate and thereafter with its manipulation utilizing bar charts and matrices approaches. Also, using Statistical Package — Statistical Package for the Social Sciences (IBM SPSS) — to produce a descriptive ANOVA analysis, correlation test, and Validity test. The results were shown in graphical form, charts, and tables that illustrate the discrepancies in the magnitude of TCs for the Traditional and Design-Build systems. After data validity, measurement and structural models were developed utilizing Amos 21 to examine relationship among constructs. Lastly, regression equations were formulated based on the factor loadings in the models, to calculate TCs because of professionals conducting procurement activities. The aim is to calculate TCs for different procurement systems for the purpose of comparison.

1.8 Organization of the Thesis

Chapter One gives a general introduction to the research and background information on the research problem. The chapter also presents the statement of the problem, aim and objectives, and the research questions. Followed by practical and theoretical justifications for the research, and the potential applications of the research. Lastly, the chapter introduces the scope of the research and an overview of the research methodology.

Chapter Two provides a general background of organization theories, particularly transaction cost economics (TCE). The chapter further introduces the factors that influence organizational structure such as environmental uncertainties. In the final section, the chapter presents a general background of procurement practice in construction.

Chapter Three reviews the literature on transaction cost, procurement system, and uncertainty in the transaction environment within the context of the construction industry. The chapter also introduces a conceptual model of the study with a discussion of hypotheses to be tested. Foremost, a summary of empirical studies applied the TC concept in the context of construction management is discussed. After that, a conceptual model identifies the relationship between pre and post-contract costs (e.g. information, procurement, administration, and enforcement) generated because of professionals conducting procurement activities and TCs. Then, models explain relations of pre and post-contract costs with TCs, procurement system, environmental uncertainties, and project phases are conceptualized and explained. Finally, a general framework model is composed to explain the relations among the constructs TCs, information cost, procurement cost, administration cost, enforcement cost, procurement system, environmental uncertainties, and project phase.

Chapter Four discusses the research methodology used in this study. It covers a description and justification of the methodological approach best suited and examines the research questions/hypotheses, and introduces the research design of the study. Further, the chapter presents the specific methods employed for data collection procedures and provides an overview of the main data sources. This is followed by a discussion of ways in which the validity and reliability of data were achieved. Next, the chapter presents a discussion of the data analysis techniques used in this research. Lastly, the measurement errors and Ethical consideration were presented.

Chapter Five presents the analytical procedures and the results of data collected from professionals through the wider questionnaire survey. Analysis on the demographic information of the participants and their organizations, the extent of TCs in procurement, and the extent of environmental uncertainties impact on TCs were performed. The results were summarized and presented in bar charts. Further, the chapter describes detailed results of hypotheses testing with Structural Equation Modeling.

Chapter Six presents the analysis of the research model and presentation of hypotheses testing. The results were interpreted and discussed in the light of theory. The chapter also introduces verifications to the research by applying the developed models to real-life projects. Transaction costs are calculated on the basis of regression equation analysis, which is explained by the interrelationship strength coefficients between latent variables in the developed models. Grounded along the outcomes of the calculations, recommendations for decision-makers make suggestions on how to decide which alternative delivery systems are the most efficient in improving cost estimates, and thus enhancing the project performance.

Chapter Seven introduces the conclusions and implications of the study. It summarizes the major findings of the research. Then, the chapter outlines the theoretical and practical implications of the study, and contributions of the research to the existing body of knowledge. Lastly, limitations of the study and areas for further research are suggested.

1.9 Summary

The purpose of the study is to examine the relationship between procurement system and transaction costs in the New Zealand construction industry. This chapter introduces a background for the research problem. It outlines the research objectives and questions. Then, the chapter presents the rationale, scope, and significance of the study. Finally, the chapter presents a reader's guide for the study.

CHAPTER TWO

Literature Review

2.0 Introduction

The purpose of this chapter is to familiarize the reader with existing theory concerning organization, organizational structure, transaction cost, and procurement in construction. It reviews several bodies of literature that were important in the development of this research. These include project delivery systems in construction and organization theory literature, specifically transaction cost economics (TCE) that provide an understanding of the current state of the construction industry. After reviewing empirical studies and models concerning applying TCE in construction, it became apparent that a variety of transaction costs perspectives currently exist.

The review presented in this chapter classifies research on this topic (TCE in construction) under six perspectives. That is: - project organization and structure, construction market and subcontracting, project delivery systems, construction contracts, project performance, and measurement of TCs. This suggests that no single perspective appears to provide sufficient theory to model the perceived dimensions of TCs. The resulting implication suggests that the needs to be focused on an integrated approach to the concept. This study combines environmental uncertainties, procurement systems, and transaction costs in a framework model for procurement selection.

This chapter starts with a review of the nature of the construction industry in section one. Next, a review of organization and organization theory is presented in section two. It also presents the factors that influence the organizational structure. In section three, a specific area of organizational theory (e.g. transaction cost economics) is explored and explained in detail, and its applications in construction are presented. Followed in section four, a summary background of procurement and procurement selection in construction. This includes a discussion of the impact of procurement selection on TCs. Finally, a specific area of the factors that influence organizational structure is reviewed in section five. Including explanations of the impact of environmental uncertainties on TCs, then on procurement decision.

In this research, TCE is used as a primary foundation for the development of the framework model that explains the impacts of procurement system, environmental uncertainties on TCs.

2.1 Nature of The Construction Industry

The construction industry is characterized as being complex, fragmented, having a lack of coordination and communication between participants. With adversarial contractual relationships, having a lack of customer supplier focus, an ineffective use of technology, and unique (Winch, 1989; O'Brien & Al-Soufi, 1993; Walker & Wing, 1999; El-Mashaleh et al., 2006; Green et al., 2008; Stacey, 2010; Hu et al., 2011; Maer, 2011). This is due to the fact that most construction projects involve many phases such as feasibility, development and design, construction, and maintenance. Here, each phase involves communication and coordination among project stakeholders such as the owner, supplier, designer, consultant, contractor, and subcontractor. Each project is unique in construction type, location, and project team-members. Also, the project is temporary by nature. As a result, traditional management practices are not well suited to enhance construction productivity (Forbes & Ahmed, 2010).

Over the past two decades there has been an increasing segmentation of the construction industry (Vernikos et al., 2012). Medium sized organizations have been squeezed out as the industry moves to a structure in which firms either become large corporations capable of competing worldwide, or become small organizations seeking to cope with uncertain demand by use of subcontracting (Chapman & Ward, 1996). The 'one stop shops' concept has grown, leading to expansion of activity types and quantity performed within organizations (Langford & Male, 2008). Partnering and strategic alliances have become more common as organizations seek to maximize competitive advantage through the combining of complementary skills (Holt et al., 2000). Larger organizations competing on the world stage establish presence and market share with several strategies - merger, acquisition, recruiting, or making strategic alliances (Walker & Wing, 1999; Stacey, 2010). Larger contractors however remain no more than management shells relying on project management staff expertise (O'Brien et al., 1995; El-Mashaleh et al., 2006).

Resource allocation in such a structure is not optimal. Forbes and Ahmed (2010) have noted that an 'excessive administrative staff' is a key component of waste in the construction industry. In the U.K. an estimate of 3.2billion order and invoice documents are sent per annum - a £24billion cost in processing and paper handling (O'Brien & Al-Soufi, 1993). An organization reducing these costs (TCs) should increase profit and market share.

The organizational structure in construction is highly fragmented (Cox et al., 1998; Green et al., 2005; Olatunji, 2010). For small size firms' production tends to be organized in hierarchical chains of players locked with restrictive forms of contract. Similarly, industry fragmentation with boundaries between elements represents a significant lost in resources (O'Brien & Al-Soufi, 1993; Green et al., 2005), generating documents and information transfer and leading to increased TCs. This is reflected in administrative, technical, and professional staff growing at the expense of tradesmen and operatives (DETR, 1998; Lockyer & Scholarios, 2007).

The industry, continually suffers from high levels of claims, counterclaims, and litigation (Chan et al., 2011; Hwang & Lim, 2012). In addition, competitive tendering is based on the “my gain-your loss” phenomena. The relationships between construction firms and clients have often failed in addressing customer satisfaction. Conflicts occur in the construction industry because of organizations fragmented nature, contract’s language ambiguity, on-site operations uncertainty, and low profit margins. Gardiner & Simmons (1995) outlined that most conflicts occur in organizational systems, and quality control, while at the project level, they occur in the design stage. Given the nature of the industry and the complex relationships between parties, it is hard to eliminate conflicts totally. Kumaraswamy (1998) argued that healthy reconciliation of constructive conflict leads to synergistic scenarios, which optimize designs, construction methods, and other operations.

Thompson (2003) classified construction as an intensive or job shops technology. Construction projects require a unique combination of labor and material inputs, performed and coordinated on-site, thus resulting in transaction implications (TCs). Construction projects require many traders such as builders, bricklayers, plumbers, pipe fitters, electricians, painters, roofers, sheet metal workers, glaziers, and general laborers. Coordinating the work of these traders during project life cycle is a complex task because they differ about work activities, training, skill level, and assessed value in the labor market. At any point in time several of these specialties will be simultaneously involved with the project, and often the work of one cannot proceed until several others have completed a phase of work (Eccles, 1981b; Bridge & Tisdell, 2004). This type of coordination results in increased TCs.

The complex nature of construction is one of the major reasons for failure (Winch, 1989; Arditi et al., 2000; Brochner, 2010; Hu et al., 2011). An element that contributes to said failure is a lack of communication or coordination. For example, the Engineer's responsibilities are to contemplate, plan, analyze, design, and prepare workshop detail drawings. After this stage, engineers who are involved with the planning or design of structures do not transmit these drawings to the construction team. Design engineers are rarely involved with construction on-site, except for a few site visits in order to check that things are in order (Chapman & Ward, 1996). Further, material technology, for example concrete, requires knowledge of designers and construction teams. This gap between design and construction processes need to be narrowed, because it increases TCs. These costs include information, communication, and quality control costs. Increased complexity of construction and procurement through technical and process innovation has an impact on resource allocation (Ball, 1988; Eriksson, 2008).

Operations in construction are not efficient, particularly in areas such as supply chain and production processes (Cox et al., 1998). Basic construction materials and components are widely dispersed among different firms, small and large making the coordination a difficult job. Authors (Dubois & Gadde, 2002) highlighted several issues in the construction industry, specifically, that the industry promotes sub-optimization, impedes innovation, and technical development. It is argued by many researchers that not much effort has been made to improve construction performance, for example adopting lean or just-in-time and partnering with supplier's techniques to improve supply chain management (Cox & Ireland, 2002; Segerstedt & Olofsson, 2010), and total quality management (Wong, 1999; Pheng & Teo, 2004).

Coase (1937) found that firms organized to reduce TCs of repeated or complex activities in providing their goods and services. This logic is repeated in corporation developments, which grow by assimilating functions to minimize TCs. Functions are assimilated until TCs incurred from dealing with an external source are less than administrative and risk costs of maintaining an internal department. This produces vertical and horizontal integration. Vertical integration is common ownership of multiple sequential stages of production and distribution in a unified product or process (Gold, 1986; Lafontaine & Slade, 2007). In construction this creates expansion as construction firms diversify back into areas such as materials supply or forward into such areas as facilities management. In horizontal integration, geographical expansion is typical.

However, construction has many forms of intermediate and incomplete integration as seen in procurement processes. Gold (1986) as well as Lafontaine & Slade (2007) present alternatives to vertical integration; joint ownership of component stages; long term supply contracts; joint production planning between suppliers and buyers, joint planning by suppliers and industrial customers. Conversely there is increasing diversification and separation into subcontracting, reflecting divested instead of assimilated functions. Thus, a dichotomous organizational structure has evolved (Jitpaiboon, 2005). At one level there is greater vertical integration as organizations seek to minimize TCs by creating quasi-organizations through partnering, alliances etc. (Williamson, 1975). At another level, construction organizations seek to cope with an uncertain market by divesting functions, which paradoxically lead to an increase in boundaries and then TCs (Winch, 1989).

The current trends of IT investment and implementation within the construction industry still appear to follow very vague goals. Too often, participants from the industry that invest in IT during initial stages forget their original identity as firms that provide construction services, thereby putting their core competencies at stake. Frequently, these investments lack a focus on establishing links between processes and corporate strategy in the long run (Garvin et al., 2004).

Finally, construction industry outputs are difficult to evaluate and measure even within the industry (Dainty et al., 2003; Love et al., 2004). Dai et al. (2009) outlined the factors affecting construction productivity. These include resources (physical and human specific assets, technology, information, and support services), on-site supervision quality, project management practices, activities' sequencing, environmental and technology uncertainties, and safety (Dai et al., 2009). Haas et al. (2009) indicated that for the last two decades or more, productivity declined for the industry as a whole. Egan (1998) suggested improving construction productivity and processes by adopting new management techniques, construction techniques, and IT utilization. The adopted techniques should resolve industry constraints, and overcome innovation barriers with a more systemic approach to change instead of undertaking isolated piecemeal change initiatives.

2.2 Organizations

In this section, an operational definition of organization, organizational structure, and organization theory are presented.

What is an organization? According to Aldrich & Ruef (2006), organization is a socially constructed system of human activities that are goal-directed and boundary maintained. This definition covers three key issues: systematic human activity, goal direction, and boundary maintenance (Aldrich & Ruef, 2006). Systematic human activity suggests that organizations are composed of people who are interacting with each other to perform certain functions or activities (Daft, 2009). Goal-directed is the purpose of such a structural design to achieve organizational aims and objectives. Boundary maintenance suggests which activity performs in-house and which performs out-house. Organization existence depends on the ways it maintains and protects its resources (human and physical) (Slater, 2003). Therefore, organizations are not static, but dynamically changing and developing entities.

This research focuses on the key issues in organization definition to investigate the impact of the factors that influence the organizational structure on the nature of transactions.

2.2.1 Organizational Structure

Organizational Structure is made up of "regularities in activities such as task allocation, coordination, and supervision within an organization which is directed towards the achievement of given aims" (Pugh, 1990). According to PMI (2008), organizational structure is an enterprise environmental factor that can affect the availability of resources and influence how projects are conducted. The structure depends on the aims and objectives of the organization, and the strategy adopted to achieve them. It is characterized by centralization, formalization, specialization and professionalism (Miller et al., 1991). Wright (2004) mentioned that organizations are often structured around what people do – their functions/specialism and whom they report to – their boss/client.

The earliest theory of the organizational structure of bureaucracy or the classical by (Weber, 1946; Taylor, 1947; Fayol, 1949) indicated that organizational structure is a matter of choice and people could fashion accordingly for effectiveness and efficiency (Mohr, 1971). The concept became important in the early 1960s when economics developed several aspects of organizational structure: entrepreneurial, machine bureaucracy, professional bureaucracy, diversified, and adhocracy (Daft, 2009). Economics developed several organizational structure theories: - The contingency theory (Donaldson, 2001), the strategic choice theory (Watson, 2013), the strategic performance framework (Rummler & Brache, 2012), the collective action view (Christensen & Tschirhart, 2010). Lastly, the population ecology model (Salimath & Jones III, 2011).

Further, when the demand for knowledge increased, Lim et al. (2010) theorized new organizational structure depends on strategies and behavior of management. The workers are constrained by the distribution of power between them, and influenced by their environment and outcomes (Lim et al., 2010). According to Daft (2009), organizational structures such as the matrix, flat, network, and virtual have been used in restructuring and downsizing and developments in technology.

An organization can be structured, as shown in Figure 2.1, in many different ways depending on its objectives. Typically, the hierarchy within which an organization arranges its' level of authorities, responsibilities, communications, and allocation of rights. The centralized structure is when the decision-making power is concentrated on the top management level with tight control exercises over departments and divisions. While, in a decentralized structure the decision-making power is distributed among management levels and the department and divisions have varied the degree of independence (Aldrich, 1972; Daft, 2009).

The interrelationship to organizational structure is presented in Figure 2.1. It provides a framework for analyzing the factors that influence organizational structure such as culture, environment, goals and strategy, size, and technology (Daft, 2009).

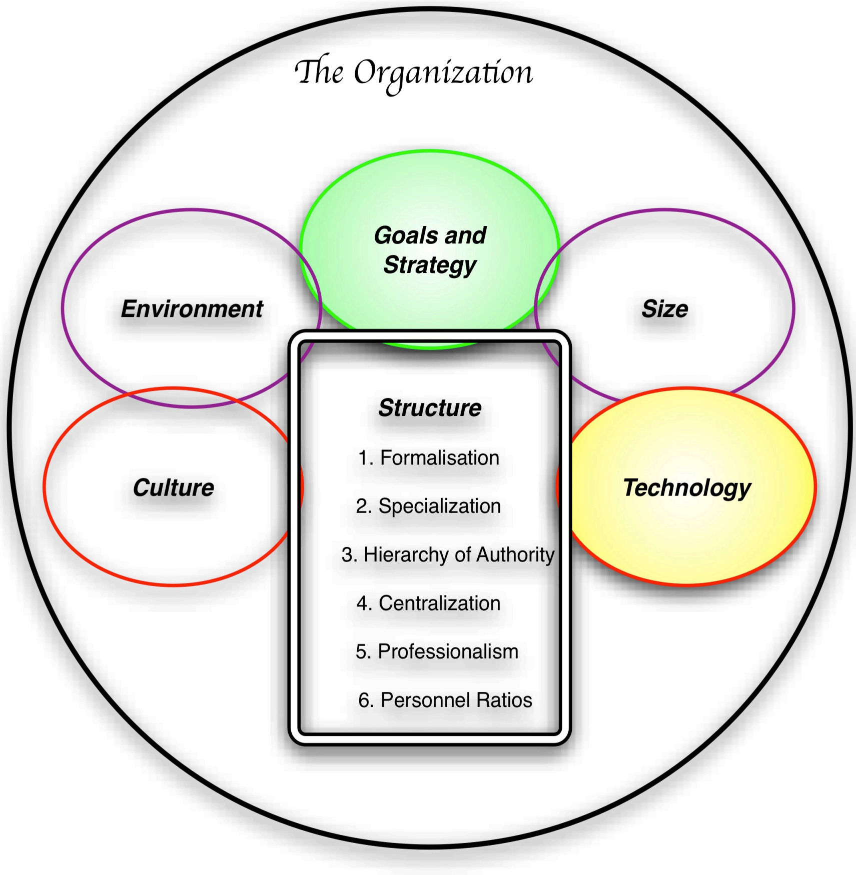


Figure 2.1: Organization Design Based on (Daft, 2009)

According to PMI (2008), enterprise environmental factors refer to both external and internal factors that influence a project's success. Structure, culture, and processes are internal factors, while environment and technology are external factors that may enhance or constrain project management options and may have a positive or negative influence on the project outcome. In this research the first step is to explore uncertainties in the transaction environment, and then investigate the client motivation to choose among alternative procurement systems based on TCs and environmental uncertainties. These include external uncertainties such as Political/Legal/Social, Economical, Technological, and Competition. Internal uncertainties include Corporate Culture, Finance/Ownership, Project Location, and Information Systems. Having addressed organization definition and the factors that influence organizational structure, the following sub-section discusses the organization theory.

2.2.2 Organization Theory

Organization theory is a macro approach that analyzes the organization as a social unit; this includes leadership, management, and human resources. It also analyzes the organization interrelationship with the environment in which it operates (Daft, 2009). Several theories of organization have evolved, for example, the bureaucracy, the classical, the environmental, and the neoclassical perspective.

The Bureaucratic Theory: Under this theory, an organization is designed to accomplish large-scale administrative tasks by systematically organizing the workplace of many people (Daft, 2009). According to Weber (1947) these include among others: rules and procedures, responsibilities, technically qualified personnel, specialization, hierarchy of authority, and written communication and records.

The Classical Theory: Under this theory, an organization is designed to accomplish productivity and efficiency of the workers. This can be achieved through defined jobs, and a definite measure of authority, responsibility, and accountability (Taylor, 1947). An example of the classical organization theory is the scientific management and administrative principles approaches. The scientific management approach states that decisions about organization structure and job design should be based on precise scientific procedures not a rule of thumb (Taylor, 1947). The administrative approach focuses on the total organization and growth from the insights of the participants. In this approach management considered as a set of planning, organizing, training, commanding, and coordinating functions (Fayol, 1949).

An example of the classical scientific management approach in construction is project management and its techniques. It provides a "unifying agent" across the various functions of the construction organization in the face of uncertainty and complexity (Cleland and King, 1968). The project manager acts as a unifying agent for project control of resources and technology by providing leadership and management skills, to meet contractual commitments. Within these goals, the project management perspective shares the same principles of transaction cost economics (TCE). Winch (1989) adopted the TCs perspective as an alternative approach to project management in systematically handling the relationships within and between firms.

The Environmental Perspective: This theory takes the environment as the central focus. It indicates that uncertainties in the environment in which an organization operates influences its structure and design. An example of the environmental perspective is the Contingency theory, which focuses on external and internal determinants of an organization that affect its behavior (Aldrich & Ruef, 2006; Daft, 2009). Political/Legal/Social, Economical, Technological, and Competition are external determinants in which an organization operates. While Project location, Finance/Ownership, Corporate culture, and Information systems are internal determinants in which an organization operates.

An important precept of the contingency theory in construction organization is buffering and boundary spanning (Thompson, 2003). Uncertainties could influence organizational structure through creating specific departments to deal with these uncertainties. The organization can be conceived as a technical core with departments that buffer environmental uncertainty. Boundary spanning, according to Thompson (2003), provides database information about the environment. Since the project organization is actually a temporary organization of firms, the information about environment plays an important role in organization structure in construction. Although, the environmental theory was used to provide responses to environmental uncertainties, there are other uncertainties that construction firms face. Winch (1989) suggests that the uncertainties within the construction process such as task uncertainty, natural uncertainty, organizational uncertainty, and contracting uncertainty cause most of the problems that construction firms face. He added that the main elements of differentiation in construction projects are between firms, not within the firms themselves.

Thus, an organization theory is needed to explain the relationships between firms joined with the consideration of uncertainties in the transaction environment. According to Erriksson (2007), TCE is the most appropriate organization theory that explains the client-contractor relationship, which contemplates the changes in the transaction environment, the construction market, and changes in construction technology.

The Neoclassical Theory: This theory defines the organization as a social system composed of various interacting parts, and a group of people with common objectives. It assumes that the units of economic decision-making are a given, and focuses on how they interact in markets. An example of this type of organization theory is Hawthorne study or human relations perspective. Hawthorne assumes that human beings are independent and their behavior can be predicted (Carey, 1967). He showed that positive treatment increased employees' motivation and productivity. Thus, productivity is a subsequent work on morality, leadership, and human resource management.

Finally, having summarized the main theories of organizations, the next section discusses the important of TCE as an organization theory in the field of strategy.

2.3 Transaction Cost Economics (TCE)

Most of the organization theories summarized in the previous section were developed to examine the relationships within organizations. However, these theories do not address the relationships between firms and the impact of governance structure on these relationships. In construction, a theory for organization must contemplate among other factors the construction project as a temporary entity with divergent goals (Langford & Male, 2008).

Transaction Cost Economics is a central theory in strategy that addresses a firms' existence, their boundaries, and the way to govern operations. According to TCE, the problem of economic organization is the problem of contracting, and there are alternative ways of accomplishing a task (Williamson, 2005a). Each alternative is associated with precise and understood contractual and administrative mechanisms (Yates, 1998). TCE assumes that choosing among alternative governance structure is determined by comparing the cost of transaction under each structure (Ruester, 2010). Thus, the goal of an organization is to find the most cost efficient governance structure that minimizes the transaction costs.

Ronald Coase first introduced the concept of transaction costs in 1937. He investigated the price mechanism and concluded that there is a cost related to searching for relevant prices, negotiating, and making a contract (Coase, 1960). The boundaries of the firm occur at the point where the cost savings from transacting within the firm are just offset by the rigidity costs (e.g. administration cost).

Williamson (1985) introduced a new concept of TCE by focusing on the economic actors' behavioral assumptions (opportunistically and bounded rationality) and transaction characteristics; i.e. Asset specificity, uncertainty, frequency, complexity, and contestability (Williamson, 1985). Economic actors behaving opportunistically with bounded rationality and uncertainties dominate to most contracts tending to be incomplete and partially account for possible contingencies. Moreover, Williamson (2005) presented TCs, as "an effort to better understands the complex economic organization by selectively joining law, economics, and organization theory". TCE is concerned with the allocation of economic activity across alternative modes of organization (markets, firms, bureaus, etc.), employs discrete structural analysis, and delineates the firm as a governance structure (Williamson, 2005a).

Importantly, TCE focuses on the individual transaction in the buyer-seller relationship. The question then "Why are some transactions performed within firms rather than in the market?" as prescribed by the neoclassical view. The Figure 2.2 illustrates the principles of the transaction cost theory (TCT). When the external transaction costs are higher than the internal transaction costs, the company will grow through conducting activities in-house. If the external transaction costs are lower than the internal transaction costs the company will be downsized through outsourcing activities. In reality, market participants have to pay a price for reaching an agreement, developing rules for implementation of that agreement, and establishing suitable systems of management and governance. This 'price of doing business' is called TCs (Ruester, 2010).

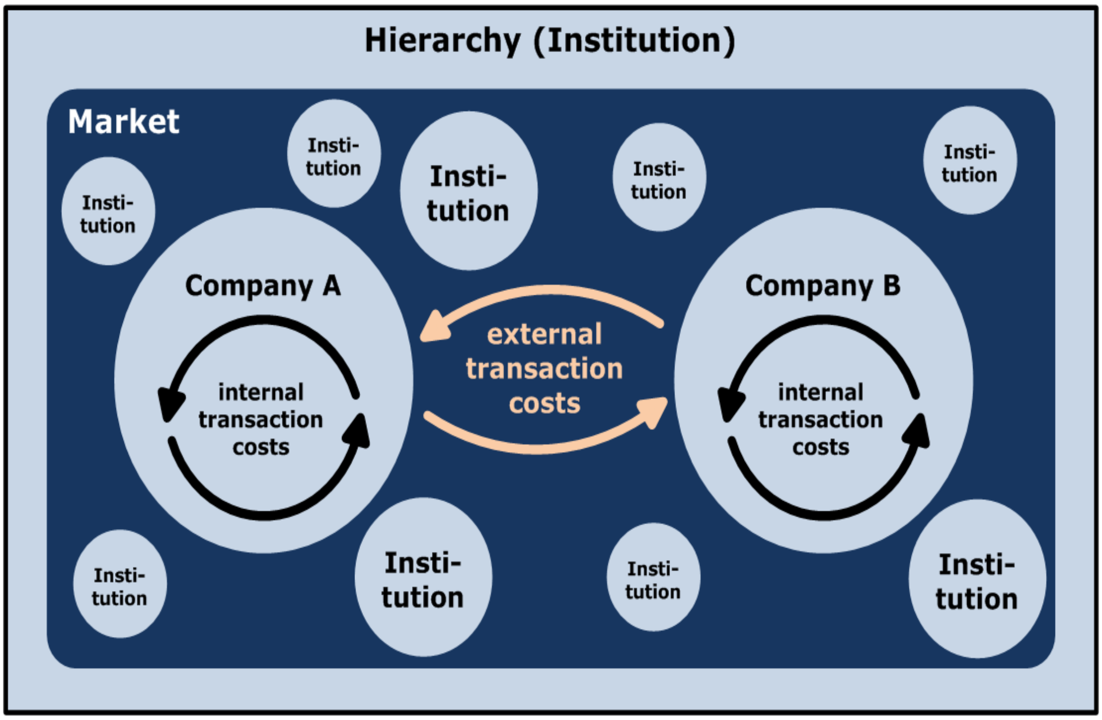


Figure 2.2: Transaction Costs Theory Based on (Commons, 1936)

TCT contends that there are costs to conduct transactions through the market; these TCs can be reduced through mechanisms other than markets (Coase, 1988; Williamson, 1975). Specifically there are costs to " drafting, negotiating, and safeguarding any exchange or transaction" that cause "friction", impeding smooth transactions (Williamson, 1985). TCT claims that these TCs are as important as production costs, or maybe even more important. Generalized TCs are expenditures necessary to maintain systems supporting delivery/production. Wenan & Mengjun (2010) stated that: "In the construction industry, TCs related to the changes in design and changes of the market-related system, the property structure of construction enterprises, organization and size, and transaction mode". In addition, they stated "no matter what, TCs are always related to information procurement. TCs can be seen as a waste of social resources and wealth" therefore, it is one of the most important factors to affect the construction market performance (Wenan & Mengiun 2010).

Researchers (Joskow, 1988; Shelanski & Klein, 1995; Lyons, 1996; Rindfleisch & Heide, 1997; Masten & Saussier, 2000; Joskow, 2002; Macher & Richman, 2008; Rindfleisch et al., 2010) have presented a narrative review of TCT. However, David and Han (2004) performed the first quantitative review of transaction cost literature. In construction management research there has been an increasing application of TCE to address construction problems such as (Eccles, 1981b; Gunnarson & Levitt, 1982; Reve & Levitt, 1984; Winch, 1989). Yates (1998) applied TCE to understand the source of conflict and disputes in construction projects. A summary of literature reviewed in this research is presented in Table 2.1 below.

Table 2.1: Summary of Empirical Studies in TCE

Authors/Year	**Article Topic**	**Method**	**Main Findings**
Klein et al. (1978)	Vertical integration in the US auto sector	Qualitative analysis	Vertical integration is positively related to hold-up problem.
Monteverde and Teece (1982a)	Supplier switching costs and vertical integration in the US auto industry	Probability Model	Vertical quasi integration is positively related to asset specificity.
Mastern (1984)	The organization of production: Evidence from the aerospace industry	Framework Model	In-source and out-source procurement depend on design and site specificity and complexity of activity.
Walker and Weber (1984)	TCs approach to analyze make-or-buy decision	Least square equation	Backward integration is related to specificity, volume, and technological uncertainty.
Joskow (1985)	Long-term vertical relationships: US coal-burning power plants	Qualitative analysis	Vertical integration and long-term contract are consistent with TCE
Masten et al. (1991)	The costs of organization based on TCs theory	Selection Model	Asset specificity has a negative impact on TCs.

Poppo and Zenger (1998)	Testing alternative theories of the firm: TCs, knowledge-based, and make-or-buy in IT	Framework Model	Asset specificity has a negative impact on market performance.
Gonzalez et al. (1999)	Regulation as a cause of firm fragmentation: the case of the Spanish construction	Quantitative analysis	As asset specificity is higher, firms tend to sub-contract less.
Hazledine (2001)	Measuring the New Zealand Transaction Sector, 1956-98	Survey	The ratio of transaction to employees increased sharply in the 1980s
Martinez (2002)	Vertical coordination of marketing systems	Qualitative analysis	Vertical structure is consistent with TCs assumptions.
Parker and Hartley (2003)	The role of TCs in relational contracting of public private partnership (PPPs)	Case study	Developed a framework to assess whether the use of PPPs leads to improved economic efficiency.
Michael (2003)	The importance of management and TCs for large UK firms	Non-linear regression equation	TCE is a primary determinant of improved firms performance
Brown and Potoski (2003)	Managing contract performance: A TCs approach	Survey and interviews	When governments contract for services in contexts that risk contract failure, they engage in a variety of monitoring techniques to improve performance
Sartorius and Kirsten (2005)	The boundaries of the firm: analysis based on TCs perspective	Case study	Strategic alliance is related to transaction frequency, asset specificity, and uncertainty.
Brickley et al. (2006)		Rate Model	Contract duration increases with the asset specificity and uncertainty.
Judge and Dooley (2006)	Examine strategic alliance outcomes utilizing TCs perspective	Two-step measurement model (AMOS)	Partner trustworthiness and contractual safeguards were negatively related to opportunistic behavior.
Athias and Saussier (2007)		Logit Model	Develop a model combining property rights and TCE.
Macher and Richman (2008)	Apply TCE across multiple social science and business fields	Survey and interviews	There is considerable support for applying TCE across indifferent business fields.
Bigelow and Argyres (2008)	TCs, industry experience, and make-or-buy decision	Data analysis	TCs effects on make-or-buy choices were nevertheless important at the population level
Kuperan et al. (2008)	Measuring TCs of Fisheries co-management	Survey	The difference in the total cost of fisheries management between centralized government management and co-management is not that

			significant.
Liu et al. (2008)	Governing buyer-supplier relationships through transactional and relational mechanisms	Regression analysis	Formal contract is more effective in restraining opportunism while relational contract improves performance.
Hirschhausen and Neumann (2008)	Long-term contracts and asset specificity	Survey	Investment in specific asset increases contract duration.
Ruester (2009)	Changing contract structure: TCs framework	Least square Equation	The higher asset specificity and uncertainty the longer is contract duration.
Townsend (2010)	TCs as an obstacle to fisheries self-governance in New Zealand	Case study	Government policy can reduce the TCs of unanimous decision-making and provide better tools for self-enforcement.
Teece (2010)	Utilizing TCE in understanding vertical decisions of firms	Case study	Developed innovation framework for evaluating forward vertical integration decisions.
Liu (2010)	TCs and market efficiency	Data analysis	Negatively impacts of TCs on the Japanese equity market efficiency
Peris-Ortiz and Rueda-Armengot (2010)	TCs theory and the organizational capability	Case study	Address the key questions of why activities are organised internally or why certain components or service are obtained from suppliers.
Jaraite et al. (2010)	TCs for firms in the EU emissions	Survey	For the largest firms –– accounting for over half the emissions –– average TCs were €0.05 per tone.
Merkert (2012)	Estimating TCs and their share in total operating costs	Quantitative analysis	There are differences in the relative size of the transaction sector at the firm level. The lower TCs of partially integrated rail firms are offset by more parent company support.
TCs in Construction			
Evaluating the project organization (governance structure)			
Eccles (1981)	TCs framework: Bureaucratic Versus Craft Administration	Quantitative analysis	Asset specificity and uncertainty have a positive impact on the governance form.
Reve and Levitt (1984)	TCs analysis: Organization and governance in construction	Framework Model	TCs framework is a useful tool in explaining contract uncertainty.

Buckely and Endewick (1989)	TCs theory in analyzing organizational structure	Framework Model	Utilizing TCs theory in analyzing organizational structure has a significant role in investigating what is missing in specifications.
Winch (1989, 2008)	TCs approach as an alternative in handling the relationships within and between firms	Framework approach	Identified the relationship between TCs and project management.
Jobin, D. (2008)	A transaction cost-based approach to partnership performance evaluation.	Framework approach	Utilizing TCs theory in evaluating partnership performance.
Investigating construction contracting and sub-contracting			
Alsagoff and McDermott (1994)	Relational Contracting: A Prognosis for the U.K. Construction Industry?	Quantitative analysis	Contractual incompleteness and opportunism are the root causes of conflicts and disputes between firms.
Walker and Chau (1999)	Integration of TCs theory and Project management	Framework Model	Develop a framework that explains the possibility of integrating PMT and TCs.
Erridge et al. (1999)	Assessment of tendering using TCs analysis	Surveys and interviews	The availability of information on previous contracts and debriefing, providing a clearer specification of user needs and of quantities.
Chang and Ive (2000)	Construction procurement behavior by quantitatively measuring TCs	Direct and indirect measure approaches (DMA, IMA)	Develop DMA and IMA to predict the amount of TCs.
Bajari and Tadelis (2001)	Incentives versus TCs: A theory of procurement contracts	Lemma equation	Developed a model that provides micro-foundations for ideas from TCE
Leiblein and Miller (2003)	TCs and the vertical boundaries of the firm	Survey	The governance of production activities is strongly influenced by both transaction and firm level effects.
Lee et al. (2009)	TCs approach in analyzing contractor-subcontractor relationship	Competitive model	TCs incurred by contractors and subcontractors vary according to the type of relationship established.
Aibinu, A et al. (2011)	Structural equation modelling of organizational justice and cooperative behaviour in the	Case study	Apply TCs concept to determine contractual parties behavior. Organizational justice system, or People's

	construction project claims process: contractors' perspectives.		perceptions of it, influenced 38% of conflict intensity, and altered 46% of contractor'
Determining the most applicable delivery system			
Lynch (1996)	Evaluating Construction Project Organizations based on TCs theory	Case Study	Project Delivery Cost Impact Framework that identifies and describes the specific cost impacts of project delivery systems.
Eriksson (2007)	Efficient governance through cooperative procurement procedures	Survey	Different governance forms are facilitated through different procurement procedures.
Change and Ive (2007)	The hold-up problem in the management of construction projects	Case study	Clients should not stretch the proactive strength of a limp-sum contract too far and that the hold-up problem can be regarded as both serious and unsolved by existing administrative structures and governance.
Whittington, J. (2008)	The transaction cost economies of highway project delivery: design-build in three states	Case Study	In six cases studies in the US, the pre-contract TCs for the traditional from 0.4-8.8%; while for design-build from 0-5.7%.
Measuring and evaluating TCs in construction projects			
McCann (2004)	Framework for measuring TCs	Survey and interviews	Develop a framework for estimating TCs.
McCann et al. (2005)	TCs measurement for evaluating environmental policies	Survey	Recommendations regarding a typology of costs as well as the measurement methodologies of TCs.
Dudkin, G., & Valila, T. (2005)	Transaction Costs in Public-Private Partnerships: A First Look at the Evidence	Case study	In PPPs, the TCs may amount 10% of contract value at the procurement phase.
Solino, A. S., & Gago de Santos, P. (2010)	Transaction Costs in Transport Public, Private Partnerships: Comparing Procurement Procedures	Case study	In PPPs, for the traditional systems post-contract TCs range from 8.9-14.7%; while for design-build systems range from 3.4-14.3%

Generally, TCs are costs incurred when dealing with outside suppliers in the context of contractual arrangement. It consists of costs not directly related to the production of goods or services (Klein, 1980). For example costs associated with:

information, negotiation, competitive advantage, contract administration and management, market structure, enforcement, and measuring/monitoring performance (Heide & Stump, 1995; Artz, 1999; Melese & Franck, 2005). Transaction costs may attribute to the incompleteness of contracts because of uncertainties and complexity with the absence of bounded rationality. In addition, inabilities and difficulties involved in existing or terminating the contractual relationship because of asset specificity (human and physical) with the absence of opportunism (Williamson, 1985). Accordingly, in order to reduce TCs associated with bounded rationality and opportunism, TCE proposed the need for the use of appropriate formal governance for transactions. This includes the form of contractual and administrative mechanism, which could safeguard the transaction and maintain the working relationship among parties.

2.3.1 Transaction Cost Characteristics

Four key characteristics of transactions can make them more costly: complexity, uncertainty, frequency, and asset specificity (Williamson, 2010a). Uncertainty and complexity are always paired with bounded rationality, while frequency and asset specificity are always paired with opportunism. Opportunistic behavior of economic actors with bounded rationality and uncertainties result in most contracts tend to be incomplete and partially account for possible contingencies (Williamson, 2005b).

"Bounded rationality" refers to the limited competence of human actors in solving complex problems and process information (Simon, 1991). This includes human physical limits and language limits. Individuals' physical limits include limits on the powers to procure, store, retrieve, and process information without error.

While individuals' language limits advert to the inability of individuals to articulate their knowledge in ways that permit them to be understood by others (Williamson et al., 1975). These limits of rationality are reached under conditions of uncertainty about possible outcomes and complexity in the number of possible outcomes of a situation. In the absence of these two conditions, the appropriate set of contingent actions can be fully specified at the outset in the contracts. Otherwise, bounded rationality causes all contracts to be incomplete and subject to opportunists that lead to hazardous results (Williamson, 1985).

"Opportunism" refers to human actors behavior with self-seeking with guile, and applying false threats or promises to take advantage of others if an opportunity to gain more profits is present (Williamson et al., 1975). It happens in the context of small numbers relationships (frequency), and information impactedness (which is used as a specific asset) when the parties to the transaction possess differing-levels of information. Williamson (1975) viewed that opportunism is the central concept in the study of transaction costs. Most TCs arise either as costs of collecting information and measuring outcomes or as costs of opportunism. Therefore, if opportunism did not exist in the contractual relationships, contractors could perform the work in an adaptive and sequential manner.

Importantly, TCE suggests that an understanding of the key characteristics of a transaction can help decision-makers improve the design of contracts, organizations, and other governance structures that reduce TCs and improve the gains from an exchange between buyers and sellers (Williamson, 2008). Meanwhile, understanding TCs may help the firm achieve results " faster, better, and cheaper." Adhering to the logic of TCE, an organization should adopt a strategy that reduces TCs and the potential for opportunism (Williamson, 1981).

2.3.2 Transaction Cost in Construction

Activities of the construction industry could be interpreted as a network of transactions, or contracts in the wide sense of transactions (Costantino et al., 2001). TCE deals with costs that are incurred at the pre and post-contract phases. At the pre-contract phase these include the costs of information search (e.g. financial, legal, and technical) and procurement such as attending meetings, preliminary design, site visits, translation of client's needs, transition observation, and training. While at the post-contract phase these include the costs of contract administration (e.g. administration, decision-making, and conflicts resolution) and contract enforcement such as enforcement and verifying compliances (Lingard et al., 1998; Dudkin & Valila, 2005; Hughes et al., 2006; Whittington, 2008b; Solino & Gago de Santos, 2010). Many Researchers have applied the perspective of TCs in the construction industry to understand the cooperation and motivation among project stakeholders through analyzing organizational behavior in the construction industry. Utilizing the transaction costs paradigm to examine buyer-supplier relationships has been the object of several investigations in construction.

Researchers and academics have applied the TCE perspective to a variety of construction topics. Firstly, in evaluating the project organization and determining the most suitable governance structure (Winch, 2001; Müller & Seuring, 2007; Jobin, 2008). Secondly, in investigating construction contracting and sub-contracting (Eccles, 1981a; Gunnarson & Levitt, 1982; Reve & Levitt, 1984; Winch, 1989; Bremer & Kok, 2000; Bajari & Tadelis, 2001b; Turner & Simister, 2001; Miller et al., 2002; Aibinu et al., 2011). Thirdly, in determining the appropriate delivery system (Lynch, 1996; Whittington, 2008b). Finally, in measuring and evaluating transaction costs in construction projects (Dudkin & Valila, 2005;

Antinori & Sathaye, 2007; Ho & Tsui, 2009; Farajian, 2010; Solino & Gago de Santos, 2010).

Although, researchers within the TCE field suggest the applicability of transaction costs theory, some have employed imperfect proxies for key variables. The TCT contends that there are costs to conduct transactions through the market, which can be reduced through certain mechanisms (Williamson, 1971; Coase, 1988). Specifically costs related to drafting, negotiating, and safeguarding an exchange or transactions that could impede smooth transactions (Williamson, 1985). Further, changes in design and information requirements for procurement are significant to TCs in construction (Wenan & Mengjun, 2010).

Buckley and Enderwick (1989) investigated the role of TCs in analyzing what is missing in organizational structure specification in construction. They applied the human resource management perspective or manpower management in solving the problems attached to the independence of trades, and employee underperforming and shirking. However, Enderwick focused on human behavior within the transaction cost framework, while other characteristics such as uncertainty, complexity, and frequency were ignored (Buckley & Enderwick, 1989).

Dudkin's (2005) study in the UK construction industry shows that the private/public partnership projects (PPPs) in the UK are continually affected by significant costs related to the procurement phase of PPPs. Currently this amounts to an average of 10% of the capital value of the projects that erodes the potential savings achieved within partnership projects (Dudkin & Valila, 2005). There are other TCs that affect the performance of PPPs that are not easily assessed. For example the opportunity costs as a result of renegotiation and delays in the completion of the project (Ho, 2006), which may significantly undermines expected benefits. Frank (2006) also found that outsourcing relationships could involve extra TCs such as negotiation, measuring, and monitoring costs that can quickly overwhelm a 10% production cost advantage. It would therefore seem apparent that TCs are highly significant in the overall cost of construction on any project.

A viewpoint in organization theory by Lynch (1996) suggested that construction project organizations must take into account the nature of the construction industry. Since TCE theory incorporates some of the organization theory with the impact of contractual relationships between firms, he adopted TCE to develop a framework model for selecting the appropriate delivery system. Lynch developed a framework model for understanding the impact of different delivery systems on organizational structure based on TCs. Therefore according to Lynch, transaction costs include the costs of information, procurement, administration, and enforcement (Lynch, 1996).

That viewpoint is developed further in this thesis. A new relationship between procurement system, transaction costs, and environmental uncertainties are proposed in Chapter Three. A framework model for procurement selection is conceptualized to determine the impact of procurement system and environmental uncertainties on the magnitude of TCs. Based on TCE analysis, the quest to reduce TCs in construction procurement by reducing opportunism, which contributes to the emergence of different governance mechanisms including procurement, contract terms and conditions, and dispute resolution systems such as contract provisions.

A summary review of literatures that applied TCE in construction management is shown in Table 2.1, and a comprehensive review of literatures that applied TCE in construction management is discussed in Chapter Three. In the table various researches undertaken on TCs perspectives and its implications are presented. It is observed that TCs perspective is applied in different industries including construction. Few of these studies applied TCE in selecting the appropriate procurement system in construction.

2.4 Procurement in Construction

Procurement defines the way that construction work is organized, documented, and awarded to project executors. Construction procurement covers the processes from the initial concept, planning, and designs to developing, construction, and monitoring of performance (Erridge & McIlroy, 2002; Hughes et al., 2006; Poon & Yu, 2006; Hackett et al., 2007; Eriksson, 2008). Common systems are the Traditional, Design and Build (DB), Management, Alliance, Build Operate and Transfer (BOT), and Public Private Partnership (PPP) (Brook, 2008; Murdoch & Hughes, 2008).

In the Traditional procurement system the design is very often completed (or near completion) before construction begins, thus the certainty of a tender price is higher because the project scope is well defined. In terms of TCs one could hypothesize that relative to other procurement systems its pre-contract costs are likely to be higher because of the time spent in defining the project scope before construction begins. With systems such as DB, BOT, and Management, it is more probable to commence construction before designs are completed. According to Brook (2004) such systems (DB, BOT, and Management) could benefit from speedy construction because the design and construction phases have been integrated.

Although incomplete documentation is often a source of uncertainty, it could pose difficulties to cost prediction and estimation. TCs for these integrated systems may be comparatively lower at the pre-contract phase but higher if and when implementation problems occur as a consequence of incomplete designs. Conversely with Alliance procurement systems, TCs at the pre-contract phase could comparatively be the highest because of the level of preparatory activities involved in setting up alliances.

Therefore, a theoretical explanation of TCs estimates for different procurement systems is needed to raise the growth of practical arrangements, and to assess under which circumstances they are suited for certain purposes. This study aims at estimating the TCs for different procurement systems used in construction. Specifically estimates the relative values of TCs for the Traditional and Design-Build systems for the purpose of comparison. This is achieved by developing a measurement model for TCs of different procurement systems. The developed model is expected to improve a firm's performance through the minimization of costs, enhanced productivity, and overall project owner satisfaction.

2.4.1 Tendering and TCs

"Although an estimator will have a feel for the prices in the marketplace, it is the responsibility of management to add an amount for general overheads, assess the risks and turn the estimate into a tender" (Martin, 2004)

The tender phase of a project — involving the acquisition of complex services or systems — is a critical factor in ensuring the ultimate success of the project (Price, 2010). Theoretically, it marks the beginning of a contractual relationship between client, construction contractors, sub-contractors, suppliers, and consultants

(Hackett et al., 2007; Chinyio, 2011). The tendering process enables the party seeking tenders to: identify potential suppliers, conduct due diligence, seek ideas and innovation, obtain a competitive price, and obtain proposals that comply with its stated objectives and requirements (Price, 2010).

The tendering cost contributes to the TCs element of their overheads (administration and support services) and it is added to a successful tender (Chinyio, 2011). For example, in the UK for large projects, such as Finance Initiative (PFI) or Build Own Operate Transfer (BOOT) contracts, bidding costs can be several millions of pounds (Brook, 2008). If the schemes are successful, overhead costs are recovered otherwise written off against annual profits for unsuccessful schemes (Martin, 2004). According to Tang et al. (2003), the significant amount of time and effort involved in the tendering process is unnecessarily wasteful to the construction industry (Tang et al., 2003). Hughes, *et al.* (2006) explained that the result of tendering waste is resulting from: ambiguity of competition, excessively long tender lists, diverse pre-qualification practices, and poor quality and timing of information for bidders were identified as wasteful practices in tendering. If such wasteful practices can be removed or minimized, it might be possible to lower tendering costs (Hughes et al., 2006).

However, proceeding with a tender is based on several factors including: - resources availability, competition level, the time it takes, quality of documentation, type of work, location, current workload, and conditions of contract (Brook, 2004). Three types of tendering mechanism are commonly used. An open tender, which is publicly notified and because of every tender should be considered, the tender may be costly because of the high level of TCs (Chinyio, 2011). A selective tender where an invitation to tender is sent to a group of contractors, the advantages of this type is reduced time and cost. A selected tender where an invitation to tender is sent to only one contractor (Brook, 2008; Chinyio, 2011; Finch, 2011). Finally, it is uncommon for parties to enter a construction contract without pre and post tender correspondence (Brook, 2008). The tenderer usually queries prior to the submission of its tender and there are often negotiations over specific provisions. This includes requests for information designed regarding uncertainties (Finch, 2011).

At tender stage, the employer introduces some competition either by open tendering or selective tendering, which is followed by clarification of the agreement and negotiation (Chinyio, 2011). The number of contractors invited to submit tenders/proposals should be limited to three or four firms in order to reduce high tendering costs (Hackett et al., 2007). This process often takes three to four months and is longer for more complex projects. In addition, the negotiations between extensive specialist and statutory bodies require even more time (Martin, 2004). This causes a discrepancy in the employer's requirements and the contractor's proposal prevails without any adjustment to the contract sum. As a result of the aforementioned issues, *the cost of unsuccessful designs and tendering is a heavy contractor's overhead costs and passed on to clients.*

Therefore — in the tendering process — the overhead costs are TCs incurred in searching and gathering information about buyers and sellers, writing and negotiating contractual agreements, setting up the mechanisms for obtaining tenders and administering their execution (Walker & Wing, 1999). TCE assumes that transaction costs are incurred because of bounded rationality and opportunism of human behavior and the characteristics of transactions — here asset specificity is involved (Williamson, 1985). In tendering, the bounded rationality is due to limitations in the human ability to process information. While, the opportunism is due to self-interest among actors that deviate from the letter and the spirit of an agreement when it suits their purpose (Williamson, 1985). Artz (1999) claimed that TCs heavily affect buyer-supplier exchange (Artz, 1999). This statement was supported by many researchers such as (Dyer, 1996; Rindfleisch & Heide, 1997; Buvik & Haugland, 2005; Rindfleisch et al., 2010).

Lastly, because of the global economic downturn, businesses have to adjust their expenditure to survive. Here, the dangers of high overheads and TCs become clear, and managers need to take extra attention in managing these costs. Researchers (Nimocks, 2005; Andrews & Boyne, 2009; Chao, 2010) were suggested ways to improve efficiency pertaining overheads costs. These include minimizing time gaps in deliverables, outsourcing some functions, consider alternatives for operations processes, consolidate certain activities, etc.

2.4.2 Impact of Procurement System on TCs

The procurement system implemented on any project has a significant impact on the TCs associated with the pre-contract phase and post-contract phase (Dudkin & Valila, 2005; Whittington, 2008b; Solino & Gago de Santos, 2010).

Pre-contract costs relate to activities carried out during initiation, preliminary design, negotiation and contracting, and feasibility studies. These include the cost of information search such as information gathering and communication. Also, the cost of project procurement such as attending meetings, translation of client's needs, project preliminary design, transition observation, training, and site visits. According to Whittington (2008), a study of public/private partnership projects (PPPs) in the U.S., pre-contract transaction costs in projects procured using

Traditional systems may amount to between 0.4% and 8.8% of the value of the contract. While for projects procured using Design-Build systems, the TCs may amount to between 0% and 5.7%.

Post-contract costs are commonly associated with monitoring and control, dispute resolution, and implementation activities for projects. Including the cost of contract administration such as administration, conflicts resolution, and decision-making. In addition, the cost of contract enforcement such as enforcement and verifying compliances cost. In countries such as Australia, the U.K and U.S.A, conflicts and disputes could inflict a high cost on the construction industry (Li et al., 2012), while the situation is similar in New Zealand. Whittington's (2008) shows that in Traditional procurement systems, post-contract TCs may amount between 8.9% and 14.7% of contract value. While for Design-Build systems it ranges between 3.4% and 14.3% of the contract value.

2.4.3 Procurement Selection

Procurement is a major improvement area and a crucial element contributing to project success, and the selection of optimal procurement system is an important and difficult step in project execution. The criteria for choosing a suitable procurement system is based on client's objectives and priorities and influenced by project constraints. Procurement path determination chart has largely dominated research in procurement selection process in construction. Eight factors need to be considered by the client when developing procurement selection criteria. At the procurement strategy the focus should be on factors such as cost, quality, and time, while at the procurement operation the consideration should focus on complexity, certainty, risk, responsibility, and degree of control by the client. However, including certain criteria and ignoring the magnitude of TCs associated with the environmental uncertainties simplifies this process.

Relationships in the form of buyer-supplier relationships have been the object of several investigations in construction (Al-Najjar, 1995; Artz, 1999; Eriksson, 2007; Bajari et al., 2009; Kajewski et al., 2010). However for the purpose of this research, the costs associated with customer-supplier relationship in the context of contractual arrangements is the primary focus. TCE focuses on economic actors' behavioral assumptions (opportunism and bounded rationality) and transaction characteristics; i.e. asset specificity, uncertainty, frequency, complexity, and contestability (Williamson 1985). Heide and John (1990) contend that TCE provides a useful framework for the selection of the most suitable procurement system for projects.

Eriksson (2007) argued that the procurement selection decisions are always judgmental, subject to bias, and heavily affected by individual experiences of a particular procurement system. Given that TCs is such a significant component of construction procurement, and that the procurement decision is highly cost sensitive, it seems apparent that there is a need to better evaluate TCs in construction procurement. As early as 1985, Williamson suggested that the comparative costs of planning, adapting, and monitoring task completion under alternative procurement systems should be examined. Moreover, Turner (1997) expanded the notion to contemplate other important factors such as engineering, economic, environmental, and social factors, in the procurement selection process (Turner, 1997). Therefore, theoretical explanation is required to enhance the development of practical concepts and techniques, and to assess the circumstances under which they are suitable for a certain purpose (Cox et al., 1998).

Theoretical concepts of applying TCE to the procurement selection process are supported by several empirical studies (Heide & Stump, 1995; Artz, 1999; Melese & Franck, 2005) and will be discussed later in Chapter Three. Although, researchers within the TCE field suggest the applicability of transaction costs theory in explaining the customer-supplier relationship in the context of contractual arrangements, some have employed imperfect proxies for key variables. As stated earlier in this chapter, TCT contends that there are costs to conducting transactions through the market, which can be reduced through certain mechanisms. Specifically, these costs relate to drafting, negotiating, and safeguarding an exchange that could impede smooth transactions (Williamson 1985). Further, changes in design and information requirements for procurement are significant to TCs in construction (Wenan & Mengjun, 2010).

This study addresses the shortcoming in procurement selection by adding to existing evaluation criteria, the TCs incurred because of information gathering, procurement, contract administration and enforcement, and external and internal environmental uncertainties. This is achieved by developing a conceptual framework model for procurement selection based on TCs. Uncertainties inherent in the transaction environment have a positive or negative impact on the costs of information gathering, procurement, contract administration, and contract enforcement. These costs are the main contributors to high TCs.

The proposed model represents an analytical form of a suitable combination of factors that influence the amount of TCs in construction procurement, which could be used in procurement decisions. It will increase the understanding of how efficient procurement selection of construction projects can be achieved through appropriate procurement procedures, which could positively impact the project performance.

2.5 Environmental Uncertainties in Construction

Environmental factors refer to institutions or forces outside the organizations that can potentially affect an organization's performance (Wright & Race, 2004). They are external and internal forces of an organization that shapes its operation and thrust (Aaker & Mills, 2005; Aldrich & Ruef, 2006; Daft, 2009). As shown in the Figure (2.3) Political/Legal/Social, Economical, Competition, and Technology refer to external uncertainties. While Corporate Culture, Project Location, Finance/Ownership, and Information Systems that represent internal uncertainties (Williamson, 1985; Wright & Race, 2004).

Environmental analysis is the process of identifying and understanding: - opportunities and threats created by external uncertainties (forces), and strength and weakness created by internal uncertainties (Aaker & Mills, 2005; Daft, 2009). It also refers to the process of assessing and interpreting the information gathered throughout environmental scanning when managers adopt certain strategies (Elliott et al., 2008). Resulting in financial benefits such as improvement in sales, profitability, and productivity, also, non-financial befits such as improved understanding of competitors' strategies, reduced resistance to change, and enhanced problem-prevention capabilities (Marcus, 2005; Grimm et al., 2006; Foss & Foss, 2008).

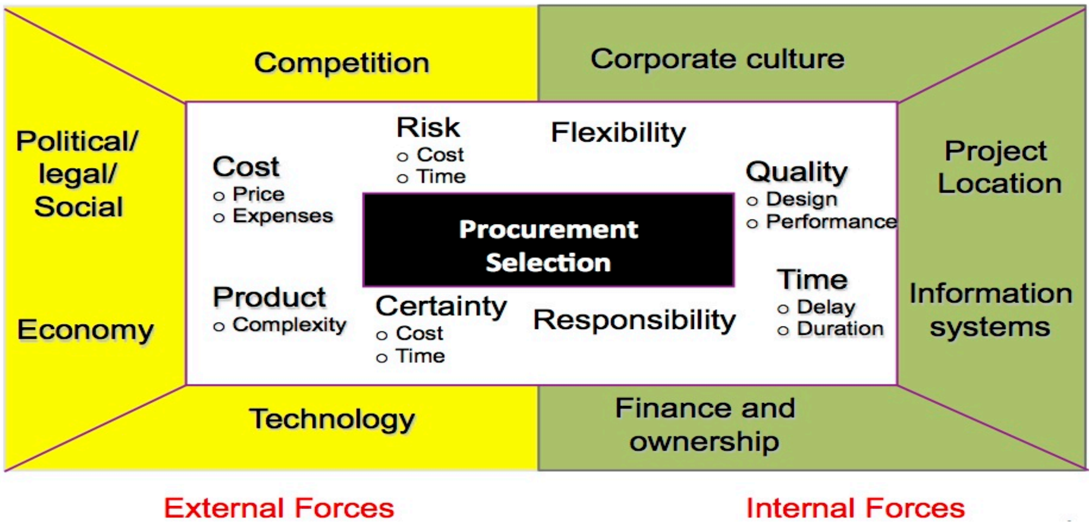


Figure 2.3: Own Depiction of Environment Uncertainties Based on Wright & Race, 2004

For instance, *legal and regulatory forces* are a number of federal laws that setup the mechanisms for implementing the contractual agreements that may influence organizations strategies such as procurement (Wright & Race, 2004; Grimm et al., 2006; Hitt et al., 2006; Elliott et al., 2008). They represent a safeguard for people who enter in contractual agreement. For example, in New Zealand, The Building Act (NZS 3902:2004) introduces the mechanisms and approaches, which might have a positive or negative impact on all aspects of the construction industry (Housing & Building, 2009).

Economy has a significant impact on the organization's strategy. It includes exchange rates, interest rates, population growth, house sales, building permits, the consumer price index, the average wage, unemployment rate, and other statistics (Wright & Race, 2004). These factors help strategy decision-makers in identifying special risks or threats of an organization (Aaker & Mills, 2005). On the other hand, changes in general economic conditions have a broad impact on the success of an organization's strategy because of changes in supply and demand, consumer expenditure levels, buying power, and the intensity of competitive behavior (Elliott et al., 2008).

Culture adverts to the combination of beliefs, norms, and values of people forming an organization (Hofstede, 1998; Schermerhorn et al., 2002; Ankrah et al., 2009). According to PMI (2008), it is the unique norms that the organization adopts in achieving its goals. Including Shared visions, values, believes, and expectations. Defining organization's policies, methods, and procedures. With a clear view of authority relationships, work ethic and work hours. Culture is one of the enterprise environmental forces that a project manager needs to understand, specifically when the project involves different organizations. A strong culture means individuals know how things are done and what is expected. Resulting in less shirking, poaching, etc. that minimize the TCs associated with behavioral uncertainties. On the other hand, in a weak culture individuals may not react in the manner that management would expect, which results in increased in TCs (Wright & Race, 2004). Accordingly, the perception of service can be enhanced at very little extra cost if a strong organizational culture exists.

The impact of environmental uncertainties on TCs and procurement decision is presented in the following sub-sections.

2.5.1 Impact of Environmental Uncertainties on TCs

TCE proposed that uncertainties affect the ability of contracting parties to fully specify the range of contingencies for unforeseen events that may disturb the project success. The costs of identifying contingencies increase rapidly in a complex and uncertain environment (Walker & Pryke, 2009). Consequently it becomes more costly to write a fully specified contract (Williamson, 1985;

Brouthers & Nakos, 2004). In this research, uncertainties inherent in the transaction environment have a substantial impact of the magnitude of TCs that are associated with information gathering, procurement and tendering, contract administration, and contract enforcement. The key factors in generating TCs are bounded rationality in the face of uncertainty and complexity, and opportunism in the context of small numbers of bargaining (Williamson, 1981).

Dealing appropriately with uncertainties in the transaction environment is an essential success factor for a project. It can avoid a great deal of conflict and disputes during project execution (Li et al., 2012). According to Elliott (2008), managers react to environmental uncertainties by accepting them as uncontrollable factors, and they try to adjust the current strategies to meet changes in these factors. Resulting in reducing organization flexibility in meeting change in demand or adopting technologies that are not sufficient any more. Therefore, managers should consider a trade-off between the degree of contractual completeness and marginal costs and the benefits of contractual completeness.

2.5.2 Impact of Environmental Uncertainties on Procurement Decision

Unlike other industries, construction is categorized as a complex, uncertain, and subject to high risks. Thus, an inappropriately defined project scope because of complexity and uncertainty increases conflict and disputes during project execution. Technical specifications, responsibilities, and terms and conditions should be complete and clear in the contractual agreements.

Various researchers support ‘environment’ as a factor affecting the procurement decision. Duncan (2009) posits that lump sum and cost reimbursement systems were the procurement trend, post-war regeneration (1946-1969). During the

1970-1979 period of high inflation, an increasing preponderance of clients started to use management contracting in order to save some money (Duncan, 2009). Meanwhile the sub-prime market collapse in 2009 was reported to have caused a shift in procurement trend to Design-Build (Duncan, 2009). Brochner (1990) suggested IT improves coordination between team members, quality control/product inspection, and translation of client needs. Other determinants of procurement systems include: corporate culture (Wright & Race, 2004), market competition, technology (Schermerhorn et al., 2002; Duncan, 2009), project location (Hughes et al., 2006), finance situations and project ownership.

2.6 Summary of TCE

The TCE approach provides a useful framework for analyzing uncertainties in the transaction environment. It focuses on economic actors' behavioral assumptions (opportunistically and bounded rationality) and transaction characteristics; i.e. asset specificity, uncertainty, frequency, complexity, and contestability (Williamson, 2005b).

The primary contention is that, the cost of construction is not only the production costs but also costs of quality (e.g. maintenance, disposal, and social) and costs of acquisition. The costs of acquisition such as procurement (contracting) cost, information cost, administration cost, and enforcement cost are important factors in choosing the appropriate procurement system. "Contracting or procurement cost" adverts to the costs associated with preparing tendering documents, negotiating, and writing a contractual agreement. "Information cost" refers to the cost associated with gathering information (e.g. technical, financial, and legal) and communication, to identify and evaluate potential trading partners.

“Administration cost” refers to the costs associated with contract administration, decision-making, and conflict resolutions. “Enforcement cost” refers to the costs linked with ex-post bargaining and sanctioning a trading partner that does not perform according to the agreement, and costs of monitoring the agreement. These costs are known as transaction costs in the study of the economics of organizations (Coase, 1937; Williamson, 1981).

Recent studies have shown generally that the New Zealand construction industry has poor productivity (Tran & Tookey, 2011). More broadly this recognition has led to extensive efforts to see a 20% increase in productivity by 2020 (see www.buildingvalue.co.nz). Since productivity is a function of cost versus revenues, developing and improved understanding of the basis of costs offers significant potential to affect construction productivity. Therefore, there is a current pressing need to examine the relationship between the procurement system and TCs in the New Zealand construction industry. In this study, the impact of the procurement system on transaction costs is conceptualized in a framework model for procurement selection. The conceptualized framework is developed further in the following Chapter (3).

CHAPTER THREE

Theoretical and Conceptual Framework

3.0 Introduction

This chapter seeks to develop a conceptual relationship between procurement systems, transaction costs, and environmental uncertainties in construction's projects (objective four). It also develops interactive effect hypotheses to address objective three. Objective three is to investigate whether environmental uncertainties and project phases would interact to influence the client's procurement decision. To achieve these objectives (four and three), common TCs incurred at project procurement should be determined first (objective one). Also, the extent to which TCs are influenced by procurement decision should be assessed (objective two). The chapter presents the main concepts of the study. It reviews the relevant empirical studies for procurement systems in construction, environmental factors for the firm, and the application of the concept of TCs in construction.

Building on the review, the chapter addresses objective five of this study by developing concepts in the context of construction procurement and its effect on the magnitude of TCs incurred as a result of professionals conducting procurement activities. Findings from previous empirical studies contribute by formulating several sub-hypotheses, which depict how interrelated variables affect one another; such as the relationship between constructs of information cost, procurement cost, administration cost, enforcement cost, procurement systems, project phases, and environmental uncertainties. Finally, the chapter presents a structural path model that guides the research in its data collection and analysis.

3.1 Transaction costs in Construction

Ronald Coase first introduced the concept of TC in 1937 (Jacobides, 2008). He subsequently further investigated pricing mechanisms and concluded that there are costs related to searching for relevant prices, negotiating, and making a contract (Coase, 1937). Williamson (1985) developed the theory of TCE by focusing on the economic actors' behavioral assumptions (opportunism and bounded rationality) and transaction characteristics (asset specificity, uncertainty, frequency, complexity and contestability). He concluded that economic actors behaving opportunistically with bounded rationality and uncertainties dominate contracts. Importantly TCE has traditionally examined the customer-supplier relationship in the context of a contractual arrangement. With the assumption, that this relationship is associated with TCs including costs of information, negotiation, competitive advantage, contract administration and management, market structure, enforcement and measuring/monitoring of performance (Heide & Stump, 1995; Artz, 1999; Melese & Franck, 2005).

The TCs perspective has received considerable attention by researchers and academics and has been applied to a variety of construction topics (Li et al., 2013). Firstly, in evaluating the project organization in order to determine the most suitable governance structure (Winch, 2001; Müller & Seuring, 2007; Jobin, 2008). Secondly, in investigating construction contracting and sub-contracting (Eccles, 1981a; Gunnarson & Levitt, 1982; Reve & Levitt, 1984; Winch, 1989; Bremer & Kok, 2000; Bajari & Tadelis, 2001b; Turner & Simister, 2001; Miller et al., 2002;

Aibinu et al., 2011). Thirdly, in determining the most applicable delivery systems (Lynch, 1996; Whittington, 2008b). Finally, in measuring and evaluating the quantities of transaction costs in construction projects compared to other construction activities (Dudkin & Valila, 2005; Antinori & Sathaye, 2007; Ho & Tsui, 2009; Farajian, 2010; Solino & Gago de Santos, 2010). The rationale behind the application of TCs in construction is to understand the cooperation and motivation among project stakeholders.

Eccles (1981) conducted an investigation on the impact of asset specificity and uncertainty in the governance form of construction firms (Eccles, 1981b). He examined the relationship between contractor and sub-contractor utilizing the transaction costs concept. Eccles concluded that by adopting the hybrid contract (the quasi-firm) the risk of uncertainty and asset specificity could be minimized. Winch (1989) applied the transaction costs perspective to investigate the relationship of socio-technical systems, organization and environment, and project management in construction. Winch believed that the three perspectives alone do not fully expose the differentiation and integration of market governance. This means that in the transaction environment, the market governance model does not fully examine the relationships between firms (Winch, 1989). Hence, Winch adopted the TCs perspective as an alternative approach in systematically handling the relationships within and between firms. The significance of this Winch study was in specifying the sources of uncertainty, complexity, and number of these situations facing construction firms.

Further, Reve and Levitt (1984) examined the effect of applying the transaction costs framework in explaining contractual uncertainties and in determining resource allocations uncertainties in construction using the project as a unit of analysis. However, construction projects do not of themselves allocate resources (Reve & Levitt, 1984). Resources such as land, labor, and capital are allocated by individual firms, which involved in the delivery of the project. This in turn is dictated by the requirements of the client. In similar view, Alsagoff and McDermott (1994) discussed applying TCE theory to explore the causes of disputes between clients, contractors, and subcontractors in the construction industry. They concluded that contractual incompleteness and opportunism are the root causes of conflicts and disputes between firms. Therefore, they introduced the relational contracts as alternative contractual approach in resolving conflicts among contractual parties (Alsagoff & McDermott, 1994).

Another viewpoint on applying TCE in construction was introduced by Walker and Wing (1999). They developed a framework explaining the possibility of integrating project management theory (PMT) and TCE. Walker and Wing tried to delineate the relationship between these approaches and the benefits of merging the two approaches in improving construction management theory. A comparison of a traditional organization structure and a design-build structure should be made to illustrate this relationship (Walker & Wing, 1999). By doing so their study tried to answer why design and construction processes are separated in the traditional system. Walker and Wing believe TCs theory provides an alternative theoretical basis, which can be integrated with the project management perspective to achieve the best structure model of an organization. The strength of this study in underpinning the behavioural assumptions of TCs theory, such as opportunism, moral hazard, and shirking that the management theory could not cover.

In contrast to other studies, Chang and Ive (2000) proposed modifications to the methods that researches used in measuring the TCs constructs and make it applicable to construction management research. They developed the direct measurement approach (DMA) and indirect measurement approach (IMA) to predict theoretically the amount of TCs in the procurement route. The DMA based on the identification and measurement of TCs elements, while, the IMA explained the relative effectiveness of governance structures in terms of TCs (Chang & Ive, 2000). Moreover, they tried to quantitatively analyze TCs elements to explore the link between these costs and procurement routes during construction. The weakness of Chang and Ive study is in dealing with theory for measuring TCs, thus the distinction between production costs and TCs became less clear.

Further, Dudkin and Valila (2005) – a study in the UK construction industry – tried to measure the TCs in the procurement phase for a project procured using private/public partnership delivery system. They concluded that the private/public partnership projects (PPPs) in the UK are continually affected by the significant costs related to the pre-contract phase of infrastructure projects. It amounts to an average 2-3% of the capital value of the project (Dudkin & Valila, 2005). A similar idea expressed by Ho and Tsui (2009) who addressed other TCs that affect private/public partnership performance, for example, opportunity costs due to renegotiation and hold-up problems. They concluded that the opportunity costs combined with hold-up problems, might significantly undermine the expected benefits of private/public partnership projects (Ho & Tsui, 2009).

Similarly, Jin and Zhang (2011) developed a framework for risk allocation decision-making process for public/private partnership projects (PPPs) based on TCs characters. In this framework, the determinants of efficient risk allocation strategy for PPPs were identified based on TCs theory. As a result, the outsourcing decisions can be taken based on the risk response evaluation for adopting certain strategies. Using a proper risk allocation strategy can significantly reduce TCs (Jin & Zhang, 2011). This is because risk allocation strategy has been judged on a cost benefit basis. Therefore, improper strategy might incur costs such as; higher contingency costs, more resources to monitor risk, quality, safeguarding, enforcement, and legal costs.

Expressed differently, Frank et al. (2007) investigated the relationship between outsourcing and the characteristics of TCs (i.e., asset specificity, uncertainty, complexity, and frequency). They found that outsourcing relationships could involve extra TCs such as negotiation, measuring, and monitoring costs that can quickly overwhelm a 10% production cost advantage (Frank et al., 2007). Importantly, TCE provides useful perspectives for improving acquisition management practices by tracking the hidden costs of managing contractual relationships. It offers useful insights on appropriate contract types, provides useful predictions about how contracting relationships evolve over the project's life, and highlights the crucial issue of resource ownership and the associated problem of asset specificity.

Most of the aforementioned studies have focused on the theoretical and qualitative aspects of transaction-related issues, but neglected to contemplate the relationship between transaction-related issues and procurement systems. For example, some studies employed imperfect proxies for key variables and others developed models that have not directly tested the parameters of the transaction costs theory. Nevertheless four key characteristics of transactions can make them more costly: complexity, uncertainty, frequency, and asset specificity (Williamson, 2010a). Therefore, understanding the key characteristics of a transaction can help decision-makers improve the design of contracts, organizations, and other governance structures that could reduce TCs and improve the gains from an exchange between buyers and sellers (Williamson 2008).

Williamson (1985) classified the costs of: drafting the contract, negotiating and enforcing the agreement, and governance and bonding, as transaction costs. Joskow (1990} expanded on TCs by adding the costs of: acquiring and processing information, legal, management and administration, and operational waste. Further, Lingard et al. (1998) distinguished between pre and post contract transaction costs. Pre-contract transaction costs included information and procurement costs and related to the activities carried out during initiation, preliminary design, negotiation and contracting, and feasibility studies; while post-contract transaction costs included administration and enforcement costs and commonly associated with monitoring and control, dispute resolution, and implementation activities for the projects (Barthélemy & Quélin, 2006; Li et al., 2012). These costs are incurred because of professionals conducting procurement activities during project phases.

The aim of this research is empirically examining the impact of procurement systems on the magnitude of transaction costs. This research tests the hypothesized relations between procurement systems and transaction costs. Structural analysis modeling is used to test construct validity and to predict the relationships within the model. The model sets the mechanisms in selecting the most appropriate procurement system based on TCs.

The following sections will explain the relationship between the transaction costs elements, procurement systems, project phases, and environmental uncertainties.

3.2 Pre-contract Costs Versus Transaction costs

There are costs incurred before a contractual agreement is signed between parties to any contract. Pre-contract costs are incurred when dealing with outside suppliers/or contractors. They include the costs associated with: information, negotiation, competitive advantage, and management. In this research the pre-contract TCs are the costs associated with professionals search for information and professionals conducting procurement activities during initiation, development, and early implementation phases of the project.

Construction professionals search the market for information about opportunities such as products, prices, demand, supply, trading rights, and market outlets (Hobbs, 1996; Solino & Gago de Santos, 2010). Therefore the consequences of seeking information are tangible forms of transaction costs. For example personnel time (professional), travel expenses, communication costs, advertising/promotion costs, and consulting/service fees. While procurement cost is attributable to environmental and technical uncertainties connected to projects. Hence to provide some certainty to project details, it will be necessary to undertake environmental assessments, feasibility studies, preliminary design, preparation of tender documents, bargaining, and training. These pre-contract activities have tangible forms of costs (TCs) attached to them such as environmental assessment fees, cost of the feasibility study, preliminary design cost, bargaining costs, training, consulting/service fees, licensing fees, and insurance premiums (Hobbs, 1996; Solino & Gago de Santos, 2010).

According to Dudkin and Valila (2005) study in infrastructure projects, the procurement phase alone accounts for average of 10% of the capital value of these types of projects. They conclude that pre-contract transaction costs is between 2%

and 3% of the contract value. Similarly, Whittington (2008) concludes that pre-contract transaction costs in infrastructure projects procured by the traditional systems amount up to 8.8% of the contract value; while for infrastructure projects procured by Design-Build systems accounts for up to 5.7% of the contract value. The cause of high pre-contract TCs for project procured in traditional system is that the design is very often completed before the construction begins, thus the certainty of a tender price is higher because the project scope is fully defined.

Tendering cost contributes to the TCs element because of the overheads (administration and support services) and it is added to a successful tender (Chinyio, 2011). For example, in the UK for large projects, such as Finance Initiative (PFI) or Build Own Operate Transfer (BOOT) contracts, bidding costs can be several millions of pounds (Brook, 2008). If the schemes are successful, the tender winner recovers overhead costs from the operational turnoffs of the project, otherwise written off against annual profits for unsuccessful schemes (Martin, 2004). According to Tang et al. (2003), the significant amount of time and effort involved in the tendering process is unnecessarily wasteful to the construction industry (Tang et al., 2003). Hughes, *et al.* (2006) explained that tendering waste result from: competition uncertainties, excessively long tender lists, diverse pre-qualification practices, and poor quality and timing of information for bidders. If such wasteful practices can be better managed, it might be possible to lower tendering costs (Hughes et al., 2006). Therefore – in the tendering process – the overhead costs are TCs incurred in searching and gathering information about buyers and sellers, writing and negotiating contractual agreements, setting up the mechanisms for obtaining tenders and administering their execution (Walker & Wing, 1999).

In the current research, procurement cost is refers to the costs associated with professionals conducting the activities involved in putting the design and construction contracts in place. Information cost is the costs associated with information search for legal, technical, and financial advice, and information flow or communication between design and construction organizations. Transaction costs theory is based on the assumption of bounded rationality and opportunism of human behavior and the characteristics of transactions – here is asset specificity involved (Williamson, 1985).

In tendering, bounded rationality is due to limitations in the human ability to process information. While, opportunism is due to self-interest among actors that deviate from the letter and the spirit of an agreement when it suits their purpose (Williamson, 1985). These elements of human behavioral assumptions represent significant lost resource, generating documents and information transfer and leading to increase TCs (O'Brien & Al-Soufi, 1993; Green et al., 2005). This is reflected in administrative, technical, and professional staff growing at the expense of tradesmen and operatives (DETR, 1998; Lockyer & Scholarios, 2007). Therefore, as the cost of information increases, there will be higher transaction costs incurred. On the other hand, more detailed information and requirements should be developed to ensure that the owner end up with the appropriate procurement systems.

In line with the assumptions of human bounded rationality and behavioral uncertainties of the contractual parties are reflected in administrative, technical, and professional staff growing at the expense of tradesmen and operatives. The following hypotheses are formulated and presented in Figure 3.1 to represent the relationship between transaction costs and procurement cost, and between transaction costs and information gathering cost.

H1: Project procurement cost (PPROC) would have a positive effect on transaction costs (TCs).

H2: Information gathering cost (INFO) would have a positive effect on transaction Costs (TCs).

H3: Information gathering cost (INFO) would have a positive effect on project procurement cost (PPROC).

In addition, because of the influence of information gathering cost (INFO) on project procurement cost (PPROC), it is reasonable to hypothesize that there is an indirect relationship between information gathering cost (INFO) and transaction costs (TCs) through project procurement cost (PPROC) as follows:

H3a: Project procurement cost (PPROC) would mediate the relationship between information gathering cost (INFO) and transaction costs (TCs).

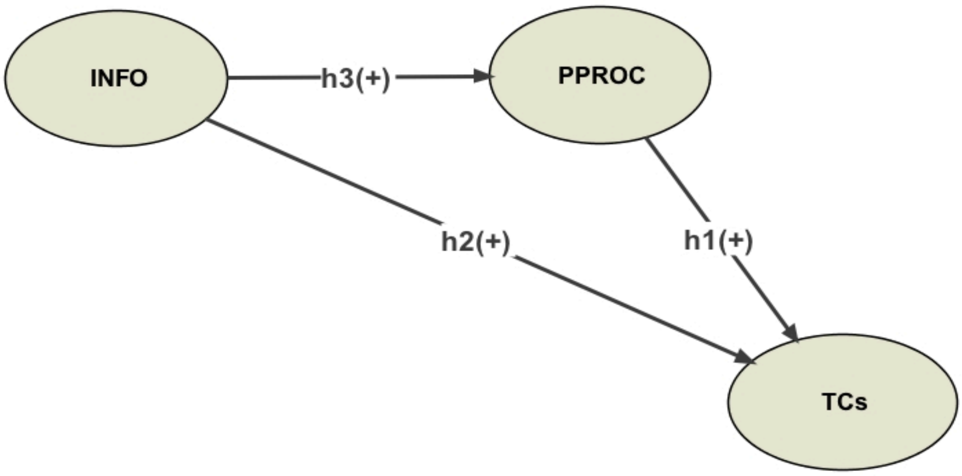


Figure 3.1: Model of the Relationship Between Pre-contract Cost and TCs

3.3 Post-contract Cost versus Transaction costs

Post-contract costs are incurred after the contractual agreement has been signed when dealing with outside suppliers/or contractors. They include the costs of contract implementation, monitoring and enforcement, and administration/or management. In this research post-contract costs are borne because of contract enforcement and administration/or management. Contract enforcement cost is associated with conducting activities such as monitoring and control and verifying compliances. While contract administration cost is associated with conducting activities such as contract administration, conflict resolution, and decision-making. The source of enforcement cost is uncertainties about transaction compliance with specified terms, possible changes in the quality of goods and services, the level of damages to a transacting party arising from contractual non-compliance, and the use of third party in solving disputes (Hobbs, 1996; Solino & Gago de Santos, 2010). Therefore the consequences of enforcing the contract are tangible forms of transaction costs. For example personnel time, auditing fees, inspection charges and investments in measurement devices, arbitration, legal court fees, and costs to bring social pressure. While, the source of management costs is uncertainties about: the willingness of others to trade on certain terms, making sure the other party sticks to the terms of the contract, the rights and obligations of the parties, and decision-making. These uncertainties are reflected in tangible forms of transaction costs such as personnel time, travel expenses, communication, consulting/service fees, licensing fees, and insurance premiums (Hobbs, 1996; Solino & Gago de Santos, 2010).

According to Whittington (2008), post-contract costs in infrastructure projects procured by the traditional systems amount to between 8.9% and 14.7% of the contract value; while for infrastructure projects procured by Design-Build systems amount to between 3.4% and 14.3% of the contract value (Whittington, 2008a). The cause of higher post-contract costs in traditional procurement system that the owner very often bares the costs of contract implementation, resolving disputes, and monitoring and control. They are included in cost estimates as unforeseen and management contingencies. Williamson (1985) assumed that the contingencies are transaction costs incurred because of two behavioral assumptions: bounded rationality, in the face of uncertainty and complexity, and opportunism in the context of small number of bargaining. Although human agents are intended to be rational, in an economic sense, complex contracts are inevitably incomplete, containing gaps, and errors. Similarly Williamson assumes human agents act opportunistically, e.g. self-seeking with guile, which means they not only purse self-interests but also apply false threats or promises. This type of behavior could subject the contracts to affect contracts adversely results.

In this research, enforcement cost are the costs associated with professionals carrying out to put the contract terms and conditions in place. While administration/or management cost are the costs associated with professionals verifying the compliances, renegotiation, dispute resolution, communication, and decision-making (Lynch, 1996; Tridico, 2007; Farajian, 2010; Williamson, 2010b). Transaction Cost Theory (TCT) contends that there are costs of conducting transactions through the market. Specifically there are costs in drafting contracts, negotiating, and safeguarding exchange that is impeding smooth transactions (Williamson, 1985). Transaction cost analysis emphasizes the need for formalized governance mechanisms such as formal contracts, rules and regulations, reputation mechanisms, termination agreements, and warranties. Also, appropriate strategies, for example, long-term agreements and alliances. Implementing these two policies, the construction firm can eliminate the risk associated with uncertainty, few numbers of bargaining/or opportunism and asset specificity. In the mean time eliminating coordination and motivation cost, which in fact reduces the TCs (Angelis et al., 2008).

The construction industry is characterized as being complex, fragmented, having a lack of coordination and communication between participants, with adversarial contractual relationships, and unique (Eccles, 1981b; Winch, 2000; Turner & Simister, 2001; Thompson, 2003; Brochner, 2010; Love et al., 2010; Hu et al., 2011). Each project is unique in construction type, location, and project team-members; also, the project is temporary by nature. The industry, continually suffers from high levels of claims, counterclaim, and litigation (Arditi et al., 2000). Conflicts occur in the construction industry because of organizations fragmented nature, contract's language ambiguity, on-site operations uncertainty, and low profit margins. Gardiner & Simmons's (1995) outlined that most conflicts occur in the organizational level are due to quality control issues, while at the project level, they occur in the design stage (Gardiner & Simmons, 1995). Given the nature of the industry and the complex relationships between parties, it is hard to eliminate conflicts totally. Kumaraswamy (1998) argued that healthy reconciliation of constructive conflict leads to synergistic scenarios which resulting in enhancing the project performance such as better designs, construction methods, and other operations (Kumaraswamy, 1998).

Accordingly, the nature of the construction industry is the major contributor to resource loss in construction (O'Brien et al., 1995; Green et al., 2005; Forbes, 2006), creating gaps between design and construction processes, requiring high coordination between stakeholders, disputes and generating documents and information transfer (Winch, 1989; Arditi et al., 2000; Cox & Ireland, 2002; Bertelsen, 2003a, 2003b; Green et al., 2005; Ribeiro & Fernandes, 2010). These features are the main contributors to high transaction costs that are reflected in administrative, technical, and professional staff growing at the expense of tradesmen and operatives (DETR, 1998; Lockyer & Scholarios, 2007). This means that cost of allied staff becomes more than the technical staff. Therefore, as the degree of uncertainties in writing a complete contract increases, the administration and enforcement costs are increasing, and resulting in higher transaction costs.

The hypotheses developed to explain the relationships between the variables discussed in this section are formulated and presented in Figure 3.2:

H4: Contract administration cost (ADMIN) would have a positive effect on transaction costs (TCs).

H5: Contract enforcement cost (ENFORC) would have a positive effect on transaction costs (TCs).

H6: Contract enforcement cost (ENFORC) would have a positive effect on contract administration cost (ADMIN).

In addition, because of the influence of contract enforcement cost (ENFORC) on contract administration cost (ADMIN), it is reasonable to hypothesize that there is an indirect relationship between contract enforcement cost (ENFORC) and transaction costs (TCs) through contract administration cost (ADMIN) as follows:

H6a: Contract administration cost (ADMIN) would mediate the relationship between contract enforcement cost (ENFORC) and transaction costs (TCs).

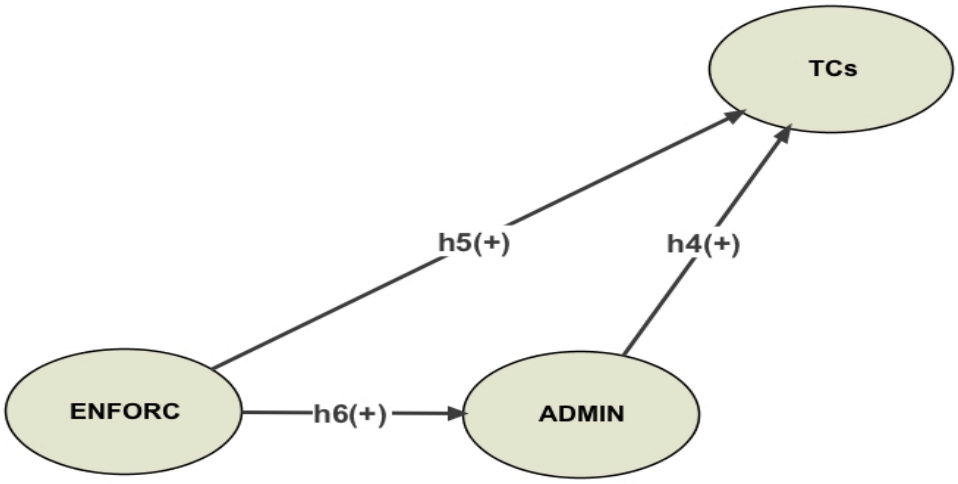


Figure 3.2: Model of the Relationship Between Post-contract Cost and TCs

3.4 Pre and Post-contract Costs versus Transaction costs

The relationship between pre-contract cot, post-contract cost, and TCs has not been thoroughly covered by researchers applying TCE in construction. Researchers confine procurement cost, to the costs of bidding and negotiation, ignoring costs related to contract monitoring and renegotiation during the project implementation phase (Li et al., 2012). In construction, the contractual relationships are commonly between client and designer, client and contractor, and contractor and subcontractor.

The contractual parties normally involved in conducting activities throughout the supply-chain of the project (Pryke, 2009). Cooperation, Information flow and communications between project stakeholders are essential factors in project success. These factors are generally influenced by the fragmented, uncertain, and complex nature of projects in construction. Thus, risk is generated at different levels of the supply-chain such as design and construction risk, financial risk, and market risk. Each of these levels (supply-chain levels) is organized in different ways with associated organizational costs and TCs. For example, in the operation phase, TCs are generated as a result of the time spent by operations personnel in measuring and reporting through the control systems (Winch, 1989). Importantly, the four main TCs incurred throughout the Project Life-cycle are procurement cost, information cost, contract administration cost, and enforcement cost. All these costs will eventually be borne by the client as contractors include them with the bids submitted.

The majority of construction projects continually suffer from high levels of claims, counterclaims, and litigation (Arditi et al., 2000). Competitive tendering based on " my gain-your loss" phenomena. Conflicts occur in construction because of organizations fragmented nature, contract's language ambiguity, on-site operations uncertainty, and low profit margins. As stated earlier most conflicts in the organizational level occur in the quality control stage, and at the project level in the design stage. Given the nature of the industry and the complex relationships between parties, it is impossible to eliminate conflicts totally. So, transaction costs in the post-contract phase are much higher than in the pre-contract phase (Li et al., 2013). However, these costs can be reduced through mechanisms such as procurement practices (Coase, 1988; Williamson, 2008). Hughes et al. (2006) claimed that the commercial costs (i.e. transaction costs) associated with the implementation of most procurement systems were influenced by; market situation, terms and conditions, monitoring and control, and resolving disputes. Transaction cost analysis emphasizes the need for formalized governance mechanisms and proper strategies to eliminate the risk associated with uncertainty, few numbers of bargaining/or opportunism and asset specificity (human and physical assets). These include formal contracts, rules and regulations, termination agreements, and warranties, also, long-term agreements and alliances.

The hypotheses developed to explain the relationships between the variables discussed in this section are formulated below:

H7: Information cost (INFO) would have a positive effect on contract administration cost (ADMIN).

H7a: Contract administration cost (ADMIN) would mediate the relationship between information cost (INFO) and transaction costs (TCs).

H8: Information cost (INFO) would have a negative effect on contract enforcement cost (ENFOC).

H8a: Contract enforcement cost (ENFORC) would mediate the relationship between information cost (INFO) and transaction costs (TCs).

H9: Project procurement cost (PPROC) would have a negative effect on contract enforcement cost (ENFOC).

H9a: Contract enforcement cost (ENFORC) would mediate the relationship between project procurement cost (PPROC) and transaction costs (TCs).

H10: Project procurement cost (PPROC) would have a negative effect on contract administration cost (ADMIN).

H10a: Contract administration cost (ADMIN) would mediate the relationship between project procurement cost (PPROC) and transaction costs (TCs).

The models (Figures 3.1 and 3.2) are now combined and include the above hypotheses and the resulting model is shown in Figure 3.3. In the new model, the negative relationship between information cost and contract administration cost, suggests that the more the information available (financial, legal, technical, etc.), the less administration needed. According to Chang and IVE (2000), incompleteness of information leads to incomplete documentation because of bounded rationality. This results in professionals having to conducting administration activities. This means more administrative wastes/expenses for professionals. While the negative effect of information cost on enforcement cost, suggests that the more detail the contracts are, the less the enforcement activities needed.

Correspondingly, errors in the cost estimate because of lack of information (e.g. materials prices) lead to more likely the contractor is to resort to opportunistic claims to recover their loss (Chang & Ive, 2000; Jin & Doloi, 2008). Consequently, increasing the frequency of quality inspection, and hiring more staff for quality control activities would lead to higher contract enforcement cost. Similarly, the negative relationship depicted in the model between procurement cost and contract administration cost, suggests that the more the procurement activities conducting by professionals before issuing a tender, the fewer administrations needed, for example fewer administration cost and post-contract cost. This results in decreasing in contract administration cost.

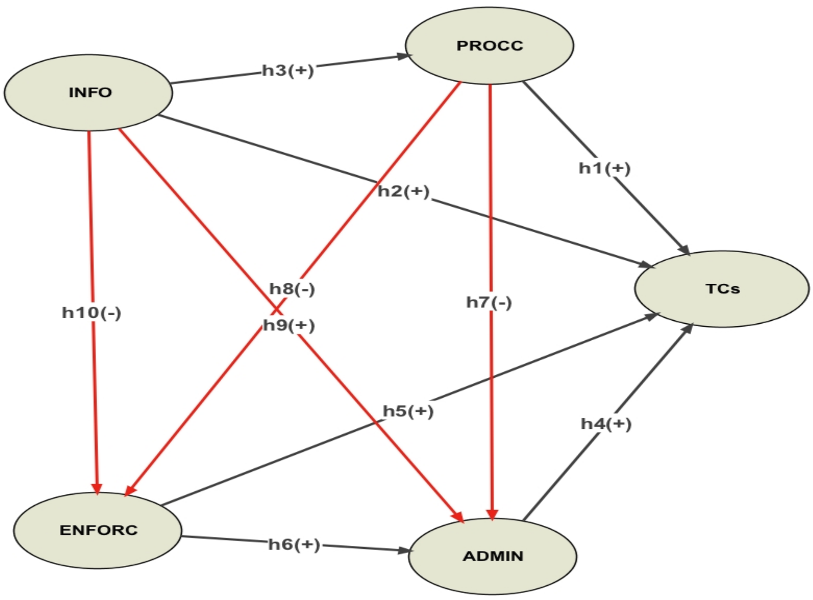


Figure 3.3: Model of the Relationship Between Pre and Post-contract Cost and TCs

3.5 Procurement System, Pre and Post-contract Costs versus TCs

Procurement is the phrase given to the process by which clients and users achieve their building projects (Franks, 1990). It describes the way the construction work is organized, documented, and awarded, and how the transaction is governed at a policy level (Murdoch & Hughes, 2008). In construction projects, procurement covers the processes from initial concept, planning and design to development, construction, and monitoring of performance. (Erridge & McIlroy, 2002; Hughes et al., 2006; Poon & Yu, 2006; Hackett et al., 2007; Eriksson, 2008). Several procurement systems exist based on risk allocation, the source of fund, tendering and selection, price basis, designs and management responsibility, and extent of subcontracting. They range from single stage traditional systems to multi stage Design-Build systems (Hackett et al., 2007). The most common are: Traditional; Design–Build; Management; Alliance; Build-Own-Transfer (BOT), Concession (Murdoch & Hughes, 2008). In essence, the procurement process marks the beginning of the contractual relationships between client, construction contractors, sub-contractors, suppliers, and consultants (Hackett et al., 2007; Chinyio, 2011).

Several researches have investigated buyer-supplier relationships in construction: (Al-Najjar, 1995; Cox et al., 1998; Artz, 1999; Winch, 2001; Tadelis, 2002; Griffith et al., 2003; Hughes et al., 2006; Eriksson, 2007; Hackett et al., 2007; Murdoch & Hughes, 2008; Walker & Pryke, 2008; Bajari et al., 2009; Crespin-Mazet & Portier, 2010; Gadde & Dubois, 2010; Chao, 2011; Chinyio, 2011). Al-Najjar suggested that an understanding of the role of incomplete contracts can be established along the principle that contractual relationships are governed using combinations of legal documents in a style that brings into account the primitive attributes of the transaction and minimizes TCs. Conversely, Chinyio (2011) claimed that the procurement system adopted affects the magnitude of TCs with a combination of other factors such as project size and complexity.

Further, Winch (2001) developed a conceptual framework model for understanding the governance of construction processes based on TCE. In this framework the roles of professionals, complex contract, and control actors in governing the project process were identified. A viewpoint suggested by Walker and Pryke (2009) that the costs of identifying contingencies (TCs) increase rapidly in complex and uncertain environments. This situation placing economics limits on contractual parties to draft and implement contractual agreements, and there is a trade-off for the owner between the completeness of contractual agreements and TCs. Finally, Murdoch and Hughes (2008) outlined the criteria for choosing procurement methods through client involvement in the construction process, integration of design with construction, client's right to alter the specification, project complexity, speed of completion, and price certainty.

With an appropriate TCE-based framework, acquisition (procurement) management practices could be improved by evaluating the largely hidden costs of managing contractual relationships. TCE offers useful insights on appropriate contract types, provides useful predictions about how contracting relationships evolve over the project's life, and highlights the crucial issue of resource ownership and the associated problem of asset specificity (Williamson, 2005b). Also, with TC analysis, emphasis could be placed on developing formalized governance mechanisms (i.e. formal contracts, rules and regulations, reputation mechanisms, termination agreements, warranties, etc.) and suitable strategies, such as long-term agreements and alliances. Therefore it would be possible to eliminate the risk associated with procurement uncertainties, limiting the number of instances of bargaining or opportunism and any asset specificity issues. This may, however, also reduce the costs of coordination and motivation, which ultimately reduces the transaction costs (Angelis et al., 2008).

In this study, the procurement systems are conceptualized as influencing the magnitude of the pre and post contract costs (i.e. information cost, procurement cost, administration cost, and enforcement cost). The hypotheses developed to explain the relationships between the variables discussed in this section are formulated below and represented by Figure 3.4:

H11: Procurement system (SYSTM) would have a positive effect on information cost (INFO).

H11a: Information cost (INFO) would mediate the relationship between procurement system (SYSTM) and transaction costs (TCs).

H12: Procurement system (SYSTM) would have a positive effect on project procurement cost (PPROC).

H12a: Project procurement cost (PPROC) would mediate the relationship between procurement system (SYSTM) and transaction costs (TCs).

H13: Procurement system (SYSTM) would have a positive effect on contract administration cost (ADMIN).

H13a: Contract administration cost (ADMIN) would mediate the relationship between procurement system (SYSTM) and transaction costs (TCs).

H14: Procurement system (SYSTM) would have a positive effect on contract enforcement cost (ENFOC).

H14a: Contract enforcement cost (ENFORC) would mediate the relationship between procurement system (SYSTM) and transaction costs (TCs).

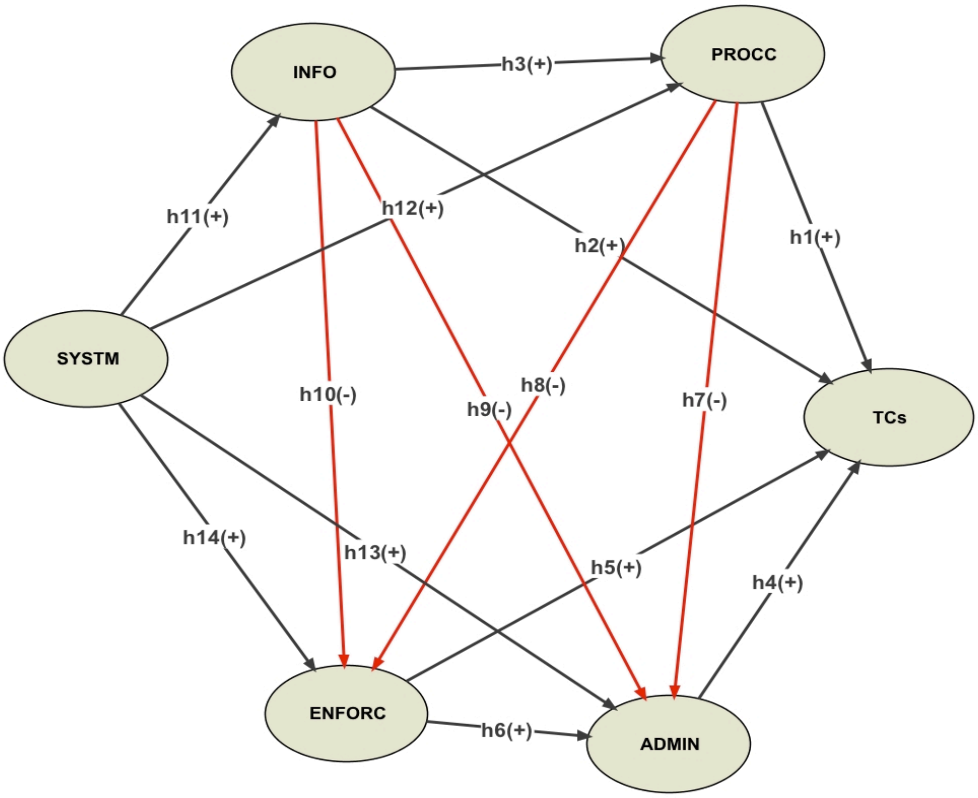


Figure 3.4: Model of the Relationship Between Procurement System, Pre and Post-contract Cost and TCs

This study hypothesizes that the procurement systems implemented on any project have a significant impact on the TCs associated with the pre-contract and post-contract phases. For example, in the traditional procurement systems the design is very often completed (or near completion) before construction begins, thus the certainty of a tender price is higher because the project scope is fully defined. In terms of TCs one could hypothesize that relative to other procurement systems its pre contract costs are likely to be higher because of the time spent in defining the project scope before construction begins. With systems such as DB, BOT, and Management, it is more usual to commence construction before designs are completed. According to Brook (2008) such systems (DB, BOT, and Management) could benefit from speedy construction because the design and construction phases have been integrated. However, incomplete documentation is often a source of uncertainty and could pose difficulties to cost prediction and estimation. The transaction costs of these integrated systems may be comparatively lower at the pre-contract phase but higher if and when implementation problems occur as a consequence of incomplete designs. Conversely with alliance procurement systems, TCs at the pre-contract phase could comparatively be the highest because of the level of preparatory activities involved in setting up alliances.

3.6 Environmental Uncertainties, Procurement System, Pre and Post-contract costs versus TCs

Environmental factors refer to institutions or forces outside an organization that would potentially impact on organization's performance and shape it's operation (Aldrich, 1972; Child & Mansfield, 1972; Ford & Slocum, 1977; Lenz, 1980; Aaker & Mills, 2005; Aldrich & Ruef, 2006; Grimm et al., 2006; Hitt et al., 2006; Artto et al., 2008; Daft, 2009). Political, legal, social, economy, competition, and technology are referring to external environmental forces. While corporate culture, project location, finance and ownership, and information system are representing internal environmental forces (Ford & Slocum, 1977; Marcus, 2005; Grimm et al., 2006; Elliott et al., 2008; Foss & Foss, 2008).

Creating data by analyzing uncertainties in the transaction environment is a strategic process conducted by organizations. It helps organizations to develop reactive plans to ensure that they can sustain a market edge and respond to increased environmental uncertainties (Hitt et al., 2006). For example deregulation, change in government policies, and increased competition created conditions of excess capacity, difficulty in managing the diverse operations of firms, and a decline in performance (Bergh & Lawless, 1998). Understanding and analyzing these uncertainties has potential financial benefits for firms such as sales improvement, profitability, and productivity. Other, non financial benefits may include improved understanding of competitors' strategies, reduced resistance to change, and enhanced problem prevention capabilities (Aaker & Mills, 2005; Daft, 2009).

As per the notions of Williamson (1985) discussed in section 3.1, uncertainties in a transaction environment affect the ability of contracting parties to fully identify the range of contingencies for unforeseen events that may disturb project success. Contingencies are costs borne by unforeseen events surrounding a transaction such as information, negotiation, competitive advantage, contract administration and management, market structure, enforcement, and measuring/monitoring performance (Heide & Stump, 1995; Artz, 1999; Melese & Franck, 2005). Walker and Pryke (2009) indicated that costs of identifying contingencies and planning responses to increase rapidly because of project complexity and environmental uncertainties. Consequently it becomes more costly to write a fully specified contract and implementing the contractual agreements (Williamson, 1985; Brouthers & Nakos, 2004).

According to TCT, the key factors in generating TCs are bounded rationality in the face of uncertainty and complexity, and opportunism in the context of small numbers of bargaining (Williamson, 1981). Bounded rationality and opportunism in a transaction environment might lead to information impactedness. That is, information impactedness refers to the situations where it is difficult to ascertain what the costs to information are (Williamson, 1981, 2002), which occurs when contractual parties have knowledge of private information in complex contracting. As a result, the contract terms might be incomplete because of the inability to specify all terms and conditions. On the other hand, the more complex and longer the contract, the more unfeasible it becomes to draft a contract that specify the obligations of all contracting problems that might arise.

Williamson (1985) claimed that the magnitude of transaction costs is correlated with uncertainty. In situations of high uncertainty contract enforcement cost is high as a result of formulation of agreement, monitoring costs and legal costs. It is proposed in this study that uncertainties in the transaction environment will increase project's pre and post contract transaction costs. In particular it affects the costs of: information, procurement, terms and conditions, writing contracts, enforcement and contract administration.

In this study, environmental uncertainties are conceptualized as influencing the magnitude of the pre and post contract costs (i.e. information cost, procurement cost, administration cost, and enforcement cost). The hypotheses developed to explain the relationships between the variables discussed in this section are formulated below and represented in figure 3.5:

H15: Environmental uncertainties (ENVIRO) would have a positive effect on information cost (INFO).

H15a: Information cost (INFO) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs).

H16: Environmental uncertainties (ENVIRO) would have a positive effect on project procurement cost (PPROC).

H16a: Project procurement cost (PPROC) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs).

H17: Environmental uncertainties (ENVIRO) would have a positive effect on contract administration cost (ADMIN).

H17a: Contract administration cost (ADMIN) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs).

H18: Environmental uncertainties (ENVIRO) would have a positive effect on contract enforcement cost (ENFOC).

H18a: Enforcement cost (ENFORC) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs).

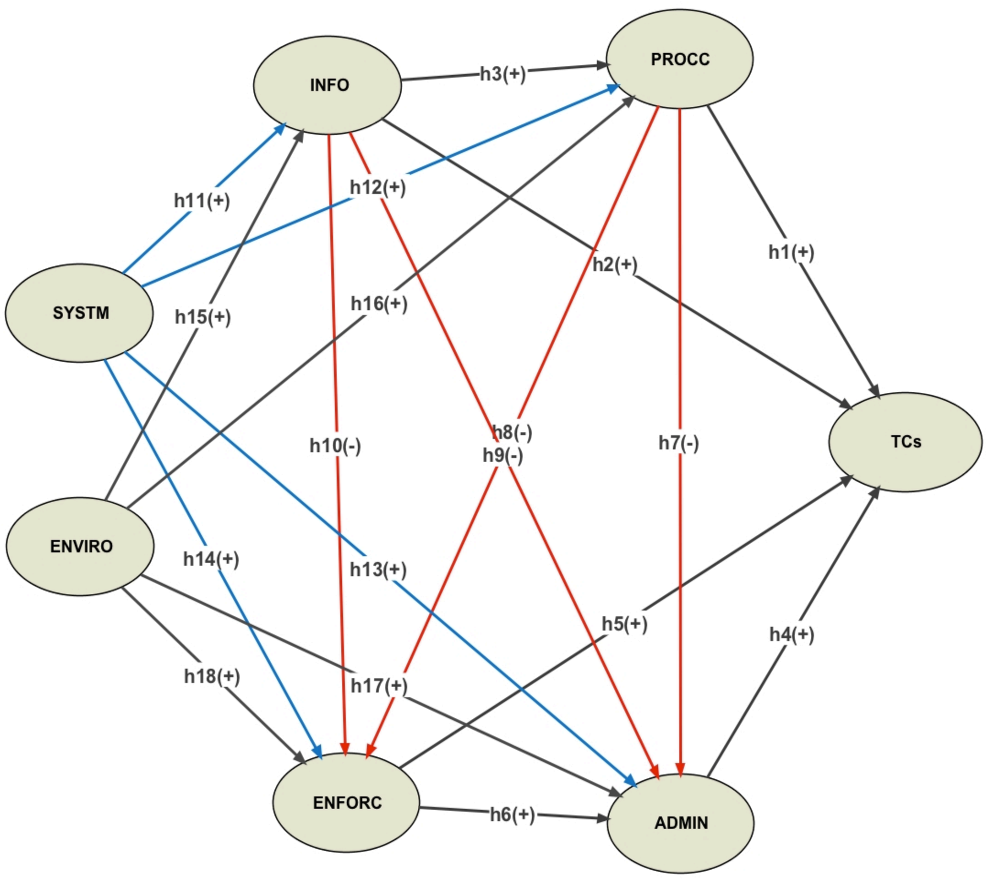


Figure 3.5: Model of the Relationship Between Environmental Uncertainties, Procurement System, Pre and Post-contract Cost and TCs

The model (Figure 3.4) is now revised to include the above sub-hypotheses and the resulting model is shown in Figure 3.5. The relations of environmental uncertainties with the costs of information, project procurement, contract administration and enforcement suggest that uncertainties in the transaction environment have a significant effect on TCs, which in turn influencing the clients' decision on choosing the appropriate procurement systems for their projects. Uncertainties in the transaction environment also increase contract complexity. This effect reflects through the increase in staff numbers involved in drafting, administration and safeguarding a contract. An increase in staff numbers is in line with Williamson (1998) suggestions in transaction costs theory that human and environmental uncertainties are the most important factors that give rise to transaction costs.

As mentioned earlier, Williamson (1981) claimed that uncertainties lead to information impactedness, which occurs when contractual parties have knowledge of private information in complex contracting. As a result, the contract terms might be incomplete because of the inability to specify all terms and conditions. On the other hand, the more complex and longer the contract, the more unfeasible it becomes to draft a contract that specify the obligations of all contracting problems that might arise. Based on this reasoning, dealing appropriately with uncertainties in transaction environment is a crucial factor that can prevent disputes and conflict during project execution. In countries such as Australia, the UK and USA, conflicts and disputes could inflict a high cost on the construction industry (Li et al., 2012), while the situation is similar in New Zealand.

In sum, to reduce uncertainty in the transaction environment and hence transaction costs, decision makers need to be aware of political stability, security, economic situation, and the infrastructure of the host country (Gray & Larson, 2008). The combination of environmental factors is important in the project selection process when organizations develop their strategies. For example implementing a project in politically unstable country with the concern for security is likely to be a high-risk project.

3.7 Project Phase, Environmental Uncertainties, Procurement System Pre and Post-contract costs and TCs

Transaction costs consist of both pre and post costs – those occurring before and after the contractual agreement. In construction projects pre contract stage covers activities during the initiation phase, development phase and early implementation phase. While Post contract stage covers activities during full implementation phase and close project phase. In the context of project management, a distinction should be made between measurement of pre contract costs and measurement of post contract costs. For example Solino and Gago de Santos (2010) distinguished between out-house pre-contract costs such as technical, legal, and financial advice and in-house once such as project preparation costs including environmental impact assessments cost. While Yates (1999) distinguished between direct post-contract costs such as Lawyers' fees, claims consultants' fees and delays fees, and indirect post-contract costs such as those associated with mistrusts between participants and lack of teamwork.

In this study the pre-contract stage focuses on TCs incurred during initiation, development and early implementation phases of the project. They include activities such as search for financial, legal and technical information, feasibility study, attending meetings, communications and translation of client's needs, project preliminary design, transition observations, bidding/negotiation and pre-contract project management. At the post-contract stage, focuses on TCs incurred during full implementation and close project phase. They include activities such as contract administration, conflict resolution, decision-making, verifying compliances and enforcement. Therefore, conducting these activities associated with costs, which can be determined at several points in time over the life cycle of a project.

The first project execution phase is the initiation phase, when there is a proposal for a project to be implemented; a project team selection is the first activity to be conducted by project managers. Then project team members search the market for technical, financial, social and legal information about the project. These activities might lead to high pre-contract transaction costs at this phase. This is due to more work needed in terms of bidders prescreening, project kick off meetings, proposal evaluations and request for proposal (Farajian, 2010).

In the development/or procurement phase, feasibility studies and proposals evaluations are conducted, preliminary designs and tendering documents are prepared. Afterwards, project professionals begin negotiating with the winning bidder. This process usually takes few months (several months on PPPs), depends on the project complexity and the delivery system selected (Farajian, 2010). The last step of the procurement process is signing the contract. The costs incurred during this phase are primarily information, design, and contract documentations. According to Williamson (2005) in the concept of TCE, incomplete contracting at the development phase leads to conflict and disputes during the execution of the contract. Therefore, it is anticipated that conducting procurement activities, during the development phase, contributed to higher pre-contract TCs.

The third phase is early implementation. In this phase, roles and responsibilities are assigned and contract management begins. In this stage project managers are looking for groups and individuals, i.e. project team members, with the right skills and knowledge to assist in the implementation of the project plan. Once team members have been located, all members involved need to have a clear understanding of goals and objectives of the project. The TCs incurred during this phase are implementation and administration costs, although information costs are important throughout the project life cycle. They are mixed costs between pre-contract and post-contract costs, indicating that this phase is a transition from pre-contract stage to the post-contract stage. Information and implementation costs are pre-contract costs while administration costs are post-contract costs. Mostly these costs are incurred because of professionals conducting procurement activities during this phase. TCT posits that the most important factors affect transaction costs and thus decision-making is frequency, uncertainty, and asset specificity (Williamson, 1998). Therefore, one can predict that in this phase, the pre-contract costs are high relative to post-contract costs.

The fourth phase is full implementation. At this stage construction operation is implemented, and quality inspection is finalized. Depending on the complexity of the project and the procurement system adopted, construction operation and quality inspection are normally associated with post-contract TCs. They are administration and enforcement costs, but information costs are also important. The main causes of these costs are conflict and disputes between contractual parties during the construction process. It is the fragmented nature of construction projects that causes most of the conflict and disputes (Winch, 1989; Pryke, 2009). Williamson (1985) viewed that uncertainty and asset specificity are the most important factors affecting the transaction. Asset specificity includes human, physical and intangible. In this study asset specificity is human asset, i.e. construction professionals involved in solving disputes. According to Kumaraswamy (1998), disputes arise when negotiation and discussion on claims made by one party and deprecated by another party. Conflict break down and the parties seek formal resolution from a third party. Here, transaction costs arise because of agent's fees and professionals' time in solving disputes.

The final phase is project closeout. In this stage all construction activities and quality inspection are finalized. Project manager reviews all information from the previous phase closures to ensure that all project work is complete and all project objectives have been met (PMI, 2004). Also, contract documents are checked to confirm that the contractual agreement has been achieved. The type of transaction costs incurred in this phase is post-contract costs, for example, enforcement and contract administration costs. Meanwhile, information cost is decreasing in this stage of the project life cycle. In this phase, the transaction costs are incurred because of professionals conducting administration activities such as decision-making on disputes. According to TCT incomplete contracting at the development phase sets the stage for conflict and disputes during the implementation phase (Williamson, 1985). Parties may behave opportunistically, specifically when contingencies are not fully covered by the contract. Leading to conflict and disputes that increase the transaction costs.

Based on these theoretical viewpoints, it is expected that there is a positive or negative relationship between project phase on one side and information, project procurement, administration, and enforcement costs on the other side. Therefore the following hypotheses are set out:

H19: Project phase (PHZ) would have a positive effect on information cost (INFO).

H19a: Information cost (INFO) would mediate the relationship between project phase (PHZ) and transaction costs (TCs).

H20: Project phase (PHZ) would have a positive effect on project procurement cost (PPROC).

H20a: Project procurement cost (PPROC) would mediate the relationship between project phase (PHZ) and transaction costs (TCs).

H21: Project phase (PHZ) would have a positive effect on contract administration cost (ADMIN).

H21a: Contract administration cost (ADMIN) would mediate the relationship between project phase (PHZ) and transaction costs (TCs).

H22: Project phase (PHZ) would have a positive effect on contract enforcement cost (ENFOC).

H22a: Contract enforcement cost (ENFORC) would mediate the relationship between project phase (PHZ) and transaction costs (TCs).

The model (Figure 3.5) is now revised to include the above sub-hypotheses and the resulting model is shown in Figure 3.6. The positive relationship between the project phase and information and project procurement costs implies that in the initiation and development phases, uncertainty is high and information is not completely available. Thus, there is a need for intense communication, information searches, and attending meetings, which increases information and project procurement costs. Apparently, the procurement system adopted during those phases is Traditional.

Similarly, the positive relationship between the project phase and administration and enforcement costs, suggests that during the implementation and project close phases, there is an extensive need for conflict and dispute resolution, contract administration, quality inspections, and decision-making. Thus, administration and enforcement cost become more resource consuming (e.g. human asset) in those phases. Presumably, the procurement system adopted during those phases is Design–Build.

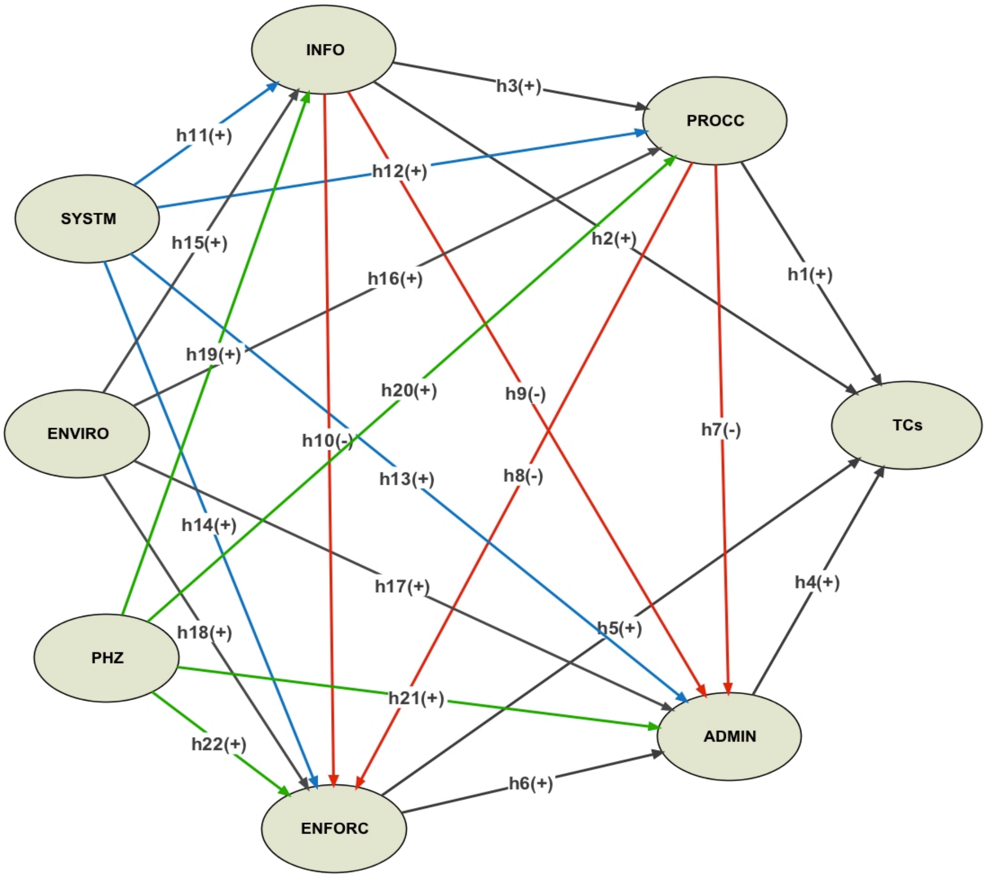


Figure 3.6: Model of the Relationship Between Project Phase, Environmental Uncertainties, Procurement System, Pre and Post-contract Cost and TCs

3.8 Interactive effect of Environmental uncertainties and Project phase on the Client's procurement decision

This section addresses objective three. Objective three investigates whether environmental uncertainties and project phases would interact to influence the client's procurement decision.

Uncertainties affect the ability of contracting parties to fully specify the range of contingencies for unforeseen events that may disturb project success. For example during the project initiation phase, uncertainty is high resulting from information irregularity about the project outcomes. In economics, information asymmetry refers to the knowledge of prices, agents, and supply and demand of products. Consequently when agents (project consultants) are uncertain about future events, they look to purchase information in order to reduce uncertainty (Fisher & Kingma, 2001). According to TCT, the key factors in generating TCs are bounded rationality because of uncertainty and complexity, and opportunism because of small numbers of negotiating (Williamson, 1981). In this sense, information becomes more costly, but decreases the risk associated with the construction process. This is why in Traditional procurement systems, it might the pre-contract cost (i.e., information and procurement costs) are high because the scope of the project should be fully defined before construction begins. While in Design-Build systems, the pre-contract cost might lower because of continuous feedback of information and cost throughout the project Lifecycle.

Several studies suggested that uncertainties in the transaction environment have a negative impact on the project's total cost (Li et al., 2012). Farajian (2010) documented that transaction costs are quite low during project initiation and procurement phases, when the competition is low i.e. high number of bidders. He added, due to a weak competitive procurement process, it is likely that total project costs might be high. However, Farajian did not explain why the total project costs become high when TCs in the procurement phase are low. This implies that the pre-contract TCs have a negative effect on post-contract TCs. It is proposed (section 3.4) in this study that information and project procurement costs (pre-contract cost) have a negative impact on enforcement and the administration costs (post-contract cost). This explains why the total project costs are high whereas pre-contract costs are low using Farajian's notion.

Expressed differently, researchers view environmental uncertainties as forces anticipated in selecting the most applicable procurement systems; hence, contributing in a project's success or failure. For example, in uncertain political situation, Duncan (2009) posits that lump sum and cost reimbursement systems were the procurement trend, post-war regeneration (1946-1969). Economic uncertainties during the 1970-1979 period of high inflation, an increasing preponderance of clients started to use management contracting in order to save some money (Duncan, 2009). Meanwhile the sub-prime market collapse in 2009 was reported to have caused a shift in procurement trend to design-build (Duncan, 2009). Brochner (1990) suggested that procurement selection could be influenced by information system (IT) usage and availability. IT improves coordination between team members, quality control/product inspection, and translation of client needs. Other determinants of procurement systems include: corporate culture (Wright & Race, 2004), market competition, technology (Schermerhorn et al., 2002; Duncan, 2009), project location (Hughes et al., 2006), finance situations and project ownership.

The hypotheses developed to explain the interactive effects of the variables discussed in this section are formulated below and represented in Figure 3.7:

H23: Project phase (PHZ) would have a significant effect on procurement systems (SYSTM) selected for a project.

H24: Environmental uncertainties (ENVIRO) would have a significant effect on procurement systems (SYSTM) selected for a project.

H24a: Project phase (PHZ) would moderate the relationship between procurement systems (SYSTM) and environmental uncertainties (ENVIRO).

3.9 The Research Model

The research model (Figure 3.7) thus developed based on the hypotheses formulated in sections 3.2 to 3.7, and the hypotheses from the interactive effects of project phases and environmental uncertainties on the client's procurement decision formulated in section 3.8. The model addresses the main objectives specified in Section 1.2 of the research. It represents the structural relationships between the transaction costs, procurement systems, environmental uncertainties, project phase, and costs of: procurement, information, enforcement, and administration.

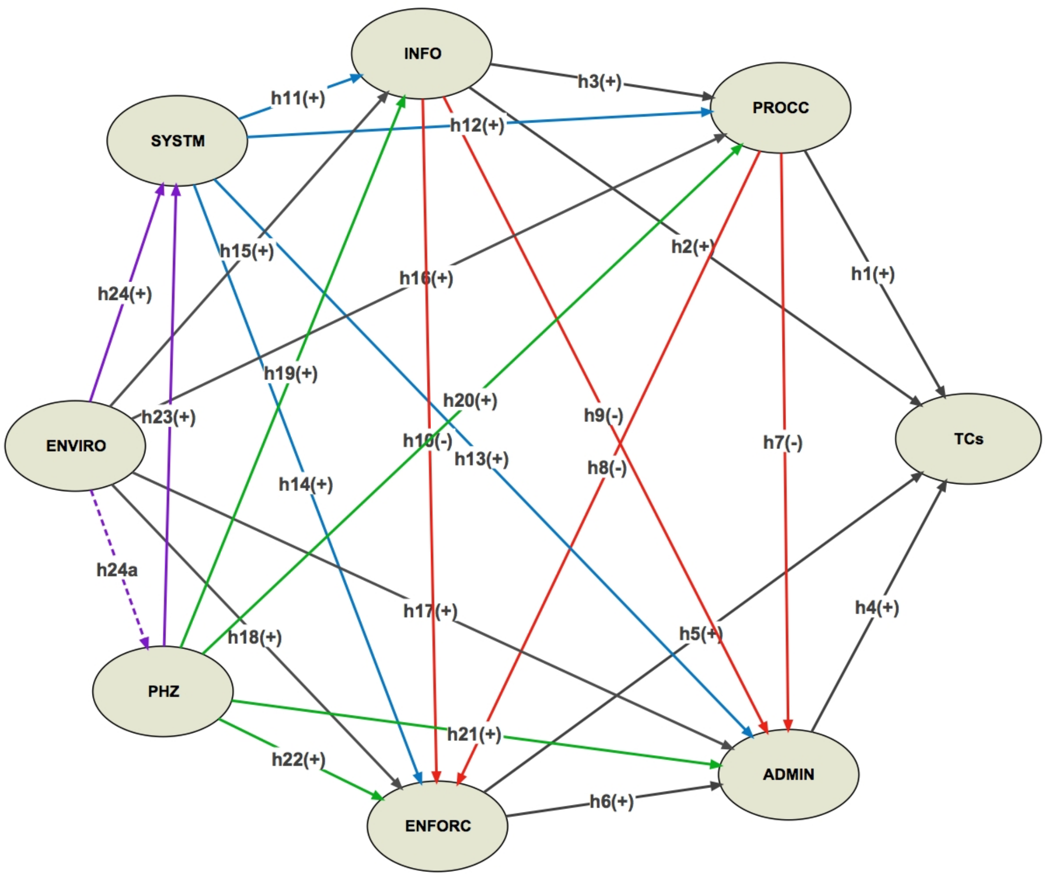


Figure 3.7: The Research Model

3.10 Summary

In this chapter, objectives one, two, and four of this study have been met through developing a conceptual model explaining the relationship between procurement systems, project phases, environmental uncertainties, and transaction costs. The model shows that the costs of information, project procurement, enforcement, and administration might directly influence TCs. Whereas, procurement systems, environmental uncertainties, and project phases might indirectly influence TCs. They might have a direct effect on the costs of information, project procurement, enforcement, and administration. Therefore, costs of information, project procurement, enforcement and administration costs would mediate the relationship between TCs on one side and the procurement systems, environmental uncertainties, and project phases on the other side.

A conceptual model has been developed to address objective five of the study (Section 1.2). The model also addresses the interactive effect of environmental uncertainties and project phases on the client's procurement decision (Objective three). The following chapter introduces the appropriate methodology used for this study to empirically test the hypothesized relationships.

CHAPTER FOUR

Research Methodology

4.0 Introduction

This chapter introduces the methodological approach and the research design best suited the current research. It covers a description and justification of: the methodological approach and examines the research questions/hypotheses; specific methods employed for data collection; and the data collection and analysis procedures. Also, the chapter presents a discussion of ways by which the validity and reliability of data were achieved. The chapter includes six sections on research methodology, starting from a description of the paradigm under which this research is conducted. The second section describes the sampling strategy, which contains a description of the unit of analysis and unit of observation. Next, is a discussion of the data collection approach is presented. That is, in section three, the measurement of the constructs, pilot survey, and the questionnaire survey are developed. In the fourth section, the constructs reliability and validity are presented. Section five, presents the data analysis strategy and describes the statistical assumptions, analytical techniques, and modeling strategy adopted by the current study. The last section outlines the measurement errors, which can be carved up into a systematic and random error. Finally, the chapter summary is presented.

4.1 Meaning of Research Methodology

Methodology refers to approaches in social sciences research that are based on correlated sets of assumptions regarding ontology, human nature, and epistemology (Morgan & Smircich, 1980). Whereas, the research methodology is a combination of tools and techniques utilized to enquire into a specific situation (Thorpe & Lowe, 2002). This implies that research methodology refers to research approaches from theoretical assumptions to data collection and analysis (Payne, 2004; Dainty, 2008a). In essence, methodology refers to the method chosen to examine the research questions in Section 1.3, and hypotheses set out in Sections 3.2 to 3.7. According to Patton (1990) "different methods are appropriate for different situations" so that designing a research methodology for a specific situation is largely determined by the purpose of the research, the questions being investigated, and the source available (Patton, 1990). In broad terms and based on Morgan and Smircich (1980), the research method chosen to investigate the research problem should underlie the assumptions of ontology, human nature, and epistemology.

4.2 Analysis of the Problem

This research addresses the research problems, which have been stated in Section 1.1 of Chapter One:

"Transaction cost economics is unknown, and the links between procurement systems and transaction costs is ambiguous in the New Zealand construction industry "

Build on the this statement of the following problems are addressed:

- There is a lack of understanding of transaction costs and their extent in New Zealand construction projects.

- There is a lack of understanding of the linkage between the procurement systems and transaction costs in New Zealand construction projects.
- There is a lack of understanding of the impact of procurement systems on the magnitude of transaction costs in New Zealand construction projects.
- There is a pressing need to improve New Zealand construction's productivity, which implies a reduction of input costs of which TCs are significant.

To solve the aforementioned problems, the current study determines the transaction costs incurred in construction projects because of the buyer-supplier relationship in construction. This relationship is sets up through the procurement process. Taking this into account, the general objective of this research is therefore, to develop a model for procurement selection based on TCs, to aid the clients in their procurement selection process for construction projects in New Zealand. The main features of the above problems are described in the follows sub-sections.

4.2.1 Scope or Generalizability of the Research Problem

The problem of determining TCs in construction projects procurement is both specific and generalizable. It is specific because the magnitude of TCs incurred by professionals conducting procurement activities have not been determined before, specifically in the New Zealand construction industry. Although, this problem at the project level, it's feasible that the problem of TCs should be generalizable as possible to all levels of construction organizations structure. In the long term the results from the methodological approach and the methods selected should be extended from a study conducted on a sample population (i.e. the Traditional and

Design-Build systems) to the population at large (i.e. cover all procurement delivery systems in construction).

Further, the results from the methodological approach extended from a sample population (i.e. project level) to the population at large (i.e. organizational level). This action is statistically possible because generalizability requires data on large populations, and a quantitative approach provides the foundation for producing broad generalizability.

4.2.2 Nature of the Problem

Researches can be classified based on the nature of the problem and the purpose of the study into: exploratory; descriptive; analytical; and predictive researches (Collis et al., 2003). In exploratory and descriptive researches, the questions being addressed take the form of 'who', 'what', 'why', 'how much', and 'how many' (Yin, 2009). While, in analytical and predictive researches, the question posed would include words such as ' how', 'why', and 'where' (Collis et al., 2003; Yin, 2009). The main research questions that current study addressed are:

- How can transaction costs be minimized so that the performance of construction projects is improved in New Zealand?
- What is the linkage between the procurement systems and transaction costs in construction projects?

The current study falls under exploratory and descriptive research, because the research questions require looking for hypotheses to be tested and rich contextual descriptive of data. It is exploratory in nature because few previous studies exist that explain the relationship between procurement systems, environmental uncertainties, and transaction costs. Specifically in the New Zealand construction industry. According to Sekaran (2003), the goal of descriptive research is to help the researcher in describing important aspects of the phenomenon of interest perspectives of individual, organizational, and industry (Sekaran, 2003).

Thus, this research uses inductive research because it moves from particular situations i.e. identify TCs at individual level and then move to the project level, to make broad general ideas; and establishing patterns and meaning to understand the concept of transaction costs in procurement projects. Also, to develop the pattern of transaction costs for different procurement delivery systems, specifically the Traditional and Design-Build for the purpose of comparison.

4.2.3 Complexity of the Problem

Evaluating TCs in construction project procurement is complex because the transaction costs is concept poorly understood in the New Zealand construction industry. It is also difficult to segregate the activities that the professionals conducting during the procurement phase of project execution activities. Cognizant of this particular problem, this study deployed a 5-point Likert scale as a measurement tool; to evaluate the professionals' daily time spent in conducting procurement activities relative to other project execution activities.

The next section will present the most suitable philosophical position for the research based on the scope, nature, and complexity of the research problem(s).

4.3 Research Philosophical Position

Philosophy is an intellectual endeavor focusing on establishing, regulating, and improving the methods of knowledge creation (Easterby-Smith et al., 2012).

Philosophical positions, such as ontology, epistemology, and axiology, guide a researcher on how to obtain valid and reliable knowledge (Neuman, 2007; Easterby-Smith et al., 2012). Philosophical position is used to examine and govern any research philosophy (Saunders et al., 2011). According to Creswell (2012), four philosophical positions are used to frame a researcher's theoretical focus in studies. The first position is when researchers seek reality; they explore multiple forms of evidence. The second position is when researchers try to get as close as possible to individual views from research conducted in the same field. The third position is when researchers express their opinions about information gathered in their research field. Finally, the fourth position is when researchers use suitable methods for collecting and analyzing data. These philosophical positions are respectively Ontological, Epistemological, Axiological, and Methodological. Saunders et al. (2011) explain that research philosophy may be examined using the philosophical stances of ontology and epistemology.

The characteristics of theses philosophical positions are discussed in the following sub-sections.

4.3.1 Ontological Positions

Gruber (1993) explains that ontology formally represents knowledge as a set of concepts within a domain; a formal explicit specification of a shared conceptualization (Gruber, 1993). Researchers utilize shared conceptualization to embrace different realities, as do the individuals being studied (Creswell, 2012). Researchers present different perspectives with evidence of multiple realities utilizing the actual words of different individuals. Collis et al. (2003) emphasize that reality is external and exists independent of the observer. Therefore, a researcher utilizes suitable methods, for example laboratory experiments and surveys, to measure and analyze such reality. Expressed differently, Morgan and Smircich (1980) argued that reality is a projection of human imagination. In general ontological positions are either objectivism and positivism, or subjectivism and interpretivism. In the first instance (objectivism and positivism) the methodological approach adopted is a quantitative method, while in the second instance (subjectivism and interpretivism) the methodological approach used is a qualitative method.

According to Collis et al. (2003), the ontological positions can only be understood by examining the perceptions of human actors. For example in construction, the buyer-supplier relationship is assumed to be uncertain in nature. Therefore any changes in this relationship reverberate throughout the transaction environment and the whole relationship. This implies that the buyer-supplier relationship is assumed to be relative rather than fixed and real. According to TCT, human beings are adaptive agents who exist in a collaborative relationship in the transaction environment. In construction projects, TCE has been used widely to examine the buyer-supplier relationship, choosing the proper governance structure, and implementing the contractual agreements. Thus based on the ontological position, there are opportunities for firms conducting construction projects; to utilize the transaction costs perspective in selecting the most applicable procurement system. More discussion of the ontological position of the research is provided in section 4.3.3.

4.3.2 Epistemological Positions

Epistemology refers to the nature of knowledge and what we accept as being valid knowledge in a particular discipline (Collis et al., 2003; Saunders et al., 2011). It is the relationship between the researcher and reality or known view (Carson et al., 2001). Therefore, epistemological positions define the ways of inquiring into the nature of knowledge. According to Cohen et al. (2011), epistemological positions are concerned with how knowledge can be created, acquired and communicated. Different assumptions of social reality propose different basis for knowledge of that reality. For example, the ontological position of objectivism refers to a single reality, and it exists independent of the observer. This means that researchers may engage the field in a value-neutral manner. On the other hand, the ontological position of subjectivism assumes multiple realities, and they are constructed to be dependent of the observer's experience.

At the other end of the continuum (philosophical position), the epistemological position of positivism assumes that knowledge may be built cumulatively by following scientific norms. This can be achieved by emphasizing empirical analysis, observation, and confirming or refuting hypotheses logically derived from theory. Therefore, the epistemological position of positivism suggests that reality is independent of the observer. Whereas, the epistemological position of interpretivism assumes that knowledge is based on observation, and theory is specific to a given social context. This means that reality is dependent on the observer.

4.3.3 Philosophical Positions Specific to this Research

Projects in construction are described as being fragmented, complex, and unique in nature, thus construction projects problems are complex. To effectively solve construction problems, Love et al. (2002) argued to employ a methodological approach that takes into consideration both ontological and epistemological viewpoints. This research adopts a combination of ontological and epistemological viewpoints about reality and knowledge. There is a social reality regarding the effect of procurement systems adopted on projects on the magnitude of TCs, and it's impact on the cost of projects in construction. Whether or not this effect can be observed and understood by clients undertaking construction procurement selection process is not clear. Thus, using an objective view of positivist epistemology is important to identify and understand that procurement system have a significant effect on the transaction costs in construction. In the meantime, using ontological positions about reality to explain the researcher's viewpoint on the subject under investigation is also important (Towers & Chen, 2008).

In this study, an interpretivism epistemology stance is adopted for the pilot study. In particular the focus group feedback on the subject matter of the research problem(s), the practicality of the research questions that needs to be surveyed, and discussion of the research findings. Meanwhile, a positivist epistemological viewpoint is adopted, consistent with the ontological assumptions described in section 4.3.1 above for the main study. The positivist approach deals with the collection of empirical evidence and using proper tools and techniques, to analyze and interpret the results. Finally, it is proposed in this study that the findings of this research depend on the researcher's perspective of reality and the relationship between the researcher and the respondents in providing knowledge regarding transaction costs in construction's procurement.

4.4 Research Paradigm

A research paradigm provides a framework that links theory with methodology (Seth & Thomas, 1994; Neuman, 2007; Creswell, 2012). It is a systematic investigation whereby data are collected, analyzed, and interpreted in an effort to understand, describe, predict or control a phenomena (Burns, 2007; Mertens, 2009). A paradigm according to Collis et al. (2003, p. 352) is " the progress of scientific practice based on people's philosophies and assumptions about the world and the nature of knowledge". Mackenzie and Knipe (2006) described a paradigm as a set of logically related assumptions, concepts or propositions that orientate thinking and research. This implies that a paradigm expresses the researcher's primary assumptions or a set of propositions that explain the way of breaking down the complexity of the researches problem(s). Generally, a paradigm consists of four components: ontology, epistemology, methodology, and methods (Collis et al., 2003). These components describe beliefs about the nature of knowledge, methodologies, and criteria for reliability and validity (Mac Naughton et al., 2001). According to Creswell (2012), different paradigms inherently contain different ontological and epistemological assumptions of reality and knowledge, which in turn is reflected in their methodology and methods.

Research paradigms are mainly categorized into two types; positivism and interpretivism (Gray, 2009). Researchers in natural science commonly use a positivist approach, but in social science they use the interpretivist approach (Love et al., 2002). In the positivist approach, researchers adopt a quantitative empirical method. While in the interpretivist approach, researchers adopt a qualitative empirical method. According to Creswell (1994), there is no true division between positivist and interpretivist paradigms, and they can be used simultaneously to provide an understanding of social phenomena. A similar idea expressed by Lee (1991) who suggested that a combination of positivist and interpretivist assumptions might be used to provide different views for the same phenomena. This stream of thought presents support for this study to adopt a combination of positivist and interpretivist paradigms, to address the nature of the current research problem.

Positivist, interpretivist, and combined paradigms and their relation to the philosophical assumptions of this research are briefly explained in the following sub-sections.

4.4.1 Positivist Paradigm

Positivism is a philosophical position that combines logic and rationality with empirical observation, to identify causes that influence outcomes (Creswell, 2012). The positivist paradigm is widely used by researchers to test a theory or describe an experience through observation and measurement. Positivists aim to test reliability, validity, and generalizability that provide a basic framework for conducting quantitative research (Saunders et al., 2011). Reliability test is conducted to examine the consistency of the means of data collection (Hair et al., 2007). Validity test is concerned with investigating the degree whereto research truly measures the item under observation. Finally, generalizability test is utilized to statistically extrapolate findings from a specified sample to a wider population (Hair et al., 2007).

There are two philosophical positions dominant in the positivists' thoughts. Researchers (Crossan, 2003; Cohen et al., 2007; Saunders et al., 2011)believe that the ontological position of positivism is one of realism, and objects have an existence independent of the researcher. This thought about reality is also emphasized by Pring (2000) who argued that reality exists independently of the Knower. Therefore, reality is not mediated by our senses, and the researcher is a neutral spectator of the object of enquiry. On the other hand, researchers (Collis et al., 2003; Creswell, 2012) point out that positivism epistemological position is one of objectivism. Researcher seeks reality independently and discovering absolute knowledge about an objective reality. Meaning that the researcher and the researched are independent entities, and reality resides in objects not in the conscience of the researcher. Thus, phenomena have an independent existence, which can be discovered via research. Based on the aforementioned features, the methodological stance for positivists in social science is a quantitative approach that allows little room for alteration of collected data and minimizes bias (Crossan, 2003).

The advantages of positivist or scientific research is in its capability of identifying precise relationships between a set of variables, using scientific analytical techniques, and establish causal laws by linking variables to a deductive theory. In this regard, researchers adopting positivism paradigm are trying to make the findings practically acceptable to real life, and create generalizable statements of the findings applicable as possible. However, in order to achieve good research results, it is important to use multiple sources of evidence and research strategies. In construction management research, this might be achieved through multi-research methods and measures of a phenomenon (Love et al., 2002).

4.4.2 Interpretivism Paradigm

On the contrary to positivists, interpretivists believe that reality is relative and multiple, constructed by the people involved in the research and derived from observations and perceptions of individuals (Fellows & Liu, 2009; Creswell, 2012). Interpretivists have the intention of understanding reality through human experience, which suggests that reality is socially constructed (Mertens, 2009; Cohen et al., 2011). Interpretivists tend to rely upon participants' perceptions of the situation being studied (Creswell, 1994). Participants' background and experience might have a huge impact on the research outcomes. This is so, because individuals' opinion towards a subject matter differs from one to another.

Regarding reality, the ontological position of interpretivism is relativism, which means that reality is subjective and differs from individual to individual (Lincoln et al., 2011). This means that multiple realities could be constructed, and reality is dependent on an observer's perceptions (Creswell, 2012). Therefore, social reality is employed through understanding and organized in memory, and the researcher engages with objects in a value-laden manner or subjectively (Collis et al., 2003). In contrast, the interpretive epistemology is one of subjectivism, which means that knowledge is based on real phenomena (Grix, 2010). Which means that knowledge is based on observation, while theory is specific to a given social context.

The advantage of interpretivist research is that interpretivists aim at understanding and interpreting participants' perceptions upon the situation being studied instead of generalization and predicting cause and effects. Particularly, in understanding participants' subjective matter about reality such as motivation, meaning, and reasoning (Hudson & Ozanne, 1988). This is implying that there might be more than a single structured way of accessing such realities, which could result in biased views of the subject studied. Similarly, the epistemological position of interpretivism indicates that knowledge is not independently created. Interpretive researchers develop a theorized justification, which exemplifies participant's understanding on a subject mater to be researched. Usually researchers decide how to interpret data and results. As a result, participants are exposed to researchers imposing their own subjective interpretations upon them (Danby & Farrell, 2004).

In sum, interpretivist research mostly rely on qualitative methods for data collection and analysis (Bailey, 2007). Though, a combination of both qualitative and quantitative methods (mixed methods) might be adopted. In which case a researcher might utilize a quantitative approach to support or expand upon qualitative data collection and analysis. This effectively deepens the description.

Having outlined the two main research paradigms, the following sub-section introduces the research paradigm specific for this study.

4.4.3 Mixed Paradigm Specific for this Research

As observed in sections 4.4.1 and 4.4.2, positivism and interpretivism paradigms have different functions. In pursuit of knowledge, both paradigms quote different beliefs, values, and concepts. It is essential to find the best paradigm(s) that provides the basis for this study in addressing the nature of the research problem. In line with to Tookey (1998), the nature of any research problem influences the philosophical assumptions of the research, and determines the means to a solution. Two approaches dominate construction management research; the positivist approach and the interpretivist approach (Love et al., 2002). However, construction management research is at the intersection between social science and natural science (Love et al., 2002). Natural science based studies consist of a sequence of realities, which are independent from the researchers. The phenomena belong to one universe, and the realities accommodate as independent objective criteria by which the certainty or validity of the scientific expression can be judged (Creswell, 1994). On the contrary, social science based studies have thoughtful participants such as construction management, while natural phenomena do not. Participants' opinions create difficulties that have no complementary in natural science. Thinking plays a dual role, where participants seek to understand the situation in which they participate, and their explanation accommodates as a substratum of decisions that influence the course of events (Creswell, 1994).

Generally, construction management research is delineated heavily by theories that have been developed in other disciplines such as economics, sociology, and law. The debate between proponents of positivism and interpretivism in construction management research is intense (Dainty, 2008b). Applying a positivist approach in construction management research alone faces a potential barrier in developing theory, because of the nature of human beings involved in construction projects (Love et al., 2002). Human behavior is a complex variable to predict. Although positivism attempts to simplify and control variables, this is extremely difficult to do in construction management. For example, if a positivist ontological approach were to be adopted, then the actors' behavior being studied would be assumed as uniform. However, human behavior is changing both intentionally and unintentionally, which in turn affect the form and structure of any system that they are a part of (Love et al., 2002; Shank & Brown, 2007). According to Chau et al. (1998), if human behavior is unpredictable then there is no place for the scientific or positivist approach. This is because most of the data needed to understand construction management problems are concerned with managerial decision-making. If human behavior is random then a bias in the data occurs (Smith et al., 1995).

Statistical tests are often misused in positivist or empirical research. Researchers may select an incorrect statistical test, and also might misinterpret results (Scotland, 2012; Walls, 2012). For example, if data is not distributed normally, i.e. either skewed to the left or to the right; therefore a non-parametric test is required. Further, the P-values interpretation depends on whether the researcher is testing hypothesis or significance. If the researcher is testing significance, then statistical significance is dependent upon the sample size (Blume & Peipert, 2003). On the other hand, if the researcher is testing hypotheses, it is important to keep in mind; firstly, that the null and alternative hypotheses are reference population values; secondly the nit observed statistics (Walls, 2012). Consequently, any results based on predictions might be affirmative because of random reasons.

A conclusive deduction from a positivist or empirical generalization is rarely explanatory (Hubbard & Lindsay, 2013). Positivistic generalizations ignore the intentionality of individuals, thus actions are not plenary understood. Actions need to be understood from the participants' perspective (Maxwell, 2012). For example, two quantity surveyors might estimate cost differently based on their experience. On the other hand, the reasoning behind applying an interpretivist approach in construction management research is to proceed from specific observations to general principles (Love et al., 2002). Generalizations can be achieved from observations, which if tested might lead to the discovery of an endorsed relationship (Babbie, 2012). The interpretivist holds to a dependent viewpoint, which assumes multiple and equal valid realities (Schwandt, 2000). Reality is constructed in the mind of the individual, rather than being external single entity (Hansen, 2004). Therefore, the rationale behind deploying the interpretivism approach is the interaction between the researcher and the object of investigation.

Most construction management research addresses practical problems that do not necessarily result in the discovery of new theories, because construction management research re-applied the existing theories to solve such issues (Chau et al., 1998). The Interpretivism approach provides a framework for theory building and later moves towards empirical investigation when data is available (Love et al., 2002). This implies that unexplained irregularities in data from a study based on a positivist approach might be investigated by utilizing an interpretivist approach.

The aim of the current research is to investigate the link between procurement systems and transaction costs, with a view to determining the effect of an adopted procurement method on the magnitude of transaction costs in construction projects. The interpretivism inquiry is based on the opinion of participants, to give a better understanding of the relationship between procurement systems and transaction costs. The participants' reality is based on their experience, vision, circumspection, thinking, and action (Näslund, 2002). Therefore, participants' views about the research problem might be different, which means multi realities exist. These features of the research in resolving the research problem suggested the current study could adopt the philosophical position of interpretivism.

On the contrary, researchers use the philosophical position of positivism in developing knowledge (Knight & Cross, 2012); for example; cause and effect thinking, reduction to specific variables, hypotheses, and questions, use of measurements and observations, and test of theories (Easterby-Smith et al., 2012).

Positivist methodology is focused at explaining relationships (Creswell, 2012). Relationships are assumed to have a probability nature, and change in one part reverberates throughout the whole relationships.

The objective of this study is to investigate the relationship between procurement system and the transaction costs in construction projects. As per the ontological position, a theoretical model is developed to explain the relationship between procurement systems and transaction costs. Then and based on the epistemological position, potential variables are observed and measured in objective way. Potential variables are measured and observed utilizing suitable statistical techniques. Afterward developing a theoretical model that illustrates the significance of this relationship. Correlation and validity tests are also used to reduce complex interactions and to indicate the relations between dependent and independent variables.

This combination of factors within the research problem points enthusiastically to mixed philosophical positions for this research. Therefore, interpretivism is initially used in the study to develop hypotheses and theory formulation (Love et al., 2002). Thereafter the research moves to empirical evidence collection, using tools and techniques in keeping with logical positivism. So, the research approach is designed to underpin these mixed philosophical positions. The next stage (Section 4.5) describes the research approach used for the current research.

4.5 Selection of Research Method

Research methods are the techniques used for collecting and/or analyzing data (Collis et al., 2003; Easterby-Smith et al., 2012). They are also the techniques chosen to investigate the research problem(s) embodying the philosophical assumptions delineated in Sections 4.3 and 4.4. According to Easterby-Smith et al. (2012), research methods enable researchers to develop a research design. This encompasses the types and sources of data, and the techniques to be used in collecting and analyzing the data. Research methods are classified into quantitative, qualitative, and a combination of both quantitative and qualitative approaches (Tashakkori & Teddlie, 2010). Mack et al. (2005) outlined the factors that influence research method classifications to include: the nature of the phenomenon, the type of research questions and the analytical objectives. Choice of research method also depends on the form of data required (numeric or non-numeric data) the techniques used for data collection and analysis, as well as the degree of flexibility required within the research design (Mack et al., 2005).

Therefore, the following sub-sections present different research approaches, and finishes of with the research approach utilized specifically for this research.

4.5.1 Quantitative Approach

The quantitative approach primarily focuses on developing knowledge based on a positivist viewpoint (Creswell, 2012). This includes the use of cause and effect principle, reduction to specific variables and hypotheses and questions, the utilization of observation and measurement, and the testing of theories. In the quantitative approach, the researcher and the research are treated as independent entities. Strategies such as experiments and surveys are deployed, and predetermined instruments such as statistics are utilized. Reality is measured objectively in this approach. Validity and reliability of scores on instruments lead to significant interpretations of data. Thus, the quantitative approach employs a clear deductive approach (Creswell, 1994). Meanwhile, the weakness of applying the quantitative approach in construction management research is in its tendency to quantify variables at a specific moment of a situation in the build environment (Amaratunga et al., 2002). Further, some construction related aspects might be changed because of the temporal nature of construction projects.

4.5.2 Qualitative Approach

Unlike the quantitative approach, qualitative approach employs different knowledge claims, strategies, and data collection and analysis methods. The qualitative approach is primarily focused on developing knowledge based on the interpretivist viewpoint (Creswell, 2012). In particular, researchers applying qualitative approach seek to understand social phenomena from participant's viewpoint (Fellows & Liu, 2009). Within the qualitative approach, reality is understood subjectively by exploring attitudes, behaviors, and experiences (Denzin, 2010). Therefore, the intention of qualitative study approach is to gather non-numeric data by using strategies such as case studies, grounded theory, and interpritivist data (Leedy & Ormrod, 2001; Creswell & Clark, 2007; Borrego et al., 2009).

The techniques used in this approach for data collection are in-depth interviews, participants observations, and focus groups/ or the focus groups (Mack et al., 2005; Parahoo, 2006). Thus, the qualitative approach employs an explicate inductive approach (Creswell, 1994). It begins with aggregating information from subject matter professionals and classifying this information into themes. These themes are developed into general patterns, grounded theories, or generalizations, which will be tested using real life cases (Creswell, 2012).

The advantages of applying a qualitative approach to research is in that it provides a useful description of complex phenomena, cross-case comparison and analysis, explain in rich detail phenomena, and determine how participants interpret constructs e.g. self-esteem. However, the weakness of the qualitative approach is that the knowledge produced might not be general, difficult to test hypotheses and theories, is often time-consuming, and the results from the approach is easily influenced by the researcher's personal biases.

The table 4.1 summarizes the features of both the quantitative and qualitative approaches, and outlines the contrasts between them based on (Mack et al., 2005).

Table 4.1: Quantitative and Qualitative Approaches (Mack et al., 2005)

Characteristics	Quantitative	Qualitative
General framework	o Seeks to confirm hypotheses regarding phenomena o Instruments use more rigid style of eliciting and categorizing responses to questions o Uses highly structured methods such as questionnaires, surveys, and structured observations	o Explores phenomena o More flexible, iterative style of eliciting and categorizing responses to questions o Semi-structured methods such as in-depth interviews, focus groups, and participant observations
Analytical objectives	o To quantify variations o To predict causal relationships o To describe characteristics of populations	o To describe variations o To describe and explain relationships o To describe individual experience o To describe group norms
Question format	o Close-ended	o Open-ended
Data format	o Numerical (obtained by assigning numerical values to responses)	o Textual (obtained from audiotapes, videotapes, and field notes)
Flexibility in study design	o Study design is stable from beginning to end o Participants' responses do not influence or determine how and which questions researchers ask next o Study design is subject to	o Some aspects of study are flexible (for example, the addition, exclusion, or wording of particular interview questions) o Participants' responses affect how and which questions

	statistical assumptions and conditions	researchers as next ○ Study design is iterative; that is, data collection and research questions are adjusted according to what is learned

Having presented the strengths and weaknesses of both quantitative and qualitative approaches, the next sub-section presents the research approach specific to the current study.

4.5.3 Combined Research Method Specific for this Research

A mixed research method is considered to be consistent with the nature of the phenomena, and the type of research questions being addressed by this study. This includes the use of a quantitative and qualitative approach to address the current research questions in the form of "What" and "How". In a mixed method approach, the techniques used for data collection are surveys and interviews. Further, a mixed method is in line with Creswell and Tashakkori's (2008) three assumptions for choosing a research method, including the research problem, experience of the researcher, and the spectators.

Moreover, a mixed method approach falls in line with Yin's (1994) three situations for selecting a research method. These situations include the type of questions, the control over behavioral elements, and the degree of focus on contemporary events. The table below (4.2) outlines the outcomes of combining the research strategy with the characteristics of research questions.

Table 4.2: Relevant Situations for Different Research Strategies (Yin, 1994)

Strategy	Form of research question	Requires control over behavioral events	Focuses on contemporary events
Experiment	How, Why	Yes	Yes
Survey	Who, What, Where, How many, How	No	Yes
Archival analysis (e.g. economic study)	Who, What, Where, How many, How much	No	Yes
History	How, Why	No	No
Case study	How, Why	No	Yes

The highlighted cells refer to the strategy adopted in the current research, which address the research questions in the form of " What and How" outlined in Section 1.2 of Chapter One. A survey questionnaire for data collection is considered appropriate in which the researcher has no control on participants' selections when responding (Rossi et al., 1983). According to Rossi et al. (1983) a survey involves the collection of information from individuals (through personal interviews and questionnaires) about themselves or the social units they belong to. Conversely Hair et al. (2007) emphasizes using surveys to test hypotheses and to generalize findings.

There would appear to be a general lack of understanding of the concept of transaction costs within the New Zealand construction industry. The relationships between procurement system, environmental uncertainties and transaction costs are ambiguous in the New Zealand construction industry. Therefore the method of conceptualizing the new phenomena was considered to be deductive and used a set of assumptions to build a conceptual model. Objective five of this study is to develop a conceptual framework model, which explains the relations between procurement systems, project phases, environmental uncertainties, and transaction costs. The model will be used to test hypotheses and to deduce generalizations from the results obtained from applying the model to 'real world' cases. These procedures in developing and testing the theoretical model are quantitative techniques.

In this research, interviews and questionnaire surveys are used for data collection. Seeking experts' opinions, using a pilot survey, containing questions that use transaction costs terminology to validate the research findings. In this case subject matters opinions enable the study to confirm the cause and effect nature of the relationship between procurement systems and transaction costs. These techniques help to explore in-depth the phenomena of transaction costs, and the influence of procurement systems on the magnitude of these costs. Similarly they help in identifying ways in which improvements can be made in the procurement selection process.

In addition to the primary research goal of determining transaction costs for different procurement systems, a further element of the objectives of this study is to develop a model for procurement selection based on transaction costs. According to Creswell (1994), the quantitative approach is ideal at explaining causal relationships among independent and dependent variables. This is in line with the research paradigm discussed in section 4.4.3, which is determined by the nature of the research problem being examined (Easterby-Smith et al., 2012).

In general, a quantitative approach was used to develop hypotheses and test relationships by the development of a structural model of the hypothesized relationships. The model is then tested using suitable statistical software to explain inter-correlation between any latent variables and observed variables. The strength of this relationship is shown by a path coefficient. The rationale behind this quantitative strategy is to answer the following research questions:

What is the link between transaction costs and procurement system in construction?
How can transaction costs be minimized so that the productivity of the construction industry is enhanced in New Zealand?

The answers to these research questions were deduced from the views of research participants through interviews and questionnaire surveys.

Given the nature of the current research problem along with the philosophical assumptions and the data required; it is considered appropriate to employ a mixed method approach. As shown in Table 4.3 on the mixed method design matrix; the current study deploys sequential data collection and analysis that is shown as shaded areas on the matrix. At the first stage, the research uses a qualitative approach for data collection through interviews and a pilot survey of subject mater experts. In this stage, experts provide feedback on terminologies used in the wider questionnaire survey and the relevance of the questions in relation to the problem of TCs in the construction industry. Thereafter, stage two consists of a quantitative approach deployed for data collection through a structured questionnaire survey administered to construction professionals via a weblink.

The data obtained from the survey is analyzed, transaction costs mapped, and a structural model is developed and tested statistically. Stage three begins with the model being tested and applied to 'real world' cases, to determine the transaction costs incurred when professionals conduct procurement activities, and verify results. The rationale behind this sequential approach is the scope, nature, and complexity of the problem being investigated and the research questions developed for the study (see Section 4.2).

However, it is worth noting that there are only a few studies that have researched the relationship between procurement systems and TCs in construction that have used a mixed-method approach e.g. (Jobin, 2008; Whittington, 2008b). Some empirical studies used either a quantitative or qualitative approach to determine the magnitude of transaction costs in project procurement.

Table 4.3: Mixed-Method Design Matrix (Johnson & Onwuegbuzie, 2004)

		Time Order Decision	
		Concurrent	Sequential
Paradigm Emphasis Decision	Equal Status	QUAL + QUAN	QUAL ⇒ QUAN
			QUAN ⇒ QUAL
	Dominant Status	QUAL + quan	QUAL ⇒ quan
			qual ⇒ QUAN
		QUAN + qual	QUAN ⇒ qual
			quan ⇒ QUAL

For example, empirical studies by (Bajari & Tadelis, 2001b; Dudkin & Valila, 2005; Antinori & Sathaye, 2007; Li et al., 2013) used a quantitative approach relevant to this. Empirical studies that use a pure qualitative approach relevant to this study are: (Eccles, 1981a; Lynch, 1996; Lyons, 1996; Farajian, 2010). Amaratunga et al. (2002) explains that the benefit of utilizing a mixed-method approach is that it combines the strengths of both the quantitative and qualitative approaches.

The data is collected through a three-stage process using a mixed method approach from construction professionals at both managerial and operational levels. The collected data is analyzed to establish patterns, reliabilities, and meaning. The mixed method approach allows an in-depth understanding of the transaction cost concept in construction projects. The next section presents the research design suitable for this study.

4.6 Research Design

Tan et al. (2012) describe research design as the strategy, plans, and steps needed to answer research questions. It is the logical sequence that links the data to the research questions and to the conclusion of a study (Yin, 2009). The research design involves aspects such as specifying precisely what is to be researched and determining the best way to do it (Babbie, 2012). According to O'Sullivan et al. (1989), the type of research design determines to what degree a researcher may engage with the research. It also guides the decisions about how the observation should be done, how to analyze the data, and the techniques to be used for analysis. In sum, the decision on research design is essential to both the philosophical background underpinning the research and the contribution that the research is expected to make (Dainty, 2008a).

Figure 4.1 shows the research design for the current study. The main aspects of mixed methods research were outlined based on Bryman's (2006) layout. First, the research commenced with identification of the research problem during the preliminary review of literature. Next, an in-depth literature review was conducted, and the research questions and objectives were formulated to address the research problem(s). Then, a conceptual framework model (Figure 3.7) was developed to address the research problem, questions, and objectives. Based on previous empirical studies and analysis, the constructs of the theoretical model were operationalized and developed into a questionnaire. The questionnaire was validated by a pilot study. After the questionnaire is validated, a wider questionnaire survey is administered through a weblink (SurveyMonkey), to professionals at the managerial an operational level throughout the construction industry in New Zealand.

A cross-sectional survey design was utilized in the current study, to measure both explanatory/independent and dependent variables. Respondents were required to answer questions in respect to the evaluation of the time-spent daily on procurement activities relative to other project activities. Also, respondents were asked to evaluate the effect of uncertainties in the transaction environment on selecting the suitable delivery systems.

The data procured from the survey questionnaire was analyzed and the model was applied on real life cases. The results were discussed with another set of focus group. Lastly, recommendations were proposed to clients that are involved in construction and procurement selection processes. The research design shows the sequential procedures of integrating the quantitative and qualitative methods for the current study. The mixed-method was followed mainly during the data collection and analysis phases as shown in Figure 4.1.

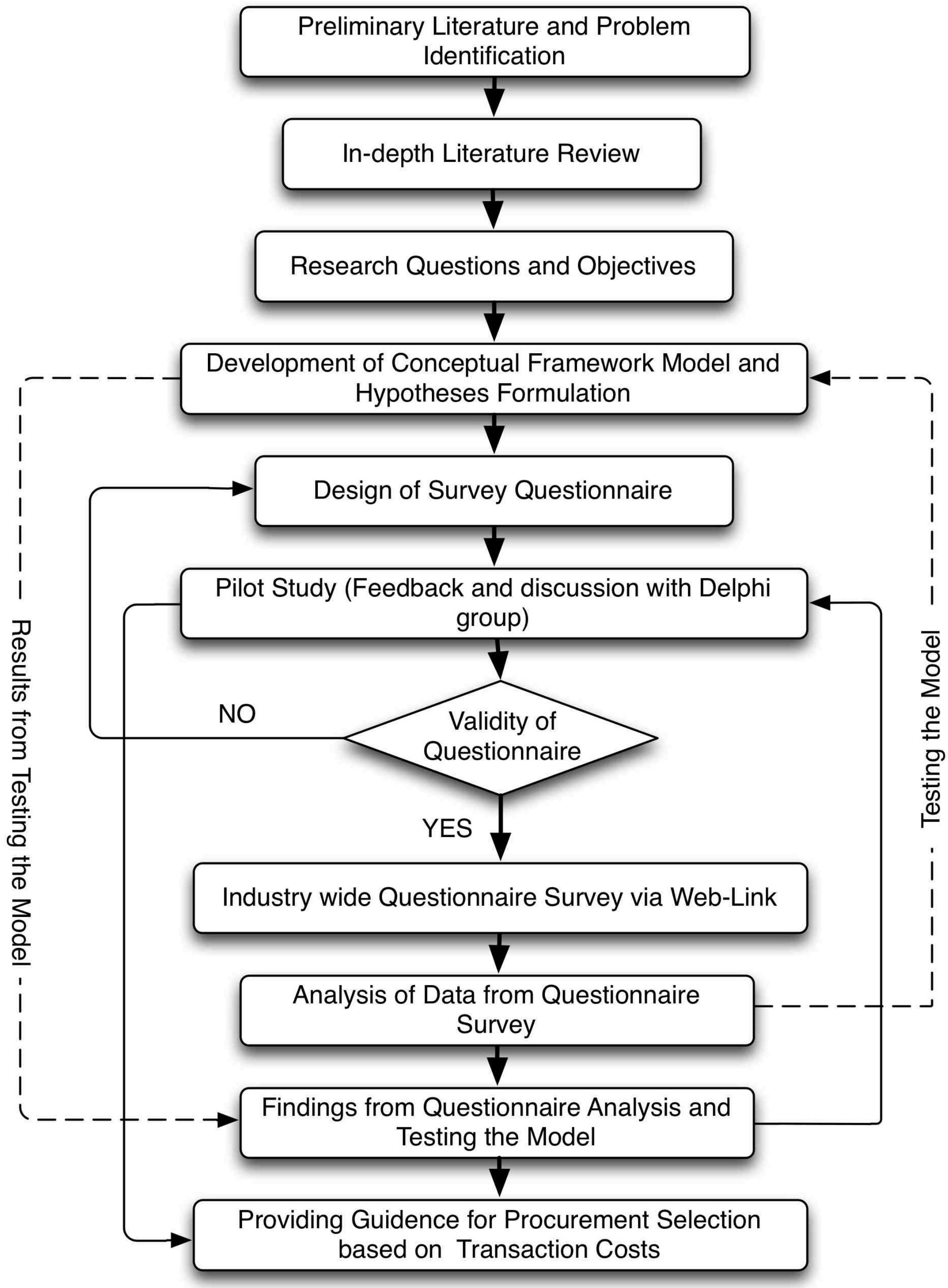


Figure 4.1: Research Design

4.7 Pilot Study

According to Parfaitt (2005), it is important to conduct a pilot study to determine the validity and usefulness of a questionnaire. In line with Parfaitt's recommendation, the current study questionnaire was validated by a pilot study involving interviews and discussions with subject-matter experts, i.e. focus group.

For the current study, eight experts within the construction industry were contacted to be part of the focus group. Four of them are from Auckland Transport, three are project managers involved in infrastructure projects and one design manager. Others are a project manager from the Auckland Council and two project managers from private organizations involved in infrastructure projects, as well as an architect from residential projects.

The focus group provided feedback on terminologies and relevance or practicality of the questions to address the problem of professionals conducting procurement activities in construction projects. The focus group suggested modifications to the initial questionnaire, for example rephrasing and including explanations to some terminologies. After, the questions were modified, an industry wide survey questionnaire was administered via an online weblink.

4.8 Sampling frame

In this study, the target population includes: City councils (Auckland, Christchurch, Wellington, Hamilton, and Dunedin), top 50 construction firms, and construction institutions that operate in New Zealand. Construction professionals at the managerial and operational levels who are involved on conducting procurement activities within the organizations mentioned were selected as the main sample frame. The reason is that construction professionals are central when considering the issues of transaction costs in construction projects.

4.8.1 Unit of Analysis

The unit of analysis is at the project level of the current study. According to Davidsson and Wiklund (2000), the unit of analysis is determined by the level in which the research questions are posed and analysed instead of the level at which the data is collected. Information of the main City Councils in New Zealand obtained from their official websites. A sample of top construction companies operating in New Zealand was selected from the information obtained from " finda": New Zealand's premier business directory, listing, and reviews (www.finda.co.nz/business/construction-services). Official websites of the principal construction institutions (e.g. NZIQS, NZIA, NZMBA etc) were the source of information about construction institutions operating in New Zealand. Information collected from professionals at the managerial and operational level, and the data were hypothesized to represent aggregated measurements at the project level. The assumption is that the main source of transaction costs occurs when professionals carry out procurement activities during a project life cycle.

4.8.2 Sampling Method

Sampling is a crucial element of the research process. It is the technique used for collecting data (Collis et al., 2003). The sampling method is largely dictated by the nature of the research method deployed in conjunction with the population being studied. Meanwhile, the purpose of the study has a large influence on the sample selected (Neuman, 2007; Babbie, 2012). In social science, a sample survey is considered to be the best method to collect data, and is widely used in construction management to solve existing problems (Love et al., 2002). A survey involves the collection of information from individuals about themselves or concerning the social units to which they belong. According to Babbie (2012), a survey method requires the collection of original data for describing a population too large to observe directly.

In the first stage of data collection in this study, a pilot survey and discussions with focus group were conducted to validate the questions in the wide industry questionnaire. This was done to achieve the research objective one stated in Section 1.2 on Chapter One. Since the relationship between procurement systems, environmental uncertainties, and transaction costs in the New Zealand construction industry is ambiguous; it is essential first to use a purposive sampling method for developing an understanding of the new concept. This is a non-probabilistic strategy that selects informative units of observation as being representative of the wider concept being studied (Teddlie & Yu, 2007). Purposive sampling provides a group of participants whose characteristics reflect those of the larger population (Easterby-Smith et al., 2008).

Therefore, this sampling method (purposive) is suitable for the context of this study because the researcher considered that the focus group members have the knowledge and expertise to respond to issues of TCs in project procurement. This is in line with Sarantakos (2005), Neuman (2007), and Creswell and Clark (2007), who emphasize the utility of purposive sampling in the context of both field study and exploratory research. Barbbie (2012) agreed that purposive sampling is useful when it is not possible to enumerate the totality of the population under study.

After validating the practicality of the questions and amendments made to the research questions, the second stage begins. The sampling method deployed for the second stage of data collection was random sampling. This is in line with the objective of this study, which is to develop a conceptual model that is practicable, using information from a large pool of practitioners. Construction professionals involved in procurement activities within City Councils, construction companies, and construction trade and professional associations based in New Zealand were the population contemplated for the survey. The participants were selected using a random sampling method to provide an unbiased subset of the population (Collis et al., 2003). According to Creswell (2007) and Neuman (2007), random samples are those that represent the population because every member has an equal probability of being selected. The total size of the population for the survey for the second stage was 360. This number was predicted from the average number of professionals working within the organizations that were surveyed as shown in the table (4.4) below.

The minimum sample size for the questionnaire survey was determined from the formula developed by (Cochran, 2007). The conditions used for the sample size choice are: t-value = 1.96; for the alpha level = 0.05; estimate of standard deviation in the population (s) = 1.25; with an acceptable margin of error (d) = 0.05.

Table 4.4: Predicted Population Size

Survey Target	**Professionals Involved**	**Total Number**
5 Councils	Architect, Quantity Surveyor, Project Manager, and Engineer	20
50 Top Construction Firms	Construction Manager and Project Manager	100
6 Construction Institutions (NZIA, NZIQS, PMINZ, NZIOB, IPENZ, and RMBF)	At Least 40 Professionals	240
Total		**360**

The standard deviation in the population was calculated by multiplying the number of points on the scale and the standard deviation used. Since the questionnaire used a 5-point scale, the minimum and adjusted sample size is deceived thus:

1. Minimum sample size (n)

$$n = (t^2 \times s^2) / d^2 \text{ .... } \textbf{Equation 4.1}$$

$$n = [(1.96)^2 \times (1.25)^2] / (5 \times 0.05)^2 = 96$$

2. Adjusted sample size (N)

$$N = n/[1 + (n/\text{ population})] \text{ .... } \textbf{Equation 4.2}$$

$$N = 96 / [1+ (96/ 360)] \approx 76$$

Finally, the third stage begins after the main survey for collecting data has been completed and the analysis for the data has been conducted and has resulted in findings. The rationale behind including this stage is to validate the findings by testing the developed model to 'real world' cases. Therefore, the sampling strategy to be employed was chosen to be purposive sampling since objective seven of this study is to provide guidance for clients in their construction and procurement selection processes. Data is collected in accordance with the procedures suggested by (Alreck, 1999; Fowler, 2009). These procedures are based on the information needed, sampling design, instrumentation, data collection and processing, and report generation. According to Marston and Straker (2001), these procedures might be used for both interviews and surveys, and are compatible with the mixed-method design, and the research design showed in Table 4.3 and Figure 4.1 respectively.

Further, for practical considerations dictated to get meaningful data, it would be only be possible to test the developed model to a limited number of real world projects. Therefore, samples of projects have been chosen in accordance to the recommendations received from the focus group. These are mainly infrastructure projects in the Auckland regional area. The sample population was project managers. In summary, four infrastructure projects, one project from the residential sector, and one asset management project were selected to test the developed model. The results from testing the model are discussed in the research validation section 4.11.

4.9 Data Collection Strategy

Data collection strategy establishes the procedures by which research tools will apply to appropriate research participants, for example the procedures used in distributing a survey. In the current study, the data collection aspect follows a sequential manner between qualitative and quantitative approaches as was presented in Sub-section 4.5.3. There are various methods of data collection for a study. The method to be used depends on the nature and type of information the researcher wants to know, the level of social interaction the researcher needs to observe, the resources available, and the time frame for the research. Based on that, a survey (e.g. questionnaires and interviews) method of data collection was deployed for this study.

A survey involves the collection of information utilizing questionnaires, personal interviews from individuals/group/focus groups, observations, and document analysis. According to Collis et al. (2003) and Babbie (2012), a survey approach in a positivist research is intended to gather primary data from a population sample, in order to analyze the gathered data statistically and generalize the results. The strength of survey research lies in its suitability as a tool for gathering, collecting, and analysing research questions about self-reported beliefs, attitudes and past behavior patterns (Neuman, 2007). Other benefits of survey research include: economics, short time frame, possibility of anonymity, and privacy to encourage more candid responses on sensitive subjects. Meanwhile, the weaknesses of a survey approach include: its vulnerability to systematic bias, low response rates, and respondent social interest.

In order to effectively design and validate the survey questionnaire, preliminary interviews were carried out with a focus group (construction professionals at managerial and operational level). Also, to provide terminology regarding the concept of TC and its relationship with the procurement systems implemented. Interviews were used widely in build environment researches adopting a qualitative approach (Amaratunga et al., 2002). Silverman (2011) describes this technique as useful in procuring the views and opinions of different groups of people at different levels of society on any phenomena. For the second stage, and after feedback was received from the focus group, a questionnaire was used as a survey instrument; ideal for a survey approach (Altinay & Paraskevas, 2008). The third stage, after data was collected and analyzed, dedicated projects were recommended by the focus group to test the developed model to real world cases. The model was tested on six different projects around the Auckland region. Finally, interviews were conducted with the focus group to discuss and validate the results and recommend guidance for the clients undertaking the construction and procurement selection process.

The combination of interview and questionnaire techniques in data collection have been used by several construction researches including: (Arcury et al., 2012; Guo et al., 2012; Tan et al., 2012; Mao et al., 2013; Pavot, 2013). Having discussed the strategy used for data collection, the next sub-sections explain the techniques used in more detail.

4.9.1 Development of Survey Questionnaire

The variables or constructs of the conceptual model, shown in figure 3.7, were operationalized into measurable indicators. Meanwhile, to test the developed model, information on each indicator needed to be procured. A cross-sectional survey design was utilized for the current study; to procure cross-sectional surveys are used to measure both explanatory/independent and dependent variables. Respondents were required to answer questions in respect of the evaluation of their the time-spent daily on procurement activities relative to other project activities. Also, the respondents were asked to evaluate the effect of uncertainties in the transaction environment on selecting the suitable delivery systems. The questions cover all the indicators of the constructs of the model. The questionnaire was designed to incorporate closed questions, because the nature of the questions is to evaluate the time-spent on procurement activities relative to other project activities.

The closed questions include: list, categorical, and rating questions. For example, to obtain general information about the participants and their company activities, they were given a list of choices from which to select suitable answers. While, rating questions were utilized to obtain participants' opinions on the time spent daily on procurement activities relative to other project activities. A 5-point Likert scale was deployed to evaluate the time spent (e.g. 1:very low, 2: low, 3: neutral, 4: high, and 5: very high). In addition, respondents evaluated uncertainties in the transaction environment using a Likert scale. A sample of the questionnaire used is presented in Appendix B2.

4.9.2 Administering the Survey Questionnaire

Questionnaires might be classified into several types based on the way they are administered (Saunders et al., 2011). Generally, the main methods of administering questionnaires are self and interviewer-administered. In self-administered questionnaires, respondents are asked to complete the questionnaires themselves. This may be administered through the internet, a postal mail, and delivery and collection (Saunders et al., 2011; Babbie, 2012). Interviewer-administered questionnaires is a situation where the researcher asks questions and records the respondent's answers (Babbie, 2012). This may be achieved through phone call interview or structured interview questionnaire (Saunders et al., 2011). This study deployed interviewer-administered pilot questionnaire and a self-administered one for the main questionnaire survey. That is in the pilot study the researcher enabled panelists in the focus group to modify their assessments and projected them beyond their own subjective opinions. While in the wider questionnaire, the researcher seeks opinions of professionals on TCs issues by evaluating their time-spent on procurement activities.

4.9.3 Interviews

A preliminary questionnaire was developed using information obtained from intensive literature review. Though, to improve and finalize the questionnaire it was necessary to conduct interviews with some subject matter experts. Purposive sampling technique, as described in section 4.8.2, was used for the selection of participants to be interviewed. Subject matter experts where selected on the basis on how likely their opinion could contribute to the research objectives. The participants have knowledge and experience in project procurement and management, and their feedback contributed to the research outcomes.

An initial concern with the use of the interview method is the problem of anonymity and confidentiality. Thus, details of the participant and their organizations were deliberately excluded and their identity kept anonymous. Subject matter experts were contacted by phone and email, to discuss TC concept in construction and the benefits of determining transaction costs in project procurement in the selection process. The sample size that consisted of 8 participants was satisfactory for qualitative analysis. In line with Gay and Airasian (2003) who conclude that relatively few individuals or selected groups can be considered to be sufficient for qualitative analysis.

Initially, the interview was conducted with 8 subject matter experts including three project managers and a design manager from Auckland Transport; two project managers from private construction firms involved in infrastructure projects; a project manager from Auckland Council as well as an architect from the residential sector. The interview technique deployed in the first instance was a phone interview and email correspondence. The interviewer deployed semi-structured questions for the interview. This technique was judged to be more convenient for both the interviewer and interviewees because of time constraints for both parties. Also, it allowed an in-depth understanding of the research topic and it's relevance to the construction industry.

The semi-structured interview facilitated cross-questioning to allow the interviewer to probe incomplete answers by asking more questions, or asking for clarifications (Fowler, 2002; Johnson & Onwuegbuzie, 2004). From an objective epistemological viewpoint, the interviewer could obtain better responses using cross-questioning. The interview questions were open-ended but pre-specified, and could be rephrased and covered by the researcher in any sequence. The subject-matter experts provided feedback on terminologies and relevance or practicality of the questions to be addressed in wide industry survey questionnaire. They also addressed the problem of uncertainties in the transaction environment, and its impact on the procurement selection process. The problem of transaction costs and uncertainties in the transaction environment might occur in all phases of projects including: concept, development, early implementation, full implementation, and the project close phase. Therefore, the questions covered all these phases.

4.9.4 Questionnaire

The main survey was conducted using the revised survey questionnaire from the pilot questionnaire. It was expected that the survey questionnaire to construction professionals might provide information, which improves project procurement selection, and creates awareness of the magnitude of transaction costs incurred when professionals undertake procurement activities. The purpose of this study had a significant effect on the sampling method selected as described in section 4.8.2. The data was collected by an Internet survey questionnaire conducted via a weblink, to construction professionals at management and operational levels. Participants' information was obtained as described in section 4.8.1.

A population of 360 construction professionals in 5 City Councils, top 50 construction companies, and 6 construction trade and professional associations working in New Zealand. Project managers, quantity surveyors, architects, and engineers were targeted to participate in the survey. The Mayor's Office of Auckland, Christchurch, Wellington, Dunedin, and Hamilton were contacted through e-mails, twitter, and Facebook. The Mayors' offices distributed the survey questionnaire to their subordinates. The officers were cooperative and supportive in distributing the questionnaire survey to construction professionals working in Councils. Auckland Transport was contacted through e-mails and phone calls with a Design Manager dealing with infrastructure projects. He distributed the questionnaire survey to construction professionals working in Auckland transport projects.

Finally, construction professional associations were contacted directly which included: New Zealand Institution of Building (NZIOB), New Zealand Institute of Architects (NZIA), The Institution of Professional Engineers in New Zealand (IPENZ), Registered Master Builders Federation (RMBF), New Zealand Institute of Quantity Surveyors (NZIQS), and Project Management Institute/New Zealand (PMINZ). These institutions were contacted through e-mails, twitter, and Facebook massages sent to their Presidents. Some of them were very cooperative and the survey questionnaire was sent directly from the President to all members. Other institutions, for example, PMINZ suggested including the questionnaire survey in their e-newsletters. E-mailed survey followed Dillman's (2000) guidelines on the mail survey questionnaire. This included the participant's information sheet and the survey questionnaire (attached in Appendices A2 and B2 respectively), which were attached to the e-mail sent. A weblink for online SurveyMonkey questionnaire was attached to the emails sent (https://www.surveymonkey.com/s/mrajeh). Also, three reminder e-mails were sent to the participants' within a three-month period from the initial e-mail.

The time frame for data collection on internet based questionnaires is between 2 and 6 weeks, depending on the number of follow-ups contacts (Saunders et al., 2011). The survey link was sent twice. The first for the pilot questionnaire sent to the focus group. This questionnaire was left open from 15th February 2013 with the intended close date of 29th February 2013 (two weeks). All members of the focus group have completed the pilot questionnaire. This was followed by data analysis and necessary amendments were made to the questionnaire. The second period was opened for the wider data collection survey, a questionnaire sent to construction professionals. This survey was left open from the 2nd of July 2013 until the 2nd of November 2013 (18 weeks).

In summary, the potential participants within the scope of the research completed 103 survey questionnaires. Out of which 72 usable responses were selected representing 70% of the minimum sample size calculated in equation 4.1. According to Saunders et al. (2011), in general response rate of 11% is a reasonable rate for an Internet administered survey. Therefore, the response rate offered a sufficient sample size for the statistical analysis required for this study.

4.9.5 Questionnaire to Validate the Model

Having selected the main techniques for data collection, it became clear that based on the epistemological position of the research that a secondary method of data collection was necessary to achieve the research objectives stated in Section 1.2 on Chapter One. The desire is to test the developed model in real life cases, and to practically validate the results. Consequently, an additional method was needed to contextualize and demonstrate the results gained from the survey questionnaire (e.g. interviews and questionnaire).

Six ongoing projects were selected to test the developed model. A survey questionnaire was sent via e-mail to six project managers involved in these ongoing projects. This included four project managers working in infrastructure projects, a project manager working in asset management project, and an architect working in residential project. All participants completed the questionnaire and send it back to the researcher within two-week time. The questionnaire was designed to test the model developed from an analysis of data of the main survey. For example, using the developed model to determine how much it cost (TCs) when a project manager involved in procurement activities. The rationale behind this practice (test the model to real-world cases) is to set a benchmark on how to calculate the transaction costs in construction projects, with the intention of this practice to be carried out for the rest of procurement systems (Management, Alliance, BOOT, etc.) used in construction in future research. Respondents were asked to estimate the time-spent daily on procurement activities.

The results of this questionnaire are not anticipated to confirm the ones procured from the main questionnaire survey instead of another source contributes an additional piece to the puzzle and in that way complements each other. Also, by conducting this practice, bias can be minimized and the validity of the findings can be enhanced. This practice (model/results validation) is in line with Love et al. (2002), who suggested using a triangulation method or measure of a phenomenon in construction management research, in order to overcome bias and validity.

4.10 Measurement of Constructs and Validation

The conceptual model shown in Figure 3.7 on Chapter Three encompasses unobservable constructs (latent variables) that must be determined by measurable or observable indicators. For instance, procurement systems, uncertainties in the transaction environment, and project phases have no direct effect on transaction costs, but they influence transaction cost elements (e.g. procurement cost, information cost, administration cost, and enforcement cost). Accordingly, a latent variable design with multiple indicators was chosen for each construct. These indicators represent the relationship between the latent variable and a combination of observed variables, which can be measured using statistical software. The table 4.5 outlined the measurable indicators used in the current study.

"Information cost" (INFO) is defined as a factor involving two key measures namely information gathering and communication. "Procurement cost" (PROC) is attributable to six key measures namely attending meetings, preliminary design, translation of client's needs, transition observation, training, and site visits (Hobbs, 1996; Solino & Gago de Santos, 2010). In this study, information and procurement costs are incurred because of professionals' daily time-spent in information gathering and procurement.

"Contract Administration cost" (ADMIN) is associated with three key measures: contract administration, conflicts resolution, and decision-making. "Contract Enforcement cost" (ENFO) is defined as a factor involving two key measures namely enforcement (monitoring and control) and verifying compliances. In this study, contract administration and enforcement costs are due to professionals' daily time-spent in implementing the contract terms and conditions (Lynch, 1996;

Tridico, 2007; Farajian, 2010). All these procurement attributes are important for understanding transaction costs in procurement.

Based on Shadish et al. (2002), the research makes valid generalizations for the relationship between procurement systems, uncertainties in the transaction environment, and the transaction costs. Validity is an overall evaluative judgment of the degree of truth of the results (Messick, 1998). The researcher should differentiate among four related components of validity which are construct, internal, external, and statistical validity (Shadish et al., 2002; Ferguson, 2004; Onwuegbuzie & Johnson, 2006; Tashakkori & Teddlie, 2008). Construct and external validity emphasize generalizability of research conclusions. While, internal and statistical validity support conclusions about covariance and causality (Austin et al., 1998). The four types of validity are explained in the following subsections.

"Environmental Uncertainties" is a latent variable involves eight key measures: political/legal/social, economy, technology, and competition are external uncertainties that represent threats and opportunities for the firm. Corporate culture, project location, finance/ownership, and information system are internal uncertainties representing weaknesses and strengths of the firm. It is proposed in this study that uncertainties in transaction environment are increasing project's pre and post contract transaction costs. In particular the costs of: information, procurement, terms and conditions, writing contracts, enforcement and contract administration.

Table 4.5: Measurement of the Constructs

Latent Variables	Observed Variables	Description
Information Cost (**INFOC**)	Information Gathering (**IG**)	Getting information about: potential suppliers/contractors and their behavior, labour market, and prices of construction materials. They are a function of opportunity costs of agent's time and personnel time (Gabre-Madhin, 2001; Baiden et al., 2006).
	Communication (**CM**)	Effective communication resulting in better cooperation among project stakeholders that eliminates uncertainties in terms of individuals' roles and responsibilities, hence reducing TCs (De Silva et al., 2008; Yang et al., 2009).
Procurement Cost (**PPROC**)	Attending Meetings (A**M**)	Meetings are a major form of communication during the project execution include pre-bid minutes, pre-construction minutes, progress minutes, and safety or tool box minutes (Klinger & Susong, 2006; Mincks & Johnston, 2010)
	Translation of Client's Needs (**TN**)	Translation of client's needs in terms of specifications, functional requirements and constrains, and to translate them into perspective information that can communicated with a contractor (Anumba & Evbuomwan, 2002; Lindahl & Ryd, 2007)
	Project Preliminary Design (**PD**)	Project preliminary design is the first phase of design process. It aims to formalize the approved design scheme into more detailed sketches of architectural, structural, and service components. Project manager coordinates a series of meetings with users and the design team for information gathering (Loosemore, 2003).
	Transition Observation (**TN**)	Transition observation including change to procedures and role or responsibilities (Rahman & Kumaraswamy, 2004; Pryke & Pearson, 2006).
	Training (**TR**)	In training, the project managers aims at improving the procurement performance, supervision of all procurement activities, and decision-making processes of a project (Edum-Fotwe & McCaffer, 2000; Walker & Rowlinson, 2007).
	Site Visits (**SV**)	Site visits could be for coordination, inspection, resolve dispute, and other interactions (Walker & Shen, 2002).
Administration Cost (**ADMINC**)	Contract Administration (**AD**)	Contract administration such as change order and claims administration (Bajari & Tadelis, 2001a; Cibinic Jr et al., 2006).

	Conflicts Resolution (**CR**)	Dispute resolution aims at providing effective resolutions to construction disputes and enabling clients to avoid conflict as possible. This include negotiation, renegotiation, mediation, and arbitration that need the deployment of extra resources (Gebken & Gibson, 2006).
	Decision-Making (**DM**)	Decision making for example dealing with contractor's problems, making policies, and coordinating with local and central Authorities (Bardhan, 2002; Thomson & Jackson, 2007).
Enforcement Cost (**ENFORC**)	Contract Enforcement (**EN**)	Enforcement activities such as monitoring and control, and contract enforcement mechanisms (Ryall & Samspson, 2008).
	Verifying Compliances (**VC**)	Verifying compliances such as time spent in inspection and translation of client's needs (Ryall & Samspson, 2008).
Environmental Uncertainties **(ENVIRO)**		
	External Uncertainties	Represent external forces i.e. threats and opportunities for the firm.
	Political/Legal/Social **(PLS)**	A number of federal Laws, Political stability of the host country, and Social responsibilities. Theses factors set up the mechanisms for implementing the contractual agreements (Wright 2004, Elliot 2008). Uncertainties of these factors may increase the TCs.
	Economy **(ECO)**	For example inflationary and market situations are factors that influenced the choice of management contracting (Duncan 2009). High inflation and market uncertainties increase the TCs as a result of high-risk project.
	Competition **(COP)**	This includes the number of bidders during the tendering process. Low number of bidders creates a less competitive procurement process that may contribute in reducing TCs but may increase opportunism (Farajian 2010).
	Technology **(TCH)**	Improves the coordination between project team members, quality control, and translation of client needs (Brochner 1990). Using improved technology such as CAD/CAM software's may lead to TCs reduction.
	Internal Uncertainties	Represent internal forces i.e. weakness and strength of the firm.
	Corporate Culture **(CCT)**	Strong culture means individual know how things are done and expected that result in minimizing the TCs associated with shirking, poaching, etc. (Wright 2004).

	Project Location **(PRL)**	The project location augments costs of logistics, and the site visits that lead to increase in TCs.
	Finance & Ownership **(FWR)**	Increase the likelihood of vertical financial ownership may increase the transaction costs (Williwaws 1985).
	Information Systems **(IS)**	Information system may have a direct effect on external and internal coordination costs and operational costs. Adopting IT in the construction operation may decrease the transaction costs (Vijay and Seungjing 991).

4.10.1 Construct Validity

This validity investigates which constructs are involved and how well the measured variables represent the conceptualized constructs (Hair et al., 2007). Measurement items were deployed from valid instruments in transaction costs literature, and were modified to be relevant with construction management. Objective five of this study is to develop a measurement model for procurement selection based on transaction costs; therefore establishing construct validity was a critical part of model development (Bagozzi et al., 1991; Sekaran, 2003). A three-step approach that is recommended by Straub (1989) was used to develop a valid research instrument. Firstly, a questionnaire was developed based on in-depth literature review. Second, to ensure that the content of each construct was appropriate; the validity of the questionnaire items were discussed and confirmed by subject-matter experts (Straub, 1989). Finally, it is important to have evidence of relevance, representativeness and technical quality of a content aspect of construct validity (Messick, 1998); thus the developed measurement model was tested in real-life cases for reliability.

Researchers (Scandura & Williams, 2000; Straub et al., 2004) expressed that measurements should represent the essence of the construct that they are focused on, and a construct should not be confused with other constructs. In this study, content suitability was achieved by matching indicators with appropriate constructs. The Table 4.5 presents the measurement of the constructs. These measurements were used to validate and test hypotheses. These constructs are used to determine the magnitude of TCs from information provided by professionals while undertaking procurement activities during project phases. Different delivery systems were used to measure the transaction costs, specifically the Traditional and Design-Build systems. In addition, respondents evaluated uncertainties in the transaction environment.

4.10.2 Internal Validity

This type of validity ensures that the researcher investigates what he intends to be investigating (Yin, 1994; Amaratunga et al., 2002). Based on the objectives of the quantitative/positivist approach of the current study, the rationale for conducting internal validity is to assess whether the covariance between independent and dependent variables resulted from a causal relationship (Austin et al., 1998; Creswell, 2012). This was achieved by adopting the modeling strategy, which provides evidence of internal validity because it shows that alternative explications are less plausible for the relationship between the adopted procurement systems (latent variable) and the magnitude of transaction costs (observed variables). The measurement model was tested on selected projects to validate the results. However, causal conclusions are limited to the context of the particular respondents. For example, the value of TCs might differ depending on the procurement selection procedures and the period of time when the project is executed. This will be discussed in-depth in Chapter 5.

4.10.3 External Validity

External validity refers to generalization where the findings of the research can be applied beyond the immediate research sample or setting in which it happens (Johnson et al., 2007). In a positivist research approach, external validity examines whether a causal relationship holds outside the observed constructs, and independent of those involved in the construct validity. Generally, external validity examines whether a cross-population exists which means the research findings about a population holds affirmative for another population (Engel, 2012). In the current study, both invariant (constant) relationships among different settings of units and across different units in the same settings were tested. This is achieved through developing a causal diagram of the relationships between procurement systems, uncertainties in the transaction environment, project phases, and the transaction costs. However, generalizability is inadequate when the independent variable depends on other factors, which means all threats to external validity interact with the independent variable (Brewer, 2000).

4.10.4 Statistical Conclusion Validity

This validity refers to the ability of the researcher to draw conclusions based on statistical evidence presented (Austin et al., 1998; Shadish et al., 2002; Straub et al., 2004). It is an integrated evaluation of statistical power, significance testing, and effect size (Austin et al., 1998). As a complement to internal validity, statistical conclusion validity is concerned with outlining conclusions about population covariation from sample data. According to Cook et al. (1990), statistical conclusions should not be based exclusively on significance tests, because empirical results and inferences might be unwarranted if they rely only on significance tests. In this study, assessment of the degree whereto the analytical procedures used might incorrectly conclude the relationship between transaction costs and procurement system, or the hypothesized relationship is oversimplified or incorrectly concluded. Although the null-hypothesis testing is a useful component of data analysis in empirical research, many researchers have uncertainties about its validity (Chow, 1996; Nayak, 1998; Bhattacherjee, 2012). This is that the null hypothesis does not clearly explain the significance effect of causal relationship, and how much covariation exists among constructs that are contemplated as the effect size. Just because the results show there's a relationship does not mean it is a causal one. There is a possibility that other variables or factors are causing the outcome. Hence, conducting a statistical validity prevents over and under estimation of the covariation size.

This study integrates the evaluation of statistical power, significance test, and effect size with data analysis; to enhance statistical conclusion validity. Statistical power refers to the sensitivity of a statistical test and support for statements about relationships between independent and dependent variables, and to test possible population effects. This is achieved by conducting a correlation test among variables for validity and reliability, and parametric versus nonparametric tests. Significance test is conducted to examine whether the independent and dependent variables covary, and the probability of an observed relationship is due to random variation alone. If the independent and dependent variables covary, then the strength of that covariation is relevant. Finally, confidence intervals were used to guide the assessment of significance of the model (Austin et al., 1998).

4.11 Data Analysis Techniques

Data collected from the questionnaire survey was analyzed utilizing a triangulation technique in order to reduce bias (Collis et al., 2003). This includes Validity and Reliability Test, Regression Analysis, Path Analysis, Confirmatory Factor Analysis, and Structural Equation Modeling. Statistical assumptions tests, such as outliers, normality, and linearity were conducted first, to ensure that basic data assumptions were met for statistical conclusion validity (Scandura & Williams, 2000). The aforementioned analyses were conducted using the statistical software IBM SPSS 20 and the structural model is tested utilizing IBM SPSS Amos 21. Data obtained from the questionnaire survey (72 usable responses) conducted to construction professionals in New Zealand was exported and saved as an Excel worksheet, PDF, and in SPSS worksheet format. Preliminary graphic representations of the variables using Excel were conducted to ensure data accuracy (Tabachnick & Fidell, 2007). Then, the data (SPSS format) was organized and coded according to the research themes. Out-of-range values were corrected, and the plausibility of variable means and standard deviations were confirmed using SPSS version 20.

Sub-sections 4.11.1 to 4.11.7 gives brief explanation/description of the data analysis techniques that were used in the current study.

4.11.1 Outliers, Normality, and Linearity Tests

In statistics, an outlier occurs when the measure of an observation is extremely distant from the rest of the data distribution. It can occur as a result of measurement error, or a heavily skewed population distribution to the right or left. Outliers might lead to weaknesses in conclusions drawn from the study, thus, an effort should be made to detect outliers and ascertain their influence (Hair et al., 2007; Tabachnick & Fidell, 2007). In this study, it was expected that outliers in data would not be a problem since the Likert-scale is used for measurement, because it is based on rating criteria 1 to 5, where 1 is very low and 5 is very high and in between them.

Normality is a theoretical frequency distribution for a variable or combination of variables, usually represented by a symmetrical curve (bell-shaped) around the mean (Albright et al., 2009). Normality can be assessed using two methods: graphically and numerically. Statistical tests for normality have the advantage of making an objective judgment; while graphical interpretation of normality has the advantage to assess normality in situations when numerical tests might be over or under sensitive (Seltman, 2012). In the current study, statistical tests were used to test normality. Normal distribution in statistics means that the data has equal mean, median and mode, thus skewness and normalized kurtosis are close to zero. Where, the kurtosis test determines whether a distribution is too peaked or too flat.

Linearity in a quantitative model assumes that the relationship between dependent and independent variables is linear. If the assumption of linearity is violated, then the forecasts and confidence intervals yielded by a regression model may be inefficient or seriously biased (Scandura & Williams, 2000; Tabachnick et al., 2001). This means that predictions are likely to be incorrect, especially when the researcher extrapolates beyond the range of the sample data i.e. generalization of the findings (Bentler & Chou, 1987; MacCullagh & Nelder, 1989; Raudenbush, 2002). Testing for linearity in relationships between variables was conducted in the current study by means of correlation coefficient and scatterplots that reveal non-linear relationships. A correlation coefficient of 0 means that there is no relationship between two variables. If there is a perfect positive relationship, then the correlation coefficient is 1, while for a perfect negative relationship the correlation coefficient is -1.

Statistical tests for outliers, normality, and linearity were used in this study, and were conducted utilizing the statistical software IBM SPSS 20.

4.11.2 Reliability Test

Validity and reliability are essential features of a quantitative research inquiry using SEM technique (Li et al., 2012). Prior to data analysis and to confirm the construct's internal consistency, the scales of the items used to measure each construct were tested for reliability (Hair et al., 2007). Amaratunga et al. (20020) and Saunders et al. (2011) explained that reliability deals with the consistency of research findings offered by the data collection techniques used. Cronbach's alpha values were measured in this study by utilizing Statistical Package for Social Science SPSS 20: to determine the intercorrelation and reliability of constructs. Reliability test help to measure how well a set of observed variables measure a single unidimensional latent construct (Gerbing & Anderson, 1988). Unidimensionality, according to Gerbing and Anderson, is the existence of a single latent construct that inspires a set of measurement items that can be accounted for by a single or common factor. The results are presented and discussed in detail in Chapter 6. Accordingly and based on the reliability test, some relationships were excluded from the analysis of the conceptual model.

4.11.3 Regression Analysis

Regression analysis is the study of relationships between variables. It can be used to predict explanatory (independent) variables from a set of response (dependent) variables (Albright et al., 2009). It can be used to analyze cross-sectional data or time series data; and also can be used to test linear or nonlinear relationships among variables. There are two types of regression analysis: simple regression analysis and multiple regression analysis. A simple regression includes a single explanatory variable, whereas a multi regression can include more than one explanatory variable (Tabachnick et al., 2001; Hair et al., 2007). The current study deployed both simple and multiple regression analyses. A simple regression analysis was used to estimate the costs associated with professionals conducting procurement activities. These costs were calculated based on experts' opinions of the time spent in accordance to the estimations received from the case studies. While, multiple regression analysis was used to estimate the transaction costs at the pre and post contract phases for different procurement systems. Specifically, multiple regression analysis was used to estimate the transaction costs for the Traditional and Design-Build delivery systems for the purpose of comparison.

4.11.4 Path Analysis

Path analysis is an extension of multiple regressions. It allows examination of more than one dependent variable at a time. Also, path analysis allows variables to be dependent with some variables and independent with others (Norman & Streiner, 2003). The Path diagram (Figure 4.2) is a visual representation for path analysis that shows relationship among variables (latent and observed). It is a graphical interface for Structural Equation Modeling (SEM) (Yang & Ou, 2008). Constructs and latent variables are represented by ovals; observed variables are represented by rectangles; single-headed arrows show dependence relationships, and double-headed arrows show covariance or correlations between pairs of variables.

In Figure 4.2, the variables A, B, and C are exogenous constructs that are determined by items outside of the model i.e. observed variables estimated through data collection. They are similar to independent variables in multi regression; they have no single-headed arrows pointing toward them.

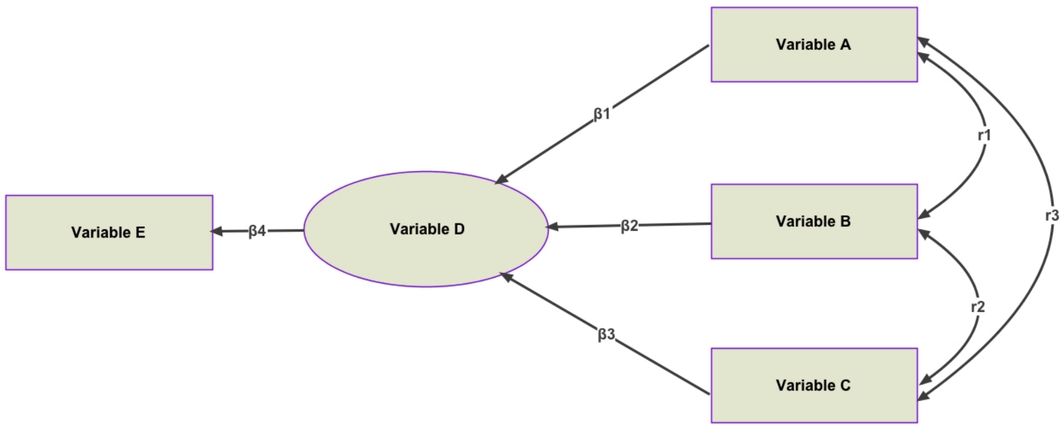


Figure 4.2: Hypothetical Path Diagram

Variables D and E are endogenous constructs; they represent the latent and multi-items equivalent to dependent variables in multi regression. Variable D is an endogenous construct with respect to variables A, B, and C but at the same time variable D is an exogenous construct with respect to variable E. Figure 4.2 also shows standardized path coefficients (e.g. β1, β2, β3, and β4) and correlations (e.g. r1, r2, and r3) among exogenous constructs are calculated by running the path analysis. The path diagram represents the foundation for developing the SEM.

4.11.5 Factor Analysis (FA)

FA is a useful technique that can be used prior to SEM: to explore data for patterns or reduce the number of variables to a manageable level, and it can be used for data summarization(Gerbing & Anderson, 1988; Kinicki et al., 2004; Hair et al., 2007). It explores the interrelationships among variables to discover underlying factors (Norman & Streiner, 2003). In this instance FA was used to factor the set of items and afterwards construct scales based on the resulting factors loaded. Scales are created by allocating to the same scale the items that anticipate at least moderately on the same factor (e.g. 0.4) and do not anticipate as highly on other factors (Gerbing & Anderson, 1988).

This study deployed FA to identify an initial parsimonious set of observed variables, which competently represent the constructs while still maintaining their character and scope. This means that FA was used to confirm the proposed structural model and refinement to the measurement model prior to SEM. The statistical software IBM SPSS Amos 21 was used to examine the relative chi-square (χ^2/df); Goodness-of-Fit Index (GFI); Parsimonious Goodness-of-fit (PGFI); Comparative Fit Index (CFI); Root Mean Square Error of Approximation (RMSEA); and Expected Cross-Validation Index (ECVI). For an acceptable model, the GFI and CFI indices should be equal or greater than 0.9, RMSEA between 0.05 and 0.1, and PGFI greater than 0.5 (Browne & Cudek, 1993; Byrne, 2009; Saris et al., 2009; Kline, 2011).

4.11.6 Structural Equation Modeling (SEM)

SEM is one of the techniques of choice for researchers across disciplines but is increasingly used in social science (Hooper et al., 2008). It is also known as causal modeling, causal analysis, simultaneous equation modeling, analysis of covariance structures, path analysis, dependence analysis, and confirmatory factor analysis (CFA) (Kline, 2011). SEM is a multivariate statistical technique used to examine direct and indirect relationships between any independent variables and any dependent variables (Li et al., 2012). It is a combination of confirmatory factor analysis, multi-regression analysis, and path analysis. According to Norman and Streiner (2012) SEM is an extension to path analysis by elucidating complex interrelationships among latent variables. The SEM approach can be used to test the developed models by estimating errors in the constructs' measurement and estimating errors in the hypothesized relationships. In this feature, SEM is superior to the multi-regression technique because it recognizes measurement error. Also, SEM offers an alternative technique for measuring principal variables of interest by the inclusions of latent and surrogate variables (Kim et al., 2009).

Researchers in construction management (Molenaar et al., 2000; Mainul Islam & Faniran, 2005; Wong & Cheung, 2005; Jin et al., 2007; Yang & Ou, 2008; Kim et al., 2009; Aibinu et al., 2011; Doloi et al., 2011; Li et al., 2012) utilized SEM to model hypothesized causal processes where complex phenomena and dynamic relationships are explored. For example Huimin Li et al. (2012) deployed SEM to test the relationship between transaction-related issues with project performance. They developed a model to test hypotheses of the likelihood of better project performance with low uncertainties in transaction environment and low magnitude of transaction costs. Aibinu et al. (2011) used SEM to determine the interactions among conflict intensity, contractors' dispute tendencies, and organization justice.

According to Kim et al. (2009), SEM shows a more accurate prediction of project performance because SEM allows for visually depicting the paths of how variables are interrelated. They developed a conceptual model to test hypotheses of the relationship between the organizational justice system and conflict and dispute. In another case, Islam and Faniran (2005) applied SEM to model the impact of project conditions on planning effectiveness. Lastly, Molenaar et al. (2000) suggested utilizing SEM to foresee the likelihood of disputes at the early stage of project execution.

The current study applied SEM to model the relationship between procurement systems, uncertainties in the transaction environment, and transaction costs. Also, to develop a measurement model to determine the transaction costs for different procurement systems, specifically the Traditional and Design-Build delivery systems. SEM involved five sequential aspects: Model Specification and Conceptualization; Model Identification; Model Estimation; Model Goodness-of-fit; and Model Re-specification or Modification (Norman & Streiner, 2012). These aspects will be discussed further in the following sub-sections.

4.11.6.1 Model Specification and Conceptualization

The basic concept of SEM is shown in Figure 4.3. In this figure, the hypothesized relationships among the latent variables are presented by means of the direction of paths (single-head arrows) and the strength of the path coefficients. The path coefficients (β1, β2, and β3) represent the inter correlations between the latent variables. Whereas, the rectangular boxes represent the observed variables that might be individual items on a questionnaire. The numbers on the arrows directed to these rectangular boxes represent the factor loadings. For example, latent variable (A) is measured by three measurement items (A1, A2, and A3), and the dotted line with a single-head arrow represents the relationship between the measurement items and the latent variable it measures. Therefore, a typical SEM is represented by a combination of exogenous and endogenous latent constructs, exogenous and endogenous observed constructs. Exogenous latent constructs are analogous to independent variables that are determined by observed variables outside the model; they are the latent variables A, B, and C in figure 4.3, and they have no single-headed arrows pointing to them. However, endogenous latent constructs are equivalent of dependent variables, which are hypothesized to be determined by items within the model. The latent variable D represents the endogenous construct in figure 4.3, and has single-headed arrows pointing to it.

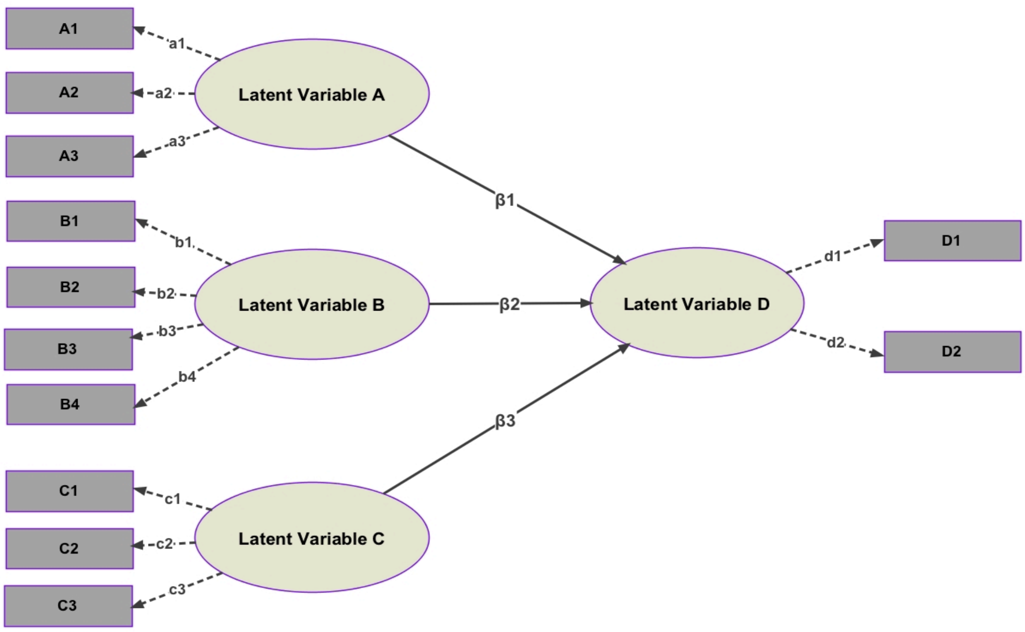


Figure 4.3: Hypothetical SEM Model

Theoretically, SEM encompasses two types of models: the measurement model and the structural model. The measurement model incorporates confirmatory factor analysis, which is concerned with how satisfactory the variables measure the latent variables, also in addressing issues such as validity and reliability. The structural model reflects multi-regression analysis and path analysis that model the relationship between the latent variables through delineating the explained and unexplained variance. This is equivalent to the examination of the relationship by the regression models (Molenaar et al., 2000). Typically, the measurement model includes the overall variables without causal relationships among them, and the structural model identifies the nature and existence of relationships among variables.

Several features of SEM distinguish it from other multivariate techniques (Kim et al., 2009; Ullman & Bentler, 2012). Firstly, a confirmatory base analysis rather than exploratory analysis, which means the analysis proceeds from a vigorous theoretical substructure allowing inferences and hypothesis testing to occur. Secondly, SEM identifies a causal relationship between independent and dependent variables allowing assessment and correction for measurement error of the observed variables. Thirdly, its capability to represent indirect affects as well as direct causal relationships among diverse variables. Fourthly, SEM improves estimation by using latent constructs and taking the measurement error of the observed variables into consideration. Finally, SEM visualize complex relations through a graphical representation (Bae, 2005; Hair et al., 2007).

4.11.6.2 Model Estimations

To quantify the relationship levels between variables, covariance-based approaches such as LISREL, AMOS or EQS may be used in SEM (Haenlein & Kaplan, 2004; Kim et al., 2009; Kline, 2011; Ullman & Bentler, 2012). That is, to minimize the discrepancy between the sample covariance and those predicted by the conceptual model utilizing a maximum-likelihood function. The research problem addressed by this study involves conceptual and hypothesized relationships of latent variables (shown in Figure 3.7) that need to be measured with observed factors. Therefore, there is a need to understand and concurrently test relationships among the exogenous (independent) and endogenous (dependent) latent variables, and also the relationship between the latent constructs and the observed variables.

This study deploys IBM SPSS Amos 21 as a statistical software package for the analysis of covariance estimation, which is widely used as the representative software for SEM. The focus of this approach (SEM) involves a comparison between the dataset, the empirical/ sample (observed) covariance matrix (S), and an estimated population covariance matrix (Σ) (Ullman & Bentler, 2012). According to Tabachnick and Fidell (2007), the fundamental question asked by SEM is " Does the model produce an estimated population covariance matrix that is consistent with the sample (observed) covariance matrix?" If the parameter estimates produce an estimated population covariance matrix closer to the sample covariance matrix, then the model is fit (Tabachnick et al., 2001; Ullman & Bentler, 2012). Estimates of parameters are essential to SEM analysis (Hair et al., 2007), and allows the researcher to assess the empirical and statistical significance of the effect among constructs, and to test direct and indirect effects. Therefore, differences between the observed and estimated covariances matrices (S–Σ) are the key factor in assessing the model fit in SEM.

4.11.6.3 Model Goodness-of-Fit Assessment

The covariance-based SEM approach provides efficient parameter estimates and a complete test of model fit. As discussed in Section 4.11.6.2, the closeness between observed and estimated covariance matrices is an essential factor in the model fit assessment. Closeness is evaluated primarily with Chi-square test statistics and goodness-of-fit indices. Basically, the null hypothesis in SEM is that the closeness between observed and estimated covariance matrix is zero ($S-\Sigma=0$) (Tabachnick et al., 2001; Ullman & Bentler, 2012). This implies that the model fits perfectly, and the Chi-square test is not desired because hypotheses about adequacy of the model cannot be tested.

Chi-square traditionally evaluates the magnitude of difference between the sample and fitted covariances matrices. Even though the Chi-square test is popular as a fit statistics, there are a number of limitations in its use. First, as stressed by Mooijaart and Satorra (2009), Chi-square in standard SEM may not be able to detect violations of linearity. Secondly, it may lead to the rejection of a well-specified model because of multivariate and deviations from normality (McIntosh, 2007). Thirdly, the chi-square test is sensitive to sample size and the model's degree of freedom (df), which means that the Chi-square statistic, nearly always rejects the model with large sample sizes. On the other hand, if the sample size is small it may lead to a lack of discrimination between good and poor fitting models (Kenny & McCoach, 2003).

Accordingly, researchers used alternative indices to assess model fit. These include three types of goodness-of-fit indices: absolute fit indices, incremental fit indices, and parsimony fit indices. *Absolute fit indices* determine how well a conceptual model fits the observed data. Included in this category are: the relative Chi-square test (χ^2/df); Root Mean Square Error of Approximation (RMSEA); Goodness-of-fit Index (GFI); and Root Mean Square Residual (RMR). *Incremental/comparative fit indices* are based on the comparison of the relative fit of a substantive model to that of a baseline (null) model (McDonald & Ho, 2002; Miles & Shevlin, 2007). Included under this category are: Normed Fit Index (NFI); and Comparative Fit Index (CFI). *Parsimony fit indices* are important in model comparisons that provide information on which model among a set of competing models is best fit the observed data. It provides a more realistic evaluation of the hypothesized model by taking into account the number of estimated parameters of the hypothesized model (Byrne, 2009). An example under this category is Expected Cross-Validation Index (ECVI).

The current study has adopted five measures to evaluate the goodness-of-fit indices, based on recommendations by researchers (Tabachnick et al., 2001; Hair et al., 2007; Byrne, 2009; Saris et al., 2009; Kline, 2011; Norman & Streiner, 2012; Ullman & Bentler, 2012). These measures are: relative chi-square (χ^2/df); Goodness-of-Fit Index (GFI); Comparative Fit Index (CFI); Root Mean Square Error of Approximation (RMSEA); and Expected Cross-Validation Index (ECVI). χ^2/df is one example of statistic that minimizes the impact of sample size (Tabachnick & Fidell, 2007). It is an absolute fit measure of the ratio of chi-square to the degree of freedom. An acceptable ratio for this statistic is between the values of 2 and 5. The GFI was created as an alternative to the Chi-square test that measures absolute fit of variance by the estimated population covariance. It measures how closely the model comes to replicating the observed covariance matrix (Diamantopoulos & Siguaw, 2000). This statistical measure ranges from 0 to 1; with its value increasing with a larger sample size and as the number of parameters increase.

With these features, GFI is similar to the coefficient of multiple determination (R^2) in multi-regression analysis (Tabachnick & Fidell, 2007).

The most commonly stated fit indices are the CFI and RMSEA (Hair et al., 2007; Tabachnick & Fidell, 2007). The CFI is an incremental fit that assumes that all latent constructs are uncorrelated (null model) and compares the observed covariance matrix with this null model (Tabachnick & Fidell, 2007). This statistical measure ranges from 0 to 1; a value equal or greater than 0.9 is needed to ensure that miss-specified models are not accepted (Hu & Bentler, 1999). The RMSEA is an absolute fit measure that tells us how well the model, with unknown but optimally chosen parameter estimates would fit the population covariance matrix. Diamantopoulos and Siguaw (2000) noted that RMSEA "has become one of the most informative fit indices in covariance structure modeling" (p.85). The statistical measure ranges form 0.05 to 0.1; with a lower value indicating a better model fit (MacCallum & Austin, 2000; Steiger, 2007). The RMSEA esteems parsimony due to its sensitivity to the number of estimated parameters in the model. Lastly, the ECVI is parsimony fit that compares one model with another using only one set of observed data. The model with the best fit is one with the smallest ECVI value, which is the most stable model in the population (Whittaker, 2011; Lomax & Schumacker, 2012). This test is important in determining problems such as over-fitting, and gives an insight on how well the model measures a generalized independent data set.

4.11.6.4 Model Identification

Model identification in SEM involves the procedures used to ensure that redundant paths are not in the model. In this instance, by excluding paths that are not supported by theory. Model identification can be determined by calculating the differences between the observed and estimated covariance matrices ($S-\Sigma$) based on data points (Tabachnick et al., 2001). The data points in SEM are the variances and covariances in the sample covariance matrix. That is, the number of data points is the number of non-redundant sample (observed) variances and covariances, which can be calculated according to the following formula:

Number of Data Points (S) = ½ p (p+1) .... **Equation 4.3**

where p equals the number of measured variables

For example, there are five measured variables (p), therefore according to Equation 4.3 there will be 15 data points (S).

Accordingly, if the data points are more than the number of parameters (e.g. path coefficients, variances and covariances) that are to be estimated ($S-\Sigma= +$), then the model is over identified. If the number of data points and the model parameters to estimate is equal ($S-\Sigma=0$), in this case the hypotheses about adequacy of the model cannot be tested. That is, the estimated parameters reproduce the sample covariance matrix, chi-square, and degree of freedom is equal to zero. Lastly, if data points are fewer than parameters to be estimated ($S-\Sigma= -$), then the model is under identified. In this case, constraining or deleting some parameters is essential to reduce their number (Ullman & Bentler, 2012).

In this study, the model developed using SEM must be over identified so that the number of parameters is less than the number of observed covariances and variances. In this instance, the degrees of freedom augmented and the possibility that the model fits in the population is plausible.

Another benefit of identification is examining the measurement portion of the model so that every latent construct has its scale determined. In a situation where unobservable latent construct does not have a metric scale, then relative scaling is assigned through constraining the construct variance to 1, or by constraining the indicator variables factor loading parameter to 1 (Gerbing & Anderson, 1988). This makes the constrained variable a reference variable (Byrne, 2009).

A constrained variable through model identification is used in this study for some of the regression paths of the observed variables leading to the latent construct. Meanwhile, the advantage of establishing model identifiability for the structural portion of the model is examining the relationships among the latent variables through the regression coefficients of these variables. If none of the latent endogenous factors predict each other, then the structural part of the model is identified. That is, if the latent endogenous factors do predict one another, then there are no correlated errors and no feedback loops (Ullman & Bentler, 2012).

4.11.6.5 Modeling Strategy and Re-specification

The research problem addressed by the current study encompasses conceptual as well as hypothesized network of latent constructs, which were conceptualized in Section 3.9 and presented in Figure 3.7 on Chapter Three. The latent constructs should be measured with observable items. Testing a model contains latent and observed variables that need a modeling strategy that recognize latent variables in their theoretical network. Thus, there is a need to understand, and simultaneously examine the relationships among independent and dependent latent variables in one hand, and between latent variables and the observed variables on the other hand.

The modeling strategy deployed for the current study is a combination of exploratory and confirmatory strategies. An exploratory model development strategy in SEM aims at improving the conceptual model through modification of the structural or measurement model (Lomax & Schumacker, 2012). While, the confirmatory modeling strategy aims at assessing how well the model fits the data population by performing confirmatory factor analysis (CFA) in SEM (Bentler & Chou, 1987). That is, in the current study, a theoretical model was specified first and then a CFA utilizing SEM was performed. Further, testing alternative models using the competing models strategy. First by examining the equality of models across groups, and second by comparing the fit of nested models. Using the same dataset, a model can be nested within another model if it contains the same variables but constrained or added other paths (Hair et al., 2007; Tabachnick & Fidell, 2007).

Consequently, a good modeling strategy is important in SEM to avoid re-specification. Model re-specification or modification was contemplated only if there was theoretical support and not only empirical justification. Researchers conducting model re-specification, attempt to improve the developed model and achieve a better fit or to test hypotheses (Ullman & Bentler, 2012). Unfortunately, this would happen at the expense of generalizability, validity, and unidimensionality (Lomax & Schumacker, 2012). An unfit model could be because of omitting important latent variables during the model specification. Thus model modification may require the need for further data collection. Finally, if the hypothesized model is wrong, tests of model modification may be insufficient to reveal the true model (Ullman & Bentler, 2012).

4.11.7 Modeling Issues and Sample Size

The covariance-based SEM approach calculates path coefficients through minimizing the differences between the observed and estimated covariance matrices. Hence, model fit in covariance-based SEM utilizes maximum likelihood estimation (ML). This approach is sensitive to normality of data distribution, which means the results from SEM may not reflect the actual relationships among variables (Norman & Streiner, 2012). In the current study, all the observed items are perception-based measures on a Likert Scale with ordinal data; there are potential risks that ML underestimates factor loading and correlations. Since data is normally distributed when using a Likert Scale of minimum five categories: risks of biased results might be negligible. Risks might be further minimized with the utilization of a covariance matrix instead of a correlation matrix in estimation (Byrne, 2009). In this study, all the measurement items have at least five categories on the Likert Scale and ML estimation of the covariance matrix was used.

4.11.7.1 Nested Model Comparisons

Model comparison involves testing alternative models fit using the competing model strategy with the same dataset. A model can be nested within another model, since fit indices such as CFI obviously compare the current model to the model of uncorrelated variables(Ullman & Bentler, 2012). Researchers used model comparison approach for identifying causes of both structural and measurement failure of models. According to Widaman and Thompson (2003), for fit indices results to be significant, models have to be nested (Widaman & Thompson, 2003). Yaun and Bentler (2003) discussed the performance of Chi-Square test when the base model is misspecified. McCallum et al. (2006) proposed a different test based on evaluating the differences of RMSEA for the two models (MacCallum et al., 2006). Li and Enter (2011a) agreed with McCallum's et al. (2006) procedure, which can be improved by a judicious use of a single RMSEA value for the nested models differences. However, Bentler and Satorra (2010) provide a procedure to evaluate nesting called NET (nesting and equivalence), for example, the two models; $X \rightarrow Y \rightarrow Z$ and $X \leftarrow Y \leftarrow Z$, are equivalent models fit identically and cannot be eminent statistically, but they might be interpreted differently (Ullman & Bentler, 2012).

Generally, the principle of nested models is that: a model M_0 is nested within another model M_1, if the parameter vector for M_0 is achieved by constraining the parameter factor for M_1. The constraints invoked when moving from M_1 to M_0 may be varied invoking equality constraints even when parameters are constrained to zero (Widaman & Thompson, 2003). The advantage of nesting M_0 within M_1 is that M_0 will have fewer parameter estimates and then more degree of freedom. Also, including new parameter estimates in M_0 is not possible if they are not appearing in the parameter factor for M_1. Another concept of nested models in SEM is a *Continuum Of Nested Models,* that is: M_A .... M_B .... M_C. This concept is adopted in the current study utilizing modeling software of IBM SPSS Amos 21. Starting with a first order measurement analysis, then specifying a second order layers internal structure, and the final stage is constructing a causal structural mode. That is, relationships among constructs were progressively constrained. Based on Mulaik and Millsap (2000), the testing procedures begin with the research conceptual model (basic model).

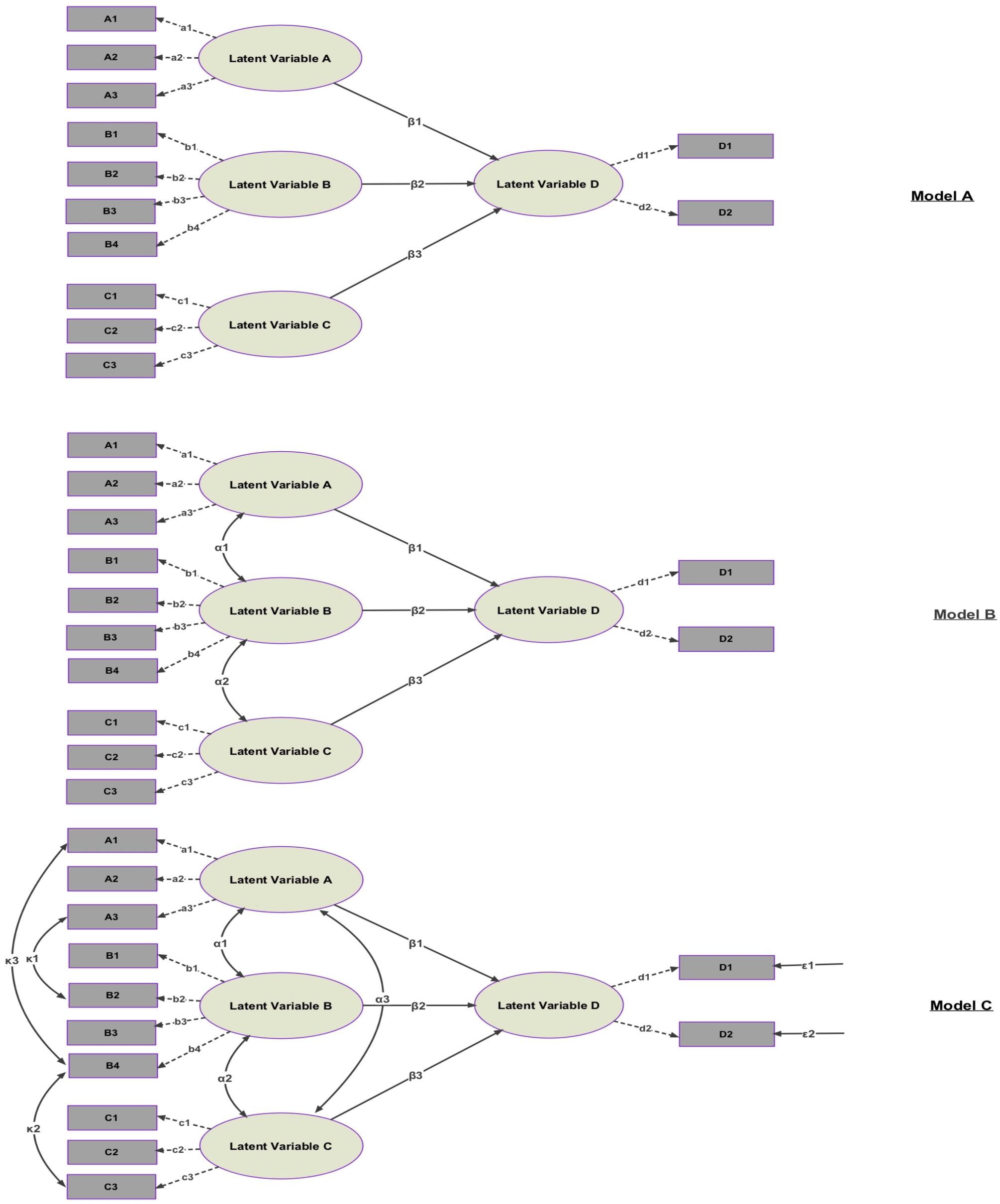


Figure 4.4: The Concept of Nested Models

The basic model (M_A) includes parameter estimates that can be equal to the elements in the sample covariance matrix. The Chi-square (χ^2) and the degree of freedom (df) are equal to zero. Next, a less restricted model with all set of free correlations is created. Adding more relations among indicators to specify another model that is even less restricted (M_B). Lastly, starting with the base model and add planned constraints (M_C). Figure 4.4 shows models that illustrate the nesting concept. The nesting and equivalence test (NET) is conducted according to Bentler and Satorra (2010) to differentiate between models in the following steps:

Step 1. Run SEM on model (M_A) and save the (df_1) and the model-reproduced covariances (Σ_A).

Step 2. Read in the Σ_A as data to be analyzed in a SEM run with model (M_B) using the same estimated method. The output needed is the (df_2), and the minimum of the fit function Φ.

Step 3. Compute $d = df_1 - df_2$, and set ε, a criterion value for Φ (e.g. $\varepsilon = 0.001$).

Step 4. (a) If $d > 0$ and $\Phi < \varepsilon$, the models are nested.

(a) If $d = 0$ and $\Phi < \varepsilon$, the models are equivalent.

(a) If $d < 0$ and $\Phi \geq \varepsilon$, M_A is not nested, or equivalent to M_B.

(Bentler & Satorra, 2010)

4.11.7.2 Mediator and Moderator Effects

Mediators and moderators are variables used for refining and understanding causal relationships (Frazier et al., 2004; Wu & Zumbo, 2008; Sardeshmukh & Vandenberg, 2013). A mediator variable links a cause and an effect, while a moderator variable modifies a causal effect (Wu & Zumbo, 2008). As stated by Wegener and Fabrigar (2012), there are three types of causal hypotheses: direct causal effect, mediated causal effect, and moderated causal effect (Fabrigar & Wegener, 2012). Figure 4.5 presents the three types of causal hypotheses. In traditional regression analysis there are direct effects of independent variables on their dependent ones. SEM has the ability to evaluate not only direct but also indirect effects via intermediary variables (Ullman & Bentler, 2012). Mediator and moderator variables have different roles in SEM analysis, and they cannot replace each other. But, a variable can be tested for a mediation effect, if the hypothesis is disconfirmed, then the same variable can be tested for moderation effect, or vice versa (Wu & Zumbo, 2008).

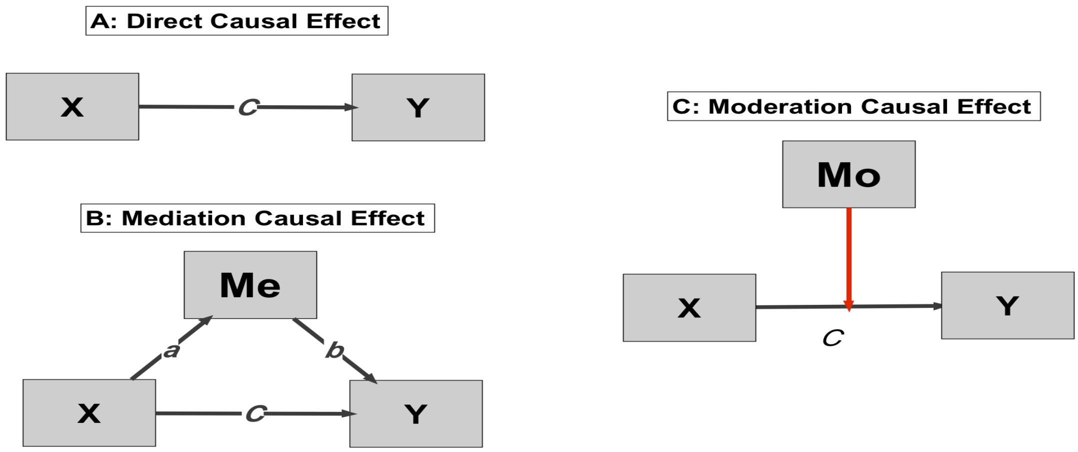


Figure 4.5: Conceptual Paths Diagrams (Direct, Mediation, and Moderation)

Researchers introduced complete theoretical, practical, and technical issues on mediation in SEM such as (Lingard & Francis, 2006; Cheung & Lau, 2008; Iacobucci, 2008; Taylor et al., 2008; Wood et al., 2008; Hayes, 2009; Preacher et al., 2010; Zhao et al., 2010; Ledermann & Kenny, 2012). For example, Lingard and Francis (2006) used the mediation effect in SEM to test whether work-family conflicts mediate the relationship between job stressors and burnout, among male administrators, professionals, and managers in the construction industry.

Wood et al. (2008) stated that the effects of full and partial mediation are based on SEM testing procedures. In another case for mediation, Zhao et al. (2010) concluded that the direct path in mediation using SEM is rarely predicted. That is, the unpredicted direct path is an indication of an omitted mediator in SEM, and mediation is required only when the indirect path coefficient is significant. Another viewpoint by Ledermann and Kenny (2012) is the domination of mediation assessment in the model testing processes. Mediation in SEM provides important information about causal relationships between variables that are mediated by a single or a set of intervening variables.

In this study, mediation and moderation issues were introduced in Chapter three during the hypotheses development. That is, the interaction among constructs of environmental uncertainties and their effect on the magnitude of pre and post contract transaction costs; would differ across different procurement systems. The theoretical model developed in Chapter 3 and presented in Figure 3.7 is relatively new in the context of construction. Thus, some of the observation measures were deployed and developed based on literature reviews coupled with experts' opinions. Certain interrelationships might not be clear regarding mediation and moderation. For example, the moderating and mediating effect of environmental uncertainties and project phases on the client's procurement decision is statistically not clear. This means that their effect is not directly influenced the clients' decisions on selecting the appropriate procurement systems for their projects. Instead they have a significant effect on the amount of time-spent in information search, procurement, contract administration and enforcement.

Calculating mediator and moderator variables effect using regression analysis is a hard task, and also hard to determine the effect utilizing SEM because of measurement error. Also, since the procurement systems and the project phases are categorical measures; the solution is to create latent variables for environmental uncertainties, procurement systems, and project phases, which are believed to be measurement error free in SEM (Wu & Zumbo, 2008). The approach provides the advantages of combining multiple observed items to represent the underlying latent variables. Finally, the SEM approach has great flexibility in incorporating multiple causes, mediators, and moderators in one single model (Frazier et al., 2004; Fritz & MacKinnon, 2007).

4.11.7.3 Sample Size

The covariance-based SEM approach is less stable when estimating from small samples (Ullman & Bentler, 2012). A small sample size reduces the statistical power such as Normality and Chi-square fit tests. There are three important elements in obtaining a good factor model in exploratory factor analysis models: the size of factor loading, the number of variables, and the sample size (MacCallum & Austin, 2000; Widaman & Thompson, 2003; Fabrigar & Wegener, 2012). However, less data might be adequate with models of strong parameter estimates, reliability of the measured variables, and well-defined constructs (Ullman & Bentler, 2012).

According to Yuan and Bentler (2000), although SEM is a large data approach, a good model fit could be achieved with as few as 60 respondents (Yuan & Bentler, 2000). Models can be validated using resampling methods of random subsets of data (Chin, 1998). When parameter assumptions are in doubt, statistical inferences could be robust using 'Bootstrapping' in SEM approach.(Bollen & Stine, 1992; Yuan et al., 2000; Nevitt & Hancock, 2001; Byrne, 2009). Validity estimates in 'Bootstrapping' are based on sub-samples rather than parametric assumptions (Chin, 1998; Hair et al., 2007). 'Bootstrapping' estimates sampling distribution by replacing data randomly from the original sample to achieve robust confidence intervals of a population parameter.

For this study, the population parameter is the path coefficient in the estimated theoretical model. According to researchers (Hall & Wilson, 1991; Efron &

Tibshirani, 1993; Byrne, 2009; MacKinnon, 2009; Chernick, 2011; Wilcox, 2012), Bootstrapping is a useful technique for hypotheses testing based on parametric assumptions when normality of data distribution is violated. Thus, in this study Bootstrapping is used with perspective data of unknown distribution such as categorical constructs, and also to strengthen statistical inferences for small sample size.

4.12 Measurement Error

The covariance-based SEM assumes that the measurement items are reflective in nature (Gerbing & Anderson, 1988; Chin, 1998). A reflective measure assumes that all indicators measure the same underlying phenomenon (latent variable). This implies that a set of measurement items is affected by the condition of the latent variable that they belong to. The current study assumes that all indicators are reflective measurement items, the observed measures have a random error variance, and measure-specific variance components. Therefore, the measurement error can be carved up into a systematic and random error. These features will be discussed further in the following Sub-sections.

4.12.1 Systematic Error

Self-reports of participants via surveys, questionnaires, and interviews are utilized in the current study to seek construction experts and professionals opinions on the procurement practices of their projects. For this study, survey questionnaires were conducted for the main data collection technique, thus data might be biased by *consistency motif*. Respondents can have the urge to keep a logical line in a series of answers (i.e. consistent line). They might also be influenced by their moods and might initiate artificial bias in their responses. Any defect in a single source may contaminate both measures in the same way (Chandler & Lyon, 2009; Woolley, 2011). In line with the scale recording method (Podsakoff & Organ, 1986; Beal, 2000; Zohar, 2000; Lapierre & Allen, 2006; Wan, 2012) and in order to avoid the *consistency motif* problem in this study, the questionnaire surveys were designed so that items relating to pre and post contract transaction costs were placed first. Then, the constructs relating to environmental uncertainties were placed afterwards.

On the other hand, there might be bias *with common method variance* as a result of measures collected from the same respondent (Podsakoff & Organ, 1986; Williams et al., 1989; Bagozzi & Yi, 1990; Doty & Glick, 1998; Kline et al., 2000; Lindell & Whitney, 2001; Podsakoff et al., 2003; Mackenzie & Knipe, 2006; Malhotra et al., 2006; Johnson et al., 2011). Bagozzi and Yi (1990) defined *common method variance (CMV)* as " variance attributable to the measurement method rather than the construct of interest". For the current study, a number of statistical tests were conducted to evaluate the presence of CMV prior to data analysis in order to isolate covariance because of artifacts. First, the existence of highly correlated variables in the correlation matrix indicates evidence of CMV (Bagozzi & Yi, 1990; Lindell & Whitney, 2001). Second, Harman's *one-factor test* was conducted to examine the presence of CMV. For the current study, a principal single factor analysis was conducted with five constructs of the theoretical model. The result of the unrotated factor solution indicated more than one factor that could be extracted. That is, there were no one-factor solution accounts for most of covariance in the measurement items, which means there is no indication of CMV. Third, a *partial correlation procedure* was conducted to examine whether relationships between the measurement items still existed after controlling for principal factor

(Podsakoff et al., 2003). Finally, for both the *one-factor* solution and the *partial correlation* tests, a valid functional relationship is ambiguous with potential common method bias.

4.12.2 Random Error

Random error in this study refers to the sampling error that occurs when a population is sampled in SEM and inferences are founded according to this sample. The sub-section of 4.8.2 presented earlier in this chapter introduced the minimum sample size for the current study which is calculated according to the rule in equation 4.1 which is n = 96 for this study, and the adjusted or sampled size which is calculated according to the rule in equation 4.2 which is N = 76 for this study. The sample size is essential for detecting when hypotheses are false, and sample size calculation is driven by consideration of statistical power. According to Cohen (1988), statistical power is a probability test of correctly rejecting a false hypothesis, and the desirable power levels are between 0.8 and 0.9. "If the power levels are low, the null hypothesis will seldom be rejected and the researcher using SEM may accept a false theory" (Fornell & Larcker, 1981). However, a justification of good model fit with a small sample size should be supported with strong parameter estimates, reliability of the measured variables, and well-defined constructs. Also, the statistical power can be strengthened by utilizing 'Bootstrapping' in the SEM approach (Bollen & Stine, 1992; Byrne, 2009). The statistical power in Bootstrapping is based on the sampled size rather than the population size (Chin, 1998; Hair et al., 2007).

Accordingly, a good model fit can be achieved with as few as 60 respondents (Yuan & Bentler, 2000). The model Goodness-of-Fit discussed earlier in the Sub-section

4.11.6.3 is the benchmark for the statistical power in evaluating model fitness. This method (i.e. the statistical power) employs the Root Mean Square Error of Approximation (RMESA). As discussed previously, the RMESA statistic (ε) is a measure of model discrepancy. The modeling statistical software Amos 21 produces a 90% confidence interval for 'ε' that can be used for null hypothesis (H_o) tests and model fit as follows:

1. For exact model fit, then H_o: $\varepsilon = 0$
2. For close model fit, then H_o: $\varepsilon < 0.05$
3. For not close model fit, then H_o: $\varepsilon > 0.05$

In sum, a sample size of 72 respondents is sufficient for this study which allowed for a significance model of alpha $\alpha = 0.05$ and models fit with a least degree of freedom of $df = 50$.

4.13 Ethical Consideration

Ethical issues were considered in all stages of the research design and execution process, for this research and prior to commencing data collection. An ethical clearance was sought from the Auckland University of Technology Ethics Committee (AUTEC). A copy of the approval by AUTEC (reference number: 13/33) is attached in Appendix A1. Supporting documents were attached with the Ethics application form (EA1): participant's information sheet (Appendix A2); participant consent form (Appendix A3); and the questionnaires (Appendix B2). Therefore preparation and administration of the questionnaires and interviews took into consideration the University Ethics Guidelines.

The purpose and objectives of the research were explained to the participants in the participant information sheet along with the questionnaire attached to e-mails sent. Also, participants were informed that the information provided would be used in this project for the partial fulfillment of a PhD award to the researcher on completion of the project. The researcher informed the participants that their participation is voluntary, and the questionnaire only takes 10-12 minuets to complete. They have the right to accept or decline their participation at any time should they choose to. However, the participants were informed that by completing the questionnaire, it indicated consent to take part in the research.

For privacy and confidentiality, the participants were assured of their rights to privacy, confidentiality, and anonymity by the study. In the case studies privacy and confidentiality was achieved by assigning participants and their project's name with a numerical code for anonymity. While, for the wider survey questionnaire administered to construction professionals via a weblink, no identifying information was collected meaning that the participant identity is anonymous. The information gathered was kept confidential and was not disclosed to anyone except the researcher and the project supervisors. Finally, there is no concern regarding cultural issues, because the research did not focus on any ethnic groups.

The contact details for AUTEC, the researcher, and the research supervisors were included in the participant information sheet if there are any concerns the participants might have about the research.

4.14 Summary

This chapter discussed the philosophical position and the methodological approach adopted in this research. The positivist paradigm stands were used for theory development. A mixed research methodology from qualitative and quantitative approaches was used to develop a conceptual model, and to explore the relationships between constructs of procurement systems, project phases, environmental uncertainties, and transaction costs. A cross-sectional survey design was employed, which involves data collection from a population through mailed questionnaire survey, and also from utilizing 'real-world' cases.

A structured survey questionnaire was administered to construction professionals at the managerial and operational levels. These include: project manager, contracts, sub-contractors, architects, engineers, quantity surveyors, procurement officers, and clients. Professionals were asked to evaluate, using a 5-point Likert scale, the time-spent daily in conducting procurement activities relative to other project activities, specifically for the Traditional and Design-Build delivery systems. The measurement items were tested for validity and reliability for example Cronbach's alpha test before data analysis, to potentially minimize non-sampling and sampling errors needed to test the hypothesized relationships of the theoretical model presented in Figure 3.7.

Also, and to minimize the problems associated with self-reported data; correlation matrix, Harman's one factor test, and partial correlation proceedings were conducted. Assumptions required for multivariate analysis such as normality, unidimensionality, and linearity were evaluated. In the current study the primary analytical technique used is Structural Equation Modeling. SEM yields information about a model's Goodness-of-Fit; model development and comparison; and confirmatory strategies. After considering the research problem, data assessment, and modeling strategy such as process, estimation and measurement assumptions, complexity, and sample size; Statistical software from IBM (SPSS Amos 21) was selected for data analysis and model development.

The next chapters present the data analysis, and tests the model using 'real world' cases to validate the findings. Also, to calculate the transaction costs for different procurement systems for comparison.

CHAPTER FIVE

Data Presentation and Results

5.0 Introduction

This chapter introduces the mixed method approach used in the current study for managing and analyzing data. A qualitative approach is used to analyze the information received from experts' opinions during the pilot survey. Followed by utilizing a quantitative approach to analyze the information received from the wider industry survey. A triangulation technique was utilized to reduce data bias. This includes normality test, validity and reliability test, confirmatory analysis, regression analysis, and structural equation modeling (SEM). Data screening and statistical assumptions test such as normality and linearity were conducted first. Next, the characteristics of the 72 usable samples that were obtained from the construction professionals are summarized, and the results are reported. Followed, the analytical procedure of the data using an exploratory factor analysis (EFA) is described and the results are presented. In research where a single data source is applied, the EFA was used to test construct validity and reliability, the common method variance (CMV), and external consistency.

After the reliability and validity test is conducted, the preliminary modeling procedure of constructs that were presented in the previous chapter (Table 4.5) is described using the structural equation modeling (SEM). This includes discussion on model fit and validity for various covariance models, and a summary of the validity heuristics is given in a table. Lastly, the steps for model development were introduced, including tests for direct and indirect effects, and mediation and moderation relationships effects. The chapter also introduces results of hypotheses for tests on the structural links between transaction costs, information cost, project procurement cost, administration cost, enforcement cost, procurement systems, project phase, and environmental uncertainties. The analytical techniques are presented in the following Figure 5.1.

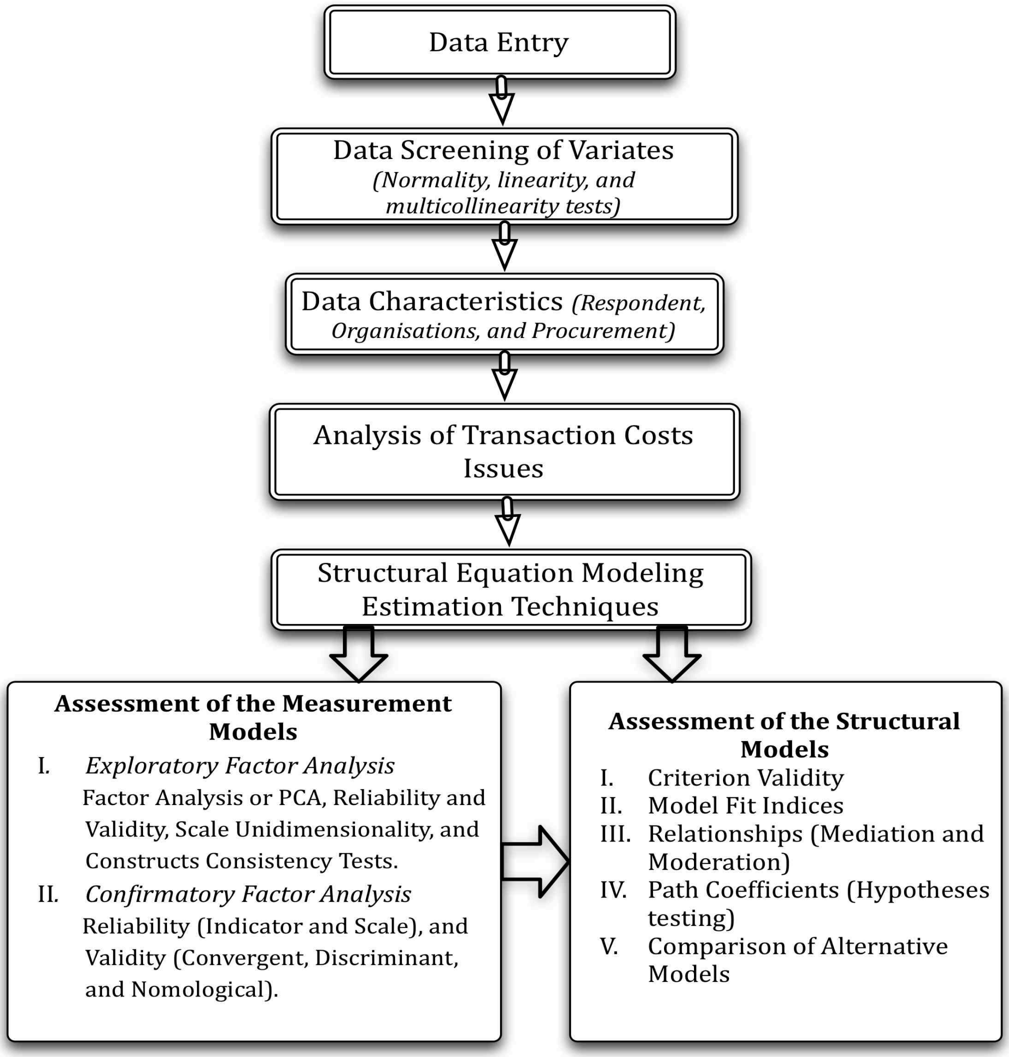


Figure 5.1: Data Analysis Techniques

5.1 Pilot Survey Analysis

This section presents results from conducting a pilot survey of the qualitative component of this study, seeking experts' opinions on the relationship between transaction costs and procurement as explained in Section 4.7. A semi-structured questionnaire explained in Sub-sections 4.9.2 and 4.9.3 was designed for this purpose, covering participants' demographic information, issues of pre and post-contract transaction costs, and current procurement practices (see Appendix B1). Eight subject-matter experts sent feedbacks on the pilot survey questionnaire via e-mail. The sample size of eight participants was satisfactory for a qualitative analysis (Gay & Airasian, 2003).

The pilot survey comprises two key sections A and B. Section A covers demographic information on participant's area of activity, proficiency, years of experience, contract value, and current procurement practices. In section B, participants express their opinions on the questions that address participant's evaluation of time spent in conducting procurement activities for the Traditional and Design-Build systems.

The results obtained from participants' responses to questions (1 – 6) in section A indicate that among the eight participants, six of them were project managers working in infrastructure projects. Also, a project manager works in asset management project, and an architect works in residential projects. All participants have more than 20 years of experience, and the most common contracts value for the projects were more than $5million. Questions (7 and 8) offered participants the opportunity to express their opinions whether the current procurement practices append more time and should be changed. Four of the participants agreed that the current procurement practices appended more time and should be changing, while the other four express their opinions as neutral. The last questions (9 and 10) of section A required from participants to suggest one aspect that should be changed in the current procurement process, and any further comments/clarifications that participants feel necessary. All participants indicate that early contractor involvement in the design stage will enhance the procurement practices that lead to better-cost estimates and reduce in conflict.

Three key themes emerged from participant's responses to questions in section A of the pilot survey: First, experts suggest a separation should be made between daily project activities from those to be contemplated as procurement activities. Second, there is an overlap between activities, so the time-spent is shared and an evaluation of TCs is hardly to be made. Finally, a clarification on transaction cost terminology used in the questions should be made. After feedbacks were analyzed, modifications were made to the initial questionnaire. For example, some terms have been clarified to reduce ambiguities, rephrasing and including an explanation to some terminologies. Finally, an industry wide survey questionnaire was administered via an online weblink. The next sections present analysis of the data procured from the wide industry survey.

5.2 Data Entry

Data obtained from the questionnaire survey (72 usable responses) conducted to construction professionals in New Zealand was exported and saved as an Excel worksheet, PDF, and in SPSS worksheet format. Preliminary graphic representations of the variables using Excel were conducted to ensure data accuracy (Tabachnick & Fidell, 2007). Then, the data (SPSS format) was organized and coded according to the research themes. Out-of-range values were corrected, and the plausibility of variable means and standard deviations were confirmed using SPSS version 20.

The pattern of missing data was scrutinized using the SPSS Missing Value Analysis (MVA) tool. No variables had more than four missing values, and the MVA revealed that the missing data was missing completely at random (MCAR). Therefore, each missing value was substituted with the mean of the variable that it belongs to. According to Tabachnick and Fidelis (2007), this procedure is a conservative procedure where: the mean for the variable does not change, the variance of the variable is reduced, and correlations with other variables are reduced. In sum, a cleaned set of data consisting of 72 responses with no missing values was used for analysis.

5.3 Data Screening of Variates

This section addresses data screening tests that were carried out for each individual variable and each variate (linear combination of variables). The screening tests include tests for normality, linearity, and multicollinearity.

Firstly, normality of data was assessed for Skewness, Kurtosis, and Kolmogorov-Smirnov Z value, and also by examining the general shape of a histogram. Normality evaluation is important because when non-normality is indicated this means there is other assumption violations (Tabachnick et al., 2001). Each individual variable was assessed for normality, where skewness and normalized kurtosis are close to zero for normal distributions.

Generally, for a bell shape distribution normality ranges between -1 and +1. A Kolmogorov Smirnov Z test for normality was also conducted, which provide another evidence of univariate normality. The threshold for Z value should be less than 2.58, and a value above this level signals that normality can be rejected (Tabachnick & Fidell, 2007; Hair et al., 2012). The results of normality and kurtosis tests, and Z test are presented in Table 5.1 (see Appendix C). In the Table shaded cells indicate any violation of kurtosis, while the Z values for normality and kurtosis are significant at 0.162, 0.219,0.204, and 0.399 respectively. Therefore normality of distribution was not violated.

Table 5.1: Skewness and Kurtosis Normality Tests

	Skewness (Std. Error = 0.091)	Kurtosis (Std. Error = 0.182)	Kolomogorov-Smirnov Z
Information Gathering	-.478	-.383	.221
Communication	-.397	-.648	.204
Attending Meetings	-.320	-.631	.195
Translation of Client's Needs	-.279	-.829	.204
Training	.559	-.251	.230
Project Preliminary Design	.082	-1.032	.162
Transition Observation	.196	-.180	.212
Site Visits	-.038	-.958	.176
Administration	.075	-.955	.166
Decision Making	-.222	-1.039	.219
Conflict Resolution	.428	-1.050	.204
Verifying Compliances	.014	-.334	.207
Enforcement	.178	-.790	.188
Pre-contract TCs	-.277	-.337	.077
Post-Contract TCs	.176	-.537	.074
Political/Legal/Social	-.519	-.327	.323
Economy	-.991	1.327	.399
Competition	-.625	.686	.271
Technology	-.085	-.577	.198
Corporate Culture	.524	.007	.225
Finance and Ownership	.548	-.166	.248
Project Location	.284	-.318	.280
Information System	.708	.163	.258

Also, histogram shapes are drawn a further check on normality of the variables (see Appendix C). These were drawn for the Pre-contract stage (i.e. information gathering, communication, etc.) and variables included at the Post-contract stage (i.e. contract administration, enforcement, etc.) and are presented as Figure 5.2 and 5.3 respectively. The histograms with superimposed normal curves show that there are normality distribution of data for all variables included at the pre and post-contract stage.

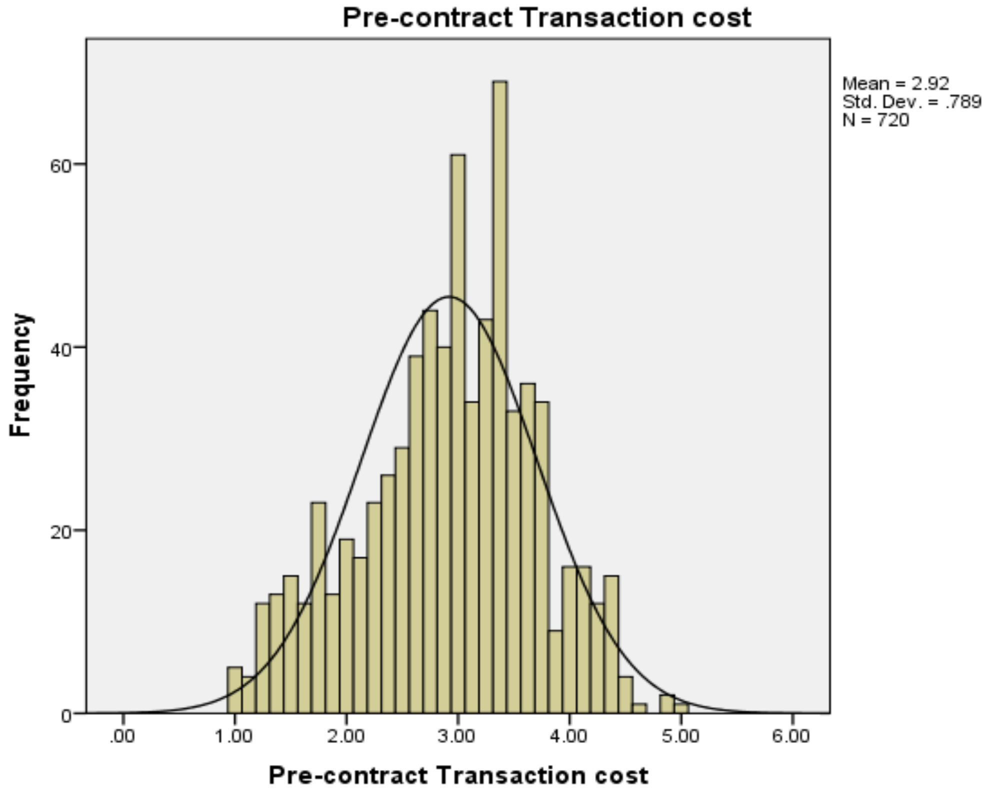


Figure 5.2: Bar Chart of Pre-contract TCs Scores

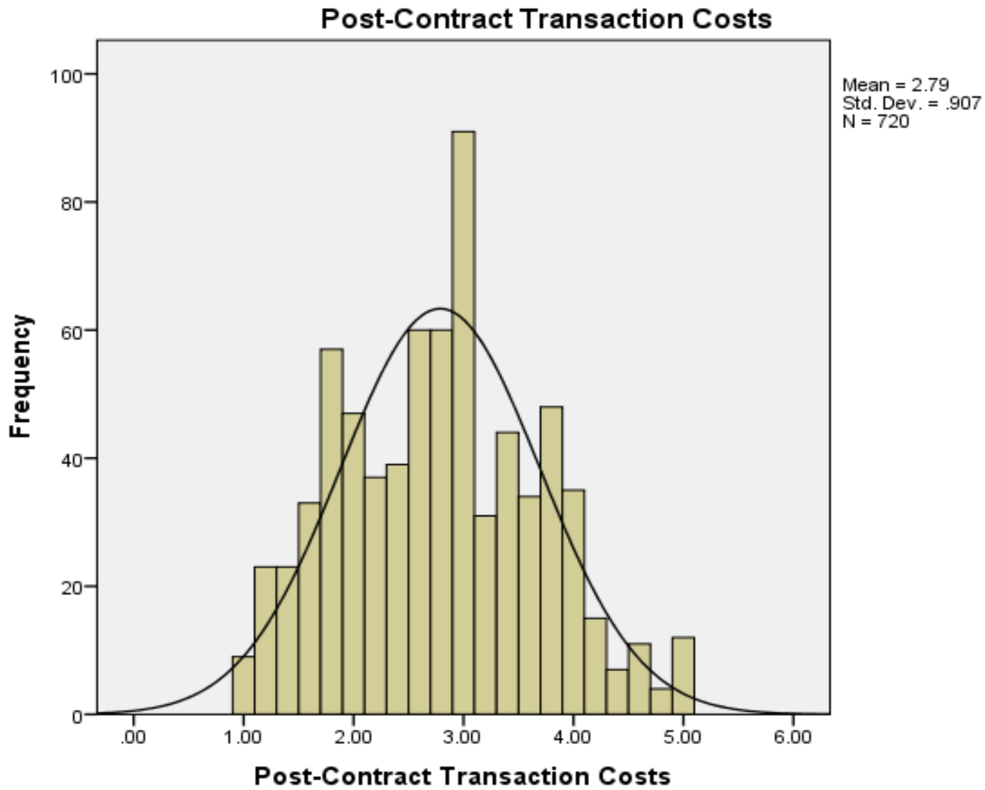


Figure 5.3: Bar Chart of Post-contract TCs Scores

Secondly, most multivariate techniques, such as structural equation modeling, assume that the relationships between variables are linear. A departure from linearity means a different calculation of correlations between variables that are not covered by SEM. In this study, linearity testing was conducted by means of scatterplots. The results of linearity test for variables at the pre and post-contract using scatterplots are shown in Figure 5.4 and 5.5 respectively. The scatterplots results revealed that linear relationships existed between variable, and linearity is not violated, thus the data collected was suitable for SEM.

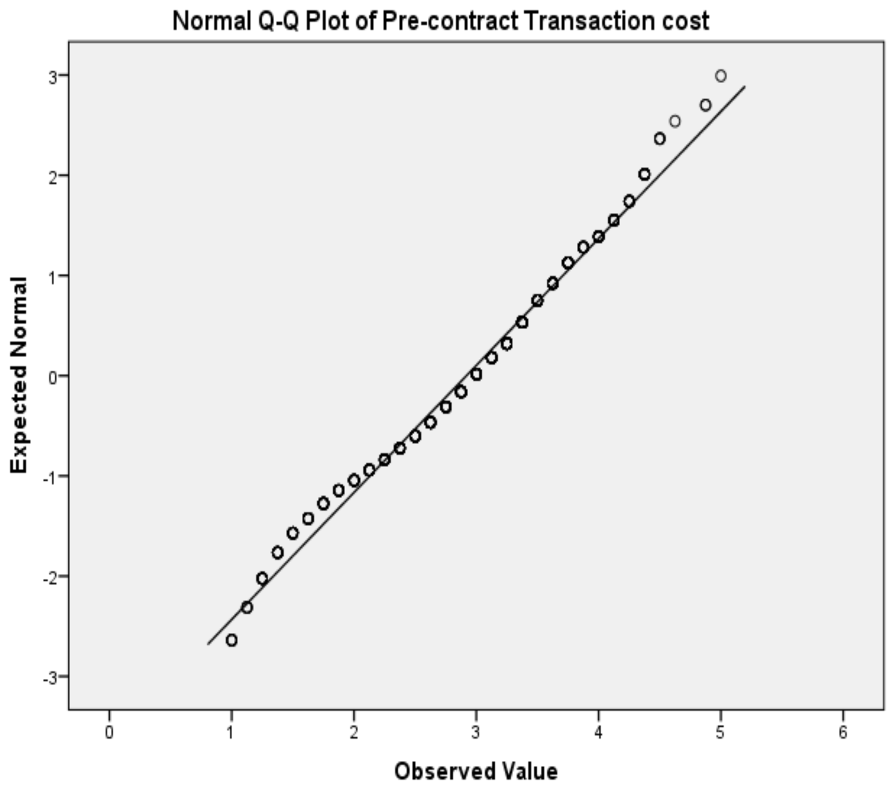


Figure 5.4: Plot of Pre-contract TCs Scores

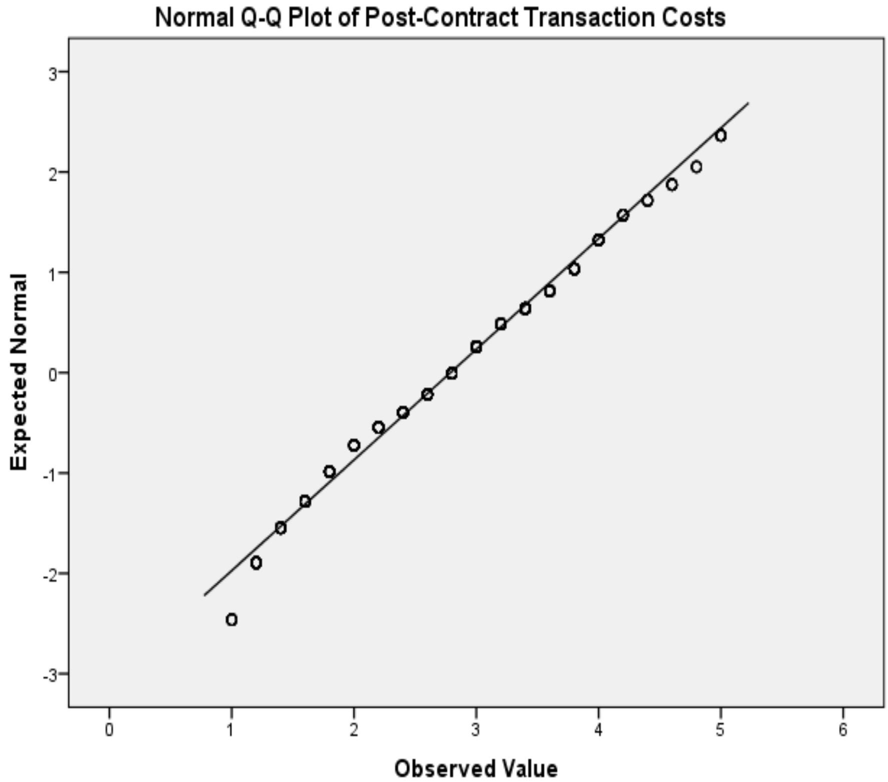


Figure 5.5: Plot of Post-contract TCs Scores

Thirdly, multicollinearity happened if the correlation between variables is higher than 0.9, thus the sizes of error terms become inflated (Tabachnick & Fidell, 2007). Correlations between constructs were calculated in SEM using Amos 21, and the results are shown in Table 5.2 (see Appendix C). All the correlation values were under 0.9, thus the results did not suggest that any of the variables were redundant. In sum, the results of data screening of the variates indicated that the data is suitable for multivariate analysis (i.e. SEM analysis).

Table 5.2: Correlation Coefficients

Correlations	IG	CM	AM	TN	TR	PD	TO	SV	AD	DM	CR	VC	EF	PLS	ECO	COP	TCH	CC	FO	PL	IS
IG	1.0	.62	.58	.67	.34	.34	.38	.45	.43	.51	.34	.38	.48	.12	.17	.15	.13	.14	.17	.13	.11
CM	.67	1.0	.73	.72	.43	.42	.32	.52	.46	.62	.48	.37	.47	.03	.00	.00	.09	.14	.13	.07	.17
AM	.58	.73	1.0	.65	.39	.38	.30	.43	.41	.52	.33	.29	.36	.00	-.02	0.01	.05	.06	.04	.03	.08
TN	.67	.72	.65	1.0	.41	.53	.43	.53	.51	.70	.50	.50	.48	.12	.02	.05	.20	.28	.23	.14	.28
TR	.34	.43	.39	.41	1.0	.47	.24	.34	.33	.35	.45	.31	.31	.02	-.14	-.19	.15	.22	.18	-.06	.26
PD	.34	.42	.38	.53	.47	1.0	.34	.27	.39	.48	.41	.40	.30	-.04	-.02	.02	.18	.28	.24	.14	.23
TO	.38	.32	.30	.43	.24	.34	1.0	.38	.39	.43	.37	.62	.51	.11	.20	.17	.05	.19	.16	.20	.14
SV	.45	.52	.43	.53	.34	.27	.38	1.0	.70	.67	.56	.45	.57	.06	.11	.06	.17	.35	.32	.17	.26
AD	.43	.46	.41	.51	.33	.39	.39	.70	1.0	.63	.47	.37	.47	-.06	.04	.09	.16	.37	.36	.21	.28
DM	.51	.62	.52	.70	.35	.48	.43	.67	.63	1.0	.52	.48	.55	.03	.11	.07	.13	.30	.27	.21	.23
CR	.34	.48	.33	.50	.45	.41	.37	.56	.47	.52	1.0	.41	.56	-.03	-.03	-.03	.16	.34	.33	.09	.27
VC	.38	.37	.29	.50	.31	.40	.62	.45	.37	.48	.41	1.0	.45	.17	.14	.11	.21	.32	.25	.16	.28
EF	.48	.47	.36	.48	.31	.30	.51	.57	.47	.55	.56	.45	1.0	.13	.17	.10	.18	.22	.23	.13	.23
PLS	.12	.03	.00	.12	.02	-.04	.11	.06	-.06	.03	-.03	.17	.13	1.0	.65	.12	.45	.01	.03	.09	.28
ECO	.17	.00	-.02	.02	-.14	-.02	.20	.11	.04	.11	-.03	.14	.17	.65	1.0	.61	.12	.03	.06	.26	-.02
COP	.15	.00	.01	.05	-.19	.02	.17	.06	.09	.07	-.03	.11	.10	.12	.61	1.0	-.06	.14	.15	.48	-.17
TCH	.13	.09	.05	.20	.15	.18	.05	.17	.16	.13	.16	.21	.18	.45	.12	-.06	1.0	.57	.50	.16	.75
CC	.14	.14	.06	.28	.22	.28	.19	.35	.37	.30	.34	.32	.22	.01	.03	.14	.57	1.0	.86	.50	.71
FO	.12	.13	.04	.23	.18	.24	.16	.32	.36	.27	.33	.25	.23	.03	.06	.15	.50	.86	1.0	.50	.63
PL	.13	.07	.03	.14	-.06	.14	.20	.17	.21	.21	.09	.16	.13	.09	.26	.48	.16	.50	.50	1.0	.18
IS	.11	.17	.08	.28	.26	.23	.14	.26	.28	.23	.27	.28	.23	.28	-.02	-.17	.75	.71	.63	.18	1.0

5.4 Data Characteristics

Out of 360 (sample population) construction professionals that were surveyed, 103 responses were returned which represents 28.6% of the sample population, and 72 responses were considered usable representing 70% of the total usable responses. As discussed in the Sub-sections 4.7.2.2 and 4.10.7.3, the minimum sample size calculated is 96 and the adjusted sample size is 74. Accordingly, the total number of responses after the data cleanup exercise is statistically significant.

The semi-structured questionnaire (see Appendix B2) administered to construction professionals comprises two key sections A and B. Section A covers the demographic information of respondents and their organizations, contract value, and participants' involvement in project procurement activities. Section B, covers the relationship between the procurement systems and transaction costs, as well as the issues of uncertainties in the transaction environment and transaction costs drivers.

5.4.1 Demographic Information of Respondents

Demographic information of respondents was addressed in the general questions within Section (A) of the questionnaire and comprised of four related questions (see Appendix B2). In response to question two in Section A, which determine the role of the respondents within their construction operation. The result is presented in Figure 5.6 and shows that 40.3% were Project Managers, 13.9% were Architects, 16.7% were Engineers, 8.3% were Surveyors, 16.7% were Construction Managers, 15.3% were Contractors, 2.8% were Clients, and 23.6% other (i.e. Procurement officers, etc.).

Figure 5.6: Participants Role in the Construction Operation

In question three of Section A, participants were further required to indicate their professional accreditation. The result is presented in Figure 5.7 and shows that 53% have other accreditations such as Chartered Engineer, 20% have none, 14% of the respondents have PMI, 8% of the respondents have CIOB, and 5% of respondents hold membership of BRANZ accreditations.

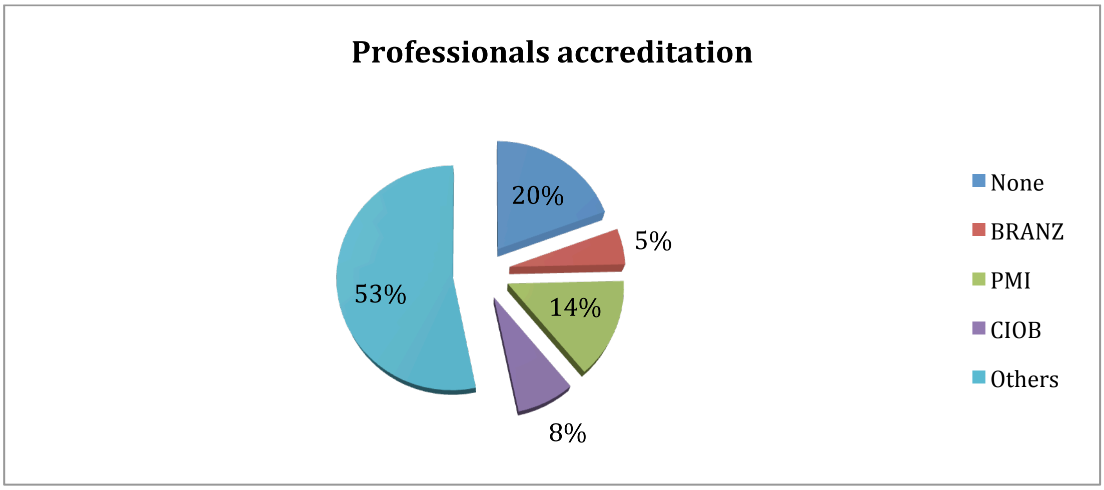


Figure 5.7: Participants Accreditation

Further in question four, participants were required to indicate their experience in the construction industry. The result is presented in Figure 5.8 and shows that 25% of the respondents have less than 10 years of work experience in the construction industry, 17% have less than 20 years experience, 32% have more than 20 years experience, and 26% have more than 30 years of experience.

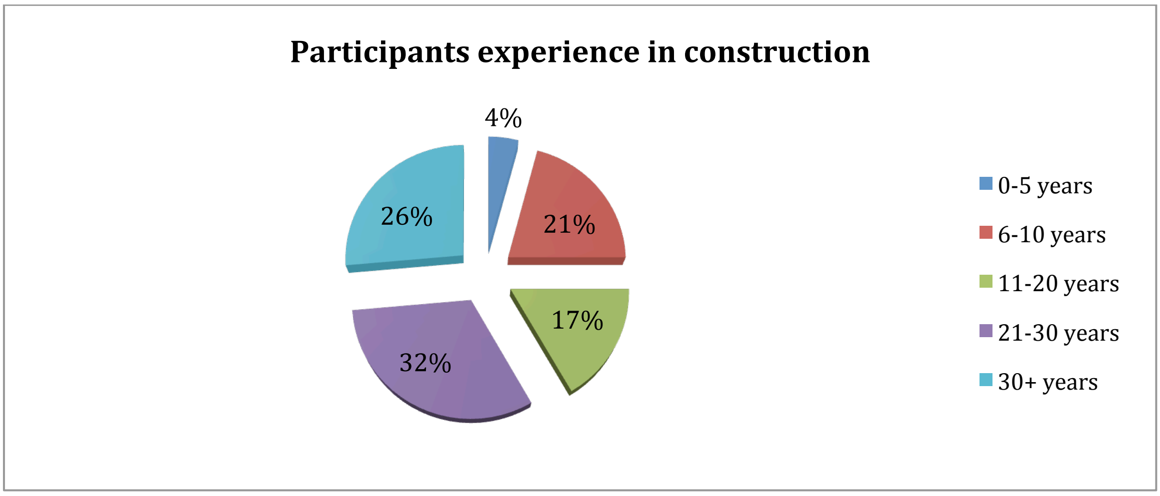


Figure 5.8: Participants Experience in Construction

In the fifth question of Section A, participants were required to indicate their participation in the procurement process. The purpose of this question was to investigate the extent of construction professionals conducting procurement and administration activities. The result is presenting in Figure 5.9 and shows that 75% of the respondents were involved in conducting procurement activities in more than four projects, 13% of the respondents were involved in four project, and the rest were involved in fewer than three projects.

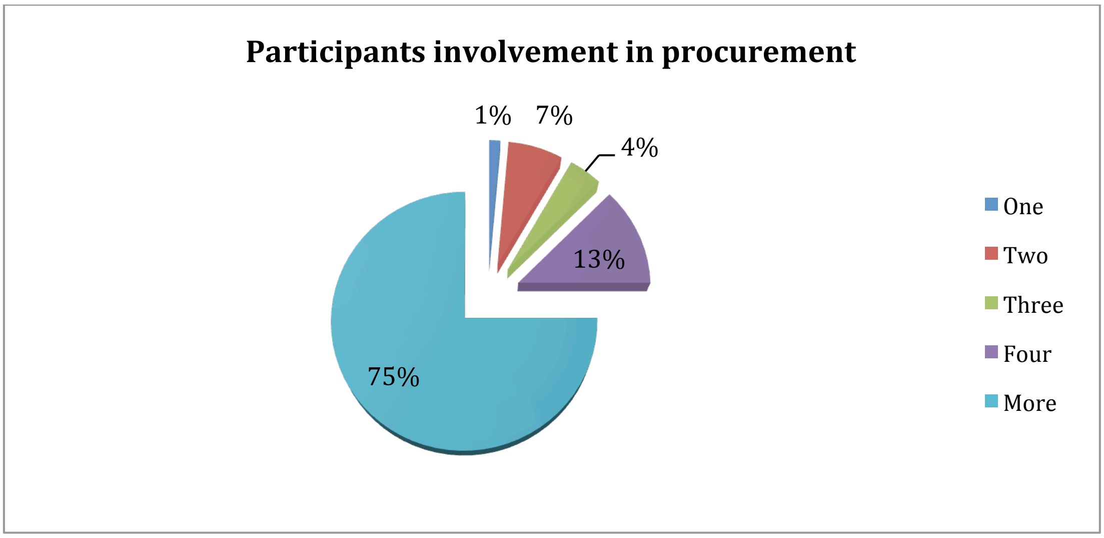


Figure 5.9: Participants Involvement in Project Procurement

5.4.2 Information about Respondents' Organizations

Information about respondents' organizations were addressed in the general questions section (A) of the questionnaire and comprised of two related questions (see Appendix B2). The first question of this section asked participants to indicate their organizations main area of activity. The survey result is presenting in Figure 5.10 and shows that the respondents' organization main areas of activity are: 36.1% of participants were involved in Infrastructure projects, 27.8% of participants were involved in Residential projects, 51.4% of participants were involved in Commercial projects, and 11.1% of participants were involved in Industrial projects.

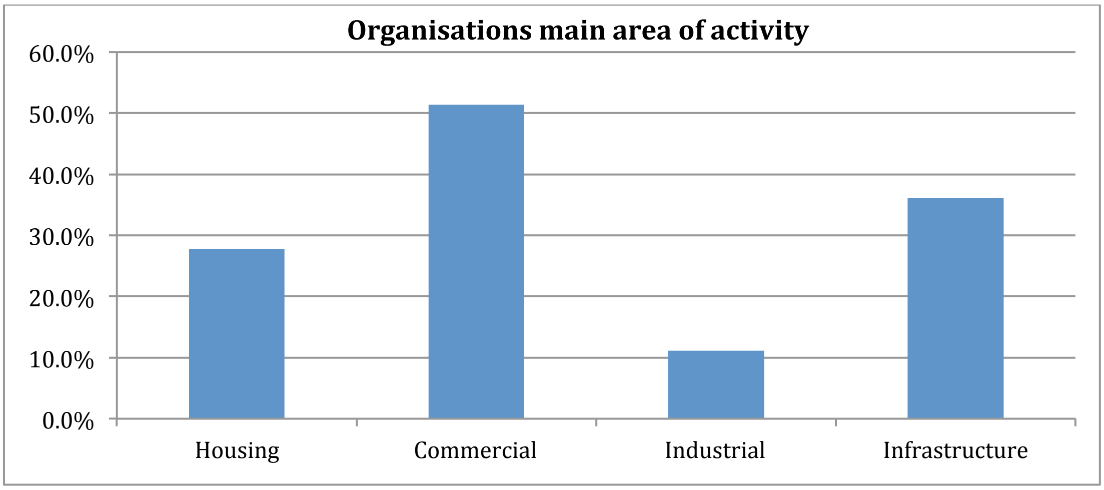


Figure 5.10: Participants' Organizations Main Area of Activity

In question six participants were asked about the most common contract value of the projects that they were involved in. The result is presenting in Figure 5.11 and shows that 33% of the respondents were involved in projects of less than $1 million contract value, 27% of respondents were involved in projects of $5 million or less of contract value, 8% involved in project of less than $10 million of contract value, 14% involved in project of less than $20 million of contract value, 6% involved in projects of less than $30 million in value, and 12% involved in project of more than $30 million in value.

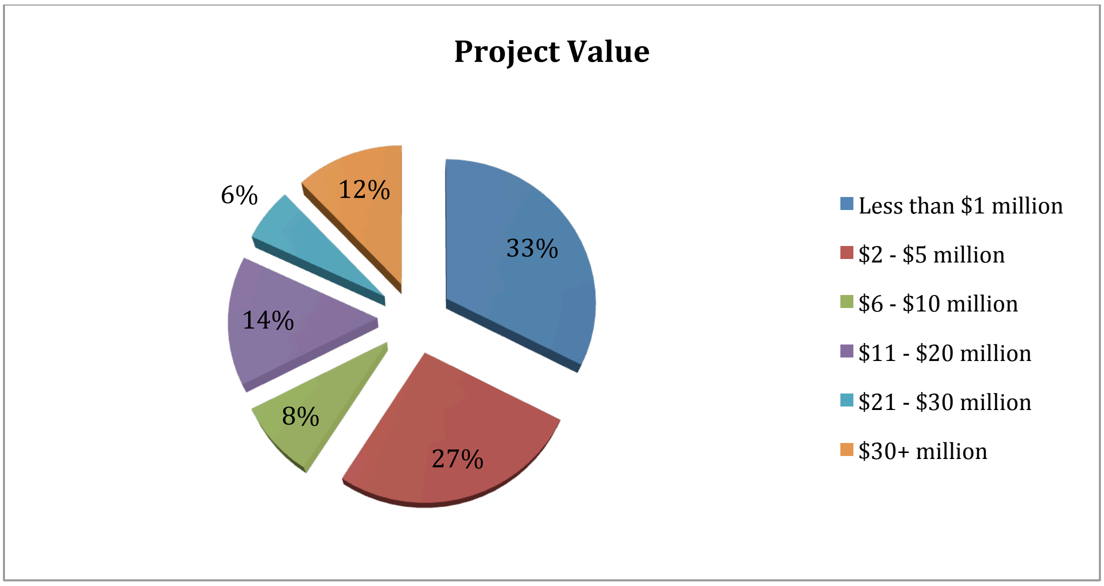


Figure 5.11: Projects' Contracts Value in General

5.4.3 Evaluation of Procurement Practices

Evaluate current procurement practices in terms of the time-spent in conducting procurement activities were addressed in the general questions section (A) of the questionnaire (see Appendix B2). In question eight, participants were required to indicate their opinions whether the current procurement practices should be changed. The result is presenting in Figure 5.12 and shows that 37% of respondents believe the procurement practices should be changed, 37% of respondents believe it might change, 8% of respondents strongly agree, 4% of respondents strongly disagree and 14% of respondents disagree that the current procurement practices are ineffective. Accordingly, the current procurement practices should be changed through mechanisms such as a better administration and enforcement of the contracts. Procurement practices in construction should be conducted from the beginning every time the client needs to procure activity. The current study introduces models for estimating professionals' time-spent on procurement, specifically the Traditional and Design-Build delivery systems. The models are another exercises for the unification the procurement practices.

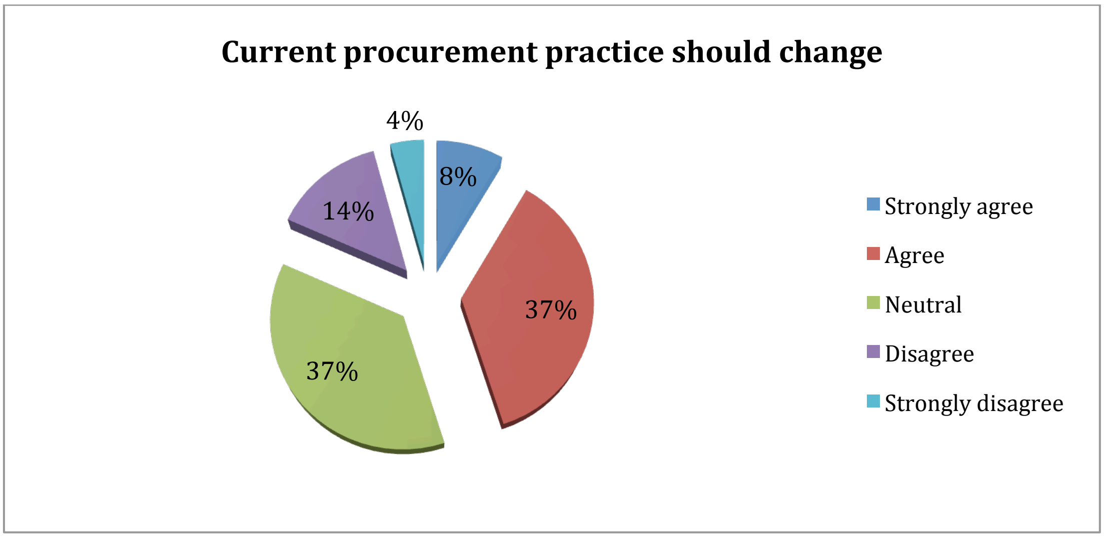


Figure 5.12: Participants' Opinions on Changing the Current Procurement

5.5 Analysis of Transaction Costs Issues

The issues of TCs are addressed in Section B of the questionnaire (see Appendix B2). This section contains three main parts. In part one, the participants were asked to estimate the daily time-spent in executing procurement activities relative to other project activities (see Sub-section 5.5.1). A 5-point Likert-Scale was deployed in estimating the time spent (e.g. 1:very low, 2: low, 3: neutral, 4: high, and 5: very high). In part two of the section, participants were also required to assess the impact of uncertainties in the transaction environment on the magnitude of transaction costs (see Sub-section 5.5.2). In addition, respondents evaluated uncertainties in the transaction environment using a 5-point Likert scale. In the final part of the section, respondents were asked to indicate their opinions on the main drivers of transaction costs (see Sub-section 5.5.3) by also using a 5-point Likert scale.

The intent of Section B is to estimate the most common TCs and its extent in construction projects. This section will also show how uncertainties in the transaction environment affect the amount of TCs, and then the selection of the most suitable procurement system. The intent is to address the research questions mentioned in Section 1.3 on Chapter One: *What are common transaction costs in construction? To what extent are transaction costs related to procurement in construction? To what extent are transaction costs related to environmental uncertainties in construction? Are there any links between procurement system and environmental uncertainties in construction?*

Two procurement systems were used for the estimation; the traditional and design-build for the purpose of comparison. Understanding the relationship between the procurement system, environmental uncertainties, and TCs will greatly increase the chances of a successful project. This will lay the foundation for the development of procurement selection based on TCs. In addition, by identifying the main TC drivers, the decision maker can make rational decisions for cost estimates of the project and therefore increase project performance.

The first set of questions (9 to 34) in Section B addresses issues of TCs for the traditional and design-build delivery systems. The next two questions (35 and 36) address the impact of environmental uncertainties on TCs. The last question (36) in this section addresses TC drivers. All the results are shown as frequencies and percentages. However, because the intention is to estimate TCs in the traditional and design-build systems, every question-pair is shown side by side to visually make a comparison.

5.5.1 Analysis of Procurement Systems' impact on Transaction Costs

The purpose of the first portion of Section B (see Appendix B2) is to evaluate the transaction costs at the pre and post contract phases. At the pre contract phase, the TCs are the cost of information and procurement or contracting. Information cost is the cost of information gathering and communication, while the cost of contracting is the cost of: attending meetings, translation of client's needs, training, project preliminary design, transition observation, and site visits. On the other hand, at the post contract phase, the TCs are the cost of contract administration and enforcement. Contract administration cost is the cost of administration, decision-making, and conflict resolution, while the cost of enforcement is the cost of enforcement and verifying compliances.

5.5.1.1 Analysis of Information and Procurement Costs

Information and procurement costs are costs incurred during pre contract activities. These include activities such as: information gathering, communication, attending meetings, translation of client's needs, training, project preliminary design, transition observation, and site visits. The intent of this set of questions is to estimate the professionals' time spent daily in executing procurement activities relative to other project activities, using a Liket-Scale 1-5 where *1: very low and 5: very high*.

The first two questions (9 and 10) in Section B, asked respondents to evaluate the time spent in attending meetings relative to other project activities. The result is presented in Figure 5.13 and shows that in the early stages of project life cycle (e.g. the concept phase), the time spent in attending meetings for the design-build system is significantly higher than the traditional system. However, as the projects approach final stages, the time-spent in attending meeting for the Traditional system is significantly higher than Design-Build system.

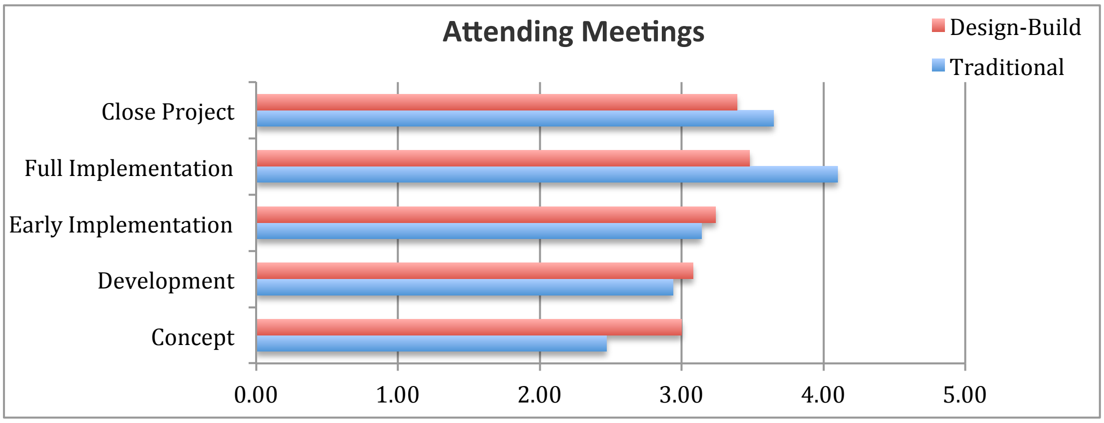


Figure 5.13: Time-spent in Attending Meetings

In questions 11 and 12, respondents were asked to evaluate the time-spent daily in communication relative to other project activities. The results (Figure 5.14) show that in the early stages of project life cycle (e.g. concept, development, and early implementation), the time spent in communication for the design-build system is marginally higher than the traditional system. However, as the projects approach final stages (e.g. full implementation and close project), the time spent in communication for the Traditional system is slightly higher than Design-Build system.

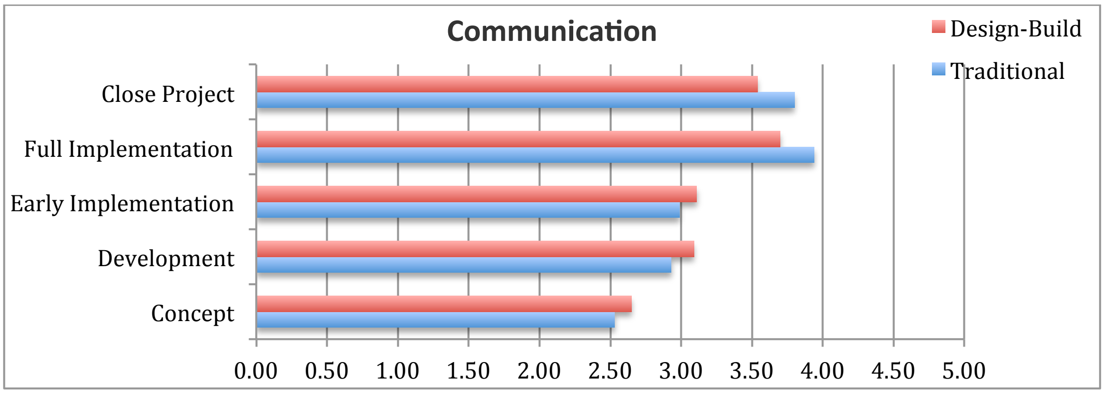


Figure 5.14: Time-spent in Communication

Answers to the questions (13 and 14) on the time-spent daily in information gathering relative to other project activities (Figure 5.15) show that at all stages of project life cycle except in the early implementation stage, the time spent in information gathering for the Design-Build system is slightly higher than the Traditional system.

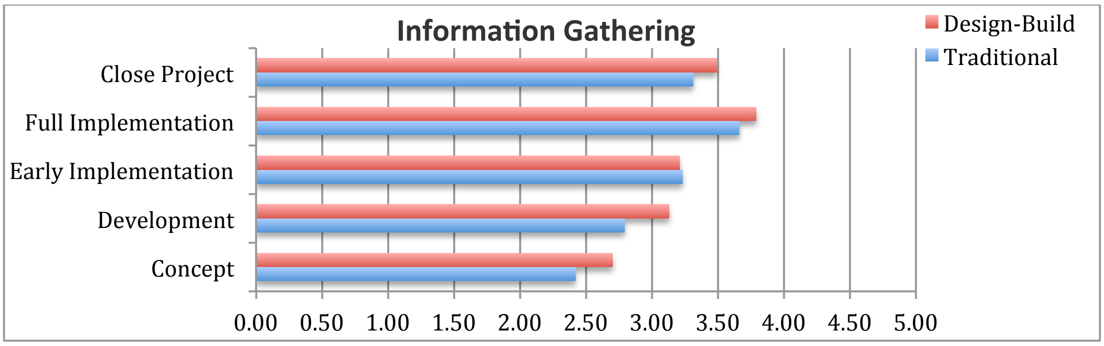


Figure 5.15: Time-spent in Information Gathering

Further, respondents were asked in questions 15 and 16 to evaluate the spent daily in the translation of client's needs relative to other project activities. The results (Figure 5.16) show that at all stages of the project life cycle except in the development stage, the time spent in the translation of client's needs for the Traditional system is considerably higher than the Design-Build system.

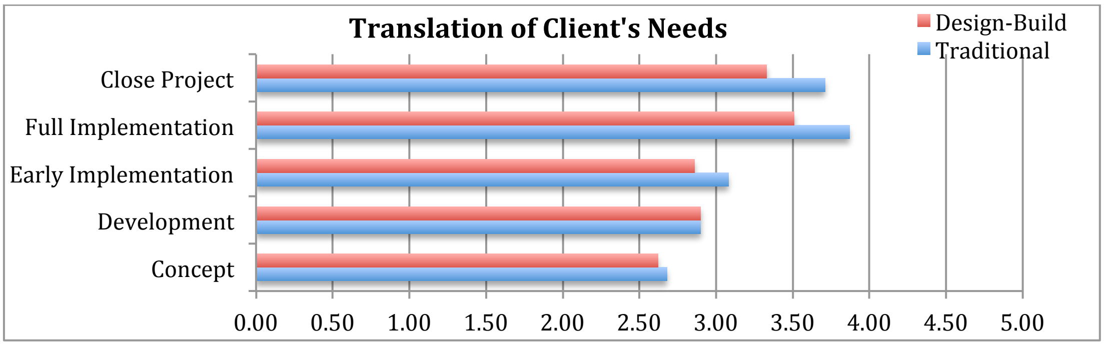


Figure 5.16: Time-Spent in Translation of Client's Needs

Respondents were asked in questions 17 and 18 to evaluate the time spent daily in training relative to other project activities. The results show (Figure 5.17) that at all stages of the project life cycle except in the concept and early implementation stages, the time spent in training for the Traditional system is marginally higher than the Design-Build system. The time spent in training in the concept stage is slightly higher in Design-Build system than in the Traditional system.

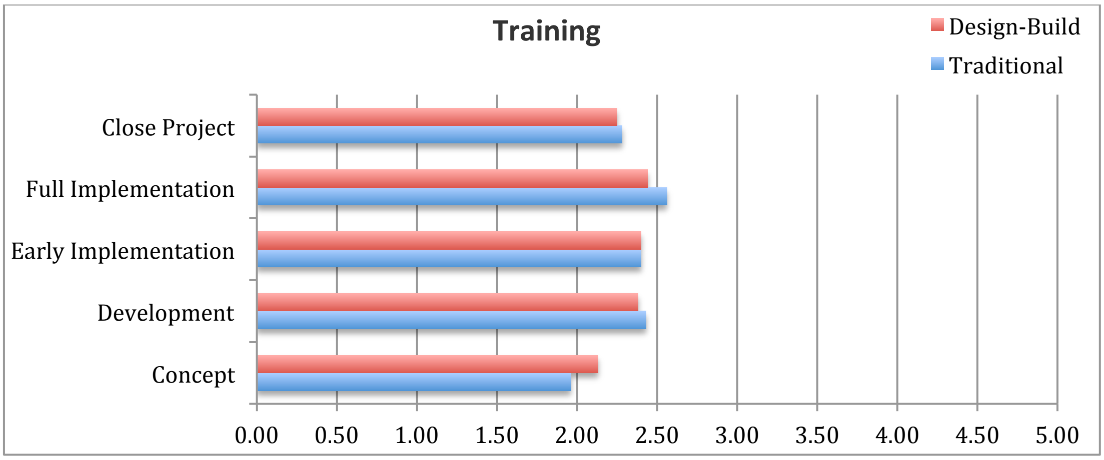


Figure 5.17: Time-spent in Training

Questions 19 and 20 in this section required participants to evaluate the time-spent daily on the project preliminary design relative to other project activities. The results show (Figure 5.18) that at all stages of the project life cycle, the time spent on project preliminary design for Design-Build system is marginally higher than the Traditional system.

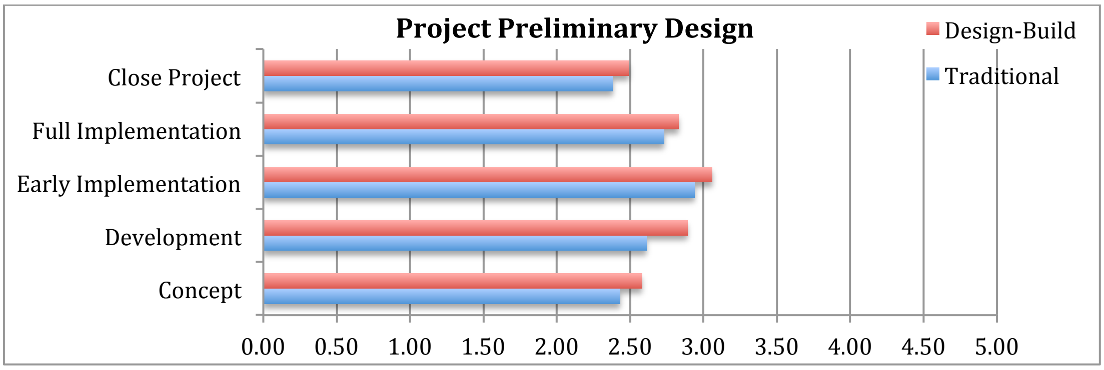


Figure 5.18: Time-spent in Project Preliminary Design

Questions 23 and 24 asked participants to evaluate the time-spent daily on the transition observation (change to procedures and role or responsibilities) relative to other project activities. The results show (Figure 5.19) that at all stages of the project life cycle, the time spent in transition observation for the Traditional system is higher than Design-Build system.

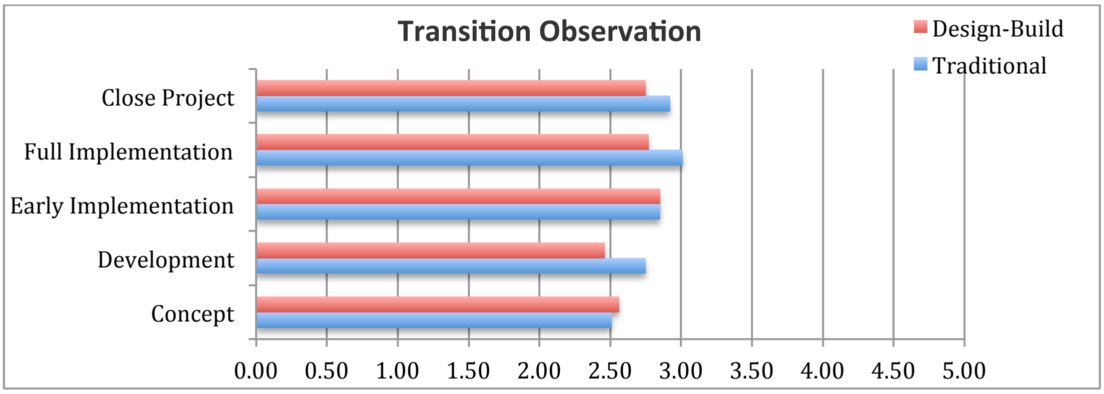


Figure 5.19: Time-spent in Transition Observation

Further, respondents were required in questions 31 and 32 to evaluate the time-spent daily in site visits relative to other project activities. The results show (Figure 5.20) that at all stages of the project life cycle except in the concept stage, the time spent in site visits for the Traditional system is slightly higher than Design-Build system. In the concept stage the time spent in site visits for Design-Build system is marginally higher than the Traditional system.

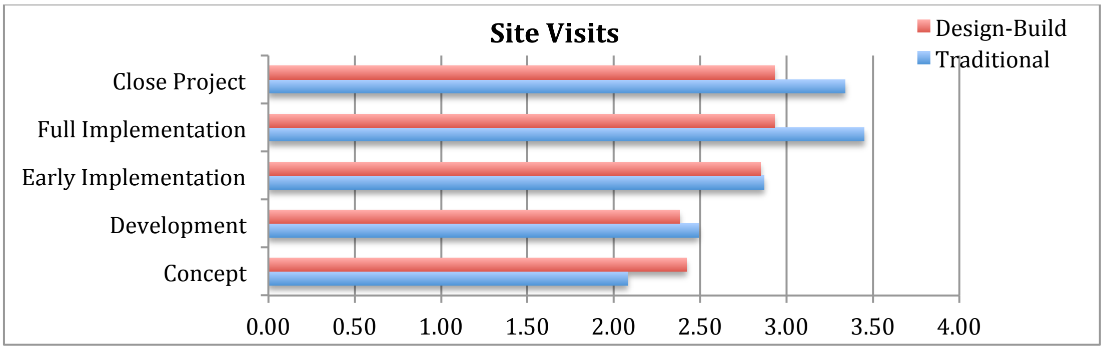


Figure 5.20: Time-spent in Site Visits

5.5.1.2 Analysis of Administration and Enforcement Costs

Administration and enforcement costs are post contract activities. These include activities such as: conflict resolution, verifying compliances, decision-making, enforcement, and administration. The intent of this set of questions is to estimate the professionals' time spent daily in executing procurement activities relative to other project activities, using a 5-point Likert scale where *1: very low and 5: very high*.

The first two questions (21 and 22) in Section B (see Appendix B2) asked respondents to evaluate the time-spent daily in conflict resolution relative to other project activities. The results show (Figure 5.21) that at all stages of the project, the time spent in conflict resolution for Design-Build system is marginally higher than the Traditional system.

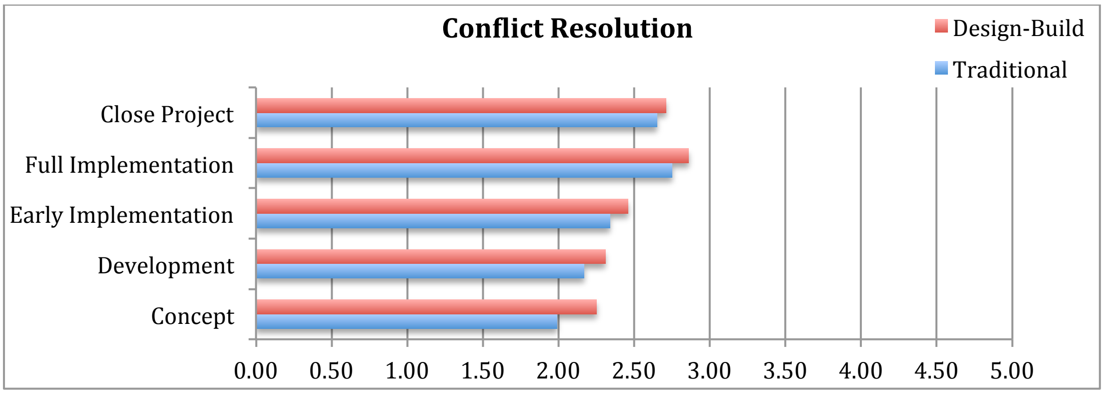


Figure 5.21: Time-spent in Conflict Resolution

Further, respondents were required in questions 25 and 26 to evaluate the time-spent daily in verifying compliances relative to other project activities. The results show (Figure 5.22) that at all stages of the project life cycle, the time spent in verifying compliances for the Traditional system is slightly higher than Design-Build system.

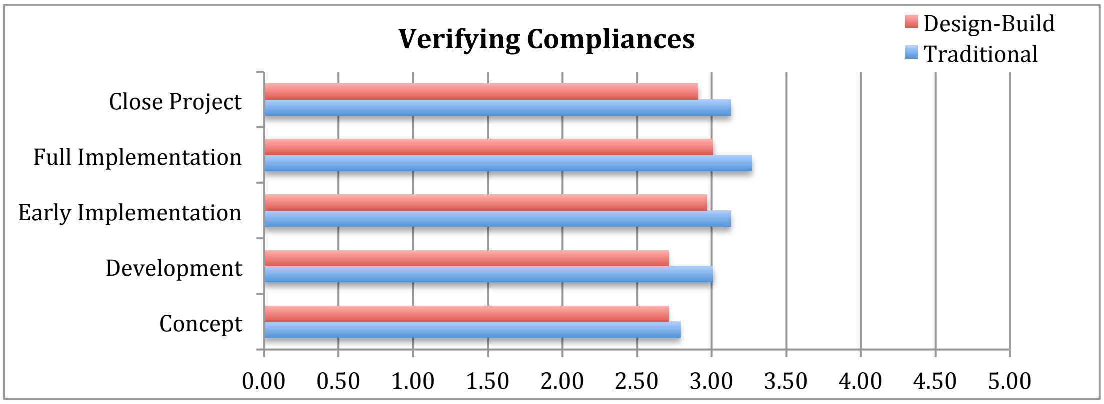


Figure 5.22: Time-spent in Verifying Compliances

Respondents were further required in questions 27 and 28 to evaluate the time spent daily in decision-making relative to other project activities. The results show (Figure 5.23) that at all stages of the project life cycle except in the concept stage, the time spent in verifying compliances for the Traditional system is slightly higher than Design-Build system. In the concept stage the time spent in decision-making for Design-Build system is higher than the Traditional system.

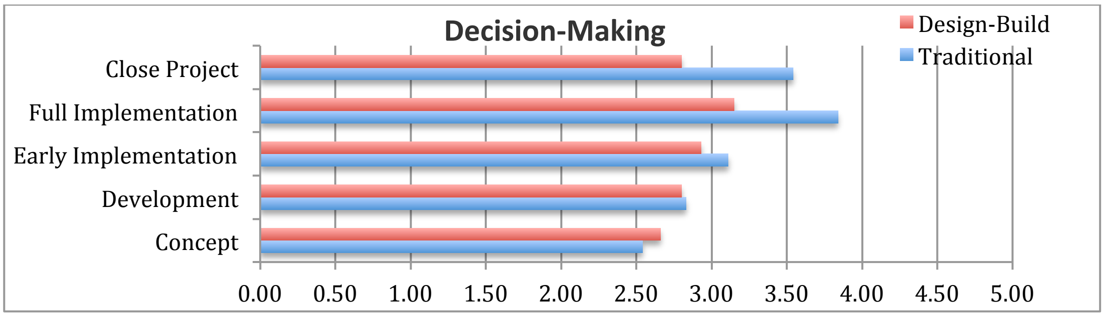


Figure 5.23: Time-spent in Decision-making

Questions 29 and 30 asked respondents to evaluate the time-spent daily in enforcement relative to other project activities. The results show (Figure 5.24) that at all stages of the project life cycle, the time spent in enforcement for Design-Build system is slightly higher than the Traditional system.

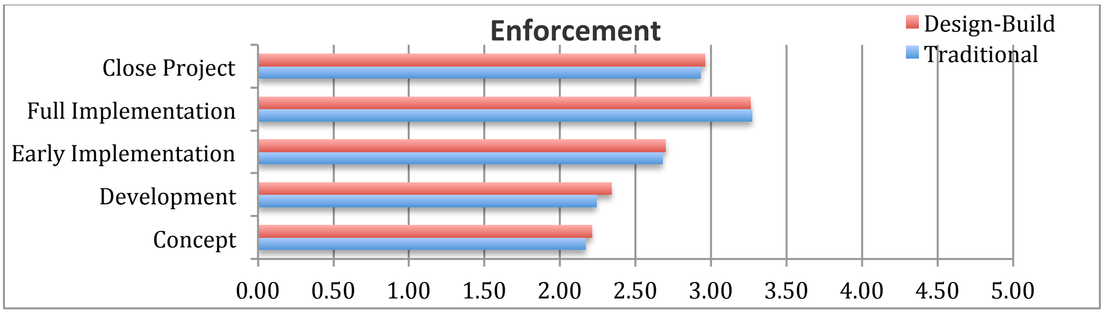


Figure 5.24: Time-spent in Enforcement

In the last two questions (33 and 34), the participants were asked to determine the time-spent daily in administration relative to other project activities. The results show (Figure 5.25) that at all stages of the project life cycle except in the concept stage, the time spent in administration for the Traditional system is marginally higher than Design-Build system.

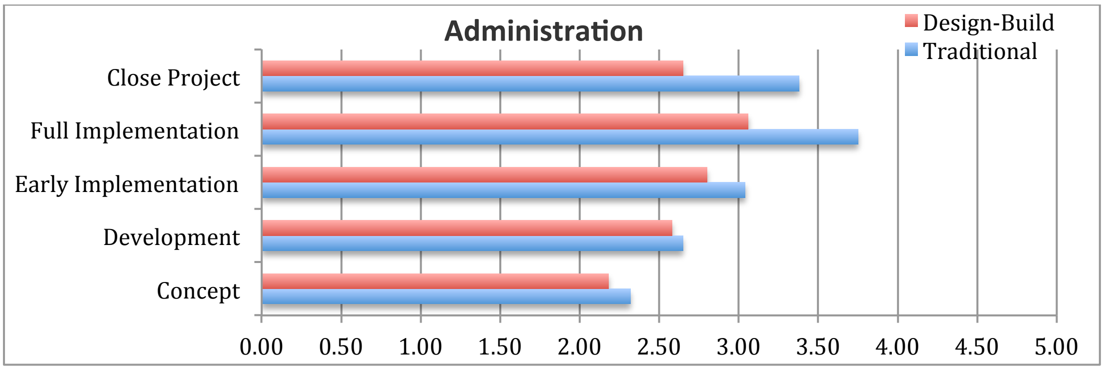


Figure 5.25: Time-spent in Administration

5.5.2 Analysis of the impact of Environmental Uncertainties' on Information, Procurement, Administration, and Enforcement Costs

The second aspect of the questionnaire (section B) required participants' opinions on the impact of uncertainties in the transaction environment on the cost of: information, procurement, administration, and enforcement (see Appendix B2). The opinions of the respondents were to be expressed using a 5-point Likert scale in evaluation where *1: very low, 2: low, 3: neutral, 4: high, and 5: very high*. Environmental uncertainties are external and internal factors of the firm that might distort the smoothness of a transaction. This may include Legal/Social/Political, Economic, Competition, Technology, Corporate Culture, Project location, Finance/Ownership, and Information systems. The purpose of the two questions (35 and 36) included in this part of section B is to determine the effects of uncertainties in the transaction environment on the transaction costs elements, which in fact helps determine the selection of the most applicable procurement delivery system.

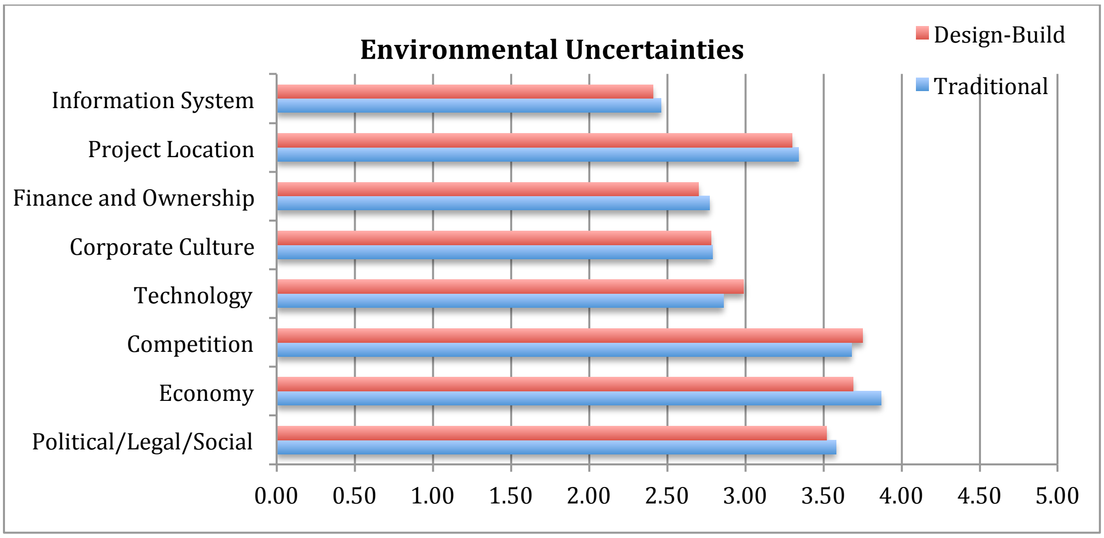


Figure 5.26: Environmental Uncertainties Impact

The Figure 5.26 clearly shows that for a project procured under Traditional arrangements, the impact of a country's political/legal and social situation on the TC elements is higher than projects procured using Design-Build system. Economical figure (e.g. interest rate, inflation, growth, etc.) of the country has a higher impact on TC elements for projects procured using the Traditional system compared to projects procured using Design-Build system. However, competition and technology in the construction industry has a higher effect on the TC elements for projects procured using Design-Build system compared to projects procured using the Traditional system.

Finally, uncertainties in the transaction environment such as corporate culture, finance/ownership, project location, and information systems have the same impact on the TC elements whether the project is procured using the traditional or design-build system.

5.5.3 Analysis of Transaction Costs Drivers

The third aspect of the questionnaire (see Appendix B2) in the questionnaire required participants' opinions on the TC drivers. The most common overhead or

TC drivers are searching, information gathering, bargaining, decision making, policing, and enforcement. The opinions of the respondents were to be expressed using a 5-point Likert scale in evaluation where *1: very low, 2: low, 3: neutral, 4: high, and 5: very high*.

This part of Section B includes one question (37), which intends to determine the greatest driver of increased TCs. This is done so that the decision maker can implement a strategy that minimizes the effect of these drivers on the project cost estimates. The most important drivers of TC as shown in Figure 5.27 are information gathering and decision-making 18%, the second important TC drivers are enforcement and policing 17%, search stand 16%, and lastly the least TC driver is bargaining 14%. The results indicate that there was no cost driver that its impact significantly different, which means that all the drivers are equally important. Therefore, a strategy for executing a project should focus on minimizing the costs associated with these cost drivers.

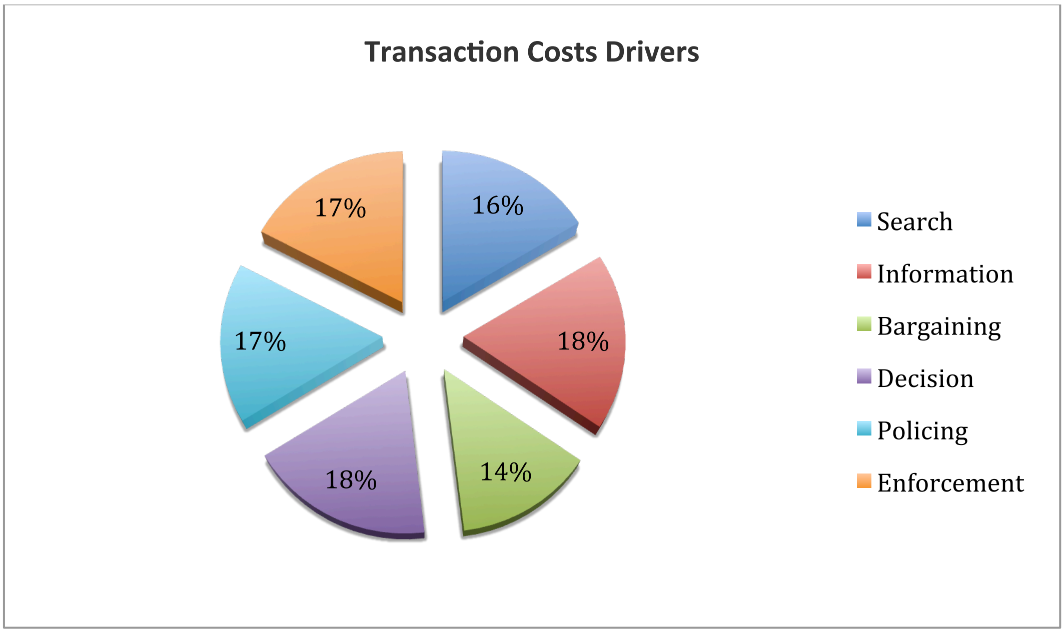


Figure 5.27: Transaction Cost Drivers

5.6 Structural Equation Modeling Analytical Procedures

Data in the previous section (5.4) were visually represented and analyzed using bar charts, but there was limited evidence to support the validity and reliability of the various measures. Validity and reliability of indicators can change when embedded in a theoretical context (Hair et al., 2012). They can be assessed by means of SEM. Meanwhile, prior to developing the structural and measurement models using SEM, a covariance structure analysis should be performed (Gerbing & Anderson, 1988) to ensure data reliability and validity. Exploratory and confirmatory factor analyses are two common standard statistical tools for developing measurement and structural models.

Following Gerbing and Anderson's procedure (1988), the first phase of data analysis includes Exploratory Factor Analysis (EFA). EFA was conducted on the sample respondents (N=72), to create potential factors for the baseline measurement models (Kinicki et al., 2004). After conducting the EFA, a Confirmatory Factor Analysis was conducted in the second phase. The intent of conducting the CFA was to confirm the accuracy of the EFA described in the first phase of SEM analysis, and to assess the measurement and structural models. The last step is testing the primary hypotheses about transaction costs, procurement systems, project phase, and environmental uncertainties specified earlier in Section 3.2 to 3.8 of Chapter Three.

5.6.1 Exploratory Factor Analysis (EFA)

EFA is an essential element of SEM analysis. It provides information about the relationship between constructs by uncovering an extremely immeasurable set of variables to compose a concentrated set of constructs that could be acclimated to approximate the observed variables. Applying multiple scales to our data set during the exploratory analysis in SEM helps to improve the conceptual model through modification of the structural or measurement model (Lomax & Schumacker, 2012). Following Gerbing and Anderson's approach (1988), Factor analysis or Principal Components Analysis (PCA) was conducted in the first step. Followed by Constructs reliability and validity tests or coefficient alpha tests in the second step. Lastly, Constructs consistency test was conducted, which includes the internal consistency test or Common Variance bias test and external Consistency test. These analyses were conducted using SPSS version 20.

5.6.1.1 Principal Components Analysis

Principal Components Analysis or Factor Analysis is a measure to test if the observed variables could be loaded onto a single latent variable. PCA was performed using statistical software SPSS 20 on the theoretical constructs that represent 21 observed variables: *information cost* which was represented with 2 items; *procurement or contracting cost* which was represented with 6 items; *administration cost* which was represented with 2 items; *enforcement cost* which was represented with 3 items; and *uncertainties in the transaction environment* which was represented with 8 items. Three criteria were used to assess whether the measured variables are sufficiently inter-correlated to produce representative factors.

First, the Kaiser-Meyer-Olkin Measure or Measure of Sampling Adequacy (MSA) was used. The MSA value of the overall sampling adequacy should be MSA > 0.5. *Second,* the Bartlett test was performed to assess whether the correlation matrix was an identity matrix. For this research a threshold correlation value of 0.4 was set to be the minimum. *Third,* the Scree plot test was used as a graphical approach to determine the number of factors to retain. By inspecting the plot where there is an "elbow", the eigenvalues remain close to each other below this point, which means this is the point where factors explain little additional variance after this point. However, above that point the variances are significantly more which means there are big drops in the size of the eigenvalues.

The results of the factor analysis from SPSS are shown in Tables 5.3 and 5.4. The principal component analysis results in 5 factors (constructs), which explain the total variance. Kaiser's criterion states that the eigenvalue should be greater than one. The results from PCA show that the eigenvalues are: for component 1 = 6.704, for component 2 = 3.074, for component 3 = 1.972, for component 4 = 1.575, and for component 5 = 1.082. The results also show that the *MSA = 0.854*, the Bartlett's Test of Sphericity *df = 210* and *p = 0.00*. This means p value is significant, and the total variance explained by component 1 = 24.07%, by component 2 = 40.47% by component 3 = 50.56%, by component 4 = 59.75%, and by component 5 = 68.6% (see Appendix C).

Table 5.3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.819
Bartlett's Test of Sphericity	Approx. Chi-Square	4589.258
	df	210
	Sig.	.000

Table 5.4: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% Variance	Cumulative %	Total	% Variance	Cumulative %	Total	% Variance	Cumulative %
1	6.70	31.96	31.92	6.70	31.92	31.92	5.05	24.06	24.0
2	3.07	14.67	46.56	3.07	14.63	46.56	3.44	16.40	40.4
3	1.97	9.39	55.95	1.97	9.39	55.95	2.12	10.09	50.5
4	1.57	7.49	63.45	1.57	7.49	63.45	1.93	9.18	59.7
5	1.08	5.15	68.60	1.08	5.15	68.60	1.86	8.85	68.6
6	.96	4.60	73.20						
7	.83	3.95	77.16						
8	.73	3.48	80.65						
9	.69	3.28	83.94						
10	.50	2.41	86.35						
11	.47	2.25	88.60						
12	.41	1.97	90.58						
13	.36	1.71	92.29						
14	.30	1.45	93.75						
15	.29	1.39	95.15						
16	.25	1.23	96.38						
17	.22	1.04	97.43						
18	.17	.82	98.25						
19	.15	.73	98.99						
20	.13	.63	99.62						
21	.07	.37	100.0						

Finally, the scree plot (Figure 5.28) analysis shows that the five components all suggested the extractions of the proposed number of factors scored an eigenvalue of greater than one. All the results from EFA analysis are shown in Appendix D.

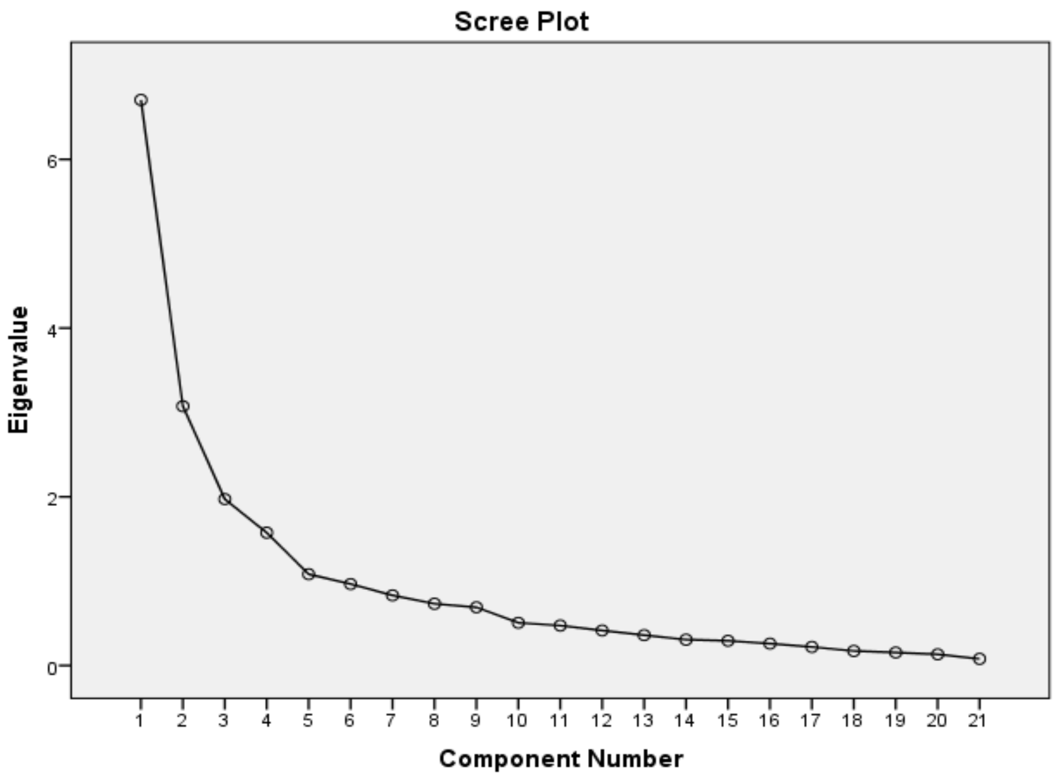


Figure 5.28: Scree Plot

5.6.1.2 Constructs Reliability and Validity Tests

Validity and reliability are essential features of a quantitative research inquiry (Li et al., 2012). Prior to data analysis using SEM and to confirm the constructs internal consistency, the scales of the items used to measure each construct are tested for reliability (Hair et al., 2007). Researchers (Amaratunga et al., 2002; Saunders et al., 2011) indicated that reliability is important for the consistency of research findings offered by the data collection techniques used.

The 21 measurement items presented in Table 4.5 page 144 were tested for reliability using SPSS version 20. In Cronbach's reliability test, the acceptable measure for constructs to score should be greater than $\alpha > 0.7$. The results (Table 5.5) show that the average of the two types associated with the *procurement system* scored an average of $\alpha = 0.842$. For the *project phase*, the five items scored an average of α = 0.849. The two items loaded as hypothesized with *information cost* scored α = 0.823. For the *procurement cost*, the six items loaded as hypothesized scored an average of α = 0.825. The two items loaded as hypothesized with the *enforcement cost* scored an average of α = 0.825.

Table 5.5: Constructs and Items Reliability Test

Construct	Items	Item Cronbach's Alpha	Construct Cronbach's Alpha
Procurement System	Traditional System	.841	0.842
	Design-Build System	.842	
Project Phase	Concept	.844	0.849
	Development	.847	
	Early Implementation	.850	
	Full Implementation	.847	
	Project Close	.859	
Information Cost	Communication	.822	0.823
	Information	.824	
Procurement Cost	Attending Meeting	.828	0.825
	Translation of Client's Needs	.819	
	Training	.832	
	Project Preliminary Design	.828	
	Transition Observation	.827	
	Site Visits	.821	
Administration Cost	Administration	.822	0.826
	Conflict Resolution	.837	
	Decision Making	.820	
Enforcement Cost	Enforcement	.823	0.825
	Verifying Compliances	.826	
Environmental Uncertainties	Political/Legal/Social	.838	0.834
	Economy	.837	
	Competition	.839	
	Technology	.833	
	Corporate Culture	.829	
	Finance and Ownership	.830	
	Project Location	.835	
	Information System	.829	

For the *administration cost*, the three items loaded as hypothesized scored an average of α = 0.826. Lastly, for the *environmental uncertainties*, the eight items loaded as hypothesized, scored an average of α = 0.834.

Table 5.5 shows that all Cronbach's alpha coefficients calculated are above the threshold level of $\alpha > 0.7$, which suggests that the set of observed variables are good measures of a single unidimensional latent construct (Gerbing & Anderson, 1988). See Appendix D for the complete results.

5.6.1.3 Constructs Consistency Test

After conducting PCA and Reliability tests, the constructs (latent variables) were tested for consistency, which includes internal (i.e. common method variance bias) and external consistency tests. The *common method variance bias* was used to assess the internal consistency of the constructs. One related test was conducted for the 5 factors that explained the 21 observed variables.

Harman's one-factor test (as part of PCA test) was conducted to examine any variance bias. In this method all variables were entered into a principal component analysis of the factor analysis in SPSS. Results of the factor analysis (Table 5.4) on all variables revealed 8 factors with eigenvalues greater than one. The first factor explained 24.07% of the total variance, and all factors explained 68.6% of variance. This means that no general factor was apparent, and the result did not suggest the presence of common method bias (Podsakoff et al., 2003; Gibbons & O'Connor, 2005).

External consistency analysis was conducted, in line with Gerbing and Anderson (1988), by including all the variables in a single factor analysis in PCA of the factor analysis in SPSS. Results of a single factor analysis (Table 5.6) show only the items with loading greater than 0.4, and there is an evidence of external consistency except for six cases which loaded in more than one component (see Appendix D).

Table 5.6: External Consistency Test

Rotated Component Matrix					
Item	**Component**				
	1	2	3	4	5
Site Visits	.869				
Administration	.809				
Decision Making	.782				
Enforcement	.748				
Communication	.709			.445	
Information	.679				
Translation of Client's Needs	.655			.515	
Attending Meeting	.590			.463	
Conflict Resolution	.429				
Corporate Culture		.915			
Finance and Ownership		.887			
Information System		.868			
Technology		.782			
Competition			.814		
Project Location		.424	.642		
Transition Observation	.415		.467		
Training			-.404		
Project Preliminary Design				.784	
Verifying Compliances	.410			.433	
Political/Legal/Social					.870
Economy			.507		.701

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization

For example, 'communication' activity is loaded in both component one and four; 'translation of client's needs' is loaded in both component one and four; and 'attending meeting' is also loaded in both component one and four. These problems will be avoided when developing the measurement model. The measurement model incorporates confirmatory factor analysis, which is concerned with how satisfactory the variables measure the latent variables, also in addressing issues such as validity and reliability. Typically, the measurement model includes the overall variables without causal relationships among them (Molenaar et al., 2000).

5.6.2 Assessment of Measurement Models Using CFA

The starting point in developing a model in SEM, after conducting EFA in the previous Sub-Section (5.6.1), is evaluating the conceptualized measurement models. These models explain how well the observed variables measure the latent variables. Validity of the measurement models depend on the Goodness-of-Fit indices which highlights the key issues of unidimensionality, reliability, construct validity (Byrne, 2009; Hair et al., 2012).

Since the objective of this study is to estimate the transaction costs of different procurement systems (specifically the Traditional and Design-Build delivery systems) there were five measurement models conceptualized for each delivery system in this research (i.e. in total ten measurement models). Pre-contract phase had two hypothesized dimensional indicators of information cost and procurement or contracting cost; Post-contract phase had two hypothesized indicators of administration cost and enforcement cost; TCs had two hypothesized indicators of pre-contract TCs and post-contract TCs; Procurement-Transaction costs linkage had five hypothesized indicators of pre-contract, post-contract, project phase, and procurement system; and Procurement-Transaction costs-Environmental Uncertainties relationship had six hypothesized indicators of pre-contract, post-contract, TCs, project phase, procurement system, and environmental uncertainties.

The measurement models were assessed using the modeling software Amos 21 by goodness-of-fit indices, which preform sufficiently across a wide range of situations (Byrne, 2009; Hair et al., 2012). The indices thresholds, as discussed in Sub-Section 4.10.6.3 of the previous chapter, were the relative chi-square (χ^2/df) > 3; Goodness-of-Fit Index (GFI) > 0.9; Comparative Fit Index (CFI) > 0.9; Square Root Mean Residual (SRMR) < 0.08; Root Mean Square Error of Approximation (RMSEA) < 0.1. The assessments of the overall measurement models are shown in Table 5.7 (see Appendix D).

The results obtained from Table 5.7 show that the chi-square values (CIMIN) for the measurement models were not significant. This is because the chi-square value is negatively affected by the large sample size. In this study the actual sample size was 72, and because the measurements were conducted throughout the project's five phases for two procurement systems, the sample size was exaggerated to be 720. Accordingly, the measurement models were assessed based on fit indices such as SRMR, GFI, AGFI, and PGFI, and the results show that the models fit the data perfectly.

Table 5.7: Overall Models Fit Summary

A. TCs-Procurement- Environmental Uncertainties Model						
Model	NPAR	CMIN	SRMR	GFI	AGFI	PGFI
Default model	78	3399.34	.01	.945	.935	.81
B. TCs-Procurement-PHZ Model						
Model	NPAR	CMIN	SRMR	GFI	AGFI	PGFI
Default model	64	2645.78	.015	.950	.939	.785
C. TCs-SYS Model						
Model	NPAR	CMIN	SRMR	GFI	AGFI	PGFI
Default model	49	979.75	.009	.976	.969	.759
D. TCs Model						
Model	NPAR	CMIN	SRMR	GFI	AGFI	PGFI
Default model	41	719.98	.008	.982	.976	.736

E. Pre-Contract Model						
Model	NPAR	CMIN	SRMR	GFI	AGFI	PGFI
Default model	24	204.96	.005	.988	.981	.611
F. Post-Contract Model						
Model	NPAR	CMIN	SRMR	GFI	AGFI	PGFI
Default model	18	26.95	.001	.998	.995	.463

5.6.2.1 Unidimensionality

Unidimensionality measure is a crucial element in theory testing (Gerbing & Anderson, 1988). It refers to the existence of a single construct underlying a set of measures, and each indicator loads on one construct. This means that all elements within a cross-loading analysis are assumed to be zero (Gerbing & Anderson, 1988; Hair et al., 2012). Accordingly, unidimensionality assumes there are no significant correlational patterns among indicators within a set of measures, and lack of unidimensionality is a form of measurement error. There are two common methods of assessing unidimensionality: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), but the preferred method is a CFA of multiple-indicator measurement models (Gerbing & Anderson, 1988).

In this research, unidimensionality scales were conducted using SPSS 20 by means of *Cronbach's Alpha Test*, *Factor analysis (i.e. PCA)*, *Confirmatory Factor Analysis (CFA)*, and *Guttman's Scaling*. The results of unidimensionality scales for *Cronbach's Alpha Test*, *PCA, and CFA* are shown in Tables 5.3, 5.4, 5.5, and 5.6 which are considered unidimentional for confirmatory purposes. Meanwhile, *Guttman's Scaling* sets the lower bound for the true reliability. The purpose is to establish a one-dimensional continuum for a concept to be measured. Thus, Guttman suggests finding the split that maximizes the lower bound *(L4)*, computing it to the other lower bounds and choosing the largest. The objective is to find a set of items that perfectly matches the pattern of reliability, therefore any item scores above *L4 = 0.654* is considered to be valid (Bagozzi and Phillips, 1991).

Table 5.8 shows that the lower bound split scale is *L4 = 0.654* for true reliability. Accordingly, the *Cronbach's* reliability test (Table 5.5) and *Kaiser-Meyer-Olkin* Measure of Sampling Adequacy (KMO – Table 5.3) show that all constructs scored a significant reliability more than the lower bound sets by *Guttman's* test. See Appendix D for complete results.

Table 5.8: Guttman's Scale for Reliability

Reliability Statistics		
Lambda	1	.847
	2	.899
	3	.887
	4	.654
	5	.879
	6	.937
N of Items		22

5.6.2.2 Construct Validity

Construct validity refers to the extent to which a set of measurement items represents the latent variable, thus it test the accuracy of the measurement (Hair et al., 2012). In the previous sub-sections (5.6.2 and 5.6.2.1) the CFA were used to assess the unidimensionality and reliability for the sets of items included in the measurement models. The scales were subject to different types of construct validity such as convergent, discriminant, and nomological validity (Bagozzi et al., 1991; Byrne, 2009; Hair et al., 2012). Although the results obtained from conducting EFA confirmed unidimensionality, the high value loadings obtained from conducting CFA provide strength to the scales obtained from conducting EFA.

Convergent validity is demonstrated by overall model fit, which assesses the degree whereto two constructs of the same concept are correlated. A construct is said to possess convergent validity if its items' indicators are sharing a high proportion of variance in common (Hair et al., 2012). There are various techniques available to estimate the convergent validity. This study focuses on four convergent validity indicators.

First, on the basis of factor loadings for items of different scales, which should indicate a significant loading in their respective constructs. Each item loading within a construct should be at least 0.5, indicating the presence of convergent validity (Bagozzi et al., 1991; Hair et al., 2012).

Second, on the basis of internal consistency for convergent validity which seeks to assure that there is a sufficient correlation among the indicators. Existence of unidimensionality with high internal consistency of the scales means there is a moderate convergent validity. For internal consistency measures of Item-to-total correlations should be greater than 0.5 and Inter-Item correlations should be greater than 0.3. Moreover, in this study the threshold for Cronbach's Alpha values > 0.7.

Third, on the basis of average percentage of variance explained (AVE) among a set of items due to random measurement errors. It was calculated as the mean square factor loading, and a construct is said to possess convergent validity if it AVE is greater than 0.5 (Fornell & Larcker, 1981). AVE can be calculated according to the following formula:

$$AVE = \Sigma \lambda_i^2 / [\Sigma \lambda_i^2 + \Sigma_i \text{var}(\varepsilon_i)] \text{ .... } \textbf{Equation 5.1}$$

where, AVE is the Average Variance Explained; λ_I is the component loading of each item to its latent construct, and var (ε_i) = $(1- \lambda_i^2)$

The results of conducting AVE (see Appendix D) as presented in Table 5.9 indicate that all latent variables scored more than the threshold value of 0.5, which suggest there is convergent validity and good internal consistency. That is, the observed items of each latent variable measure them well and are not measuring another latent variable.

Table 5.9: Average Variance Explained (AVE)

Construct	Item	Item Loading	Average variance Explained (AVE)
Information Cost (INFOC)	IG	0.73	0.765
	CM	0.80	
Project Procurement Cost (PPROC)	AM	0.64	0.648
	TN	0.84	
	TR	0.51	
	PD	0.56	
	TZ	0.58	
	SV	0.76	
Administration Cost (ADMC)	AD	0.72	0.733
	DM	0.80	
	CR	0.68	
Enforcement Cost (ENFORC)	EN	0.70	0.665
	VC	0.63	
Transaction Costs (TCs)	PRE	0.97	0.965
	POST	0.96	
Environmental Uncertainties (ENVIRO)	PLS	0.32	0.568
	ECO	0.27	
	COP	0.16	
	TCH	0.65	
	CCT	0.93	
	EWR	0.86	
	PRL	0.47	
	ISM	0.88	

Fourth, on the basis of CFA fit indices such as GFI, AGFI, and CFI in SEM. The acceptable limits for theses scales, as discussed in sub-section 5.5.2, are generally close to 0.9, which is a proof of a strong convergent validity.

Discriminant validity is the degree to which measurement items hypothesized to reflect a construct are unrelated to those that are hypothesized for another construct. That is, low correlation confirms discriminant validity of the measurement items (Hair et al., 2012).

In this study, discriminant validity was assessed using a two-step approach. First, on the basis of Harman's one-factor test that loaded all measured items into PCA with factor loading for all scales to one. The outcomes of conducting PCA (see Appendix D) as shown in Table 5.4 reveal no single dominant factor, one factor had only 24.07% of total variance explained while five factors generated 68.6% of the total variance explained.

Harman's test with communalities (Table 5.10) reveal a positive extraction for all scales after setting the loadings to one, which is shown in the re-scaled column. Communality tells us how much of the variance in each of the original variables is explained by the extracted factors, and the threshold value should be greater than 0.5 (see Appendix D). The shaded values represent non-significant loadings.

Table 5.10: One-factor Analysis with Communalities

Communalities				
	Raw		Rescaled	
	Initial	Extraction	Initial	Extraction
Information Gathering	1.091	.539	1.000	.494
Communication	1.393	.827	1.000	.594
Attending Meetings	1.312	.564	1.000	.430
Translation of Client's Needs	1.413	.981	1.000	.694
Training	1.100	.320	1.000	.291
Project Preliminary Design	1.484	.566	1.000	.381
Transition Observation	1.005	.363	1.000	.362
Site Visits	1.347	.796	1.000	.591
Administration	1.467	.816	1.000	.556
Decision Making	1.477	.973	1.000	.659
Conflict Resolution	1.683	.872	1.000	.518
Verifying Compliances	.925	.386	1.000	.417
Enforcement	1.257	.635	1.000	.505
Political/Legal/Social	.624	.016	1.000	.026
Economy	.441	.011	1.000	.024
Competition	.749	.011	1.000	.015
Technology	1.106	.130	1.000	.117
Corporate Culture	.831	.207	1.000	.249
Finance and Ownership	.890	.190	1.000	.213
Project Location	.644	.047	1.000	.073
Information System	1.080	.241	1.000	.223

Likewise, the results of conducting PCA with Harman's One-Factor Test that presented in Table 5.11 provide evidence of discriminant validity among the measurement items, because one component explained only 40.6% of the total variance (see Appendix D).

Table 5.11: Harman's One-factor Test

Total Variance Explained						
Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.980	40.642	40.642	10.980	40.642	40.642
2	3.057	11.317	51.959			
3	1.975	7.310	59.269			
4	1.651	6.110	65.378			
5	1.345	4.978	70.356			
6	1.153	4.267	74.623			
7	.970	3.589	78.212			
8	.791	2.929	81.141			
9	.646	2.390	83.532			
10	.620	2.296	85.828			
11	.543	2.011	87.839			
12	.482	1.783	89.621			
13	.446	1.650	91.271			
14	.385	1.426	92.697			
15	.330	1.221	93.918			
16	.317	1.175	95.092			
17	.297	1.099	96.192			
18	.265	.981	97.173			
19	.243	.901	98.074			
20	.181	.669	98.743			
21	.175	.648	100.000			

Secondly, on the basis of Average Variance Explained (AVE), which estimates where, all possible pairs of constructs were compared with their squared correlations. For a proof of discriminant validity, the AVE estimates of the measurement items should be higher than the squared correlation of the same items. This means that the latent construct explains its item measures better than other constructs (Malhotra et al., 2006; Hair et al., 2012). The results (see Table 5.12) provide evidence of discriminant validity among the measurement items. The squared correlation values as shaded diagonal cells. Two of the six sets of items had AVE less than the squared correlation of the same items. The AVE indicator of project procurement cost had less indicator value than its squared correlation value. Environmental uncertainties had AVE indicator less than its squared correlation value. However, all the validity values in Table 5.5 were significantly less than one, which suggested a reasonable overall degree of discriminant validity (see Appendix D).

Table 5.12: AVE and Squared Correlations – General Measurement Model

	AVE	TCs	INFOC	PPROC	ENVIRON	ADMINC	ENFORC
TCs	.965	.461					
INFOC	.765	.476	.664				
PPROC	.648	.658	.655	.705			
ENVIRON	.568	.170	.057	.166	1.687		
ADMINC	.733	.680	.446	.694	.209	.664	
ENFORC	.665	.624	.380	.568	.249	.607	.584

Nomological validity refers to the degree of correlation, for a proposed relationship, between a latent construct with measurement items of different but related latent construct (Malhotra et al., 2006; Hair et al., 2012). It provides evidence whether the correlations between constructs of the measurement model hold the same significance as predicted by the conceptual model. Using Amos 21 for modeling the relationship among constructs, the results are presented in Table 5.13. The shaded cells show the correlation values between constructs were positive and significant (greater than 0.01) that gives an evidence of nomological validity among the theoretically expected constructs (see Appendix C).

Table 5.13: Correlations - General Measurement Model

Parameter			SE	SE-SE	Mean	Bias	SE-Bias
PPROC	<-->	INFOC	.016	.000	.977	-.001	.001
ENFORC	<-->	INFOC	.041	.001	.782	.001	.001
ADMINC	<-->	INFOC	.027	.001	.819	-.001	.001
ENVIRON	<-->	INFOC	.041	.001	.233	.001	.001
INFOC	<-->	TCs	.015	.000	.927	-.001	.000
INFOC	<-->	PHZ	.037	.001	.156	-.002	.001
INFOC	<-->	SYS	.041	.001	.038	.000	.001
ENFORC	<-->	PPROC	.033	.001	.944	.002	.001
ADMINC	<-->	PPROC	.016	.000	1.007	.000	.000
ENVIRON	<-->	PPROC	.042	.001	.392	.001	.001
PPROC	<-->	TCs	.007	.000	1.073	.000	.000
PPROC	<-->	PHZ	.042	.001	.083	-.002	.001
PPROC	<-->	SYS	.040	.001	-.051	-.001	.001
ENFORC	<-->	ADMINC	.033	.001	.988	.001	.001
ENFORC	<-->	ENVIRON	.050	.001	.502	.001	.002
ENFORC	<-->	TCs	.024	.001	1.098	.001	.001
ENFORC	<-->	PHZ	.048	.001	.101	-.002	.002
ENFORC	<-->	SYS	.046	.001	-.058	-.001	.001
ADMINC	<-->	ENVIRON	.040	.001	.446	.002	.001
ADMINC	<-->	TCs	.013	.000	1.109	.000	.000
ADMINC	<-->	PHZ	.045	.001	.081	-.002	.001
ADMINC	<-->	SYS	.041	.001	-.101	.000	.001
ENVIRON	<-->	TCs	.038	.001	.439	.001	.001
ENVIRON	<-->	PHZ	.038	.001	-.001	-.001	.001
ENVIRON	<-->	SYS	.039	.001	-.026	-.001	.001
PHZ	<-->	TCs	.040	.001	.092	-.002	.001
SYS	<-->	TCs	.038	.001	-.059	-.001	.001
PHZ	<-->	SYS	.038	.001	-.002	-.002	.001

5.6.3 Assessment of Structural Models

As already discussed in sections 3.3 to 3.8 on Chapter Three, sets of theory-driven relationships between factors were specified. Relationships were proposed in this study through direct and indirect relationships among constructs. Single head arrow points towards a variable with path coefficient represents direct relationship, while an indirect relationship is represented with intervening variable (i.e. mediator and moderator variable). The theoretical structure (Figure 3.1 to 3.6) of the relationship between the transaction costs, procurement system, project phase, and environmental uncertainties was developed independently from the measurement models. According to Gerbing and Anderson (1988), developing and assessing a theoretical structure independently from its measurement model provided an excellent and comprehensive confirmatory evaluation of construct validity.

Structural Equation Modeling using Amos 21 was utilized to develop the pattern of relationships among the constructs. In this study the structural models were recursive (repeated or related relationships among variables), which means all paths proceeded from a predictor construct to the resulting construct. Meanwhile, a non-recursive relationship between any two constructs implies that their relationship is causal and they influence each other. As stated by Hair et al. (2012), the situation of a causal relationship is unlikely with cross-sectional data. SEM assesses and tests the key theoretical relationships among constructs, and taking into account measurement error by estimating measurement error variances from the data and the specified model. Also, SEM analysis undertakes comparison of alternative models through nesting models technique (Raykov & Marcoulides, 2006).

The resulting paths from conducting SEM using Amos 21 were indicated on a path diagram, which depicts the relationships among variables through principal regression equations that were solved for various parameters. There are two types of parameters that explain the relationship among constructs: those describing the effect of an exogenous construct (external construct) on an endogenous construct (measured construct); and those that link endogenous constructs with each other. By estimating the parameters of the model, the discrepancy between the population covariance matrix (Σ) and the sample covariance matrix (S) was minimized. As discussed in Section 4.10.6, the differences between matrix S and matrix Σ are the key factor in assessing the model fit in SEM. Accordingly, for specified model $S - \Sigma = 0$ which implies that the data is fitted the model, and for $S - \Sigma > 0$ means that the model is over specified, and the data fits the model well.

Finally, in this study the cost of information, procurement or contracting, administration, and enforcement were hypothesized through first-order factors (direct relationship). Transaction costs were hypothesized through a second-order structure, and for procurement system and uncertainties in the transaction environment impacts were also hypothesized through a second-order structure. The hypothesized relationships were finally presented in two comprehensive models; the traditional model and the design-build model. These models explain the hypothesized impact of procurement systems and uncertainties in the transaction environment on the magnitude of transaction costs. The models were used to test: Goodness-of-Fit; Criterion Validity; Cross validation; Fit Indices; Causal relationships; and Test Hypotheses, using Amos 21.

5.6.3.1 Criterion Validity

Criterion-related validity is the degree of correlation between the exogenous variables (independent variables) and the related endogenous variables (dependent or criterion variables). Criterion-related validity deals with whether the obtained measurement scores are predicting the constructs that they relate to. SEM was used to estimate the correlations between the dependent and independent constructs (criterion-related) of the structural models.

The benefit of utilizing SEM that it takes into account data measurement error through estimating a measurement error variance (Hair et al., 2012). There are two types of criterion validity: Concurrent and Predictive. Concurrent validity when the correlation exists at the same time as the measure, while, predictive validity occurs when the correlation exists in the future (Straub et al., 2004; Barki & Pinsonneault, 2005; Hair et al., 2012). Constructs that measured the cost of information, procurement, administration, enforcement, and uncertainties in the transaction environment were included in each structural model, but were not used for testing hypotheses. That is, the perception of the respondent was measured and deployed as a criterion measure (Barki & Pinsonneault, 2005).

In this study, which adopted a survey-based technique for data collection and a 5-point Likert scale in evaluation, criterion-related validity deals whether assessment scores obtained from participants are predictive of something related to the goal of the assessment. Accordingly, criterion-related validity was used to estimate the magnitude of transaction costs incurred as a result of construction professionals performing procurement activities. The structural models for the Traditional and Design—Build systems were used for estimation, and for the purpose of comparison between these two systems. For example, the structural model explains through the correlation coefficients the relationship between the latent variables and the observed measured variables.

Using Amos 21 to develop the structural models, the effects of the correlations between constructs are presented in Table 5.14 (see also Appendix C). The results show that the regression weights between most of the constructs (except the shaded ones) were high and positive. This would suggest a high degree of criterion-related validity, which implies that the observed measures do indeed predict the latent variables. In Chapter Six, the findings from testing the structural models in real life cases based on criterion-related validity (Concurrent and Predictive) will be introduced; to execute the developed model and validate the findings of transaction costs for different procurement systems within the New Zealand construction industry.

Table 5.14: Standardized Regression Weights

			Estimate
SYS	<---	PHZ	.642
SYS	<---	ENVIRO	.766
INFOC	<---	ENVIRO	.169
INFOC	<---	SYS	.063
INFOC	<---	PHZ	.936
PPROC	<---	INFOC	.802
PPROC	<---	ENVIRO	.195
PPROC	<---	SYS	.021
PPROC	<---	PHZ	.127
ENFORC	<---	ENVIRO	.298
ENFORC	<---	SYS	.002
ENFORC	<---	PHZ	.040
ENFORC	<---	INFOC	.605
ENFORC	<---	PPROC	.238
ADMINC	<---	ENFORC	.474
ADMINC	<---	ENVIRO	.117
ADMINC	<---	SYS	-.001
ADMINC	<---	PHZ	.061
ADMINC	<---	INFOC	.434
ADMINC	<---	PPROC	.000

			Estimate
TCs	<---	INFOC	.294
TCs	<---	ENFOC	.383
TCs	<---	PPROC	-.080
TCs	<---	ADMINC	.412
PRE	<---	TCs	.972
POST	<---	TCs	.964
TN	<---	PPROC	.835
TR	<---	PPROC	.510
PD	<---	PPROC	.561
TZ	<---	PPROC	.581
SV	<---	PPROC	.757
IG	<---	INFOC	.730
CM	<---	INFOC	.804
EN	<---	ENFORC	.700
VC	<---	ENFORC	.628
DM	<---	ADMINC	.798
CR	<---	ADMINC	.682
AD	<---	ADMINC	.723
PRL	<---	ENVIRO	.469
FWR	<---	ENVIRO	.859
CCT	<---	ENVIRO	.928
TCH	<---	ENVIRO	.647
COP	<---	ENVIRO	.156
ECO	<---	ENVIRO	.268
TRD	<---	SYS	.060
DB	<---	SYS	-.056
CLZ	<---	PHZ	.116
FIMP	<---	PHZ	.269
EIMP	<---	PHZ	-.023
DVP	<---	PHZ	-.159
CPT	<---	PHZ	-.314
PLS	<---	ENVIRO	.319
ISM	<---	ENVIRO	.878
AM	<---	PPROC	.644

5.6.3.2 Cross Validation

The structural models were also examined using a cross validation method, which estimates the out of sample error rate for predictive function. Cross validation is the key function to avoid under fitting of the structural models, and to choose the model that best fits the data (Bagozzi & Yi, 1988; Barrett, 2007; Hair et al., 2012). Cross validation is important for exploratory and cross-sectional survey researches, and provide additional evidence that structural models are valid (Byrne, 2009; Hair et al., 2012). The procedures used in cross validation are: First, split the data set into equal sets; Second, build a model on the test set of data set; Third, evaluate the predictive model on the test set; Fourth, repeat the procedures on all sets and evaluate the average estimated errors. Based on these procedures there are two types of cross validation; the K-Fold cross validation and the Leave-one-out cross validation.

K-Fold cross-validation divides data to equal data sets, for example, a 3-Fold divided the data into three equal sets (Figure 5.29). Firstly, build a model on the first set of data and evaluate the predictive model, and then build a model on the second and third set of the data and evaluate the predictive model. Secondly, build a model on the second set of data and evaluate the predictive model, and then build a model on the first and third set of data and evaluate the predictive model. Thirdly, build a model on the third set of data and evaluate the predictive model, and then build a model on the first and second set of data and evaluate the predictive model. Finally, compare the results of the predictive models to choose the best model that fit the data.

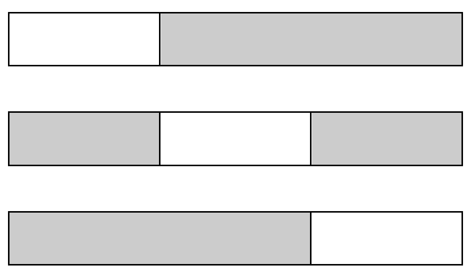


Figure 5.29: K-fold Cross Validation

Leave-one-out cross-validation; in this technique excluding an individual sample (Figure 5.30) and predict the model, and then evaluate the goodness-of-fit of the predictive model. Repeat this procedure for each individual sample sequentially and compare the goodness-of-fit of the developed models and select the model with the best fit. By adopting this technique the bias is minimized significantly, compared with other techniques because this technique takes into consideration every single sample.

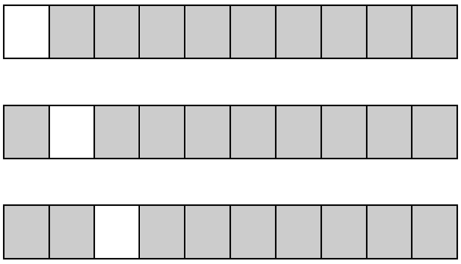


Figure 5.30: Leave-one-out Cross Validation

Finally, the benefits of conducting cross validation are: picking the most suitable variables to be in the developed model, picking the type of prediction function to be used; and picking the parameters in the prediction function (Gerbing & Anderson, 1988; Byrne, 2009; Hair et al., 2012). For this study, the technique used for cross validation is to include all the measured variables for every latent variable, and then develop the predictive model. Utilizing Amos 21 to predict the structural models. The resulting models predict the regression weights for every criterion in the set of measures predicting the latent variable. Afterward, the measures with no significant coefficients were taken out and the model fit is assessed. This process is repeated frequently by excluding measures with the least significant coefficients until the best model fit is achieved.

5.6.3.3 Fit Indices

"Fit indices" are an important factor in the structural model evaluation. They provide information on alternative models because they quantify the discrepancies between the observed and estimated covariance matrices (S–Σ) among the indicator items (Tabachnick et al., 2001; Ullman & Bentler, 2012). Also, fit indices provide information on how well the model best represents the data exposes an underlying theory (Hooper et al., 2008; Hair et al., 2012).

As discussed in the Section 4.10.6.3 there are three types of specific model fit indices: absolute, incremental, and parsimonious. In the absolute fit index, each model is evaluated for goodness-of-fit independently from other alternative models to ascertain how well the primary model fits the data sample set (Malhotra et al., 2006). Incremental fit index or comparative fit index are based on the assumptions that all the observed variables are uncorrelated. Using the nesting model technique, it measures how well goodness-of-fit of a specified model relative to a baseline model (McDonald & Ho, 2002; Miles & Shevlin, 2007). Finally, the parsimonious fit index aims at correcting the underspecified fitting of the model by comparing the parsimony ratio of the model to the goodness-of-fit of that model (Hair et al., 2012). The most common fit indices measures are shown in Table 5.15 below, which shows the acceptable threshold levels of the fit indices based on previous empirical studies (Hair et al., 2007; Tabachnick & Fidell, 2007; Aibinu et al., 2011; Li et al., 2013).

Table 5.15: Fit Indices - Recommended Values

Measure	Average Value	Description
χ^2		Chi-Square
df		Degree of freedom
χ^2/df	< 3	Relative Chi-square minimizes the impact of sample size
CFI	> 0.8	Comparative Fit Index (CFI) is used for comparison of alternative models, the higher value means better model fit.
GFI	> 0.7	Goodness-of-Fit Index (GFI) is used for models comparison, the higher value means better model fit.
AGFI	< GFI	Average Goodness-of-Fit Index (AGFI) is used for complex models, the higher value means better model fit but should be less than GFI.
PGFI	> 0.5	Parsimony Goodness-of-Fit Index (PGFI) is used for complex models, the higher value means better model fit but should be less than GFI.
RMSEA	< 0.1	Root Mean Square of Approximation (RMSEA) is an absolute fit measure that tells us how well the model fit. The lower value the best model fit.
SRMR	< 0.08	Square Root Mean Residual (SRMR) is an absolute fit measure that tells us how well the model fit. The lower value the best model fit.
ECVI	P < 0.05	Expected Cross-validation Index (ECVI) provides information on which model among a set of competing models is best fit. the observed data.. The best model fit with

In the current study, fit indices were used to make a comparison of fit between the Traditional and Design-Build models. The results of the overall models fit was presented in Tables 5.7 however, a comparison between models fit for the traditional and design-build systems will be discussed in the following Chapter Six.

5.6.4 Causal Relationships

For the current study, causal relationships tests are aimed at testing the proposed hypotheses that link transaction costs, procurement systems, and uncertainties in the transaction environment. They were hypothesized to examine direct and indirect effects of procurement systems, project phase, and uncertainties in the transaction environment on the magnitude of transaction costs. Direct relationship was shown with a single headed straight arrow between two variables (see Figure

4.2). While, indirect relationship was indicated with an arrow towards a variable that mediate or moderate the relationship between two variables.

Structural models for the hypothesized relationships for pre-contract costs, post-contract costs, transaction costs, procurement systems, project phase, and uncertainties in the transaction environment were integrated into a full structural model (see Figure 3.7) that link all these concepts. Also for comparison, structural models for both the traditional system and design-build system were developed. All constructs for these models were identified as either exogenous (independent) or endogenous (dependent).

5.6.5 Mediation and Moderation

The concepts of mediation and moderation variables were discussed in the previous chapter in Section 4.10.7.2. Mediators and moderators are variables used for refining and understanding causal relationships (Frazier et al., 2004; Wu & Zumbo, 2008; Sardeshmukh & Vandenberg, 2013). A mediator variable links a cause and an effect, while a moderator variable modifies a causal effect (Wu & Zumbo, 2008).

In the current study, the effects of information, procurement, administration, and enforcement costs on TCs were conceptualized to be direct effects. Similarly, the effects of procurement systems, project phase, and environmental uncertainties on the costs of information, procurement, administration and enforcement were conceptualized to be direct effects. In the contrary, the effects of procurement systems, project phase, and environmental uncertainties on TCs were conceptualized to be mediated by the costs of information, procurement, administration, and enforcement. Whereas the structural effect of procurement cost on TCs was conceptualized to be moderated by the information cost.

The effect of administration cost on TCs was conceptualized to be moderated by the procurement and the enforcement costs. Similarly, the effect of enforcement cost on TCs was conceptualized to be moderated by the procurement and the information costs. The effects of the information cost on the procurement, administration, and enforcement costs were conceptualized to be moderated by procurement systems, project phase, and environmental uncertainties. The effects of procurement cost on the administration and enforcement costs were conceptualized to be moderated by the procurement systems, project phase, and environmental uncertainties. Finally, the effects of the environmental uncertainties and the project phase were conceptualized to be direct effect.

Following the technique deployed by Green et al. (2006), the effects of mediating and moderating variables and the constructs were assessed for significance using the correlation matrix (Green et al., 2006). The results of the correlation matrix are shown in Appendix (C). As the correlation values indicate 'strong' for some variables, and 'weak' correlation for other variables. It was found that the proposed mediating and moderating with weak loading did not induce a substantial influence on the relationships (see Appendix C).

Two approaches introduced by Hair et al. (2012), to test the structural theory. First, by constraining all factor loading estimates for constructs that have been estimated earlier in model development. This approach was used in this study, which assumed that measures of transaction costs established as valid and will remain so in the structural model even when linked with other factors such as procurement system, project phase, and environmental uncertainties. That is, the positivistic notion of independence between theory and data was emphasized (Chin et al., 2003). Second, by allowing freely estimates, such as model coefficient, error variance, and loadings, for all parameters in the full model. This approach is the core element in SEM that allows theory and data to be interact, therefore it was adopted in the current study. Accordingly, for weak correlation loadings the mediating and moderating variables were not have a significant effect on the development of the structural the model

5.6.6 Path Coefficients (Hypotheses Testing)

Path coefficients might be presented in three different theoretical models to explain the causal relationships among constructs. In Figure 5.31: DV represents the dependent variable; IV represents the independent variable; M stands the mediating variable; and *d* is the path coefficient. Model 1 explains an indirect effect, which is a fully mediated effect among constructs whereas the path coefficient is constrained to zero. Model 2 explains the direct and indirect effect, which is a partially mediated effect among constructs whereas the path coefficient weight is affected by the mediating variable M. Model 3 explains the direct effect among constructs. The three models explain how the concept of mediation was developed throughout this study using SEM, and the standardized estimate between IV → M and M → DV is significant at 0.01 levels for mediation and moderation cases (Inman et al., 2011).

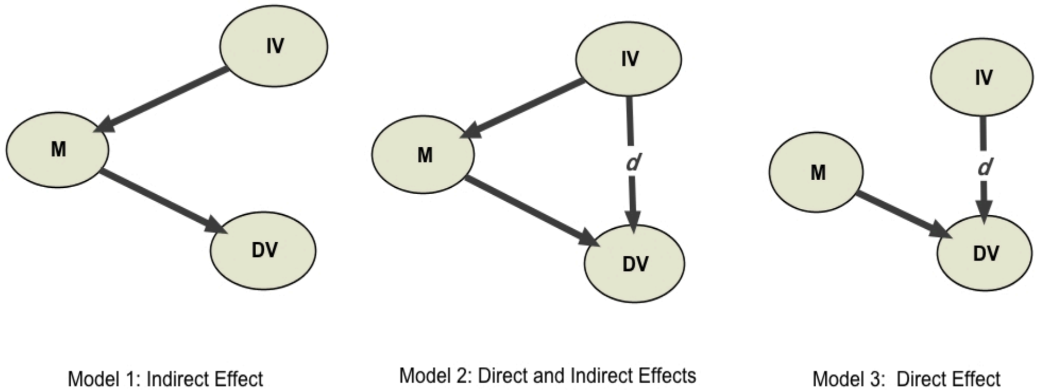


Figure 5.31: Comparison among Models for Mediation Effect

Test for direct effects (Model 3): In the research model (Figure 3.7), the hypotheses that deal with direct effect are:

1. Information, procurement, administration, and enforcement costs have a direct effect on the transaction costs (H1, H2, H4, and H5).

2. Information cost has a direct effect on the procurement, administration, and enforcement costs (H3, H9, and H10).

3. Procurement cost has a direct effect on both administration and enforcement costs (H7 and H8).

4. Enforcement cost has a direct effect on contract administration cost (H6).

5. There is also a direct effect of the procurement system on information, procurement, administration, and enforcement costs (H11, H12, H13, and H14).

6. Environmental uncertainties have a direct effect on the information, procurement, administration, and enforcement costs on the other side (H15, H16, H17, and H18).

7. Project phase has a direct effect on the information, procurement, administration, and enforcement costs (H19, H20, H21, and H22).

8. There is a direct relationship between the project phase and the procurement system (H23), and also between the environmental uncertainties and the procurement system (H24).

Test for direct and indirect effects (Model 2): This test examined the effects of partial mediation between constructs. In the current study, the hypotheses that deal with direct and indirect effect are:

9. The relationship between information cost and the transaction costs is partially mediated by project procurement cost (H3a), administration cost (H7a), and enforcement cost (H8a).

10. The relationship between enforcement cost and the transaction costs is partially mediated by administration cost (H6a).

11. The relationship between project procurement cost and the transaction costs is partially mediated by enforcement cost (H9a) and also by administration cost (H10a).

12. The relationship between the procurement system and the transaction costs is partially mediated by information cost (H11a), project procurement cost (H12a), administration cost (H13a), and enforcement cost (H14a).

13. The relationship between environmental uncertainties and the transaction costs is partially mediated by information cost (H15a), project procurement cost (H16a), administration cost (H17a), and enforcement cost (H18a).

14. The relationship between the project phase and transaction costs is partially mediated by information cost (H19a), project procurement cost (H20a), administration cost (H21a), and enforcement cost (H22a).

Test for indirect effects (Model 1): This test examined the effects of a full mediation between constructs. In the current study, the indirect (fully mediation) relationships are:

15. The relationship between the procurement system and transaction costs is fully mediated by information cost, project procurement cost, administration cost, and enforcement cost.

16. The relationship between the environmental uncertainties and the transaction cost is fully mediated by information cost, project procurement cost, administration cost, and enforcement cost.

17. The relationship between the project phase and transaction cost is fully mediated by information cost, project procurement cost, administration cost, and enforcement cost.

The aforementioned hypotheses were tested for direct and indirect effect on the basis of standardized path coefficients of the structural model using Amos 21. The standardized estimates are shown in Figure 5.32. The results of hypotheses testing of causal relationships are presented in the following sub-sections, and full results of Hypotheses testing are presented in Table 5.17.

5.6.6.1 The relationship between Pre-contract Costs and TCs

Direct and indirect effects of the pre-contract costs (information cost and project procurement cost) on transaction costs were tested based on the path coefficients shown in Figure 5.32.

"**H1:** Project procurement cost (PPROC) would have a positive effect on transaction costs (TCs)". PPROC had a direct positive effect on TCs as indicated by the structural path coefficient ($\beta = 0.12$), thus the hypothesis H1 was not rejected.

"**H2:** Information cost (INFOC) would have a positive effect on transaction Costs (TCs)". INFOC had a direct positive effect on TCs as indicated by the structural path coefficient ($\beta = 0.21$), thus the hypothesis H2 was not rejected.

"**H3:** Information cost (INFOC) would have a positive effect on project procurement cost (PPROC)". INFOC had a direct positive effect on PPROC as indicated by the structural path coefficient (β = 0.0.15), thus the hypothesis H3 was not rejected.

"**H3a:** Project procurement cost (PPROC) would mediate the relationship between information cost (INFOC) and transaction costs (TCs)". PPROC had a partially mediation effect on the relationship between INFOC and TCs, because the relationship between the independent variable INFOC and the dependent variable TCs is significant ($\beta > 0.01$) as indicated by the structural path coefficients ($\beta = 0.21$). Thus, the hypothesis H3a was not rejected.

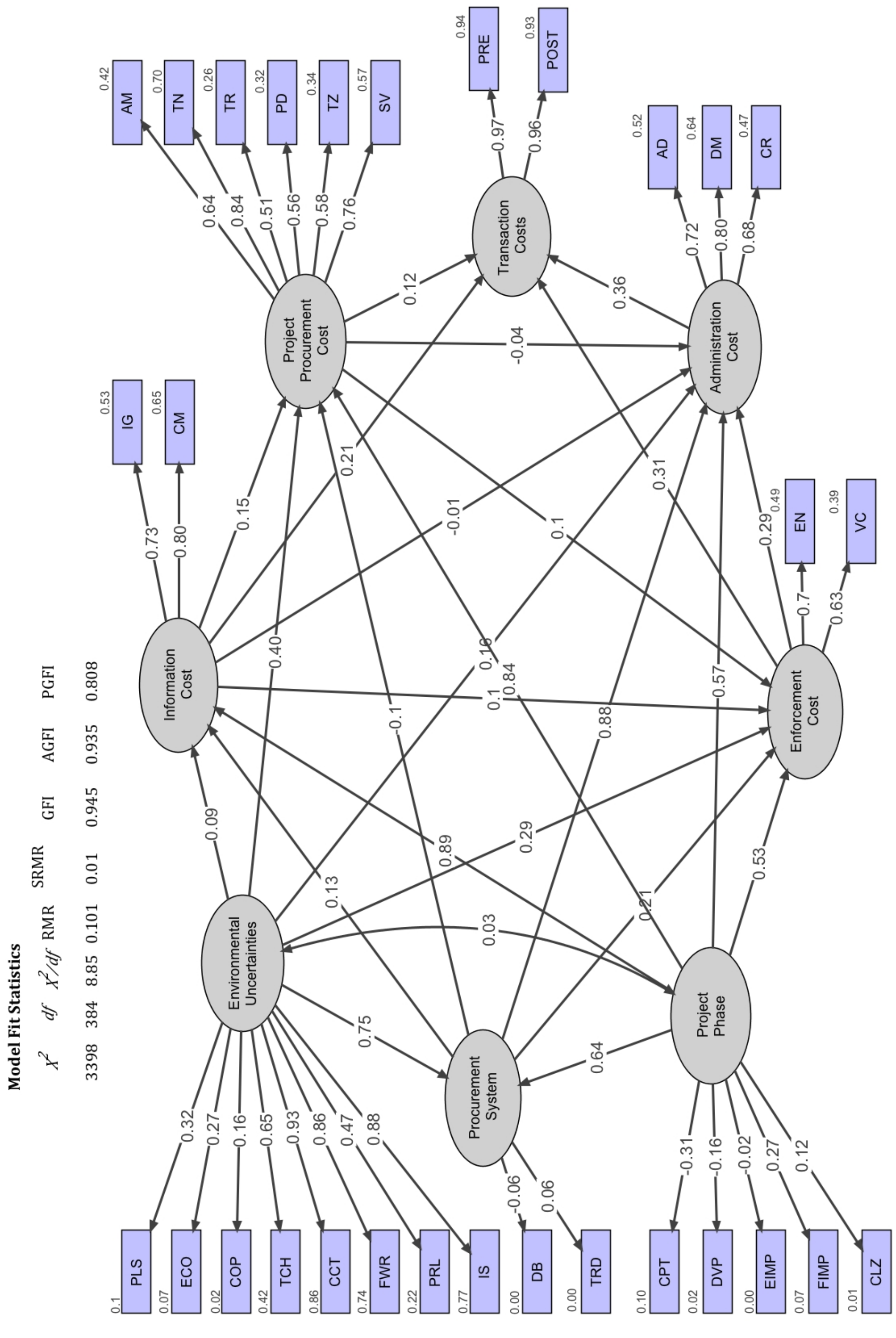


Figure 5.32: Structural Model with Direct and Indirect Effects (M2)

5.6.6.2 The relationship between Post-contract Costs and TCs

Direct and indirect effects of the post-contract costs, such as administration cost and enforcement cost, on the transaction costs were tested based on the path coefficients shown in Figure 5.32.

"**H4:** Administration cost (ADMINC) would have a positive effect on transaction costs (TCs)". ADMINC had a direct positive effect on TCs as indicated by the structural path coefficient (β = 0.36), thus the hypothesis H4 was not rejected.

"**H5:** Enforcement cost (ENFORC) would have a positive effect on transaction costs (TCs)". ENFORC had a direct positive effect on TCs as indicated by the structural path coefficient (β = 0.31), thus the hypothesis H5 was not rejected.

"**H6:** Enforcement cost (ENFORC) would have a positive effect on contract administration cost (ADMINC)". ENFORC had a direct positive effect on ADMINC as indicated by the structural path coefficient (β = 0.29), thus the hypothesis H6 was not rejected.

"**H6a:** Contract administration cost (ADMINC) would mediate the relationship between contract enforcement cost (ENFORC) and transaction costs (TCs)". ADMINC had a partially mediation effect on the relationship between ENFORC and TCs, because the relationship between the independent variable ENFORC and the dependent variable TCs is significant (β > 0.01) as indicated by the structural path coefficients (β = 0.31). Thus, the hypothesis H6a was not rejected.

5.6.6.3 The relationship between Pre-contract Costs, Post-contract Costs and TCs

Direct and indirect effect of the information cost, project procurement cost, administration cost, and enforcement cost on transaction costs were tested based on the structural path coefficients shown in Figure 5.32.

"**H7:** Information cost (INFOC) would have a positive effect on contract administration cost (ADMINC)". INFOC had a direct negative effect on ADMINC as indicated by the structural path coefficient (β = -0.01), thus the hypothesis H7 was rejected.

"**H7a:** Contract administration cost (ADMINC) would mediate the relationship between information cost (INFOC) and transaction costs (TCs)". ADMINC had a partially mediation effect on the relationship between INFOC and TCs, because the relationship between the independent variable INFOC and the dependent variable TCs is significant (β > 0.01) as indicated by the structural path coefficients (β = 0.21). Thus, the hypothesis H7a was not rejected.

"**H8:** Information cost (INFOC) would have a negative effect on enforcement cost (ENFORC)". INFOC had a direct positive effect on ENFORC as indicated by the structural path coefficient (β = 0.1), thus the hypothesis H8 was rejected.

H8a: Enforcement cost (ENFORC) would mediate the relationship between information cost (INFOC) and transaction costs (TCs). ENFORC had a partially mediation effect on the relationship between INFOC and TCs, because the relationship between the independent variable INFOC and the dependent variable TCs is significant (β > 0.01) as indicated by the structural path coefficients (β = 0.21). Thus, the hypothesis H8a was not rejected.

"**H9:** Project procurement cost (PPROC) would have a negative effect on contract enforcement cost (ENFORC)". PPROC had a direct positive effect on ENFORC as indicated by the structural path coefficient (β = 0.1), thus the hypothesis H9 was rejected.

H9a: Enforcement cost (ENFORC) would mediate the relationship between project procurement cost (PPROC) and transaction costs (TCs). ENFORC had a partially mediation effect on the relationship between PPROC and TCs, because the relationship between the independent variable PPROC and the dependent variable TCs is significant (β > 0.01) as indicated by the structural path coefficients (β = 0.12). Thus, the hypothesis H9a was not rejected.

"**H10:** Project procurement cost (PPROC) would have a negative effect on contract administration cost (ADMINC)". PPROC had a direct negative effect on ADMINC as indicated by the structural path coefficient (β = -0.04), thus the hypothesis H10 was not rejected.

H10a: Contract administration cost (ADMINC) would mediate the relationship between project procurement cost (PPROC) and transaction costs (TCs). ADMINC had a partially mediation effect on the relationship between PPROC and TCs, because the relationship between the independent variable PPROC and the dependent variable TCs is significant (β > 0.01) as indicated by the structural path coefficients (β = 0.12). Thus, the hypothesis H10a was not rejected.

5.6.6.4 The relationship between Procurement system, Pre-contract Costs, Post-contract Costs and TCs

Direct and indirect effects of the procurement system on the information cost, project procurement cost, administration cost, enforcement cost, and transaction costs were tested based on the structural path coefficients shown in Figure 5.32.

"**H11:** Procurement system (SYS) would have a positive effect on information cost (INFOC)". SYS had a direct positive effect on INFOC as indicated by the structural path coefficient (β = 0.13), thus the hypothesis H11 was not rejected.

"**H11a:** Information cost (INFOC) would mediate the relationship between procurement system (SYS) and transaction costs (TCs)". INFOC had a fully mediation effect on the relationship between SYS and TCs, because the relationship between the independent variable SYS and the mediation variable INFOC is significant (β = 0.12), and between the mediation variable INFOC and the dependent variable TCs is also significant (β = 0.21) as indicated by the structural path coefficients. Thus, the hypothesis H11a was not rejected.

"**H12:** Procurement system (SYS) would have a positive effect on project procurement cost (PPROC)". SYS had no direct and positive effect on PPROC as indicated by the structural path coefficient (β = -0.1), thus the hypothesis H12 was rejected.

"**H12a:** Project procurement cost (PPROC) would mediate the relationship between procurement system (SYS) and transaction costs (TCs)". PPROC had no mediation effect on the relationship between SYS and TCs, because the relationship between the independent variable SYS and the mediation variable PPROC is not significant (β = -0.1), and between the mediation variable PPROC and the dependent variable TCs is also significant (β = 0.21) as indicated by the structural path coefficients. Thus, the hypothesis H12a was rejected.

"**H13:** Procurement system (SYS) would have a positive effect on contract administration cost (ADMINC)". SYS had a direct positive effect on ADMINC as indicated by the structural path coefficient (β = 0.19), thus the hypothesis H13 was not rejected.

"**H13a:** Contract administration cost (ADMINC) would mediate the relationship between procurement system (SYS) and transaction costs (TCs)". ADMINC had a full mediation effect on the relationship between SYS and TCs, because the relationship between the independent variable SYS and the mediation variable ADMINC is significant (β = 0.19), and between the mediation variable ADMINC and the dependent variable TCs is also significant (β = 0.36) as indicated by the structural path coefficients. Thus, the hypothesis H13a was not rejected.

H14: Procurement system (SYS) would have a positive effect on contract enforcement cost (ENFORC). SYS had a direct positive effect on ENFORC as indicated by the structural path coefficient (β = 0.21), thus the hypothesis H14 was not rejected.

H14a: Enforcement cost (ENFORC) would mediate the relationship between procurement system (SYS) and transaction costs (TCs). ENFORC had a full mediation effect on the relationship between SYS and TCs, because the relationship between the independent variable SYS and the mediation variable ENFORC is significant (β = 0.21), and between the mediation variable ENFORC and the dependent variable TCs is also significant (β = 0.31) as indicated by the structural path coefficients. Thus, the hypothesis H14a was not rejected.

5.6.6.5 The relationship between Environmental Uncertainties, Pre-contract Costs, Post-contract Costs and TCs

Direct and indirect effects of the environmental uncertainties on the information cost, project procurement cost, administration cost, enforcement cost, and transaction costs were tested based on the structural path coefficients shown in Figure 5.32.

"**H15:** Environmental uncertainties (ENVIRO) would have a positive effect on information cost (INFOC)". ENVIRO had a direct positive effect on INFOC as indicated by the structural path coefficient (β = 0.09), thus the hypothesis H15 was not rejected.

"**H15a:** Information cost (INFOC) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs)". INFOC had a full mediation effect on the relationship between ENVIRO and TCs, because the relationship between the independent variable ENVIRO and the mediation variable INFOC is significant (β = 0.09), and between the mediation variable INFOC and the dependent variable TCs is also significant (β = 0.21) as indicated by the structural path coefficients. Thus, the hypothesis H15a was not rejected.

"**H16:** Environmental uncertainties (ENVIRO) would have a positive effect on project procurement cost (PPROC)". ENVIRO had a direct positive effect on PPROC as indicated by the structural path coefficient (β = 0.40), thus the hypothesis H16 was not rejected.

"**H16a:** Project procurement cost (PPROC) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs)". PPROC had a full mediation effect on the relationship between ENVIRO and TCs, because the relationship between the independent variable ENVIRO and the mediation variable PPROC is significant (β = 0.40), and between the mediation variable PPROC and the dependent variable TCs is also significant (β = 0.12) as indicated by the structural path coefficients. Thus, the hypothesis H16a was not rejected.

"**H17:** Environmental uncertainties (ENVIRO) would have a positive effect on contract administration cost (ADMINC)". ENVIRO had a direct positive effect on ADMINC as indicated by the structural path coefficient (β = 0.16), thus the hypothesis H17 was not rejected.

"**H17a:** Contract administration cost (ADMINC) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs)". ADMINC had a full mediation effect on the relationship between ENVIRO and TCs, because the relationship between the independent variable ENVIRO and the mediation variable ADMINC is significant (β = 0.16), and between the mediation variable ADMINC and the dependent variable TCs is also significant (β = 0.36) as indicated by the structural path coefficients. Thus, the hypothesis H17a was not rejected.

"**H18:** Environmental uncertainties (ENVIRO) would have a positive effect on contract enforcement cost (ENFORC)". ENVIRO had a direct positive effect on ENFORC as indicated by the structural path coefficient (β = 0.29), thus the hypothesis H18 was not rejected.

"**H18a:** Enforcement cost (ENFORC) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs)". ENFORC had a full mediation effect on the relationship between ENVIRO and TCs, because the relationship between the independent variable ENVIRO and the mediation variable ENFORC is significant ($\beta = 0.29$), and between the mediation variable ENFORC and the dependent variable TCs is also significant ($\beta = 0.31$) as indicated by the structural path coefficients. Thus, the hypothesis H18a was not rejected.

5.6.6.6 The relationship between Project phase, Pre-contract Costs, Post-contract Costs and TCs

Direct and indirect effects of the project phase on the information cost, project procurement cost, administration cost, enforcement cost, and transaction costs were tested based on the structural path coefficients shown in Figure 5.32.

"**H19:** Project phase (PHZ) would have a positive effect on information cost (INFOC)". PHZ had a direct positive effect on INFOC as indicated by the structural path coefficient ($\beta = 0.89$), thus the hypothesis H19 was not rejected.

"**H19a:** Information cost (INFOC) would mediate the relationship between project phase (PHZ) and transaction costs (TCs)". INFOC had a full mediation effect on the relationship between PHZ and TCs, because the relationship between the independent variable PHZ and the mediation variable INFOC is significant ($\beta = 0.89$), and between the mediation variable INFOC and the dependent variable TCs is also significant ($\beta = 0.21$) as indicated by the structural path coefficients. Thus, the hypothesis H19a was not rejected.

"**H20:** Project phase (PHZ) would have a positive effect on project procurement cost (PPROC)". PHZ had a direct positive effect on PPROC as indicated by the structural path coefficient ($\beta = 0.84$), thus the hypothesis H20 was not rejected.

"**H20a:** Project procurement cost (PPROC) would mediate the relationship between project phase (PHZ) and transaction costs (TCs)". PPROC had a full mediation effect on the relationship between PHZ and TCs, because the relationship between the independent variable PHZ and the mediation variable PPROC is significant (β = 0.84), and between the mediation variable PPROC and the dependent variable TCs is also significant (β = 0.12) as indicated by the structural path coefficients. Thus, the hypothesis H20a was not rejected.

"**H21:** Project phase (PHZ) would have a positive effect on contract administration cost (ADMINC)". PHZ had a direct positive effect on ADMINC as indicated by the structural path coefficient (β = 0.57), thus the hypothesis H21 was not rejected.

"**H21a:** Contract administration cost (ADMINC) would mediate the relationship between project phase (PHZ) and transaction costs (TCs)". ADMINC had a full mediation effect on the relationship between PHZ and TCs, because the relationship between the independent variable PHZ and the mediation variable ADMINC is significant (β = 0.57), and between the mediation variable ADMINC and the dependent variable TCs is also significant (β = 0.36) as indicated by the structural path coefficients. Thus, the hypothesis H21a was not rejected.

"**H22:** Project phase (PHZ) would have a positive effect on contract enforcement cost (ENFORC)". PHZ had a direct positive effect on ENFORC as indicated by the structural path coefficient (β = 0.53), thus the hypothesis H22 was not rejected.

"**H22a:** Enforcement cost (ENFORC) would mediate the relationship between project phase (PHZ) and transaction costs (TCs)". ENFORC had a full mediation effect on the relationship between PHZ and TCs, because the relationship between the independent variable PHZ and the mediation variable ENFORC is significant (β

= 0.53), and between the mediation variable ENFORC and the dependent variable TCs is also significant (β = 0.31) as indicated by the structural path coefficients. Thus, the hypothesis H22a was not rejected.

5.6.6.7 Interactive effect of environmental uncertainties and Project phase on the client's procurement decision

The interactive (direct) effects of environmental uncertainties and the project phase on the client's procurement decision were tested based on the structural path coefficients shown in Figure 5.32.

H23: Project phase (PHZ) would have a positive effect on procurement system (SYS). PHZ had a direct positive effect on SYS as indicated by the structural path coefficient (β = 0.64), thus the hypothesis H23 was not rejected.

H24: Environmental uncertainties (ENVIRO) would have a positive effect on procurement system (SYS). ENVIRO had a direct positive effect on SYS as indicated by the structural path coefficient (β = 0.75), thus the hypothesis H24 was not rejected.

H24a: Procurement system (SYS) would mediate the relationship between project phase (PHZ) and environmental uncertainties (ENVIRO). SYS had no moderation effect on the relationship between PHZ and ENVIRO, because the relationship between PHZ and ENVIRO was constrained to zero during the model development. Thus, there is no relationship between PHZ and ENVIRO, and hypothesis H24a was rejected.

5.6.7 Comparison of Alternative Models

Comparing one model to alternative model (model nesting) is an essential practice in SEM (Bentler & Satorra, 2010; Hair et al., 2012). Nesting models approach, as discussed in Section 4.10.7.1, is coherent even if a given theoretical model exhibits acceptable fit indices with reliable cross-validation, there may be alternative models that could indicate same level of goodness-of-fit. Hair et al. (2012) suggested a nesting model approach to SEM when alternative formulations are proposed by the underlying theory. According to Bentler and Satorra (2010), it is not possible to achieve perfect values of fit indices because fit indices are sensitive to sample size. There are no golden rules for the assessment of model fit, but reporting the most common fit indices is essential for comparison between alternative models. Researchers have different approaches for assessing the overall goodness-of-fit of a model. However, it is important to report more than one fit measure, report at least one goodness-of-fit index, and the chi-square value and degree of freedom (Malhotra et al., 2006; Hair et al., 2012). The fit indices were discussed in sub-section 5.5.2 and shown in Table 5.7 above.

In the current study, the structural models explain the direct, partially mediated, and full mediated effects between constructs (M1, M2, and M3). The direct effect (M1) between the independent variables and dependent variables is shown in Figure 5.33. While the indirect or fully mediation effect (M3) between independent and dependent variables is shown in Figure 5.34. Lastly, the mixed of direct and indirect or partially mediation effect (M2) between the independent and dependent variables is shown in Figure 5.32 above.

In addition, the models are used to test the research hypotheses as discussed, but mixed support is found for the hypothesized relationships between constructs.

Therefore, a comparison between the three models was conducted based on Chi-square and relative chi-square (χ^2, χ^2 / df), and fit indices (CFI, GFI, AGFI, PGFI, RMSEA, SRMR, and ECVI), to choose the best model that fits the data and explain the relationships between exogenous and endogenous variables. The results of testing the three models are shown in Table 5.16 (see Appendix D).

Table 5.16: Comparison of Models Fit Indices

Alternative Models	***X^2***	***df***	***X^2/df***	**RMR**	**SRMR**	**GFI**	**AGFI**	**PGFI**
M1	4308	340	12.67	0.129	0.017	0.917	0.902	0.781
M 2	3398	384	8.85	0.101	0.01	0.945	0.935	0.808
M 3	23350	345	67	0.283	0.08	0.548	0.480	0.476

Overall, the fit indices indicated that the models (M1 and M2) fit the data very well, but the model M3 has a poor fit. Therefore, the proposed theoretical relationships of only direct effect exist between the independent and dependent variables of model M1 is not supported. On the basis of the best-fit indices values of model M2 presented above, it can be concluded that the direct and indirect effect between variables were selected to test the hypotheses. This means that the model M2 was the best alternative model chosen for this study even though that the chi-square and relative chi-square values were significant ($X^2/df > 3$).

According to Schumacker and Lomax (2004), the Chi-square value is sensitive to sample size. With large sample size, the chi-square values will be statistically significant, and might indicate a poor data-to-model fit. This is why fit indices were introduced to offer a means to claim that one has a good model, despite the fact that chi-square is inflated (Schumacker & Lomax, 2004). That is, the chi-square value was used for comparison between the alternative models not to evaluate the models fit, and the fit indices were used for testing the models fit.

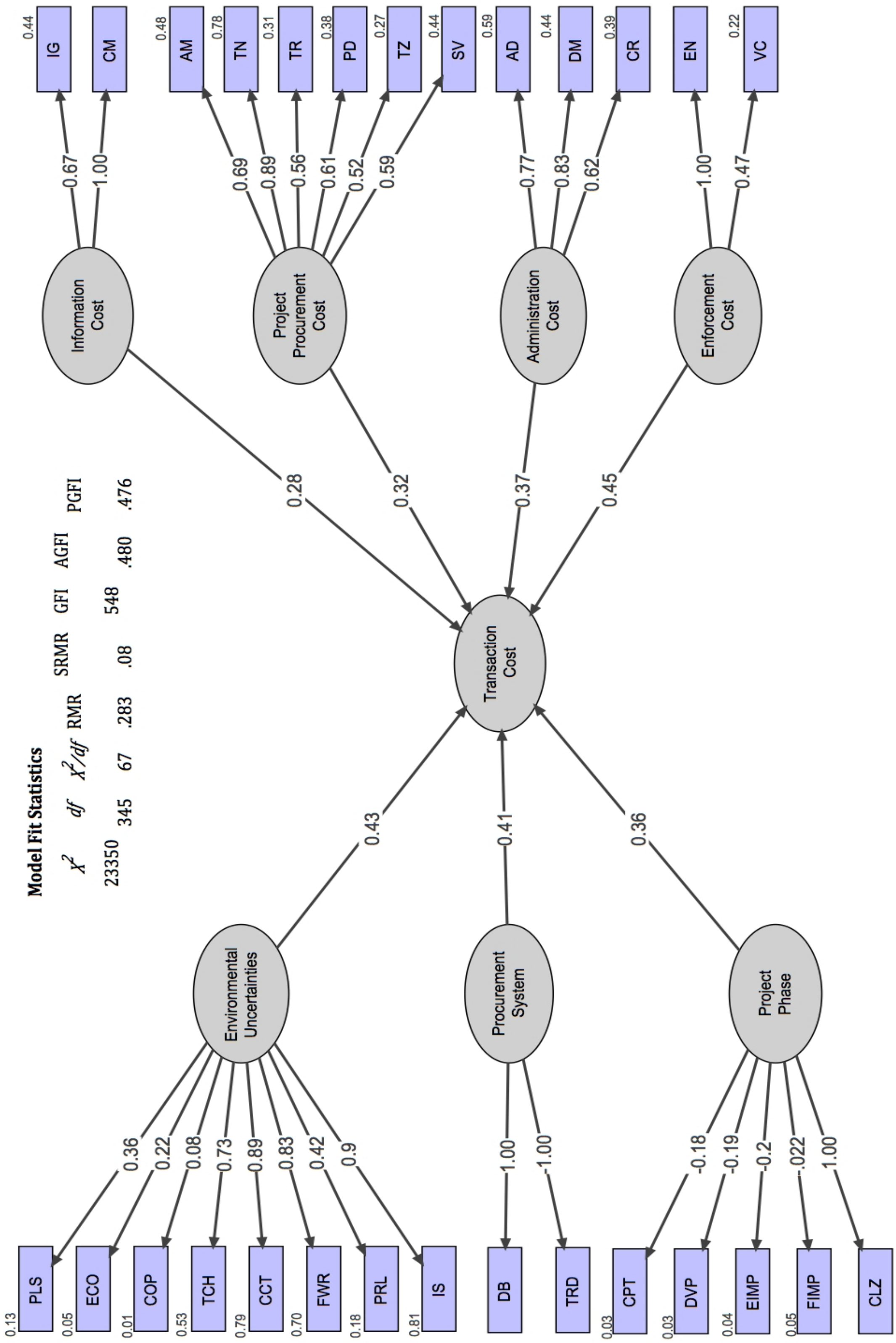
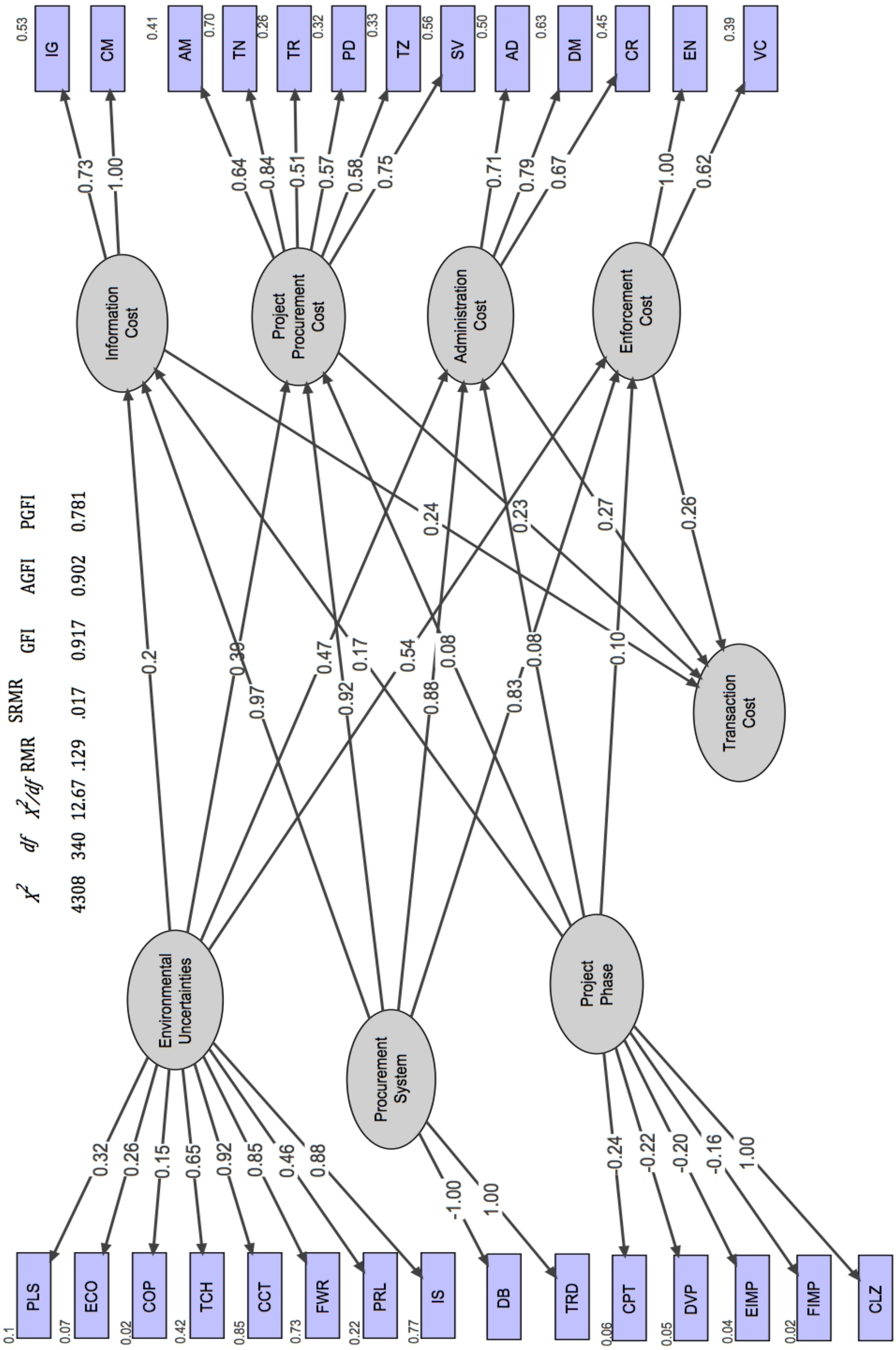


Figure 5.33: Structural Model with Direct Effects (M3)



Model Fit Statistics

χ^2	*df*	χ^2/df	RMR	SRMR	GFI	AGFI	PGFI
4308	340	12.67	.129	.017	0.917	0.902	0.781

Figure 5.34: Structural Model with Indirect Effects (M1)

5.7 Summary of Findings

The characteristics of the data were consistent with univariate and multivariate normality assumptions underlying SEM testing of research hypotheses. Out of forty-three hypotheses being tested in this study, only six of the null hypotheses were rejected. Addressing the main research questions: What is the linkage between transaction costs and procurement systems in construction? How can transaction costs be minimized so that the productivity of the construction industry is enhanced in New Zealand?

The findings indicated that there is a linkage between the procurement system chosen, and the magnitude of transaction costs associated with this adoption. For example at the pre-contract stage, the transaction costs are higher in the Traditional procurement system than in Design-Build system. Also, at the post-contract stage, the transaction costs are higher in Design-Build system than in the Traditional system. A comparison between these costs for different procurement systems can help the decision-maker in choosing the most suitable procurement system that minimizes them, and thus enhance the performance of the construction industry.

The research problem referred to earlier in chapter one "Transaction cost economics is unknown, and the linkage between transaction cost economics and procurement systems is ambiguous in the New Zealand construction industry" was addressed by synthesizing the findings of the main research questions. Further, five of the objectives identified in Chapter one are achieved, and the sixth objective will be address in the next chapter through the estimation of transaction costs for the Traditional and Design-Build systems for the determination of comparison. Table 5.17 summarizes the results of hypotheses testing.

Table 5.17: Results of Hypotheses Testing

			Hypothesis	Result
O1 O2	Q1 Q2 Q3	H1	Project procurement cost (PPROC) would have a positive effect on transaction costs (TCs).	Supported
O1 O2	Q1 Q2 Q3	H2	Information gathering cost (INFO) would have a positive effect on transaction Costs (TCs).	Supported
O1 O2	Q1 Q2 Q3	H3	Information gathering cost (INFO) would have a positive effect on project procurement cost (PPROC).	Supported
O1 O2	Q1 Q2 Q3	H3a	Project procurement cost (PPROC) would mediate the relationship between information gathering cost (INFO) and transaction costs (TCs).	Supported
O1 O2	Q1 Q2 Q3	H4	Administration cost (ADMIN) would have a positive effect on transaction costs (TCs).	Supported
O1 O2	Q1 Q2 Q3	H5	Enforcement cost (ENFORC) would have a positive effect on transaction costs (TCs).	Supported
O1 O2	Q1 Q2 Q3	H6	Enforcement cost (ENFORC) would have a positive effect on contract administration cost (ADMIN).	Supported
O1 O2	Q1 Q2 Q3	H6a	Contract administration cost (ADMIN) would mediate the relationship between contract enforcement cost (ENFORC) and transaction costs (TCs).	Supported
O1 O2	Q1 Q2 Q3	H7	Information cost (INFO) would have a positive effect on contract administration cost (ADMIN).	Not Supported
O1 O2	Q1 Q2 Q3	H7a	Contract administration cost (ADMIN) would mediate the relationship between information cost (INFO) and transaction costs (TCs).	Supported
O1 O2	Q1 Q2 Q3	H8	Information cost (INFO) would have a negative effect on enforcement cost (ENFOC).	Not Supported
O1 O2	Q1 Q2 Q3	H8a	Enforcement cost (ENFORC) would mediate the relationship between information cost (INFO) and transaction costs (TCs).	Supported
O1 O2	Q1 Q2 Q3	H9	Project procurement cost (PPROC) would have a negative effect on contract enforcement cost (ENFOC).	Not Supported
O1 O2	Q1 Q2 Q3	H9a	Enforcement cost (ENFORC) would mediate the relationship between project procurement cost (PPROC) and transaction costs (TCs).	Supported
O1 O2	Q1 Q2 Q3	H10	Project procurement cost (PPROC) would have a negative effect on contract administration cost (ADMIN).	Supported
O1 O2	Q1 Q2 Q3	H10 a	Contract administration cost (ADMIN) would mediate the relationship between project procurement cost (PPROC) and transaction costs (TCs).	Supported
O1 O2	Q2 Q3	H11	Procurement system (SYSTM) would have a positive effect on information cost (INFO).	Supported
O1	Q2	H11	Information cost (INFO) would mediate the relationship	Supported

O2	Q3 Q5 Q6	a	between procurement system (SYSTM) and transaction costs (TCs).	
O1 O4 O5	Q2 Q3 Q5 Q6	H12	Procurement system (SYSTM) would have a positive effect on project procurement cost (PPROC).	Not Supported
O1 O4 O5	Q2 Q3 Q5 Q6	H12a	Project procurement cost (PPROC) would mediate the relationship between procurement system (SYSTM) and transaction costs (TCs).	Not Supported
O1 O4 O5	Q2 Q3 Q5 Q6	H13	Procurement system (SYSTM) would have a positive effect on contract administration cost (ADMIN).	Supported
O1 O4 O5	Q2 Q3 Q5 Q6	H13a	Contract administration cost (ADMIN) would mediate the relationship between procurement system (SYSTM) and transaction costs (TCs).	Supported
O1 O4 O5	Q2 Q3 Q5 Q6	H14	Procurement system (SYSTM) would have a positive effect on contract enforcement cost (ENFOC).	Supported
O1 O4 O5	Q2 Q3 Q5 Q6	H14a	Enforcement cost (ENFORC) would mediate the relationship between procurement system (SYSTM) and transaction costs (TCs).	Supported
O1 O3	Q4	H15	Environmental uncertainties (ENVIRO) would have a positive effect on information cost (INFO).	Supported
O1 O3	Q4	H15a	Information cost (INFO) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs).	Supported
O1 O3	Q4	H16	Environmental uncertainties (ENVIRO) would have a positive effect on project procurement cost (PPROC).	Supported
O1 O3	Q4	H16a	Project procurement cost (PPROC) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs).	Supported
O1 O3	Q4	H17	Environmental uncertainties (ENVIRO) would have a positive effect on contract administration cost (ADMIN).	Supported
O1 O3	Q4	H17a	Contract administration cost (ADMIN) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs).	Supported
O1 O3	Q4	H18	Environmental uncertainties (ENVIRO) would have a positive effect on contract enforcement cost (ENFOC).	Supported
O1 O3	Q4	H18a	Enforcement cost (ENFORC) would mediate the relationship between environmental uncertainties (ENVIRO) and transaction costs (TCs).	Supported
O1 O3	Q4	H19	Project phase (PHZ) would have a positive effect on information cost (INFO).	Supported
O1 O3	Q4	H19a	Information cost (INFO) would mediate the relationship between project phase (PHZ) and transaction costs (TCs).	Supported
O1 O3	Q4	H20	Project phase (PHZ) would have a positive effect on project procurement cost (PPROC).	Supported

O1 O3	**Q4**	**H20 a**	Project procurement cost (PPROC) would mediate the relationship between project phase (PHZ) and transaction costs (TCs).	Supported
O1 O3	**Q4**	**H21**	Project phase (PHZ) would have a positive effect on contract administration cost (ADMIN).	Supported
O1 O3	**Q4**	**H21 a**	Contract administration cost (ADMIN) would mediate the relationship between project phase (PHZ) and transaction costs (TCs).	Supported
O1 O3	**Q4**	**H22**	Project phase (PHZ) would have a positive effect on contract enforcement cost (ENFOC).	Supported
O1 O3	**Q4**	**H22 a**	Enforcement cost (ENFORC) would mediate the relationship between project phase (PHZ) and transaction costs (TCs).	Supported
O3	**Q4 Q5**	**H23**	Project phase (PHZ) would have a positive effect on procurement system (SYSTM).	Supported
O3	**Q4 Q5**	**H24**	Environmental uncertainties (ENVIRO) would have a positive effect on procurement system (SYSTM).	Supported
O3	**Q4 Q5**	**H24 a**	Procurement system (SYSTM) would mediate the relationship between project phase (PHZ) and environmental uncertainties (ENVIRO).	Not Supported

CHAPTER SIX

Research Verification: Findings of Model Testing

6.0 Introduction

This chapter addresses objectives 6 and 7 of the research (Section 1.2). Objective six is to estimate TCs for different procurement systems, specifically the Traditional and Design-Build systems for the purpose of comparability. While, objective seven is to examine the extent to which research results can be applied to real life cases. The chapter starts by making a comparison between the traditional and design-build models. This includes comparing the reliability and validity tests, Goodness-of-Fit assessment, testing hypothesized relationships, and assessment of the significant of variances explained (R^2). Next, six cases have been chosen as experimental vehicles to execute the traditional and design-build models to calculate the TCs.

The TCs are calculated on the basis of regression equation analysis, which is explained by the interrelationship strength coefficients between latent variables in the developed models. Grounded along the outcomes of the calculations, recommendations for decision-makers make suggestions on how to decide which alternative strategies (i.e. delivery systems) are the most efficient in improving cost estimates, and thus enhancing the project performance.

6.1 Demographic Information of Participants

The first section (A) of the questionnaire is general questions about the participants and their project/and or organization (see appendix B3). The objective of this section is to provide information, which can be used to provide a basis for TCs calculations (e.g. calculate the percentage of TCs in the annual salary of project manager). The Tables 6.1 and 6.2 summarize the demographic information of the participants and their projects. Data analysis shows that five out of the six cases are infrastructure projects and one is housing. Regarding participants' designation, the analysis shows that the majority participants are project managers with the exception of an architect and civil engineer. The participants' minimum years of experience in the construction operation is 11 years. Thus the information, about the time spent by professionals in conducting procurement activities, provided is credible and reliable.

Table 6.1: Participant's Demographic Information – Case Studies

Project Case	Participant's Designation	Years of Experience
Case 1	Project Manager	11-20
Case 2	Project Manager	30+
Case 3	Civil Engineer	21-30
Case 4	Project Manager	11-20
Case 5	Project Manager	21-30
Case 6	Architect, Project Manager	21-30

Finally, the Table 6.2 shows that most of the projects were procured with the traditional delivery system. A state owned organization manages these infrastructure projects. That is, the Traditional delivery system is the favorite procurement system adopted for state owned organizations. For example, Case 1 is a project for the improvement of a main road in West Auckland procured in a Traditional delivery system, with a contract value of NZ$25M and scheduled to be delivered in 60 months. Case 2 is a NZ$50M project for upgrading a main road in Central Auckland, scheduled to be completed in 48 months and procured in a Traditional delivery system. Case 6 is a project to build a block of houses in West

Auckland, procured in a Design-Build delivery system with a contract value of NZ$2.8M, and scheduled to be completed in 12 months.

Table 6.2: Project's Demographic Information – Case Studies

Case	Project Type	Contract Value	Project Duration	Delivery System
Case 1	Infrastructure	$25 million	60 months	Traditional
Case 2	Infrastructure	$50 million	48 months	Traditional
Case 3	Infrastructure	$654,000	12 months	Traditional
Case 4	Infrastructure	$600,000	8 months	Traditional
Case 5	Infrastructure	$40 million	48 months	Design-Build
Case 6	Housing	$2.8 million	12 months	Design-Build

6.2 Comparison Between the Traditional and Design-Build Models

Two structural models for the Traditional and Design-Build delivery systems were developed based on the determinants shown in Table 4.5 (Chapter 4), to examine direct and indirect relationships between any independent variables and any dependent variables. The independent variables represent the latent variables, e.g. procurement systems, project phases, information costs, procurement costs, administration costs, and enforcement costs. While, the dependent variables are the measured items representing the latent variable that they belong to.

The measurement model incorporates confirmatory factor analysis, which is concerned with how satisfactory the variables measure the latent variables, also in addressing issues such as validity and reliability. The structural model (Figures 6.1 and 6.2) reflects multi-regression analysis and path analysis that model the relationship between the latent variables through delineating the explained and unexplained variance (see Appendix D). This is equivalent to the examination of the relationship by the regression models.

Model Fit Statistics

X^2	df	X^2/df	RMR	SRMR	GFI	AGFI	PGFI
3772	379	9.95	0.106	0.01	0.932	0.920	0.799

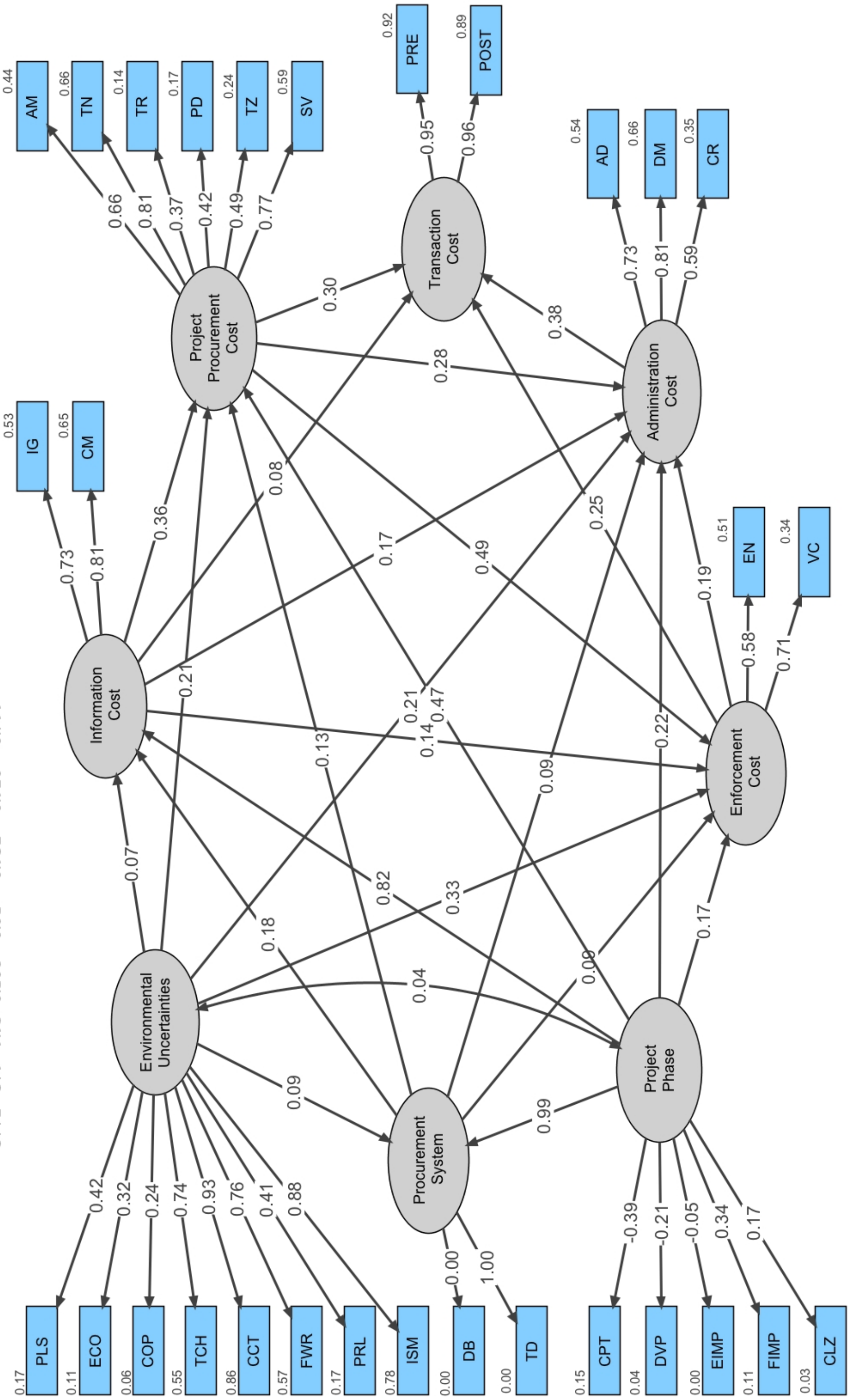


Figure 6.1: Structural Model for the Traditional System

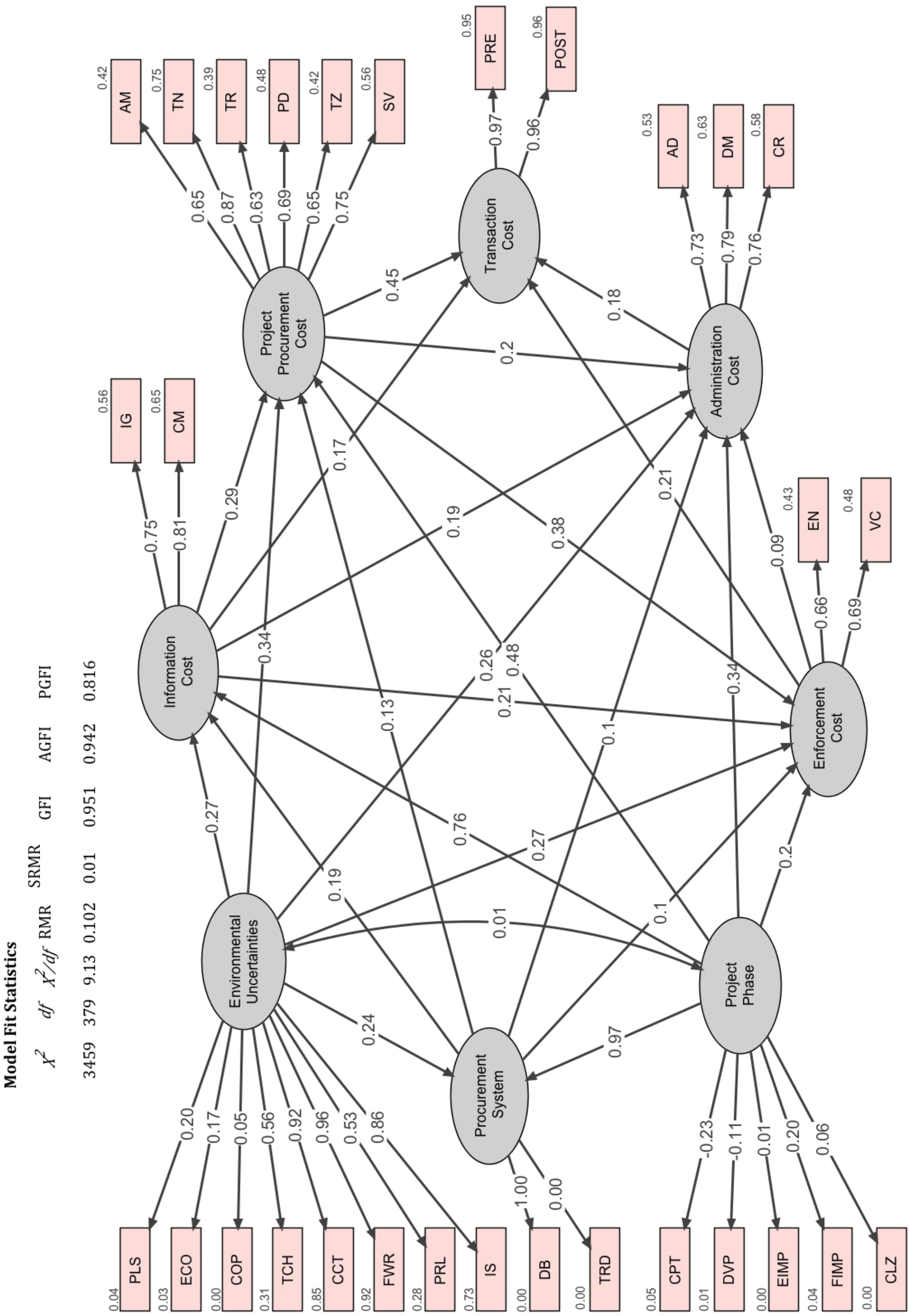


Figure 6.2: Structural Model for the Design-Build System

6.2.1 Reliability and Validity Tests

The reliability and validity tests of the constructs that are included in the Traditional and Design-Build models were conducted using SPSS version 20. The Tables 6.3 and 6.4 below shows that all of Cronbach's alpha coefficients are above the threshold level of α > 0.7 (see Appendix D), which suggests that the set of observed variables are good measures of a single unidimensional latent construct in these models (Gerbing & Anderson, 1988). As discussed in Section 5.5.3, the results indicate satisfactory of internal consistency reliability for both models, which means there is no need of excluding any item from the structural models (Malhotra & Birks, 2007).

Table 6.3: Reliability and Validity Test for Traditional Model

Construct	Items	Factor Loading	Item Cronbach's Alpha	Construct Cronbach's Alpha
Procurement System	Traditional System	0.06	.864	0.864
Project Phase	Concept	-.39	.867	0.87
	Development	-.21	.869	
	Early Implementation	.05	.871	
	Full Implementation	0.34	.867	
	Project Close	.17	.877	
Information Cost	Communication	.81	.851	0.85
	Information Gathering	.73	.849	
Procurement Cost	Attending Meeting	.66	.852	0.853
	Translation of Client's Needs	.81	.847	
	Training	.37	.859	
	Project Preliminary Design	.42	.857	
	Transition Observation	.49	.855	
	Site Visits	.77	.848	
Administration Cost	Administration	.73	.848	0.849
	Conflict Resolution	.59	.847	
	Decision Making	.81	.851	
Enforcement Cost	Enforcement	.58	.853	0.851
	Verifying Compliances	.71	.850	
Transaction	Pre-Contract	.95	.849	0.847

Costs	Post-Contract	.96	.846	
Environmental Uncertainties	Political/Legal/Social	.42	.860	0.859
	Economy	.32	.860	
	Competition	.24	.861	
	Technology	.74	.857	
	Corporate Culture	.93	.855	
	Finance & Ownership	.76	.858	
	Project Location	.41	.861	
	Information System	.88	.856	

Table 5.4: Reliability and Validity Test for Design-Build Model

Construct	Items	Factor Loading	Item Cronbach's Alpha	Construct Cronbach's Alpha
Procurement System	Design-Build System	0.06	.89	0.89
Project Phase	Concept	-.23	.888	0.893
	Development	-.11	.890	
	Early Implementation	.01	.892	
	Full Implementation	0.20	.893	
	Project Close	.06	.901	
Information Cost	Communication	.81	.875	0.875
	Information Gathering	.75	.874	
Procurement Cost	Attending Meeting	.65	.878	0.876
	Translation of Client's Needs	.87	.872	
	Training	.63	.878	
	Project Preliminary Design	.69	.876	
	Transition Observation	.65	.877	
	Site Visits	.75	.874	
Administration Cost	Administration	.73	.875	0.874
	Conflict Resolution	.76	.874	
	Decision Making	.79	.874	
Enforcement Cost	Enforcement	.66	.876	0.876
	Verifying Compliances	.69	.875	
Transaction Costs	Pre-Contract	.97	.873	0.873
	Post-Contract	.96	.872	
Environmental Uncertainties	Political/Legal/Social	.20	.886	0.883
	Economy	.17	.885	
	Competition	.05	.887	
	Technology	.56	.883	
	Corporate Culture	.92	.879	
	Finance and Ownership	.96	.878	
	Project Location	.53	.883	
	Information System	.86	.879	

6.2.2 Goodness-of-Fit Assessment

All factor loadings, as shown in Figures 6.1 and 6.2, of the measurement items should be above 0.5 for good model fit. After constructs were tested for reliability and validity, the structural models are evaluated using confirmatory factor analysis. Model evaluation includes examining identification, the relative value of Chi-square, and goodness-of-fit indices.

A confirmatory factor analysis was conducted for both models (the Traditional and Design-build models) to examine the models identification, the relative value of Chi-square, and goodness-of-fit indices (see Appendix D). The models that were developed using Structural Equation Modeling (SEM) are over identified, which means the number of parameters is less than the number of observed covariances and variances. In this instance, the degree of freedom augmented and the possibility that the model fits in the population is plausible. Also, the measurement portion of the model is examined so that every latent variable has its scale.

Generally, the acceptable values of fit indices for good model fits (as presented in Table 5.15), the goodness-of-fit index (GFI) should be greater than 0.9; the adjusted goodness-of-fit index (AGFI) greater than 0.8; the parsimonious goodness-of-fi index (PGFI) greater than 0.5; the square root mean residual (SRMR) should be less than 0.08; and the relative value of chi-square (X^2 / df) should be less than 3.0 (Hair et al., 2012; Li et al., 2013).

Table 6.5: Identification and Goodness-of-Fit Indices for Traditional and Design-Build Models

Items	Traditional	Design-Build	Recommended Levels
Model identification	Over identified	Over identified	
Degree of Freedom *df*	379	370	
Relative Chi-square X^2 / df	9.95	9.13	< 3.0
Square Root Mean Residual *SRMR*	0.01	0.01	< 0.08
Goodness-of-fit index *GFI*	0.932	0.951	> 0.9
Adjusted goodness-of-fit index *AGFI*	0.920	0.942	> 0.8
Parsimonious goodness-0f-fit index *PGFI*	0.799	0.816	> 0.5

The Table 6.5 shows that all the parameters (see also Appendix D), except the relative chi-square value in shaded cells, are within the recommended limits of good fit model. Although, the Design-Build model scores better fit, both the Traditional and Design-Build models fit the data well. The relative chi-square value is significant with a large sample size, thus the models fit was assessed based on fit indices (Hu & Bentler, 1999; Kline, 2011). Lastly, as shown in Tables 6.1 and 6.2 all the constructs are significantly correlated with each other, which also indicates that the measured items fit the models well.

6.2.3 Hypothesized Relationships

The structural models (Figures 6.1 and 6.2) reflect multi-regression analysis and path analysis that model the relationships between the latent variables through delineating the explained and unexplained variance. Significant differences were observed in the linear regression weights between the two models. These include regression weights that explain the relationship between latent variables and observed variables, and within the latent variables. Sign, size, and statistical significance of the path coefficients represent the strength of relationships among the constructs. The hypothesized relationships were determined by testing the developed models using Amos 21. Maximum likelihood and bootstrap function were used to estimate hypothesized paths with a resampling size (a so-called "Bootstrapping" exercise) of 1000. The results are presented in Table 6.6, which shows all path coefficients are positive and significant *β > 0.01*, except the shaded cells with negative path coefficients (see also Appendix D).

Table 6.6: Standardized Coefficient for Traditional and Design-Build Models

			Estimate (DB)	Estimate (TR)
SYS	<---	PHZ	.537	.528
SYS	<---	ENVIRON	.355	.137
INFOC	<---	PHZ	.853	.940
INFOC	<---	ENVIRON	.827	.233
INFOC	<---	SYS	.394	.382
PPROC	<---	INFOC	.408	.453
PPROC	<---	PHZ	.769	.687
PPROC	<---	ENVIRON	1.470	.850
PPROC	<---	SYS	.382	.352
ENFORC	<---	INFOC	.202	.116
ENFORC	<---	PPROC	.259	.308
ENFORC	<---	PHZ	.222	.161
ENFORC	<---	ENVIRON	.784	.871
ENFORC	<---	SYS	.199	.149
ADMINC	<---	PPROC	.141	.245
ADMINC	<---	INFOC	.196	.192
ADMINC	<---	ENFORC	.100	.266
ADMINC	<---	PHZ	.392	.276
ADMINC	<---	ENVIRON	.798	.749
ADMINC	<---	SYS	.217	.195
TCs	<---	PPROC	.709	.327
TCs	<---	INFOC	.382	.113
TCs	<---	ADMINC	.391	.472
TCs	<---	ENFORC	.497	.424
VC	<---	ENFORC	.521	.484
EN	<---	ENFORC	.669	.656
AD	<---	ADMINC	.654	.572
DM	<---	ADMINC	.732	.629
CR	<---	ADMINC	.754	.496
ECO	<---	ENVIRON	.281	.477
COP	<---	ENVIRON	.087	.529
TCH	<---	ENVIRON	1.290	1.939
CCT	<---	ENVIRON	1.963	1.993
FWR	<---	ENVIRON	2.141	1.661

			Estimate (DB)	Estimate (TR)
PRL	<---	ENVIRON	.903	.833
SV	<---	PPROC	.478	.505
TZ	<---	PPROC	.366	.271
PD	<---	PPROC	.479	.277
TR	<---	PPROC	.382	.209
TN	<---	PPROC	.540	.569
IG	<---	INFOC	.610	.538
CM	<---	INFOC	.715	.708
POST	<---	TCs	.312	.430
PRE	<---	TCs	.282	.367
CPT	<---	PHZ	-.081	-.131
DVP	<---	PHZ	-.077	-.139
EIMP	<---	PHZ	.005	-.054
FIMP	<---	PHZ	.280	.452
CLZ	<---	PHZ	.108	.291
DB	<---	SYS	.000	.000
TD	<---	SYS	.000	.000
PLS	<---	ENVIRON	.393	.727
ISM	<---	ENVIRON	2.081	2.162
AM	<---	PPROC	.373	.466

Further, as discussed in Section 5.5.6, the general model supported the research Hypotheses 1 to 24, so as the results of Hypotheses testing in the Traditional and Design-Build models provide support for most of the research Hypotheses (1 to 24 in Table 5.17). For instance, as shown in the Design-Build model, information cost (INFOC) is significantly influenced by environmental uncertainties (ENVIRO) at $\beta = 0.32$, while in the Traditional model the effect is significantly lower at $\beta = 0.07.$ That is, environmental uncertainties have little to no effect on the pre-contract cost in the Traditional system. Another example, in the Traditional model, project procurement cost (PPROC) is significantly influenced by the information costs (INFOC) at $\beta = 0.36.$ This means an increase in information cost will cause an increase in procurement cost also. In the Traditional systems the scope of the project is fully identified causing the rise in the pre-contract phase cost i.e. increase in information and procurement cost.

6.2.4 Significance of Variance Explained (R^2)

The structural models (Traditional and Design-Build) can be assessed by examining the scores of variance (R^2) for the endogenous constructs, which can be explained by the model. Twenty-one measures, enclosed by rectangles, were specified for each model, each measure with a nonzero loading on the construct it was designed to measure. The R^2 scores were computed during model development utilizing Amos 21. According to Breiman and Friedman (1985), the criterion R^2 is critical in evaluating a structural model, and the threshold value for an item to score on its measured construct should be $R^2 \geq 0.1$. Therefore, if any item (endogenous) sores 10% of the variance or less, then the hypothesized relationship is uninformative (Flak and Miller, 1992).

The results of R^2 scores are summarized in Table 6.7 (see also Appendix D), which indicate that R^2 for all endogenous constructs are significant ($R^2 \geq 0.1$). For example, in the Design-Build model (Figure 6.2) the single headed arrow leading from information cost to item communication (CM) shows that CM score depends mostly on information cost; specifically the hypothetical 'information cost' construct accounts for 65% of the variance in scores for item CM. That is, the linear regression estimate between INFOC and IG explains 65% of the data. Alternatively, the path coefficient that describes the effect of CM on information cost is 0.81.

Further, the results suggest that all the hypothesized relationships, except the shaded cells, are informative for both models. In the data analysis Chapter (5), the impact of the environmental uncertainties was assessed in Section 5.4.2 and presented in Figure 5.26, which indicates that environmental uncertainties such as political/legal/social (PLS), economical (ECO), and competition (COP) have a substantial impact on the pre and post-contract costs.

Table 6.7: Standardized Coefficient Estimates for R^2

Exogenous Variable	Endogenous Variable	R^2 Design-Build	R^2 Traditional
Information Cost (**INFOC**)	**IG**	0.56	0.53
	CM	0.65	0.65
Project Procurement Cost (**PPROC**)	**AM**	0.42	0.44
	TN	0.75	0.66
	TR	0.39	0.14
	PD	0.48	0.17
	TZ	0.42	0.24
	SV	0.56	0.59
Contract Administration Cost (**ADMINC**)	**AD**	0.53	0.54
	DM	0.63	0.66
	CR	0.58	0.59
Contract Enforcement Cost (**ENFROC**)	**EN**	0.43	0.58
	VC	0.48	0.34
Environmental Uncertainties (**ENVIRO**)	**PLS**	0.04	0.17
	ECO	0.03	0.11
	COP	0.00	0.06
	TCH	0.31	0.55
	CCT	0.85	0.86
	FWR	0.92	0.57
	PRL	0.28	0.17
	IS	0.73	0.78

Insignificant items scores of variance explained R^2 might be due to the use of Likert scale in evaluation. Thus, the impact of environmental uncertainties is also relevant, although they have insignificant R^2 values and it is useful to be included in the models.

6.3 Applying the Models Using Real Life Cases

The analysis of the data in the previous Chapter (5) shows that the structural model needs to be validated. Criterion validity, as discussed in Section 5.5.3.1, is the most suitable test for the concurrent and predictive validity. Thus, for the current estimation of TCs, this study uses concurrent validity by applying the structural model in real life cases. Predictive validity is used for TCs prediction in construction. The current study uses predictive validity for the estimation of TCs, to aid future researches in calculating TCs for other procurement systems that are not encompassed in this study. These needs are crucial in estimating TCs and subsequent validation within the research. This practice is in line with Love et al. (2002), who suggested using a triangulation method or measure of a phenomenon in construction management research, in order to overcome bias and validity.

6.3.1 Analysis of the Real Life Cases

Data was collected, as discussed in Section 4.8.2.3, from Project Managers working in projects around the Auckland regional area, to determine the TCs incurred because of professionals performing procurement activities. Practicality considerations have been taken to get meaningful data, by executing the models to a limited number of real life projects. Therefore, samples of projects recommended by the focus group have been chosen as experimental vehicles. They are mainly infrastructure projects in the Auckland Regional Area. As discussed in Section 4.7.2, the participants in this questionnaire were project managers, architects and civil engineers. A total of six projects consisting of four infrastructure projects, one project from residential sector, and one asset management project were selected for executing the developed model. A semi-structured questionnaire (see Appendix B3) was designed to facilitate cross-questioning in the process.

A survey questionnaire was sent via e-mail to 6 subject matter experts mainly project managers involved in ongoing projects. This included four project managers working on infrastructure projects, a project manager working on asset management projects, and an architect working on residential projects.

Respondents were asked to estimate the time-spent daily in conducting procurement activities. All participants completed the questionnaire and sent it back to the researcher. The questionnaire was designed to test the model developed from an analysis of data of the main survey. The key theme is to set a benchmark on how to calculate TCs in construction projects, with the intention of this practice to be carried out for the rest of the model's elements in future research. The findings from this questionnaire provide a further insight to the understanding of TCs in construction. Also, by conducting this practice, bias can be minimized and the validity of the findings can be enhanced.

6.3.2 Estimation of TCs

The second section (B) of the questionnaire (see Appendix B3) aims at estimating the magnitude of TCs at the pre and post-contract phases. It required participants to estimate the time-spent daily in conducting procurement activities relative to other project activities. At the pre-contract phase (includes 9 questions), participants were asked to estimate the time-spent daily in information gathering and project procurement activities. Information gathering includes activities such as search for technical/legal/financial information and communication. While, project procurement covers the preparation of tendering documents. This includes activities such as attending meetings, translation of client's needs, training, project preliminary design, transition observation, and site visits.

At the post-contract phase (includes 5 questions), participants were required to estimate their time-spent in contract administration and enforcement. Contract administration covers conducting activities such as administration, decision-making, and conflict resolution. While, contract enforcement deals with conducting activities such as enforcement and verifying compliances.

First, Table 6.8 summarizes the estimated time-spent by project manager on Case 1 at the pre and post-contract phases (see also Appendix B3). Data analysis shows that a project manager spent in aggregate $5\frac{1}{2}$ hrs in conducting procurement activities. Yet, because the respondent is a project manager who is conducting activities that might have a percentage of overlapping between them, it might compromise the aggregate time-spent on each activity alone. Activities such as communication (CM), attending meetings (AM), decision-making (DM), and enforcement (EN) might overlap between each other. In construction projects, procurement covers the processes from the initial concept, planning and designs to development, construction, and monitoring of performance. (Erridge & McIlroy, 2002; Hughes et al., 2006; Poon & Yu, 2006; Hackett et al., 2007; Eriksson, 2008). That is why the time-spent in conducting procurement activities is mixed between the project manager's responsibilities and may be considered to be TCs.

Table 6.8: Time-spent Estimates for Case 1

Participant's Designation	**Phase**	**Activity**	**Measure**	**Time-spent (hrs/day)**	**Total Time-spent (hrs/day)**
Project Manager	Pre-Contract	Information Search	IG	0	1
			CM	1	
		Project Procurement	AM	1	2
			TN	0	
			TR	0	
			PD	0	
			TZ	1/2	
			SV	1/2	
	Post-Contract	Contract Administration	AD	0	$1\frac{1}{2}$
			DM	1	
			CR	1/2	
		Contract Enforcement	EN	1	1
			VC	0	

Second, Table 6.9 summarizes the estimated time-spent by a project manager at the pre and post-contract phases for case 2 (see Appendix B3). Data analysis shows that a project manager spent in aggregate $5^1/_2$ hrs in conducting procurement activities. However, as discussed in case 1, the total time might have a percentage of overlapping between activities, which might compromise the aggregate time-spent on each activity alone. For instance, out of the total time-spent, this research considered the time-spent by project managers in administration, decision-making, and conflict resolution as contributing to increasing TCs.

Table 6.9: Time-spent Estimates for Case 2

Participant's Designation	Phase	Activity	Measure	Time-spent (hrs/day)	Total Time-spent (hrs/day)
Project Manager	Pre-Contract	Information Search	IG	1/4	$1^1/_4$
			CM	1	
		Project Procurement	AM	$1^1/_4$	2
			TN	0	
			TR	0	
			PD	1/4	
			TZ	0	
			SV	1/2	
	Post-Contract	Contract Administration	AD	1/2	$1^1/_2$
			DM	1/2	
			CR	1/2	
		Contract Enforcement	EN	1/4	3/4
			VC	1/2	

Third, the estimated time-spent by a Civil Engineer for case 3 are summarized in Table 6.10. Data analysis indicates that a senior civil engineer spent in aggregate $4^1/_4$ hrs in conducting procurement activities. However, the time-spent in site visits is part of civil engineer duties, and therefore may assumed to be TCs.

Table 6.10: Time-spent Estimates for Case 3

Participant's Designation	Phase	Activity	Measure	Time-spent (hrs/day)	Total Time-spent (hrs/day)
Civil Engineer	Pre-Contract	Information Search	IG	1/4	1/2
			CM	1/4	
		Project Procurement	AM	1/2	$2^{1}/_{4}$
			TN	1/4	
			TR	0	
			PD	1/2	
			TZ	0	
			SV	1	
	Post-Contract	Contract Administration	AD	1/2	$1^{1}/_{4}$
			DM	1/2	
			CR	1/4	
		Contract Enforcement	EN	1/4	1/4
			VC	0	

Fourth, the Table 6.11 summarizes the estimated time-spent by Project Manager on Case 4. Data analysis indicates that a civil engineer spent in aggregate $2^{1}/_{4}$ hrs in conducting procurement activities. This project is fairly a small asset management project, thus there are only a few procurement activities to be carried on.

Table 6.11: Time-spent Estimates for Case 4

Participant's Designation	Phase	Activity	Measure	Time-spent (hrs/day)	Total Time-spent (hrs/day)
Project Manager	Pre-Contract	Information Search	IG	1/4	1/2
			CM	1/4	
		Project Procurement	AM	1/4	1
			TN	0	
			TR	0	
			PD	1/4	
			TZ	0	
			SV	1/2	
	Post-Contract	Contract Administration	AD	1/4	1/2
			DM	1/4	
			CR	0	
		Contract Enforcement	EN	1/4	1/4
			VC	0	

Fifth, the estimated time-spent by a Project Manager for case 5 is summarized in Table 6.12. It shows that a project manager spent in aggregate $4^{3}/_{4}$ hrs in conducting procurement activities. As discussed previously, the total time is mixed between the project manager's responsibilities and might consider as TCs.

For instance, out of the total time-spent, this research considered the time-spent by project managers in administration, decision-making, and conflict resolution is mixed between their duties and may considered to be TCs. This is inline with what the project manager for this case was commented *"that there is a percentage of overlap between the activities that might compromise the total time-spent on each activity alone, for instance; 10-11-12-13-14 are close proximity type of activity in a good chances these could occur in one occasion (Site meeting, Toolbox talk, etc.)"*

Table 6.12: Time-spent Estimates for Case 5

Participant's Designation	Phase	Activity	Measure	Time-spent (hrs/day)	Total Time-spent (hrs/day)
Project Manager	Pre-Contract	Information Search	IG	1/4	3/4
			CM	1/2	
		Project Procurement	AM	1	$1^{1}/_{2}$
			TN	0	
			TR	0	
			PD	0	
			TZ	0	
			SV	1/2	
	Post-Contract	Contract Administration	AD	1/2	$1^{3}/_{4}$
			DM	1	
			CR	1/4	
		Contract Enforcement	EN	1/4	3/4
			VC	1/2	

Lastly, Table 6.13 summarizes the estimated time-spent by a Project Manager for case 6. It shows that a Project Manager/Architect spent in aggregate 6 hrs in conducting procurement activities. However, this case is a residential project, there is more time spent in carrying out procurement activities. For instance, out of the total time-spent, this research considered the time-spent by project managers in administration, decision-making, and conflict resolution is mixed between their duties and may considered to be TCs.

Table 6.13: Time-spent Estimates for Case 6

Participant's Designation	Phase	Activity	Measure	Time-spent (hrs/day)	Total Time-spent (hrs/day)
Project Manager/ Architect	Pre-Contract	Information Search	IG	1/4	3/4
			CM	1/2	
		Project Procurement	AM	1/2	$2\frac{1}{4}$
			TN	1/4	
			TR	0	
			PD	1	
			TZ	0	
			SV	1/2	
	Post-Contract	Contract Administration	AD	1	2
			DM	1/2	
			CR	1/2	
		Contract Enforcement	EN	1/2	1
			VC	1/2	

In sum, the results reported in this section provide evidence that in the Traditional procurement systems, for instance cases 1,2,3, and 4, it is the pre-contract costs (information and project procurement costs), which are higher than in the Design-Build systems. Similarly, the results show that in Design-Build systems, for instance cases 5 and 6, it is the post-contract costs (administration and enforcement costs), which are higher than in the Traditional systems. In addition, the results reported in this section provide support for the following research Hypotheses:

At the pre-contract stage:

Hypothesis 11: "Procurement system (SYS) would have a positive effect on information cost (INFOC)".

Hypothesis 12: "Procurement system (SYS) would have a positive effect on project procurement cost (PPROC)".

At the post-contract stage:

Hypothesis 13: "Procurement system (SYS) would have a positive effect on contract administration cost (ADMINC)".

Hypothesis 14: "Procurement system (SYS) would have a positive effect on contract enforcement cost (ENFROC)".

6.4 Calculation of TCs for the Traditional and Design-Build Systems

To determine the TCs for different procurement systems in line with Williamson (1998) wherein human and environmental forces were considered the most important contributory factors to TCs; cognitive mapping and path models were used to depict and interpret the various factors highlighted in Table 4.5. The Figures 6.1 and 6.2 above present models for the Traditional and Design-Build systems. The sign, size, and statistical significance of the path coefficients represent the strength of relationships among constructs. The hypothesized relationships were determined by testing the developed models using Amos 21. "Maximum likelihood" and "Bootstrapping" functions were used to estimate hypothesized paths with Bootstrapping sample size of 1000.

The Traditional and Design-Build models can be used to estimate and evaluate the root causes contributing to high TCs. Also, users can estimate the magnitude of TCs as a result of professionals performing procurement activities throughout the project life cycle. Subsequently by estimating TCs, a better-cost estimate for a project could be achieved. The TCs are calculated on the basis of regression equation analysis, which is explained by the interrelationship strength coefficients between latent variables in the developed models.

Simple and multi regression analyses were employed for dealing with research problems. Simple regression involves measuring a single measured dependent variable, while multiple regression involves with more than one measured independent variables. They both assume that the data used for analysis have a normal distribution, and that the dependent and independent variables are directly measured during the data collection process. Further, in multi regression analysis there must be no linear relationship among the independent variables in the model (Dirk and Bart, 2004). Accordingly, the calculations of TCs were conducted in accordance to the procedures described in the sub-sections followed.

6.4.1 Traditional System

The Table 6.14 summarizes the regression estimates obtained from examining the traditional model utilizing Amos 21.

Table 6.14: Standardized Regression Estimates for Traditional Model

			Estimate
SYS	<---	PHZ	.992
SYS	<---	ENVIRON	.091
INFOC	<---	PHZ	.817
INFOC	<---	ENVIRON	.072
INFOC	<---	SYS	.177
PPROC	<---	INFOC	.359
PPROC	<---	PHZ	.473
PPROC	<---	ENVIRON	.207
PPROC	<---	SYS	.129
ENFORC	<---	INFOC	.143
ENFORC	<---	PPROC	.481
ENFORC	<---	PHZ	.173

			Estimate
ENFORC	<---	ENVIRON	.332
ENFORC	<---	SYS	.085
ADMINC	<---	PPROC	.279
ADMINC	<---	INFOC	.173
ADMINC	<---	ENFORC	.194
ADMINC	<---	PHZ	.216
ADMINC	<---	ENVIRON	.208
ADMINC	<---	SYS	.081
TCs	<---	PPROC	.299
TCs	<---	INFOC	.082
TCs	<---	ADMINC	.379
TCs	<---	ENFORC	.248
VC	<---	ENFORC	.585
EN	<---	ENFORC	.712
AD	<---	ADMINC	.734
DM	<---	ADMINC	.812
CR	<---	ADMINC	.595
ECO	<---	ENVIRON	.324
COP	<---	ENVIRON	.242
TCH	<---	ENVIRON	.740
CCT	<---	ENVIRON	.925
FWR	<---	ENVIRON	.755
PRL	<---	ENVIRON	.407
SV	<---	PPROC	.770
TZ	<---	PPROC	.491
PD	<---	PPROC	.418
TR	<---	PPROC	.375
TN	<---	PPROC	.810
IG	<---	INFOC	.726
CM	<---	INFOC	.806
POST	<---	TCs	.946
PRE	<---	TCs	.957
CPT	<---	PHZ	-.392
DVP	<---	PHZ	-.208
EIMP	<---	PHZ	-.053
FIMP	<---	PHZ	.338
CLZ	<---	PHZ	.174
DB	<---	SYS	.000
TD	<---	SYS	.000
PLS	<---	ENVIRON	.415
ISM	<---	ENVIRON	.880
AM	<---	PPROC	.661

The regression equations (6.1 to 6.6) predict the time-spent in conducting procurement activities for the Traditional system, while equation (6.7) predicts the TCs for the Traditional system. These equations were formulated in accordance to the interrelationships illustrated in Figure 6.1 and the standardized regression weights presented in Table 6.14 as follows:

1. Predicted time-spent in information search for the Traditional

$$\textit{Predicted } \boldsymbol{INFO_t} = B_{it} + 0.81*\boldsymbol{CM_t} + 0.73*\boldsymbol{IG_t} \text{ ....} \textbf{Equation 6.1}$$

Where:

$INFO_t$ is the time-spent in Information search for the Traditional,

CM_t is the time-spent in communication for the Traditional,

IG_t is the time-spent in information gathering for the Traditional, and

B_{it} is a constant where to anchor the slope (regression line) in the Traditional Model

The equation 6.1 implies that if all other variables are constant, the time-spent in information search for the traditional system increases by 0.81 of an hour when the time-spent in communication increases by 1 hour. Similarly, if all other variables are constant, the time-spent in information search increases by 0.73 of an hour when the time-spent in information gathering increases by 1 hour.

2. Predicted time-spent in procurement for the Traditional

$$\textit{Predicted } \boldsymbol{PPRO_t} = B_{pt} + 0.66*\boldsymbol{AM_t} + 0.81*\boldsymbol{TN_t} + 0.38*\boldsymbol{TR_t} + 0.42*\boldsymbol{PD_t} + 0.49*\boldsymbol{TZ_t} + 0.77*\boldsymbol{SV_t} \text{ ....} \textbf{Equation 6.2}$$

Where:

$PPRO_t$ is the time-spent in performing procurement activities for the Traditional,

AM_t is the time-spent in attending meetings for the Traditional,

TN_t is the time-spent in translation of client's needs for the Traditional,

TR_t is the time-spent in training for the Traditional,

PD_t is the time-spent in project preliminary design for the Traditional,

TZ_t is the time-spent in transition observation for the Traditional,

SV_t is the time-spent in site visits for the Traditional, and

B_{pt} is a constant where to anchor the slope in the Traditional model

The equation 6.2 indicates that if all other variables are constant, the time-spent in project procurement for the traditional system increases by: 0.66 of an hour when the time-spent in attending meetings increases by 1 hour; 0.81 of an hour when the time-spent in translation of client's needs increases by 1 hour; 0.38 of an hour when the time-spent in training increases by 1 hour; 0.42 of an hour when the time-spent in project preliminary design increases by 1 hour; 0.49 of an hour when the time-spent in transition observation increases by 1 hour; and 0.77 of an hour when the time-spent in training increases by 1 hour.

3. Predicted time-spent in administration for the Traditional

$$\text{Predicted } \boldsymbol{ADMIN_t} = B_{at} + 0.73*\boldsymbol{AD_t} + 0.81*\boldsymbol{DM_t} + 0.6*\boldsymbol{CR_t} \text{.........} \textbf{Equation 6.3}$$

Where:

$ADMIN_t$ is the time-spent in contract administration for the Traditional,
AD_t is the time-spent in administration for the Traditional,
DM_t is the time-spent in decision-making for the Traditional,
CR_t is the time-spent in conflict resolution for the Traditional, and
B_{at} is a constant where to anchor the slope in the Traditional model.

The equation 6.3 specifies that if all other variables are constant, the time-spent in contract administration for the traditional system increases by: 0.73 of an hour when the time-spent in administration increases by 1 hour; 0.81 of an hour when the time-spent in decision-making increases by 1 hour; and 0.60 of an hour when the time-spent in conflict resolution by 1 hour.

4. Predicted time-spent in enforcement for the Traditional

$$\text{Predicted } \boldsymbol{ENFOR_t} = B_{et} + 0.59*\boldsymbol{VC_t} + 0.71*\boldsymbol{EN_t} \text{..............................} \textbf{ Equation 6.4}$$

Where:

$ENFOR_t$ is the time-spent in contract enforcement for the Traditional,

VC_t is the time-spent in verifying compliances for the Traditional,
EN_t is the time-spent in enforcement for the Traditional, and
B_{et} is a constant where to anchor the slope in regression for the Traditional model.

The equation 6.4 suggests that if all other variables are constant, the time-spent in contract enforcement for the traditional system increases by 0.59 of an hour when the time-spent in verifying compliances increases by 1 hour. Similarly, if all other variables are constant, the time-spent in contract enforcement increases by 0.71 of an hour when the time-spent in enforcement increases by 1 hour.

5. Predicted total time-spent for the Traditional

$$\text{Predicted } \mathbf{TS_t} = B_{tt} + 0.08*\mathbf{INFO_t} + 0.3*\mathbf{PPRO_t} + 0.38*\mathbf{ADMIN_t} + 0.25*\mathbf{ENFOR_t} \quad \textbf{Equation 6.5}$$

Where:
TS_t is the total time-spent for the Traditional,
B_{tt} is a constant where to anchor the slope in the Traditional model

Importantly, the regression equation (6.5) implies that: *First,* if the information search (INFO) increases by 1 hour and all other variables are constant, the transaction time (TS) increases by 0.08 of an hour. *Second,* if the project procurement time (PPRO) increases by 1hour and all other variables are constant, the transaction time (TS) increases by 0.3 of an hour. *Third,* if the contract administration time (ADMIN) increases by 1 hour and all other variables are constant, the transaction time (TS) increases by 0.38 of an hour. *Fourth,* if the contract enforcement time (ENFOR) increases by 1 hour and all other variables are constant, the transaction time (TS) increases by 0.25 of an hour.

However, the relationship between information search and TCs is mediated by project procurement. The relationship between project procurement and TCs is moderated by information search. Similarly, the relationship between contract enforcement and TCs is mediated by contract administration. The relationship between contract administration and TCs is moderated by contract enforcement. Accordingly, the total time-spent in conducting procurement activities that was calculated in equation 6.5 is reformatted based on (Muller et al., 2005), to include the interactions effect of mediation and moderation (Figure 6.3).

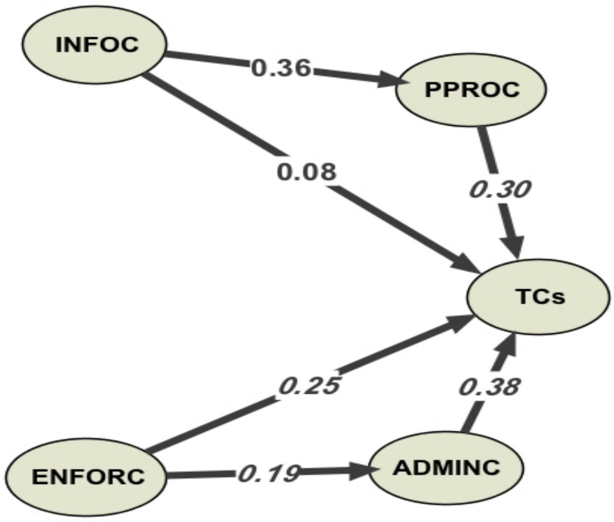


Figure 6.3: Mediation and Moderation Effects for Traditional Model

6. Predicted total time-spent with Mediation & Moderation effects for the Traditional

$$\textit{Predicted } \boldsymbol{TS_t} = B_{tt} + 0.36*\boldsymbol{INFO_t} + 0.3*\boldsymbol{PPRO_t} + 0.08*\boldsymbol{INFO_t}*\boldsymbol{PPRO_t}$$

$$0.19*\boldsymbol{ENFOR_t} + 0.38*\boldsymbol{ADMIN_t} + 0.25*\boldsymbol{ENFOR_t}*\boldsymbol{ADMIN_t} \text{.............} \textbf{ Equation 6.6}$$

7. Predicted Transaction costs for the Traditional

$$\textit{Predicted } \boldsymbol{TCs_t} = \textit{Predicted } \boldsymbol{TS_t}*\boldsymbol{HR} \text{.......................................} \textbf{ Equation 6.7}$$

Where:

TCs_t is the transaction costs for the Traditional (worked out on the basis of individual professionals who are involved in conducting procurement activities, and the sum is the amount of all TCs incurred because of professionals performing procurement activities).

HR is the hourly-rate for a construction professional.

Therefore, the TCs incurred because of construction professionals conducting procurement activities can be calculated using the aforementioned equations (6.1 to 6.7). Four of the tested cases (1 to 4) were procured using the traditional delivery system, and the TCs are calculated merely for the surveyed professionals. However, there are other professionals that are involved in conducting procurement activities, and the TCs can be calculated in the same way in future research.

Case 1

1. Predicted $\boldsymbol{INFO_t}$ = 0.81*1 + 0.73*0 = 0.81 hrs. /day

2. Predicted $\boldsymbol{PPRO_t}$ = 0.66*1 + 0.81*0 + 0.38*0 + 0.42*0 + 0.49*0.5 + 0.77*0.5 = 1.29 hrs. /day

3. Predicted $\boldsymbol{ADMIN_t}$ = 0.73*0 + 0.81*1 + 0.6*0.5 = 1.11 hrs. /day

4. Predicted $\boldsymbol{ENFOR_t}$ = 0.59*0 + 0.71*1 = 0.71 hrs. /day

5. *Predicted* $\boldsymbol{TS_t}$ = 0.36*0.81 + 0.3*1.29 + 0.08*0.81*1.29 + 0.19*0.71 + 0.38*1.11 + 0.25*0.71*1.11 = 1.515 hrs. /day

Note: For an experienced project manager such as in this case, the annual salary is NZ$135,000 (i.e. Hourly-rate $65/hr.) which obtained from (http://www.careers.govt.nz/jobs/management-consulting/project-manager/

thus, $\boldsymbol{TCs_t}$ = 1.515 * 65 = $98.48/day

The results show that the magnitude of TCs, as a result of project manager conducting procurement activities, is **$98.48** per day. Thus, for a project procured in a traditional delivery system with contract value of NZ$25 million, and scheduled to be complete in 60 months as in case 1, the total TCs incurred because of a project manager conducting procurement activities is equal to **$128,024** (worked out on 260 working days/year). Representing **19%** of the total salary costs (i.e. 60 months) of a Project Manager.

Case 2

1. Predicted $\boldsymbol{INFO_t}$ = 0.81*1.0 + 0.73*0.25 = 0.99 hrs. /day

2. Predicted $\boldsymbol{PPRO_t}$ = 0.66*1.25 + 0.81*0 + 0.38*0 + 0.42*0.25 + 0.49*0 + 0.77*0.5 = 1.32 hrs. /day

3. Predicted $\boldsymbol{ADMIN_t}$ = 0.73*0.5 + 0.81*0.5 + 0.6*0.5 = 1.07 hrs. /day

4. Predicted $\boldsymbol{ENFOR_t}$ = 0.59*0.5 + 0.71*0.25 = 0.47 hrs. /day

5. Predicted $\boldsymbol{TS_t}$ = 0.36*0.99 + 0.3*1.32 + 0.08*0.99*1.32 + 0.19*0.47 + 0.38*1.07 + 0.25*0.47*1.07 = 1.478 hrs. /day

thus, $\boldsymbol{TCs_t}$ = 1.478 * 65 = $96.1/day

The results show that the magnitude of TCs, as a result of Project Manager performing procurement activities, is **$96.1** per day. Thus, for a project procured in a traditional delivery system with contract value of NZ$50 million, and scheduled to be complete in 48 months as in case 2, the total TCs incurred because of a Project Manager performing procurement activities is equal to **$99,951**. Representing **18.5%** of the total salary cost (i.e. 48 months) of a Project Manager

Case 3

1. Predicted $\boldsymbol{INFO_t}$ = 0.81*0.25 + 0.73*0.25 = 0.385 hrs. /day

2. Predicted $\boldsymbol{PPRO_t}$ = 0.66*0.5 + 0.81*0.25 + 0.38*0 + 0.42*0.5 + 0.49*0 + 0.77*1 = 1.51 hrs. /day

3. Predicted $\boldsymbol{ADMIN_t}$ = 0.73*0.5 + 0.81*0.5 + 0.6*0.25 = 0.92 hrs. /day

4. Predicted $\boldsymbol{ENFOR_t}$ = 0.59*0 + 0.71*0.25 = 0.18 hrs. /day

5. Predicted $\boldsymbol{TS_t}$ = 0.36*0.385 + 0.3*1.51 + 0.08*0.385*1.51 + 0.19*0.18 + 0.38*0.92 + 0.25*0.18*0.91 = 1.063 hrs. /day

Note: For a senior civil engineer working as a team leader project manager such as in this case, the annual salary is NZ$220,000 (i.e. the Hourly-rate is 105.77) which obtained from (http://www.careers.govt.nz/jobs/engineering/civil-engineer/about-the-job)

thus, $\boldsymbol{TCs_t}$ = 1.063 * 105.77 = $112.42/day

The results show that the magnitude of TCs, as a result of a senior civil engineer conducting procurement activities, is **$112.42** per day. Thus, for a project procured in a traditional delivery system with contract value of NZ$654,000, and scheduled to be complete in 12 months as in case 3, the total TCs incurred because of a senior Civil Engineer conducting procurement activities is equal to **$29,228**. Representing **13%** of the total salary cost (i.e. 12 months) of a Civil Engineer.

Case 4

1. Predicted $\boldsymbol{INFO_t}$ = 0.81*0.25 + 0.73*0.25 = 0.385hrs. /day

2. Predicted $\boldsymbol{PPRO_t}$ = 0.66*0.25 + 0.81*0 + 0.38*0 + 0.42*0.25 + 0.49*0 + 0.77*0.5 = 0.65 hrs. /day

3. Predicted $\boldsymbol{ADMIN_t}$ = 0.73*0.25 + 0.81*0.25 + 0.6*0 = 0.385hrs. /day

4. Predicted $\boldsymbol{ENFOR_t}$ = 0.59*0 + 0.71*0.25 = 0.18hrs. /day

5. Predicted $\boldsymbol{TS_t}$ = 0.36*0.385 + 0.3*0.65 + 0.08*0.385*0.65 + 0.19*0.18 + 0.38*0.385 + 0.25*0.18*0.385 = 0.551 hrs. /day

thus, $\boldsymbol{TCs_t}$ = 0.551 * 65 = $35.84/day

The results show that the magnitude of TCs, as a result of a project manager conducting procurement activities, is **$35.84** per day. Thus, for a project procured in a Traditional delivery system with contract value of NZ$60,000, and scheduled to be complete in 8 months as in case 4, the total TCs incurred because of project manager conducting procurement activities is equal to **$6,989** (worked out on 260 working days/year). Representing **10.35%** of the total salary cost (i.e. 8 months) of a Project Manager.

6.4.2 Design-Build System

The Table 6.15 summarizes the regression estimates obtained from examining the design-build model utilizing Amos 21.

Table 6.15: Standardized Regression Estimates for Design-Build

			Estimate
SYS	<---	PHZ	.969
SYS	<---	ENVIRON	.238
INFOC	<---	PHZ	.757
INFOC	<---	ENVIRON	.272
INFOC	<---	SYS	.194
PPROC	<---	INFOC	.288
PPROC	<---	PHZ	.480
PPROC	<---	ENVIRON	.341
PPROC	<---	SYS	.132
ENFORC	<---	INFOC	.210
ENFORC	<---	PPROC	.382
ENFORC	<---	PHZ	.205

			Estimate
ENFORC	<---	ENVIRON	.268
ENFORC	<---	SYS	.102
ADMINC	<---	PPROC	.195
ADMINC	<---	INFOC	.191
ADMINC	<---	ENFORC	.094
ADMINC	<---	PHZ	.339
ADMINC	<---	ENVIRON	.256
ADMINC	<---	SYS	.104
TCs	<---	PPROC	.445
TCs	<---	INFOC	.169
TCs	<---	ADMINC	.177
TCs	<---	ENFORC	.211
VC	<---	ENFORC	.657
EN	<---	ENFORC	.690
AD	<---	ADMINC	.725
DM	<---	ADMINC	.793
CR	<---	ADMINC	.762
ECO	<---	ENVIRON	.174
COP	<---	ENVIRON	.046
TCH	<---	ENVIRON	.559
CCT	<---	ENVIRON	.921
FWR	<---	ENVIRON	.960
PRL	<---	ENVIRON	.527
SV	<---	PPROC	.748
TZ	<---	PPROC	.648
PD	<---	PPROC	.692
TR	<---	PPROC	.625
TN	<---	PPROC	.867
IG	<---	INFOC	.747
CM	<---	INFOC	.808
POST	<---	TCs	.973
PRE	<---	TCs	.982
CPT	<---	PHZ	-.232
DVP	<---	PHZ	-.110
EIMP	<---	PHZ	.005
FIMP	<---	PHZ	.201
CLZ	<---	PHZ	.062
DB	<---	SYS	.000
TD	<---	SYS	.000
PLS	<---	ENVIRON	.201
ISM	<---	ENVIRON	.857
AM	<---	PPROC	.648

The regression equations (6.8 to 6.13) predict the TCs for Design-Build system, which were formulated in accordance to the interrelationships illustrated in Figure 6.2 and the standardized regression weights presented in Table 6.15 as follows:

8. Predicted time-spent in information search for Design-Build

$$\textit{Predicted } \boldsymbol{INFO_d} = B_{id} + 0.81*\boldsymbol{CM_d} + 0.75*\boldsymbol{IG_d} \text{.................................} \textbf{ Equation 6.8}$$

Where:

$INFO_d$ is the time-spent in Information search for Design-Build,

CM_d is the time-spent in communication for Design-Build,

IG_d is the time-spent in information gathering for Design-Build, and

B_{id} is a constant where to anchor the regression line in Design-Build model

The equation 6.8 implies that if all other variables are constant, the time-spent in information search for Design-Build system increases by 0.81 of an hour when the time-spent in communication increases by 1 hour. Similarly, if all other variables are constant, the time-spent in information search increases by 0.75 of an hour when the time-spent in information gathering increases by 1 hour.

9. Predicted time-spent in procurement for Design-Build

$$\textit{Predicted } \boldsymbol{PPRO_d} = B_{pd} + 0.65*\boldsymbol{AM_d} + 0.87*\boldsymbol{TN_d} + 0.63*\boldsymbol{TR_d} + 0.69*\boldsymbol{PD_d} + 0.65*\boldsymbol{TZ_d} + 0.75*\boldsymbol{SV_d} \text{...} \textbf{ Equation 6.9}$$

Where:

$PPRO_d$ is the time-spent in conducting procurement activities for Design-Build,

AM_d is the time-spent in attending meetings for Design-Build,

TN_d is the time-spent in translation of client's needs for Design-Build,

TR_d is the time-spent in training for Design-Build,

PD_d is the time-spent in project preliminary design for Design-Build,

TZ_d is the time-spent in transition observation for Design-Build,

SV_d is the time-spent in site visits for Design-Build, and

B_{pd} is a constant where to anchor the slope in Design-Build model

The equation 6.9 indicates that if all other variables are constant, the time-spent in project procurement for design-build system increases by: 0.65 of an hour when the time-spent in attending meetings increases by 1 hour; 0.87 of an hour when the time-spent in translation of client's needs increases by 1 hour; 0.63 of an hour when the time-spent in training increases by 1 hour; 0.69 of an hour when the time-spent in project preliminary design increases by 1 hour; 0.65 of an hour when the time-spent in transition observation increases by 1 hour; and 0.75 of an hour when the time-spent in training increases by 1 hour.

10. Predicted time-spent in administration for Design-Build

Predicted $\boldsymbol{ADMIN_d} = B_{ad} + 0.73*\boldsymbol{AD_d} + 0.79*\boldsymbol{DM_d} + 0.76*\boldsymbol{CR_d}$...............**Equation 6.10**

Where:

$ADMIN_d$ is the time-spent in contract administration for Design-Build,

AD_d is the time-spent in administration for Design-Build,

DM_d is the time-spent in decision-making for Design-Build,

CR_d is the time-spent in conflict resolution for Design-Build, and

B_{ad} is a constant where to anchor the slope in Design-Build model

The equation 6.10 specifies that if all other variables are constant, the time-spent in contract administration for design-build system increases by: 0.73 of an hour when the time-spent in administration increases by 1 hour; 0.79 of an hour when the time-spent in decision-making increases by 1 hour; and 0.76 of an hour when the time-spent in conflict resolution by 1 hour.

11. Predicted time-spent in enforcement for Design-Build

Predicted $\boldsymbol{ENFOR_d} = B_{ed} + 0.66*\boldsymbol{VC_d} + 0.69*\boldsymbol{EN_d}$......................... **Equation 6.11**

Where:

$ENFOR_d$ is the time-spent in contract enforcement for Design-Build,

VC_d is the time-spent in verifying compliances for Design-Build,

EN_d is the time-spent in enforcement for Design-Build, and

B_{ed} is a constant where to anchor the slope in Design-Build model

The equation 6.11 suggests that if all other variables are constant, the time-spent in contract enforcement for design-build system increases by 0.66 of an hour when the time-spent in verifying compliances increases by 1 hour. Similarly, if all other variables are constant, the time-spent in contract enforcement increases by 0.69 of an hour when the time-spent in enforcement increases by 1 hour.

12. Predicted total time-spent for Design-Build

$$\text{Predicted } \boldsymbol{TS_d} = B_{td} + 0.17^*\boldsymbol{INFO_d} + 0.45^*\boldsymbol{PPRO_d} + 0.18^*\boldsymbol{ADMIN_d} + 0.21^*\boldsymbol{ENFOR_d} \quad \textbf{Equation 6.12}$$

Where:
TS_d is the total time-spent for Design-Build, and
B_{td} is a constant where to anchor the slope in Design-Build model

Importantly, the regression equation (6.12) implies that: *First,* if the information search (INFO) increases by 1 hour and all other variables are constant, the transaction time in Design-Build system (TS_d) increases by 0.17 of an hour. *Second,* if the project procurement cost (PPRO) increases by 1 hour and all other variables are constant, the transaction time (TS_d) increases by 0.45 of an hour. *Third,* if the contract administration time (ADMIN) increases by 1 hour and all other variables are constant, the transaction time (TS_d) increases by 0.18 of an hour. *Fourth,* if the contract enforcement time (ENFOR) increases by 1 hour and all other variables are constant, the transaction time (TS_d) increases by 0.21 of an hour.

However, as discussed in the previous Section (6.3.1), the effect of interactions of mediation and moderation between constructs should be considered in determining the transaction cost. Accordingly, the time-spent in conducting procurement activities (the time-spent in transaction) that was calculated in equation 6.12 is reformatted based on (Muller et al., 2005), to include the interactions effect of mediation and moderation (as shown in Figure 6.4).

Therefore,

13. Predicted total time-spent with Mediation & Moderation effects for Design-Build

$$\textit{Predicted } \boldsymbol{TS_d} = B_{td} + 0.29*\boldsymbol{INFO_d} + 0.45*\boldsymbol{PPRO_d} + 0.17*\boldsymbol{INFOC*PPRO_d} + 0.09*\boldsymbol{ENFOR_d} + 0.18*\boldsymbol{ADMIN_d} + 0.21*\boldsymbol{ENFOR_d*ADMIN_d} \text{.........} \textbf{Equation 6.13}$$

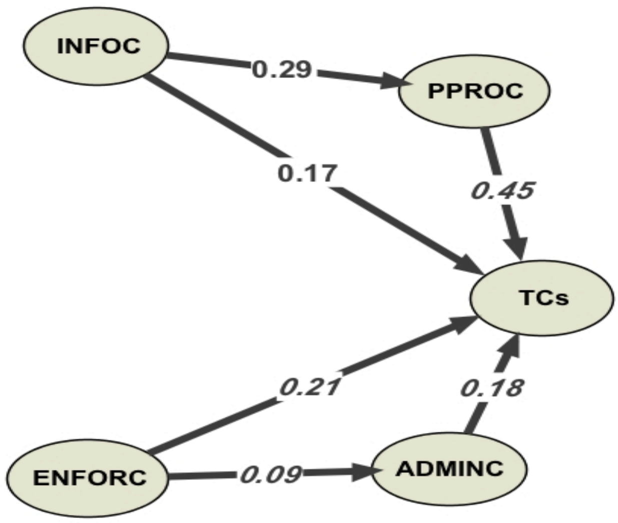


Figure 6.4: Mediation and Moderation Effects for Design-Build

14. Predicted Transaction costs for Design-Build

$$\textit{Predicted } \boldsymbol{TCs_d} = \textit{Predicted } \boldsymbol{TS_d*HR} \text{..} \textbf{ Equation 6.14}$$

Where:

TCs_d is the transaction costs for Design-Build (worked out on the basis of individual professionals who are involved in conducting procurement activities, and the sum is the amount of all TCs incurred because of professionals conducting procurement activities).
HR is the hourly-rate for a construction professional.

Accordingly, the TCs incurred because of construction professionals conducting procurement activities can be calculated using the aforementioned equations (6.8 to 6.14). Two of the tested cases (5 and 6) were procured using the Design-Build delivery system, and the TCs are calculated only for the surveyed professionals. However, there are other professionals that are involved in conducting procurement activities, and the TCs can be calculated in the same way in future research.

Case 5

1. Predicted $\boldsymbol{INFO_d}$ = 0.81*0.25 + 0.75*0.5 = 0.578 hrs. /day

2. Predicted $\boldsymbol{PPRO_d}$ = 0.65*1 + 0.87*0 + 0.63*0 + 0.69*0 + 0.65*0 + 0.75*0.5 = 1.025 hrs. /day

3. Predicted $\boldsymbol{ADMIN_d}$ = 0.73*0.5 + 0.79*1 + 0.76*0.25 = 1.345 hrs. /day

4. Predicted $\boldsymbol{ENFOR_d}$ = 0.66*0.5 + 0.69*0.25 = 0.503 hrs. /day

5. Predicted $\boldsymbol{TS_d}$ = 0.29*0.578 + 0.45*1.025 + 0.17*0.578*1.025 + 0.09*0.503 + 0.18*1.345 + 0.21*0.503*1.345 = 1.159 hrs. /day

thus, $\boldsymbol{TCs_d}$ = 1.159*65 = $75.34/day

The results show that the magnitude of TCs, as a result of project manager performing procurement activities, is **$75.34** per day. Thus, for a project procured in a Design-Build delivery system with contract value of NZ$40 million, and scheduled to be complete in 48 months as in case 5, the total TCs incurred because of a project manager conducting procurement activities is equal to **$78,354** (worked out on 260 working days/year). Representing **14.5%** of the total salary cost (i.e. 48 months) of a Project Manager.

Case 6

1. Predicted $\boldsymbol{INFO_d}$ = 0.81*0.25 + 0.75*0.5 = 0.578 hrs. /day

2. Predicted $\boldsymbol{PPRO_d}$ = 0.65*0.5 + 0.87*0.25 + 0.63*0 + 0.69*1 + 0.65*0 + 0.75*0.5 = 1.61 hrs. /day

3. Predicted $\boldsymbol{ADMIN_d}$ = 0.73*1 + 0.79*0.5 + 0.76*0.5 = 1.505 hrs. /day

4. Predicted $\boldsymbol{ENFOR_d}$ = 0.66*0.5 + 0.69*0.5 = 0.675 hrs. /day

5. Predicted $\boldsymbol{TS_d}$ = 0.29*0.578 + 0.45*1.61 + 0.17*0.578*1.61 + 0.09*0.675+ 0.18*1.505 + 0.21*0.675*1.505 = 1.595 hrs. /day

Note: For a registered Architects with more than five years experience such as in this case, the annual salary is NZ$110,000 (i.e. the Hourly-rate is 53) which obtained from (http://www.careers.govt.nz/jobs/architectural-technical-design/architect/about-the-job)

thus, $\boldsymbol{TCs_d}$ = 1.595*53 = 84.55/day

The results show that the magnitude of TCs, as a result of an Architect conducting procurement activities, is **$84.55** per day. Thus, for a project procured in a Design-Build delivery system with contract value of NZ$2.8 million, and scheduled to be complete in 12 months as in case 6, the total TCs incurred because of an Architect conducting procurement activities is equal to **$21,983**. Representing **20%** of the total salary cost (i.e. 12 months) of an Architect.

In conclusion, for projects that have the same contract value with the same schedule of delivery time such as Case 2 for the Traditional and Case 5 for Design-

Build, it was found that the amount of TCs in Project Managers total salary cost was **18.5%** and **14.5%** respectively. This result of transaction cost calculations can aid a decision-maker to determine which procurement delivery system is the most efficient in improving cost estimates, and thus resulting in enhanced project performance.

6.5 Discussion of the Results of the Structural Models Testing

The reliability and validity of the eight constructs (latent variables) for both the Traditional and Design-Build models (Tables 6.1 and 6.2) are satisfactory. The Goodness-of-Fit Indices of the structural models (Tablet 6.3) are also quite satisfactory for both models. The results of coefficient estimates of variance explained (Table 6.5) indicate that R^2 for all endogenous constructs are significant ($R^2 \geq 0.1$). In this research, maximum likelihood and unweight least square estimates were used to estimate hypothesized path coefficients between constructs. The results indicate that all path coefficients were statistically significant at $\beta > 0.01$ (Figures 6.1 and 6.2). In addition, the results of applying the models to real life cases confirmed the hypothesized relationships between the procurement systems and the magnitude of the pre and post-contract TCs.

6.5.1 Pre-contract transaction costs

As mentioned earlier that the pre-contract TCs are composed of information costs and project procurement costs. The hypothesis (11) that assumes procurement systems have a positive effect on information cost is verified by the structural models and likewise by the selected cases. That is, the path coefficient between information cost and TCs, as shown in Figure 6.1 and 6.2, is significant at $\beta = 0.08$ for the Traditional system and $\beta = 0.17$ for Design-Build system. However, the relationship between information costs and TCs are fully mediated by project procurement costs. The relationship between information costs and project procurement costs for the Traditional system is significant at β *= 0.36,* which means that the relationship between information cost and TCs, when considering the mediation and moderation interactions, is significant at β *= 0.11 (i.e. 0.08 + 0.08*0.36).* Similarly, the relationship between information costs and project procurement costs for Design-Build system is significant at β *= 0.29,* which means that the relationship between information cost and TCs is significant at β *= 0.22 (i.e. 0.17 + 0.17*0.29).*

At the same time, the hypothesis (11) was examined by comparing the results of applying the structural models at selected projects that are similar in complexity, contract value, and duration. Based on these criteria, Case 2 and 5 were selected to represent the Traditional and Design-Build system respectively because of the closeness in contract value, complexity, and duration (see table 6.7). The outcomes show that the time-spent by a project manager in information search is **0.99** hours per day for the Traditional system and **0.58** of an hour per day for Design-Build system. This implies that in the Traditional procurement system, construction professionals spent more time in information search (legal, technical, financial, etc.) so that the scope of the project is as fully defined as possible before the construction begins.

Moreover, the hypothesis (12) that assumes the procurement system has a positive effect on project procurement cost is confirmed by the structural models and also by the selected cases. As shown in Figure 6.1 and 6.2 of the structural models, the path coefficient between project procurement cost and TCs is significant at β *= 0.30* for the traditional system and β *= 0.45* for the design-build system. However, the relationship between project procurement costs and TCs is moderated by information costs. Thus, the relationship between project procurement costs and TCs for the Traditional system is significant at *β = 0.32 (i.e. 0.3 + 0.3*0.08).* Also, the relationship between project procurement costs and TCs for Design-Build system is significant at *β = 0.53 (i.e. 0.45 + 0.45*0.17).*

Meanwhile, the results of executing the structural models to the same Cases (2 and 5) support the hypothesis (12). They show that the time-spent by a project manager in procurement is **1.32** hours per day for the Traditional system and **1.025** hours per day for Design-Build system. This means that in the Traditional procurement system, construction professionals spent more time in project procurement (attending meetings, project preliminary design, translation of client's need, etc.) so that the procurement documents are as complete as possible before the tendering starts.

Despite the discussion above showing that the pre-contract TCs for the Traditional system are higher than Design-Build system. Objective four of this research is to investigate whether environmental uncertainties and project phases interact to influence the client's procurement decision. Uncertainties in the transaction environment affect the ability of construction professionals to fully define unforeseen events, and generate bounded rationality. The consequences are incomplete contracts that lead to increase in costs of information and project procurement (i.e. increase in TCs). For example, search the market for information about opportunities such as products, prices, demand, supply, trading rights, and market outlets (Hobbs, 1996; Solino & Gago de Santos, 2010).

Also, procurement costs are attributable to environmental and technical uncertainties connected to projects. Hence to provide some certainty to project details, it will be necessary to undertake environmental assessments, feasibility studies, preliminary design, preparation of tender documents, bargaining, and training. These pre-contract activities have tangible forms of TCs attached to them such as environmental assessment fees, cost of the feasibility study, preliminary design costs, bargaining costs, training, consulting/service fees, licensing fees, and insurance premiums (Hobbs, 1996; Solino & Gago de Santos, 2010).

The hypotheses that concerned with environmental uncertainties were tested according to the significance of path coefficients depicted by the structural models. Hypothesis (15) assumes environmental uncertainties have a positive effect on information costs. While hypothesis (16) assumes environmental uncertainties have a positive effect on project procurement costs. The structural models verify both hypotheses where the path coefficients, as depicted in Figures 6.1 and 6.2, between environmental uncertainties on one side and the costs of information and project procurement, on the other side are significant. For the Traditional system the path coefficients for environmental uncertainties are $\beta = 0.07$ with information costs, and $\beta = 0.21$ with project procurement costs. While for Design-Build system the path coefficients are $\beta = 0.27$ and $\beta = 0.34$ respectively.

6.5.2 Post-contract transaction costs

The post-contract TCs are encompassed of contract administration and contract enforcement costs. Two research hypotheses are supported in this part.

Firstly, the hypothesis (13) that assumes procurement system has a positive effect on contract administration costs is confirmed by the structural models and also by the real-life cases. As depicted by the structural models (Figures 6.1 and 6.2), the path coefficients between project procurement costs and TCs are significant at $\beta =$

0.38 for the Traditional system and $\beta = 0.18$ for Design-Build system. However, the structural models show that the relationship between contract administration costs and TCs is moderated by contract enforcement costs. This moderation is affecting the relationship between contract administration costs and TCs. Hence, for the Traditional system the path coefficient is significant at $\beta = 0.42$ *(i.e. 0.38 + 0.19*0.25)*, and for Design-Build system is significant at $\beta = 0.2$ *(i.e. 0.18 + 0.09*0.21).*

Meanwhile, the hypothesis (13) was examined by comparing the results from testing the structural models into real-life projects. As mentioned earlier, Case 2 was selected for the Traditional system and case 5 for Design-Build system. The outcomes show that the time-spent by a project manager in contract administration is **1.07** hours per day for the Traditional system and **1.345** hours per day for Design-Build system. Although, the path coefficient for the traditional system is more significant than for the Design-Build system, this result confirms that construction professionals spent more time in contract administration in a project procured with Design-Build delivery system than in the Traditional system. Accordingly, well-defined contractual arrangements would minimize the time-spent by professionals in administrating the contract.

Secondly, the hypothesis (14) that assumes procurement system has a positive effect on contract enforcement costs is confirmed by the structural models and also by the real-life cases. As depicted in Figures 6.1 and 6.2, the path coefficient between contract enforcement costs and TCs is significant at $\beta = 0.25$ for the Traditional system and $\beta = 0.21$ for Design-Build system. But, the relationship between contract enforcement costs and TCs is fully mediated by contract administration costs. This mediation is interacting the relationship between contract enforcement costs and TCs. Thus, for the Traditional system the path coefficient is significant at *β = 0.32 (i.e. 0.25 + 0.19*0.38)*, and for Design-Build system is significant at *β = 0.22 (i.e. 0.21 + 0.09*0.18).*

At the same time, the hypothesis (14) was confirmed by testing the structural models to the same Cases (2 and 5). The results show that the time-spent by a project manager in contract enforcement is **0.47** of an hour per day for the Traditional system and **0.503** of an hour per day for the design-build system. This means that in the Traditional procurement system, construction professionals spent less time in contract enforcement than in Design-Build system. The results from testing the path coefficients and from the real-life cases are in line with the results obtained by other empirical studies such as those by Dudkin and Valila (2005), Solino and Gago de Santos (2009), and Li et al. (2013). In the Design-Build systems, construction professionals spent more time in contract enforcement than in the Traditional systems.

6.5.3 Environmental Uncertainties

As mentioned earlier one of the objectives (3) of this research is to investigate whether environmental uncertainties and project phases interact to influence the client's procurement decision. Uncertainties in the transaction environment affect the ability of construction professionals to fully define unforeseen events, and generate bounded rationality. The consequences are incomplete contracts that lead to conflict and dispute, which in turn increase the costs of contract administration and enforcement (i.e. increase the TCs). In situations with high uncertainty for example, the enforcement costs are high as a result of formulation of agreement, monitoring costs and legal costs. In this study, environmental uncertainties are conceptualized as influencing the magnitude of the contract administration and enforcement costs (H17 and H18).

Environmental uncertainties hypotheses were tested in conformity to the significance of path coefficients depicted by the structural models. Hypothesis (17) assumes environmental uncertainties have a positive effect on contract administration costs. While hypothesis (18) assumes environmental uncertainties have a positive effect on contract enforcement costs. The structural models confirm both hypotheses, where the path coefficients as depicted in Figures 6.1 and 6.2, between environmental uncertainties on one side and the costs of contract administration and enforcement, on the other side are significant. For the Traditional system the path coefficients for environmental uncertainties are $\beta = 0.21$ with contract administration costs and $\beta = 0.33$ with contract enforcement costs. While for Design-Build system the path coefficients are $\beta = 0.26$ and $\beta = 0.27$ respectively.

In conclusion, the above results show the extensive effect of procurement systems, project phase, and environmental uncertainties on the pre and post-contract TCs. The results are supported by other empirical studies such as those by Dudkin and Valila (2005), Solino and Gago de Santos (2009), and Li et al. (2013). The discrepancy of this study is at combining the factors that affecting the magnitude of pre and post-contract stages TCs in one structural model. The effects of procurement system, project phases, and environmental uncertainties on TCs were visually presented in structural models, and statistically calculated by applying the models to real life cases. Two structural models were introduced so that comparisons between different procurement systems can be made. Also, regression equations were bestowed upon aid decision-maker on who to use the structural models in calculating the professionals' time-spent in conducting procurement activities and then TCs.

6.6 Summary of the Findings

This chapter has presented the results of applying the structural model to six real life cases. A comparison of TCs was conducted between two cases that have closeness in contract value, complexity, and duration. Case 2 is a project procured in Traditional system, while case 5 is a project procured in Design-Build system. The objectives (6 and 7) are to estimate TCs for different procurement systems for comparison, and applying the research results to real life cases for verification. These objectives have been achieved, and the real life cases provided in-depth information about the time spent by professionals in conducting procurement activities, which indeed provided information about the factors that contributing into increasing the TCs. Moreover, eight hypotheses (H11 to H18) have been examined using the structural models, and confirmed by the real-life cases analyses.

Procurement systems were confirmed as having a positive effect on information costs (H11), project procurement cost (H12), contract administration costs (H13), and contract enforcement costs (H14).

Environmental uncertainties were confirmed as having a positive effect on information costs (H15), project procurement costs (H16), contract administration costs (H17), and contract enforcement cost (H18).

Research problem R: This research finds evidence of a positive relationship between the procurement system adopted and the amount of transaction costs incurred because of this adoption in the New Zealand construction industry.

In this study, transaction costs was not operationalized as a single concept, rather TCs was defined through costs of pre-contract stage such as information and project procurement costs, and costs of post-contract stage namely contract administration and enforcement costs. Other factors have been included that have significant effects on the magnitude of TCs, namely procurement system, project phases, and environmental uncertainties. The relationships among the constructs have been combined in a complete model, to test the significant effect between any latent variable and belong observed variables, and among the latent variables themselves.

The results from applying the structural models to real life cases have provided interesting and important information to the research objective, and indicate areas of improvement to the procurement practices. Two structural models, the traditional and design-build, have been used to formulate 14 regression equations, which were used in calculating the time-spent in information search, project procurement, contract administration, and contract enforcement. Six cases have been used for testing the Traditional and Design-Build structural models. However, two cases of same complexity, budget, and duration have been selected for comparison: Case 2 from the Traditional systems; and Case 5 from the Design-Build systems. Calculations from Case 2 show that the TCs incurred, because of a project manager conducting procurement activities, is **$96.1** per day, and at project completion **$99,951**. Representing **18.5%** of the total salary cost of a Project Manager. While, calculation from Case 5 show that the TCs, because of a project manager conducting procurement activities, is **$75.34** per day, and at project completion **$78,354.** Representing **14.5%** of the total salary cost of a Project Manager This implies that TCs for the Traditional systems is higher than for the Design-Build systems, and one can conclude it is the pre-contract transaction costs for the Traditional system that contribute to higher TCs.

Chapter six concludes data collection, analysis, and research verification phase of the study. The next chapter presents a synthesis of the complete research by comparing the findings with the findings of some empirical researches analyzed in the literature review chapter.

CHAPTER SEVEN

Conclusions and Implications

7.0 Introduction

The purpose of the current research is to examine the relationship between procurement systems and transaction costs within the context of New Zealand. It is the first research that attempts to quantitatively measure TCs in the New Zealand construction industry. There have been very few research attempts to quantify TC's internationally. This chapter presents the conclusions and implications of the current research. The chapter starts with contribution of the research to construction management, and a summary of the research questions. Next is a summary of the major findings of the research. The third section outlines the implications of the study. Followed by contributions of the research to the existing body of knowledge are outlined in section four. The fifth section explains the limitations of the study and areas for further research are suggested. Finally, overall conclusions of the research are presented.

7.1 Contribution of the Research

As stated in Chapter One, this study explores issues related to a lack of understanding of transaction costs and their relationship with procurement selection processes in construction. Therefore to address these issues, a number of research questions and sub-questions were formulated in order to achieve the aim and objectives of the research. There are two main questions that are addressed in the current study:

R1. What is the link between transaction costs and procurement systems in construction?

R2. How can transaction costs be minimized so that the productivity of the construction industry is enhanced in New Zealand?

The sub-questions that are addressed in this research include:

Q1. What are common transaction costs in construction?

Q2. To what extent are transaction costs related to procurement in construction?

Q3. To what extent are transaction costs related to environmental uncertainties in construction?

Q4. Are there any links between procurement systems and environmental uncertainties in construction?

Q5. How can the client's procurement selection procedures be improved in construction?

7.1.1 What are common transaction costs in construction?

This study determines transaction costs on the basis of the surrogate measure of time-spent by professionals in conducting procurement activities at pre and post-contract stages. That is, professionals' time spent in information search, project procurement, contract administration, and contract enforcement. The key sources of TCs are economic actors' behavioral assumptions (opportunistically and bounded rationality) and transaction characteristics; i.e. asset specificity, uncertainty, frequency, complexity, and contestability (Williamson, 1981). The opportunity costs as a result of renegotiation and delays in the completion of the project (Ho, 2006), which may significantly undermine expected benefits.

Similarly, Frank (2006) found that outsourcing could involve extra TCs such as negotiation, measuring, and monitoring costs. Given that TCs minimization is constantly associated with the capability of contractual parties to fully define terms and conditions in the contractual agreements (Eccles, 1981a; Reve & Levitt, 1984; Winch, 1989; Bajari & Tadelis, 2001b; Aibinu et al., 2011). Measuring and evaluating TCs in construction projects is often broad and subjective (Dudkin & Valila, 2005; Ho & Tsui, 2009; Solino & Gago de Santos, 2010).

This study found the 13 most common procurement activities that contribute to an increase in TCs, which can be measured based on the time-spent in conducting said activities. They are information search, communication, attending meetings, translation of client's needs, transition observation, project preliminary design, training, site visits, administration, decision-making, conflict resolution, verifying compliances, and enforcement.

This empirical study contributes to the knowledge of TCE in construction by identifying the common procurement activities that lead to an increase in TCs. Minimizing or eliminating the time-spent on conducting these activities will minimize the TCs, which in turn will enhance productivity. These efforts will thus hopefully contribute to the current initiatives to increase productivity by 20% within the New Zealand construction industry by the year 2020.

7.1.2 To what extent are transaction costs related to procurement in construction?

This study proposes that transaction costs and procurement systems are related by a mechanism in the procurement selection processes. The criteria for choosing a suitable procurement system is based on the client's objectives and priorities and are influenced by project constraints (Chinyio, 2011). The procurement path determination chart has largely dominated research in procurement selection process in construction (Cheung et al., 2001). Eight factors need to be considered by the client when developing procurement selection criteria (NEDO, 1985; Franks, 1990; Singh, 1990). At the procurement strategy stage the focus should be on factors such as cost, quality, and time (Kumaraswamy & Dissanayaka, 1998), while at the delivery stage the consideration should focus on complexity, certainty, risk, responsibility, and degree of control by the client (Alhazmi & McCaffer, 2000). However, including certain criteria and ignoring the magnitude of TCs incurred because of professionals conducting procurement activities simplifies this process. To support this argument, procurement decisions must be viewed as a combination of factors that interact with each other.

This study combines procurement systems, project phases, and environmental uncertainties with TCs in a framework model for procurement selection. The model represents an analytical form of a suitable combination of factors influencing procurement systems, which guide procurement decisions. This is an important contribution, because in existing studies procurement systems and TC are frequently conceptualized in terms of independent tangible entities in organizational strategies such as procurement decision. In the context of construction procurement decisions, TCE could generate a valuable understanding of the costs associated with pre and post-contract stages (Li et al., 2013). In the pre-contract stage, the procurement activities that contribute to TCs include market research (financial, legal, and technical), conducting feasibility studies, bidding documents, and negotiations (Solino & Gago de Santos, 2010). While at the post-contract stage, procurement activities include activities such as administrating contracts, claims, change orders, disputes, decision-making, and contract enforcement (Whittington, 2008b).

This study confirms research that assumes the pre-contract TCs in the Traditional system are likely to be higher than in the Design-Build system. Also, the post-contract TCs are higher in the Design-Build system than in the Traditional system (Dudkin & Valila, 2005; Whittington, 2008b; Solino & Gago de Santos, 2010). Accordingly, this study extends the research domain of procurement decision by utilizing SEM to develop a structural model that explains the relationship between procurement systems, project phases, environmental uncertainties, and TCs. Further, the study introduced six real-life cases to aid the client's in calculating TCs, hence selecting the most appropriate procurement systems that minimize TCs.

The structural model and real-life cases increase understanding of how efficient procurement selection of construction projects can be achieved through appropriate procurement procedures, which could positively impact project performance. This enables the development of appropriate strategies, such as long-term agreements and alliances, to eliminate the risks associated with contracting uncertainty, limiting the number of instances of bargaining or opportunism and asset specificity.

7.1.3 To what extent are transaction costs related to environmental uncertainties in construction?

This study explores the interaction between environmental uncertainties and TCs. The study found eight environmental uncertainties that contribute the most to increased TCs: Political/Legal/Social, Economical, Competition, Technology, Project location, Corporate culture, Finance and ownership, and Information systems. Thus, ignoring the magnitude of TCs associated with the environmental uncertainties in the procurement selection simplifies this process. A variety of research conducted states that environmental uncertainties have an effect on project performance (Mitropoulos & Howell, 2001; Walker & Pryke, 2009; Jin & Zhang, 2011; Li et al., 2013). However, these studies addressed environmental uncertainties in terms of technical uncertainties, while this study addresses uncertainty in terms of external and internal factors that affect project success and performance.

The study provides empirical evidence that uncertainties in the transaction environment have a substantial impact on the magnitude of TCs, for instance, the cost of information, procurement, administration, and enforcement. A structural model is presented to demonstrate the effect environmental uncertainties. However, the effect of uncertainties in the transaction environment is different from one procurement system to another. Two structural models for Traditional and Design-Build systems have been provided to demonstrate the discrepancies in the effect of uncertainties. The models visually present the significant impact of the environmental uncertainties of TCs in construction. Thus, the study contributes to an emerging research stream, which has suggested the environment as a factor affecting the project success and performance.

Finally, it was found that uncertainties in the transaction environment affect the ability of contracting parties to fully define contingencies in the contract. The high level of uncertainty forces contractors to jack up their bids, file numerous claims, substantial extra work and rework, and antagonistic relationships with owners, which end up in dispute and conflict. Those in turn more likely increase TCs because of information incompleteness, the time-spent in contract documentation and negotiation, more staff in contract administration, and more staff for enforcing the contract such as quality control and etc. Thus, for smooth project execution clients should account for contingencies borne because of uncertainties. This could be achieved by including uncertainties impact in the risk allocation strategy. This study extends the research domain by measuring the impact of uncertainties on the amount of TCs for different procurement systems.

7.1.4 Are there any links between procurement systems and environmental uncertainties in construction?

This study suggests that procurement systems and environmental uncertainties are related in procurement selection processes. Uncertainties affect the ability of contracting parties to fully specify the range of contingencies for unforeseen events that may disturb project success. Consequently it becomes more costly to write a fully specified contract (Williamson, 1985; Brouthers & Nakos, 2004). To support this argument, a construction organization must be viewed as a collection of entities that interact with the environment (Hodgson, 2004).

Duncan (2009) suggests that lump sum and cost reimbursement systems were the procurement trend during post-war regeneration (1946-1969). During the 1970-1979 period of high inflation, an increasing preponderance of clients started to use management contracting in order to save some money (Duncan, 2009). Meanwhile the sub-prime market collapse in 2009 was reported to have caused a shift in procurement trend towards Design-Build (Duncan, 2009).

This study empirically found evidence that uncertainties in the transaction environment have a significant effect on the procurement system adopted. This effect was visually presented in two structural models for the Traditional and Design-Build systems. Thereby the models can increase our understanding of how to select the proper procurement system to achieve better project execution. The models were tested empirically through a large-scale quantitative investigation, in contrast to previous studies of procurement systems that have been restricted to proposing theoretical models. Therefore the practical contribution of this empirical test is potentially very high.

The structural models indicate that there is a strong positive correlation between environmental uncertainties and procurement systems. Accordingly, in order to develop an appropriate procurement selection process, the client should be prepared to deal with uncertainties in the transaction environment, and to account for higher TCs by making sure that the risk contingencies is covered as much as possible in the cost estimates. Other researchers (Mitropoulos & Howell, 2001; Walker & Pryke, 2009; Love et al., 2010) also support the extensive effect of transaction environment. Accordingly, the theoretical contribution of this study is high, since the model developed is a unique attempt to assume a more systematic and holistic view on the issue of uncertainties in the transaction environment on procurement systems.

7.1.5 How Can the client's procurement selection procedures be improved in construction?

This study explores the relationship between procurement systems, project phases, environmental uncertainties, and transaction costs. Two structural models were developed for the Traditional and Design-Build systems based on TCs, to indicate the significant effect of procurement systems, project phases, and environmental uncertainties. The models represent an analytical form of a suitable combination of factors influencing procurement systems, which guide procurement decisions. Decision-makers will be able to use the models to differentiate between alternative delivery systems based on the magnitude of TCs associated with each system. The models will increase our understanding of how efficient procurement selection of construction projects can be achieved through useful procurement procedures, which could positively affect project performance and cost.

Researchers have developed several theoretical models for the procurement selection procedures in construction (NEDO, 1985; Skitmore & Marsden, 1988; Franks, 1990; Singh, 1990; Kumaraswamy & Dissanayaka, 1998; Alhazmi & McCaffer, 2000; Chan et al., 2001; Cheung et al., 2001). These models generally do not address the impact of uncertainties in the transaction environment and TCs on the procurement decision. This study introduces the potential use of transaction cost theory for identifying the link between procurement systems, project phases, environmental uncertainties, and TCs in construction. Further, the quantitative method presented has sought to provide empirical evidence of this link.

Finally, developing a model for procurement selection based on TCs could help to improve the procurement phase. Firstly this can be achieved, by identifying the service goals, objectives and priorities through better contractual agreements. Secondly, by identifying capacity development requirements through enhanced long-term strategic procurement approaches. Thirdly, by ensuring adequate funding through improved cost estimation. Finally, by defining the most feasible contractual approach under certain circumstances. Thus the study contributes to the research domain of procurement selection.

7.2 Major Findings

This study introduced a structural model to predict the key elements that contribute to higher TCs in construction, utilizing a SEM approach. Also, a structural model (Figure 5.30) was used to predict the relationship between eight constructs (latent variables). These include: - Information search, Project procurement, Contract administration, Contract enforcement, Transaction costs, Project phases, procurement systems, and Environmental uncertainties. Two structural models (Figures 6.1 and 6.2) were used, respectively the Traditional and Design-Build models, for comparison.

Construct reliability and validity were conducted as shown in Table 5.5. All constructs score Cronbach's alpha reliability more than the threshold of $\alpha > 0.7$. Also, the Average Variance Explained (AVE) was conducted and the results (Table 5.9) show that all constructs score more than the threshold of $AVE > 0.5$. The research hypotheses were tested, and out of the forty-three hypotheses only six of the null hypotheses were not supported (Table 5.17). Finally, six projects were used as experimental vehicles for testing the model, to calculate the time-spent by professionals in conducting procurement activities. The major findings are presented as follows.

7.2.1 Transaction Costs in Construction

This study finds that in Traditional procurement, it is the pre-contract costs (information and project procurement costs), which are higher than in the Design-Build systems. Similarly, the study finds that in the Design-Build procurement, it is the post-contract costs (administration and enforcement costs), which are higher than in the Traditional systems. The finding supports research e.g. Dudkin and

Valila (2005), Solino and Gago de Santos (2009), and Li et al. (2013) what states that pre-contract costs are higher in the traditional system and post-contract costs are higher in the design-build systems.

The TCs were calculated using the equations 6.1 to 6.14, and it was found that TCs in the Traditional systems amounts to **18.5%** of the total salary cost of a project manager (Case 2 on page 331), while in the Design-Build systems it amounts to **14.5%** of the total salary cost of a project manager (Case 5 on page 341). The findings of applying the models to 'real world' cases support Williamson's (1998) proposition that human and environmental uncertainties are the most contributors to higher TCs. Interestingly, this study quantifies TCs at the project level through estimating professionals' cost on conducting procurement activities, resulting in better cost estimates for the project.

The findings provide support for several related streams of research. Firstly, in determining the most suitable governance system (Winch, 2001; Müller & Seuring, 2007; Jobin, 2008). Secondly, in determining the most applicable delivery system (Lynch, 1996; Whittington, 2008b). Finally, in measuring and evaluating transaction costs in construction projects (Dudkin & Valila, 2005; Antinori & Sathaye, 2007; Ho & Tsui, 2009; Farajian, 2010; Solino & Gago de Santos, 2010). These related ideas are supported by the findings of this research that the magnitude of TCs is related to the pre and post-contract costs.

7.2.2 Transaction costs, Pre and Post-Contract Costs

This study finds that transaction costs is positively related to pre-contract costs (i.e. information costs and project procurement costs), and positively related to post-contract costs (i.e. contract administration costs and contract enforcement costs). Figure 7.1 shows the results of the analysis of the research model and hypotheses. “Information cost” such as information gathering and communication positively influences TCs (H2). The two aforementioned dimensions of information explained about 77% of the changes in information cost (Table 5.9 in Section 5.5.2.2). This finding supports the literature that associates the increase in TCs to higher information cost (Alchian & Demsetz, 1972; Müller & Seuring, 2007; Ho & Tsui, 2009; Poplin, 2010).

Further, information cost moderates the relationship between project procurement cost and TCs rather than having a positive effect on project procurement costs (H3). This finding is significant because project procurement costs are expected to have an impact on TCs apart from the cost of information. In the meantime, the relationship between information cost and TCs is fully mediated by the project procurement cost (H3a). The finding here resonates with Hobbs (1996) who found in a survey of small U.K. firms that systematic information improves cooperation among parties through out the firm’s supply chain.

“Procurement cost” such as attending meetings, project preliminary design, translation of client’s needs, site visits, training, and transition observation positively influenced TCs (H1). The six dimensions of procurement explained about 65% of the changes in procurement cost. This finding supports the literature that associates the increase in TCs to higher procurement cost (Bing et al., 2005; Dudkin & Valila, 2005; Whittington, 2008b; Solino & Gago de Santos, 2010; Li et al., 2013).

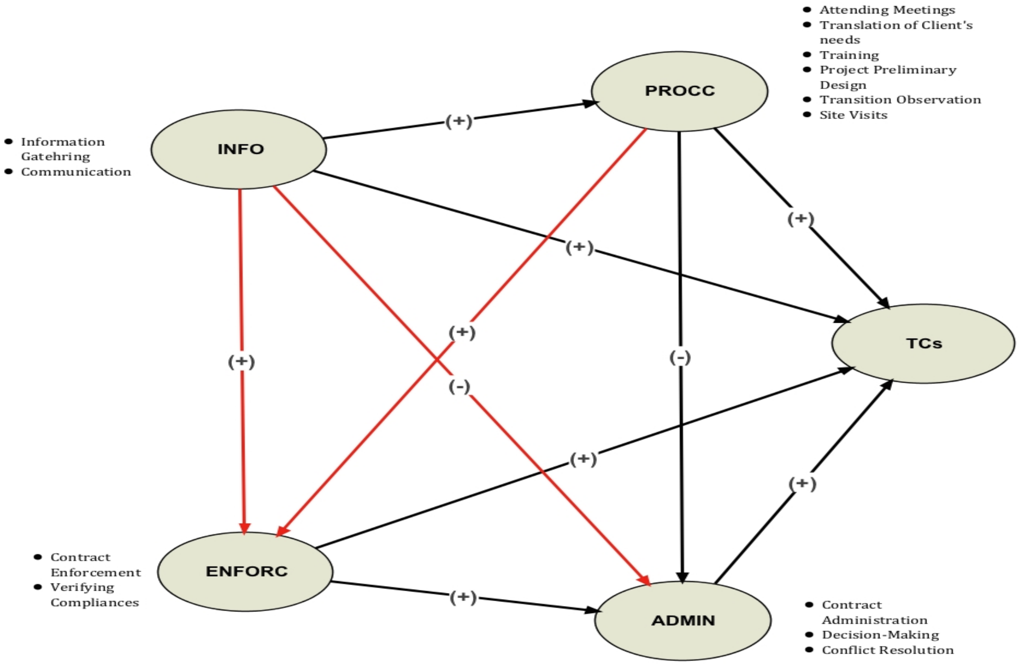


Figure 7.1: Transaction Costs, Pre and Post-contract Costs

Further, the procurement cost(s) partially mediated the relationship between information costs and TCs (H3a). Figure 5.33 shows that the relationship between information costs and TCs is stronger than the relationship between information cost and procurement cost, also it is stronger than the relationship between procurement cost and TCs. This is one of the major findings of this study because systematic information is positively affecting the ability of professionals conducting procurement process to fully define contingencies, which leads to a decrease in TCs. The finding supports Williamson's (1985) proposition that unsystematic information leads to higher TCs.

"Administration cost" such as contract administration, decision-making, and conflict resolution positively influences TCs (H4). The three dimensions of contract administration explained about 73% of the changes in administration. This finding supports the literature that associates the increase in TCs to higher administration cost (Foss, 2005; Williamson, 2005b). Further, the relationship between administration cost and TCs is moderated by enforcement cost. Enforcement cost would have a positive effect on the administration cost (H6) because administration cost mediates the relationship between enforcement cost and TCs. That is, the total effect of administration cost on TCs consists of a dominant direct effect and a secondary effect through enforcement cost.

This finding is important because enforcement generates disputes, documents, and information transfer (Winch, 1989; Arditi et al., 2000; Cox & Ireland, 2002; Bertelsen, 2003a, 2003b; Green et al., 2005; Ribeiro & Fernandes, 2010). These activities are main contributors to higher TCs that are reflected in administrative, technical, and professional staff growing at the expense of tradesmen and operatives (DETR, 1998; Williamson, 2005b; Lockyer & Scholarios, 2007; Whittington, 2008b; Li et al., 2012).

"Enforcement cost" such as contract enforcement and verifying compliances positively influences TCs (H5). The two dimensions of enforcement explained about 67% of the changes in enforcement cost (Table 5.9 in Section 5.5.2.2). This finding supports the literature that associates increase in TCs to professionals conducting enforcement activities such as verifying the compliances, renegotiation, dispute resolution, communication, and decision-making (Lynch, 1996; Tridico, 2007; Farajian, 2010; Williamson, 2010b). Further, the relationship between enforcement cost and TCs is fully mediated by the administration cost (H6a).

As shown in Figure 5.33, the relationship between administration cost and TCs is stronger than the relationship between enforcement cost and administration cost, and also stronger than the relationship between enforcement cost and TCs. This means that the cost of administration is fully mediated the relationship between enforcement cost and TCs. That is, the total effect of administration cost on TCs consists of a direct effect and a secondary effect through administration cost. The direct effect of enforcement cost on TCs and the indirect effect through administration cost were found to be both significant. The indirect effect of enforcement activities on TCs may provide an explanation for the findings of Alsagoff and McDermott (1994), who concluded that contractual incompleteness and opportunism are the root causes of conflicts and disputes between firms.

Further, this study examines the relationship between the pre and post-contract transaction costs (Figure 7.1). The study found that information cost would not have a positive effect on contract administration cost (H7), but it found that the contract administration cost positively mediates the relationship between information cost and TCs (H7a). This study also found that information cost would not have a negative effect on enforcement cost (H8), however the relationship between information cost and TCs was positively mediated by enforcement cost (H8a).

Finally, this study found that the procurement cost would not have a negative effect on contract enforcement cost (H9), but the relationship between procurement cost and TCs was positively mediated by contract enforcement cost (H9a). Also, this study found a negative effect of procurement cost on the contract administration cost (H10), and that contract administration cost mediates the relationship between procurement cost and TCs (H10a). This explains the relationship between the pre and post-contract transaction costs. This finding further supports Williamson's (1985) proposition that fully specified clauses at the pre-contract stage would minimize the post-contract cost.

7.2.3 Procurement System and TCs in Construction

This study finds that choosing the most suitable procurement system is significantly associated with information, project procurement, contract administration, and contract enforcement costs, also with environmental uncertainties.

At the pre-contract stage: - "Information cost" refers to the cost associated with gathering information such as technical, financial, and legal; and communication, to identify and evaluate potential trading partners (DETR, 1998; Dudkin & Valila, 2005; Lockyer & Scholarios, 2007; Whittington, 2008b; Solino & Gago de Santos, 2010). This study found that procurement systems have a positive effect on information cost (H11), also found that the relationship between procurement systems and TCs was fully mediated by information cost (H11a). "Procurement cost" is in effect the costs associated with preparing tendering documents such as attending meetings, project preliminary design, translation of client's needs, and site visits; negotiating; and writing a contractual agreement (Walker & Wing, 1999; Whittington, 2008b; Solino & Gago de Santos, 2010; Tang et al., 2010; Chinyio, 2011). This study found that procurement systems have a significant effect on the procurement cost (H12), in addition the project's procurement cost mediates the relationship between procurement systems and TCs (H12a).

At the post-contract stage: - "Administration cost" implies the costs associated with contract administration, decision-making, and conflicts resolutions (Williamson, 1985; Hobbs, 1996; Whittington, 2008b; Ho & Tsui, 2009; Solino & Gago de Santos, 2010). This study found that procurement systems similarly have a significant effect on the contract administration cost (H13), in addition, it found that the relationship between procurement systems and TCs was mediated by the contract administration cost (H13a). “Enforcement cost” refers to the costs linked with ex-post bargaining and sanctioning a trading partner that does not perform according to the agreement, and costs of monitoring the agreement (Williamson, 1985; Lynch, 1996; Tridico, 2007; Whittington, 2008b; Solino & Gago de Santos, 2010; Li et al., 2012). This study found that procurement systems have a substantial effect on the contract enforcement cost (H14), also it found that the relationship between procurement systems and TCs was mediated by the contract enforcement cost (H14a).

Furthermore, this study found that the differentiation between procurement systems is based on professionals’ time-spent in conducting procurement activities. A comparison between the traditional and design-build systems is introduced through two structural models; to estimate the time-spent in information search, project procurement, contract administration and enforcement. Thus, the time-spent in conducting these activities represents pre and post-contract transaction costs. For example, the pre-contract transaction cost because of project managers performing procurement activities in the Traditional systems will amount **11.14%** of the total salary cost of a project manager (Case 2 on page 291), while in the Design-Build systems it amounts to **6.7%** of the total salary cost of a project manager (Case 5 on page 300). Similarly, the post-contract transaction costs because of project managers conducting procurement activities in the Traditional systems will amount to **7.4%** of the total salary cost of a project manager, while in the Design-Build systems they amount to **7.8%** of the total salary cost of a project manager. The finding provides support for several related streams of research. For instance, Whittington (2008) finds that pre-contract transaction costs in the Traditional systems amount to 2.6% of contract value, while for the Design-Build systems amount to 2.2% of the contract value. Also, he finds that the post-contract transaction costs in the Traditional systems amount to 12.6%, while for the Design-Build systems amount to 9.5%. Meanwhile, this study is estimated the percentage of TCs in the annual salary cost of professionals, different from Whittington's study in which the percentage of TCs in the contract value was determined.

7.2.4 Environmental Uncertainties and TCs in Construction

"Environmental uncertainties" refer to institutions or forces outside the organization that could potentially affect the organization's performance. Political/legal/social, economic, competition, and technology are all examples of external uncertainties. While corporate culture, project location, finance, and ownership, and information systems are examples of internal uncertainties (Williamson, 1985; Wright & Race, 2004). Uncertainties affect the ability of contracting parties to fully specify the range of contingencies for unforeseen events that may disturb project success.

Consequently it becomes more costly to write a fully specified contract (Williamson, 1985; Brouthers & Nakos, 2004). This study finds that the impact of uncertainties in the transaction environment can be measured in terms of the coefficient loadings (Figure 5.33) between environmental uncertainties on one side and procurement systems, information cost, project procurement cost, contract administration cost, and contract enforcement cost on the other side. The eight dimensions of environmental uncertainties explained about 57% of the changes in uncertainties (Table 5.9 in Section 5.5.2.2). Figure 7.2 shows the results of the analysis of the research model and hypotheses.

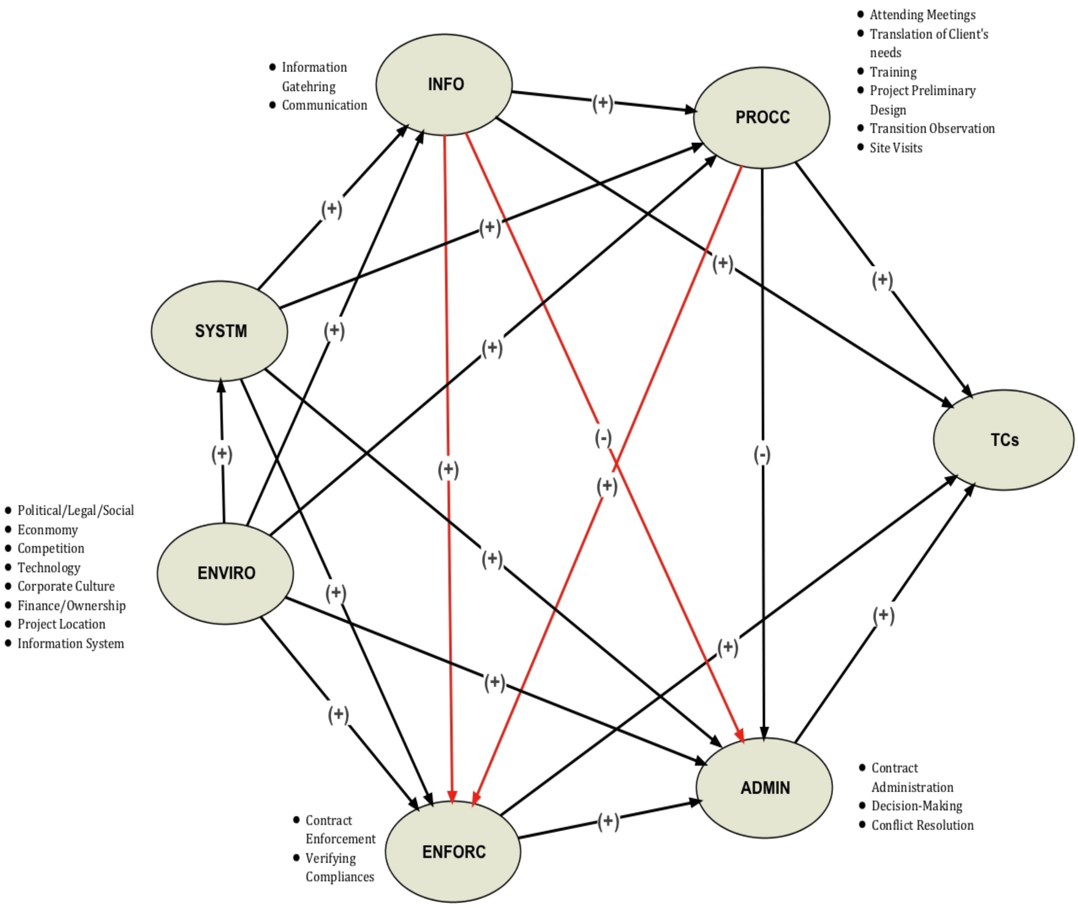


Figure 7.2: Environmental Uncertainties, Procurement System, and Pre and Post-contract Costs

This study found that uncertainties in the transaction environment have a substantial effect on information cost (H15). It also found that the relationship between environmental uncertainties and TCs was fully mediated by information cost (H15a). This result suggests that for unforeseen events surrounding a transaction, there are costs borne because of uncertainties such as information, negotiation, competitive etc. (Heide & Stump, 1995; Artz, 1999; Bajari & Tadelis, 2001b; Melese & Franck, 2005; Walker & Pryke, 2009). Walker and Pryke (2009) found that costs of identifying contingencies would increase rapidly because of environmental uncertainties. This finding further supports Williamson's (1998) proposition that human and environmental uncertainties are the largest contributors to higher TCs.

Further, this study found that uncertainties in the transaction environment have a significant effect on project procurement cost (H16). Also, the relationship between environmental uncertainties and TCs was fully mediated by project procurement cost (H16a). As mentioned above, it is hard to fully identify contingencies in an uncertain transaction environment, which leads to an increase in procurement costs such as negotiation, competitive advantage, meetings etc. (Wathne & Heide, 2000; Williamson, 2002; Walker & Pryke, 2008; Bajari et al., 2009). Brouthers and Nakos (2004) noted that it becomes more costly to write a fully specified contract and implementing the contractual agreements in an uncertain environment (Brouthers & Nakos, 2004). The result also supports Williamson's (1985) proposition that environmental uncertainties affect human ability to fully specified contractual agreements.

The direct effect of environmental uncertainties on administration cost was found substantially significant (H17). Also, the indirect effect of environmental uncertainties on TCs was found significant and fully mediated by contract administration cost (H17a). Williamson's (1985) stated that uncertainties in the transaction environment affect the ability of contracting parties to fully specify the range of contingencies, resulting in extra costs for example administration and management, enforcement, monitoring etc. According to Walker and Pryke (2009), the costs of identifying contingencies increase rapidly in uncertain environments because of professionals conducting procurement activities. This result suggests that environmental uncertainties have an indirect significant effect on the elements that contribute to higher TCs.

Further, this study found that uncertainties in the transaction environment have a significant effect on contract enforcement cost (H18), and the relationship between environmental uncertainties and TCs was fully and significantly mediated by contract enforcement cost (H18a). It is implied that risk and its allocation may be due to uncertainties in the transaction environment, which result in extra costs of enforcement and measuring/monitoring performance (Mitropoulos & Howell, 2001; Ibbs et al., 2003; Walker & Pryke, 2009). This result supports Williamson's (1981) proposition that the key factors in generating TCs are bounded rationality in the face of environmental uncertainties and complexity.

Prior research has identified that it is advantageous for organizations to account for uncertainties in the transaction environment in their strategies (Aaker & Mills, 2005; Aldrich & Ruef, 2006; Hitt et al., 2006; Artto et al., 2008; Daft, 2009). Dealing with environmental uncertainties is an essential success factors for a firm, which can avoid a great deal of trouble and conflict between contractual parties. The significance of this study is through quantifying the impact of uncertainties in the transaction environment at the project level by determining their effect on the pre and post-contract transaction costs. This study found that environmental uncertainties positively effect the selection of the most suitable procurement system (H24). This result will aid decision-maker in accounting for contingencies based on transaction cost theory in selecting the appropriate delivery system, which will lead to better project performance.

Finally, this study extends the theoretical models for procurement selection in construction (NEDO, 1985; Skitmore & Marsden, 1988; Franks, 1990; Singh, 1990; Kumaraswamy & Dissanayaka, 1998; Alhazmi & McCaffer, 2000; Chan et al., 2001; Cheung et al., 2001) through including the effects of environmental uncertainty. Uncertainties in transaction environment and their impact on TCs emanate to be the core construct in developing a model for procurement selection. A path analysis model or structural equation model (SEM) was developed utilizing Amos 21. In which the structural and measurement models were used to determine: - Firstly, the existence of a single latent independent variable as a result of a set of measurement items. Secondly, the relationship between the latent variables by means of the path direction and coefficients strength.

Thus, the effect of environmental uncertainties reported here add to existing empirical evidence that uncertainties in the transaction environment have a significant impact on the selection of the proper procurement system. Also, uncertainties in the transaction environment have different impact on different procurement systems. For instance, the Traditional model shows that environmental impact on the procurement system is significant at $\beta = 0.09$, while the Design-Build model shows that environmental impact on the procurement system is significant at $\beta = 0.24$. The two structural models for the Traditional and Design-Build systems (Figures 6.1 and 6.2) provide empirical evidence that uncertainties in the transaction environment have different impact on different procurement systems. This result confirms that environmental uncertainties have a significant effect on selecting the most suitable procurement system for a project.

7.2.5 Project Phase and TCs in Construction

"Project phases" indicates the steps need to be taken and checklist of responsibilities to verify the project runs as smoothly as possible (PMI, 2004). They help the clients to have cost-efficient development of a complete product or service. There are five phases throughout the project lifecycle in construction: initiation, development, early implementation, full implementation, and close project. The effect of project phases on TCs can be measured in terms of the coefficient loadings (Figure 5.33) between project phases on one side and procurement systems, information cost, project procurement cost, contract administration cost, and contract enforcement cost on the other side. Figure 7.3 shows the results of the analysis of the research model and hypotheses.

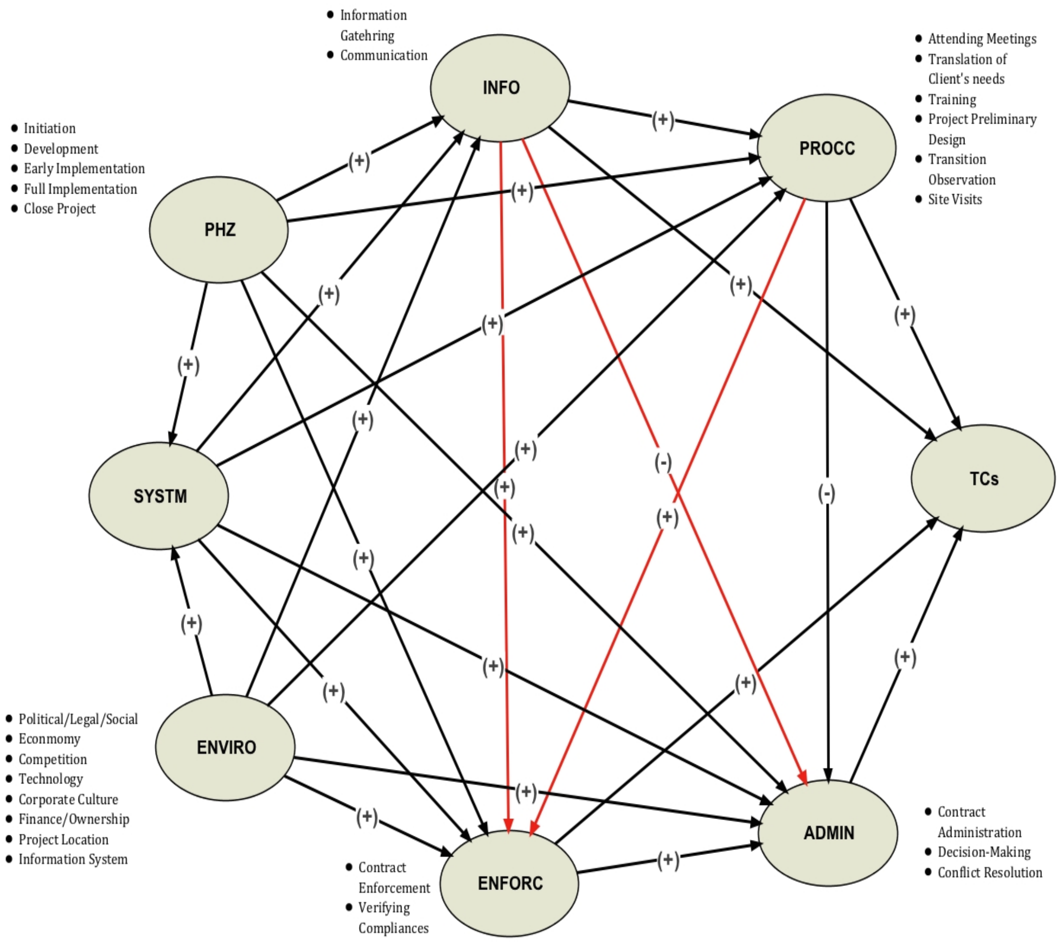


Figure 7.3: Project Phase, Environmental Uncertainties, Procurement System, and Pre and Post-contract Costs

This study finds that project phases affect the magnitude of TCs at the pre and post-contract stages. At the pre-contract stage, project phases were found to have a significant effect on information cost (H19) and project procurement cost (H20). Also, found that the relationship between project phases and TCs was fully mediated by information cost (H19a) and project procurement cost (H20a). At the post-contract stage, project phases were found to have a significant effect on contract administration cost (H21) and contract enforcement cost (H22). Also, found that the relationship between project phases and TCs was fully mediated by contract administration cost (H20a) and contract enforcement cost (H22a).

Further, the study found that project phases have a significant effect on the selection of the most proper procurement system (H23). This result supports Williamson's (2005) proposition about TCE in construction that an incomplete contract and design at the development phase leads to conflict and disputes during the execution of the contract. Therefore, it is anticipated that conducting procurement activities, during the development phase, contributed to higher pre-contract transaction costs. Finally, this study finds that environmental uncertainties have no indirect effect on project phases; therefore the procurement system would not mediate this relationship (H24a).

7.3 Implications of the Study

This section discusses three main sets of implications emanating from the study: theoretical, recent research context, and practical.

7.3.1 Implications for Theory

The findings of this study imply that transaction costs (TCs) are a resultant, but multi-dimensional phenomenon in construction management. Further, TCs can influence the selection of procurement systems in construction.

The first aspect is that TCs are a "resultant phenomenon" because it is associated with the costs at pre-contract stage (information cost and procurement cost) and with the costs at the post-contract stage (administration cost and enforcement cost). An implication that follows from this conceptualization is that TCs may influence procurement selection indirectly rather than directly. Stated differently, the adopted procurement system causes an increase in the cost of information, procurement, administration, and enforcement, which in turn increases TCs.

This study contributes to construction management knowledge by applying a new theoretical model for procurement selection based on TCs. The model is used to investigate and empirically demonstrate the influence of procurement systems on the magnitude of TCs in construction. It offers a new plausible explanation for the factors influencing TCs in construction project procurement.

The study is the first in construction management literature to quantify TCs in project procurement based on professionals' time-spent in conducting procurement activities. It provides two theoretical models (the Traditional and Design-Build) and six experimental cases: to demonstrate the cost impacts of different procurement systems, also to identify and estimate TCs for different procurement systems for the purpose of comparability. Transaction costs were decomposed into several categories of costs including information, procurement, contract administration, and contract enforcement. By identifying the cost impacts of different procurement systems, they may be more objectively compared.

The second aspect is that TCs are a " multidimensional phenomenon" because it links procurement systems, project phases, environmental uncertainties, information cost, project procurement cost, contract administration cost, and enforcement cost in a conceptual model for procurement selection. Previous research — Skitmore & Marsden (1988), Franks (1990), Kumaraswamy & Dissanayaka (1998), Alhazmi & McCaffer (2000), and Cheung et al. (2001) — on project procurement selection often provided information on advantages, disadvantages, and success factors. Although, such information is useful, it does not sufficiently provide an understanding of underlying principles and reasons for those outcomes. TCE was chosen to provide an understanding for the selection of the proper procurement system.

In this study, TCE was used as the basis for model development for procurement selection. To develop the model, TCs for project procurement were identified and categorized. Several categories for TCs including information, procurement, contract administration, and contract enforcement were identified and eventually measured and compared for different procurement systems. Previous researchers have noted the difficulty in identifying and measuring TCs such as Williamson (1975), Reve and Levitt (1984), Winch (1989), Lynch (1996), Tridico (2007), Whittington (2008), Solino and Gago de Santos (2010), and Li et al. (2012). In this study, TCs were measured on the basis of time-spent by professionals in conducting procurement activities. Further, a method for calculating TCs in two models (the Traditional and Design-Build) was introduced by applying the models to real-life cases.

This research finds that there is a substantial impact of environmental uncertainties (i.e. threats and opportunities) on selecting the appropriate procurement system for a project. Procurement in construction, however, primarily deals with the relationships between firms where contracts dictate these relations, and the way that construction work is organized, documented, and awarded. Further, the construction project is described as unique and complex which requires procurement process to be made for every single project, and there is no single procurement practice that suited all projects. TCE was chosen as an organization theory that appeared to have the most potential in providing an understanding of construction procurement. It helped explain how the adopted procurement systems affect the costs of pre and post-contract stages (i.e. information search, procurement, contract administration, and contract enforcement). This research developed a model that applied TCE to explain the relationship between procurement system, environmental uncertainties, and TCs.

7.3.2 Implications in recent Research Context

Utilizing the transaction costs paradigm has been the object of several investigations in construction. Researchers have applied the TCE perspective to a variety of construction topics. Firstly, in evaluating the project organization and in determining the most suitable governance structure (Winch, 2001; Müller & Seuring, 2007; Jobin, 2008). Secondly, in investigating construction contracting and sub-contracting (Eccles, 1981a; Gunnarson & Levitt, 1982; Reve & Levitt, 1984; Winch, 1989; Bremer & Kok, 2000; Bajari & Tadelis, 2001b; Turner & Simister, 2001; Miller et al., 2002; Aibinu et al., 2011). Thirdly, in determining the most applicable delivery system (Lynch, 1996; Whittington, 2008b). Finally, in measuring and evaluating transaction costs in construction projects (Dudkin & Valila, 2005; Antinori & Sathaye, 2007; Ho & Tsui, 2009; Farajian, 2010; Solino & Gago de Santos, 2010).

Lynch (1996) applied TCE as an organizational theory, based on TCs characteristics, to develop a framework model for selecting the most suitable delivery system. While, Dudkin and Valila (2005) applied TCE to evaluate the pre and post-contract costs for different delivery systems. The implications of the current study are somewhat different to those of Lynch and Dudkin & Valila. The findings here imply that TCE, which constitute that the firm is an economic entity, can be used for examining the linkage between factors influence organizational structure, procurement systems, and TCs in two ways: -

Firstly, this study found that factors which influence organizational structure, such as environmental uncertainties, could lead to incomplete contracts, which in turn could escalate conflict and disputes that generate further TCs. According to Pugh (1990), organizational structure is made up of “regularities in activities such as task allocation, coordination, and supervision” within an organization which is “directed towards the achievement of given aims”. In construction, uncertainties in the transaction environment lead to professionals conducting administration and procurement activities.

This study found a mechanism for procurement selection based on TCE, by finding the relationship between the factors influencing the organization structure (i.e. environmental uncertainties), procurement systems, and TCs. Another implication of this study is the ability to determine TCs at the individuals’ level, by estimating the professionals’ time-spent in conducting administration and procurement activities. This will lead to better-cost estimates for the project.

Secondly, this study found that external (threats) and internal (opportunities) factors that influenced the governance structure could lead to information impactedness. That is, information impactedness refers to the situations where it is difficult to ascertain what the costs to information are (Williamson, 1981, 2002). This study found that uncertainties about threats including political/legal/social, economical, technological, and competition influence the elements of TCs; i.e. the costs of information, procurement, administration, and enforcement. Also, this study found that uncertainties about opportunities including corporate culture, finance/ownership, project location, and information systems also influence the elements TCs.

The implications of this research are the ability to determine the relation between uncertainties in the transaction environment, procurement systems, and the elements of TCs. However, this study also found when uncertainties in the transaction environment were high, the costs of information, project procurement, contract administration, and contract enforcement were also high. Thus, this study complements the TCE approach to research in construction procurement by showing that uncertainties in the transaction environment have a significant effect on selecting the proper procurement system. That is, according to organization theory of TCE the procurement system could influence organizational structure. The reason is that organizational structure combines the effect of the environment and regularities in activities such as task allocation (procurement activity) and coordination (information sharing).

7.3.3 Implications for Business Practice of TCs

The findings of this study suggest some practical issues that decision-makers in the New Zealand construction industry should consider.

TCE has traditionally examined the customer-supplier relationship in the context of a contractual arrangement. In the construction industry, the relationship between procurement strategies, contractual arrangements, and tendering procedures is not always articulated and that contractual arrangement is often dictated by the procurement strategy (Hackett et. al., 2007; Hughes et al., 2006; Murdoch & Hughes, 2008). Thus, selecting the suitable procurement system is a strategic decision in construction. As stated above, the procurement selection is grounded on the advantages, disadvantages, and success factors of each system. TCE was chosen to provide an understanding of underlying principles and reasons for procurement selection. By determining TCs for different procurement systems in construction projects, some practical issues that construction industry decision-makers in New Zealand and elsewhere should be considered.

This research finds there is a significant relationship between procurement systems, environmental uncertainties, and TCs for construction projects under a variety of contingencies. The finding has implications for the business practice of construction projects that are relevant because the research was empirical in nature, relied on construction professionals experience, case studies, and feedback. Also, the research was based on a robust theoretical framework (Figure 7.3) that illustrated the impact of TCs on the procurement selection, and the associated practice in construction projects. It allowed the organizational and economic implications of TCs to be assessed, which demonstrates how the adoption of the TCs perspective alters the organizational dynamics of the construction and procurement selection process.

The practical implication is that this framework (Figure 7.3) will inform strategic thinking in regard to the relationship between information search, procurement, contract administration and enforcement, procurement systems, and environmental uncertainties. Solely focusing on the design of formal procurement processes and procedures is not enough for cost savings, minimizing claims, and reducing conflict and dispute. There is a need to consider the interaction of uncertainties in the transaction environment, and the costs of information, procurement, contract administration, and contract enforcement.

The conclusion here is that considering these factors in the procurement selection process and/or make-or-buy decisions lead to the minimization of TCs and enhance the performance of the construction industry. In addition, by understanding the impact of procurement's decisions on TCs should allow clients to be more effective in their selection of appropriate delivery mechanisms for their infrastructure needs.

Another practical implication is that the framework illustrate the moderating (interacting) effect of: - *First*, the project procurement cost, contract administration cost, and contract enforcement cost on the relationship between information costs and TCs. *Second*, the contract administration cost and contract enforcement cost on the relationship between project procurement cost and TCs. *Lastly*, the contract administration cost on the relationship between contract enforcement cost and TCs. The moderation effect is a phenomenon that provides a practical implication to decision-makers on cost drivers of the significant TCs, specifically those related to information search, procurement, contract administration, and contract enforcement.

For instance, early involvement of the contractor in the procurement phase improves coordination between contractual parties. This is reflected in information transfer (technical, financial, etc.) and better communication, which lead to the reduction in information and procurement costs, and reducing conflict and disputes. According to Chang and Ive (2000), incompleteness and uncertainties in information, for example materials prices, increases the likeliness of the contractor restoring opportunistic claims to recover their loss. Consequently, increasing the frequency of quality inspection, and hiring more staff involved in conducting quality control activities that lead to higher enforcement cost. This is another implication of understanding firms' motivation to choose amongst alternative procurement systems.

Further, another practical implication is the mediating (intervening) effect that the framework illustrates in Figure 7.3. The intervention of costs of information, project procurement, contract administration, and contract enforcement on the relationship between environmental uncertainties and TCs are phenomena of practical significance. Uncertainties in the transaction environment increase the threats of opportunism and bounded rationality. For instance, the high level of uncertainties in the transaction environment that force contractors to exaggerate their bids, number of claims, disputes and disagreement with clients and considerable amount of extra work. These issues are exposed in antagonistic relationships between the contractors and owners, which are reflected in extra costs of information, procurement, administration, and enforcement hence increasing TCs.

The practical implication here is that reducing TCs because of uncertainties, the client should be prepared to deal with project complexity, clear risk allocation strategy, fair competition among bidders, make sure the design is as complete as possible, and encourage early contractor's involvement in the project. The findings of this research provide a framework for the relationship between environmental uncertainties, procurement systems, and TCs that aid the clients in mitigating the potential risk of uncertainties during the procurement process, which thereby improves operational performance.

7.4 Recommendations

The objective (7) of this research is to recommend methods of administering transaction costs in construction procurement in New Zealand. Based on the results obtained from: hypotheses testing (Table 5.17), the indicators of the constructs of the study (Figure 5.32), and applying the model to real-life cases (Cases 1 to 6 in Section 6.3), the following sub-sections setout recommendations for the clients undertaking construction and the procurement process. Also, some recommendations for future research are discussed.

7.4.1 Recommendations to Clients

The factors loading of constructs used in the developed model (Figure 5.32) indicate a strong linkage between procurement systems, environmental uncertainties, project phases, and TCs. Each construction project is unique and suitable strategies should be developed, such as procurement, to handle particular TCs in the transaction mechanism associated with the project. Procurement process has to begin from scratch for every single project, which means the TCs — because of professionals conducting procurement activities — should be considered in the costs estimate during the procurement process for the project. According to Williamson (2008), understanding the key characteristics of a transaction can help decision-makers improve the design of contracts, organization, and other governance structure that could reduce TCs and improve gains from an exchange between buyers and sellers.

At the pre and post-contract stage, there is a strong positive relationship between the procurement systems, environmental uncertainties, project phases on one side and information, project procurement, contract administration and contract enforcement costs on the other side (Figure 5.32). This exposes the importance of leadership, decision-making, claims administration, and conflict management. Thus, the clients may consider theses factors when appointing project managers, claims officers, and consultants for their projects. It is also important that the contract be as complete as possible by including clauses in the contract for contingencies. These actions will significantly reduce TCs, as per the factor loading shown in Figure 5.32, because of the strong positive relationship between contract administration cost and TCs.

Further, the procurement cost is attributable to environmental and technical uncertainties connected to projects, hence, to provide some certainty to project details, it is necessary to undertake environmental assessments, feasibility studies, preliminary design, preparation of tender documents, bargaining, and training. The client can make sure the engineering design is as complete as possible before bids are sought from contractors, which in turn reduce the uncertainties in the construction process. This means fewer change orders and fewer claims. However, there is a tradeoff between completeness of engineering design and TCs. The more complete the engineering design, the longer it takes the client to be in a position to seek bidders.

In addition and as mentioned before, the client can adopt a strategy for project delivery that allow the contractor to be engage in the early stages of design. The early engagement of the contractor in the design stage can potentially eliminate disputes in the construction phase. Also, it is important to suggest that items standardization in the construction operations may simplify this operation. These actions can lead to enhancing constructability, reducing design flaws, and reducing the frequency of claims and change orders.

Finally, the client can adopt a clearly defined risk allocation/sharing strategy in his project procurement, by agreeing to share some of the risk with contractors. Transferring all risks to contractors may involve extensive bonding and insurance coverage, which means involves extra TCs. By adopting a risk-sharing strategy with contractors, the client might reduce excessive TCs. As shown in the factor loadings (Figure 5.32), it is the high level of environmental uncertainties that increases the costs of information, procurement, administration, and enforcement. This is reflected in extra costs that clients deliver to suffer because of contractors jack up their bids, file numerous claims, more disputes, and extra work or rework.

7.4.2 Recommendations for future Research

The primary goal of this research was establishing new directions for determining TCs in the construction procurement in New Zealand. The framework and models developed in this study open up many possibilities for exploration in future studies.

Firstly, this study determines the in-house TCs or in the perspective of the client. By estimating the professionals' time-spent in conducting procurement activities during the pre and post-contract stages. It is important for future research to determine the out-house TCs or in the perspective of the contractor.

Secondly, this study establishes framework models for calculating TCs in the traditional and design-build systems for the purpose of comparability. It is useful in a position for future research to have TCs calculations for most of procurement systems used in construction and make comparison among them.

Thirdly, the models presented in this study are to examine the linkage between procurement systems, project phases, environmental uncertainties, and TCs at the project level. The models were applied to real-life cases, and TCs were calculated on the basis of factor loadings. For a wider image on TCs, it is essential for future research to develop models for determining TCs at the organizational level.

Finally, the environmental uncertainties addressed in this study are those who influenced the organizational structure, specifically the procurement decision. However Winch (1989) differentiates between task uncertainty, natural uncertainty, organizational uncertainty, and contracting uncertainty. It will be useful if future research conducting analysis on the influence of different sets of uncertainties on TCs and then on the procurement decision.

7.5 Contributions to Existing Body of Knowledge

Several contributions to knowledge in construction management were made by this research related to applying the TCE concept in construction. The following represent a summary of the major contributions of this research.

First, a framework was developed for identifying the relationship between procurement system, environmental uncertainties, project phase and TCs. Procurement system influences the associated TCs at pre and post-contract phase. At the pre-contract phase, procurement system is significantly influencing the costs of information search and project procurement. Whereas at the post-contract phase, procurement system is significantly affect the costs of contract administration and enforcement. Similarly, uncertainties and project phase have a substantial effect on TCs.

Second, models were developed utilizing Structural Equation Modeling (SEM), to demonstrate impact of different procurement systems on TCs at the project level. Transaction costs at the project level were classified into several categories of costs including information, procurement, administration, and enforcement. Procurement systems were objectively compared on the basis of their impacts on TCs. This is a new Knowledge in construction management.

Third, organization theory of TCE was applied to develop the framework and models for procurement selection. Previous models on procurement selection process in construction provided information on advantages, disadvantages, and success factors. Although the information was useful, but deficient in providing an understanding of underlying principles and reasons for procurement selection. TCE was used to provide an understanding of the impacts of different construction procurement on TCs. Also, TCE has the most potential, among organization theories, in providing understanding of construction project as one economic entity.

Fourth, transaction costs in construction procurement were identified and classified. TCs were used as a basis for the framework and models developed for procurement selection. By identified and classified TCs, this research manages to measured and compared TCs for different procurement systems. Previous researchers such as Winch (1989), Lynch (1996), Dudkin and Valila (2005), and Li et al. (2103) have noted difficulty in identifying and measuring TCs in construction. This research has increased the understanding of the extent of TCs as well as the most common types occurring at construction procurement.

Fifth, an appropriate method was used for measuring the constructs in the models and determining the interrelationship between them. The constructs included in the models were estimated through two survey questionnaire: First, a wide range survey was conducted to collect data for estimating TCs in different procurement systems (traditional and design-build), and to evaluate the impact of environmental uncertainties on TCs. Second, a survey was conducted to project managers working in selected cases, four project procured in traditional way and two procured in design-build, to apply the developed models to real-life cases.

Sixth, regression equations were formulated for calculating TCs based on the factor loadings in the developed models. As mentioned above, this is the first research in construction management that measures and evaluates TCs in construction procurement. By evaluating the extent of TCs in the cost salary of construction professionals such as project managers, the decision-maker now knows where attention is most need for a better project cost estimate.

7.6 Limitation of the Study

There were several limitations to the research including the framework and models developed, the research methods used, and the theories that formed the basis of the research.

7.6.1 Limitation of the Theoretical Framework and Models

First, the framework and models that developed in this study take the viewpoint of the client. For instance, uncertainties of contractors' behavior such as opportunistic behavior are prone extra transaction costs. The models developed in this research do not take this into account.

Second, some concepts from transaction cost economics have not translated into variables in the models. According to Williamson (2010) four key characteristics of transactions can make them more costly: complexity, uncertainty, frequency, and asset specificity. This study addresses only two of TCE characteristics: uncertainty (environmental) and asset specificity (human asset) in developing models based on TCs for procurement selection. Therefore, some concepts of TCE theory may not be translated clearly in the models. But, the path models developed in this study provide explanations of the relationships between the observed variables, i.e. procurement systems, environmental uncertainties, and TCs.

Third, the framework and models only consider the procurement process at the project level. The planning and management at the organizational level have not been included in the models. Eventually these two management activities should be included to provide a more complete picture of TCs at the construction organizational level.

Fourth, possible factors' impact such as payment method don't included in the framework and models. The effect of contract payment methods may be used effectively to reduce the impacts of opportunism and uncertainties, which in turn reduce TCs. Payment strategies such as lump sum, unit price, and cost plus are factors that reduce uncertainty and opportunism in the transaction environment.

Fifth, the framework and models don't consider possible combinations of procurement delivery systems. For example, a procurement strategy using the Design-Build system for certain stages in the project lifecycle, while using the traditional system for the rest of the construction process. The models consider one generic type of procurement system against another.

7.6.2 Limitation of the Research Methods

In this research, the technique utilized for data collection is survey base technique (general and experimental cases). Although, the methods selected were appropriate for social science research (construction management), there were several limitations to the measuring and testing the variables in the developed models.

First, the self-reporting technique was susceptible to social desirability bias in measuring the items to be surveyed. This research asked professionals to evaluate the time-spent in conducting procurement activities for the traditional and design-build systems. Respondents may have more experience in one type of procurement system than the other, which biased the professionals to answer inaccurately.

Second, the results of the model evaluation may not be generalizable to all situations. The models in this research were developed in certain time and conditions, and the results may not be generalizable to all projects. However, testing the models for validity shows all variables score above the threshold level of $\alpha > 0.7$. Also, testing the models, using Amos 21, for goodness-of-fit also score high levels. The only concern is the relative Chi-square value, which is the ratio of Chi-square (χ^2) over the degree of freedom *(df)* that should be $\boldsymbol{\chi^2 / df < 5.0}$. The reasons behind high value of the relative Chi-square are the technique used for evaluation using a 5-point Likert scale and the sample size. The response rate (20%) for this study was satisfactory but not as large. The usable data obtained from a population of 360 is 72. The sample size for good model fit using Amos 21 prefer to be as high as possible depends on the number of the endogenous (measured) variables.

Last, this research applied the developed models to real-life cases compared only two procurement systems the traditional and design-build. Also, two cases out of six were used for comparison, and both cases were infrastructure projects. Although, this practice provides evidence for the generalizability of the results, it may increase the validity of the results if the research manages to use multiple cases (residential, commercial, etc. projects) to apply the developed models. Also, evaluation of procurement systems should consider trade-offs in costs between the different transaction costs and production costs, to validate the results obtained from comparing TCs for different procurement systems.

7.6.3 Limitation of TCE theory

TCE is useful in explaining clients-contractors relationships in the context of contractual agreements. The theory has the potential to incorporate other organization theories such as resource-based view. In construction, this theory is more inclusive to be applied than other theories, and it fits perfectly with construction management. However, there were some limitations when applying the TCE in construction.

First, the TCE perspective is developed for the make-or-buy decision in manufacturing. In construction it takes a different perspective. It focuses in examining the clients-contractors relationship in the context of contractual agreements. The construction industry is categorized as a combination between servicing and manufacturing industry. Most clients use single delivery system for their projects. Therefor, integrating additional capabilities within a single firm is the owner's decision. Therefor, the tradeoff decision between transaction costs and production costs is not made at the project level.

Second, the TCE perspective focuses on the cost associated with writing and enforcing the contract such information, procurement, administration, and enforcement. Although this is a large cost for construction, most construction contracts are currently standardized such as NZS 3910:2013, which minimize the cost of writing the contract. There are might be other costs that not emphasized by

Williamson (1975, 1981, 1998, 2008), for example the team's experience working together and its effects on construction capabilities, information and communication, and team behavior. Also, Williamson (2008) discussed buffers in terms of inventory when applying TCE in supply-chain management. In construction, it may be that time buffers between the design and construction phases may be a significant contributor to higher TCs for some type of facilities. This is because the aim of buffers is to generate a plan that protects against uncertainties and reduces the potential impact of construction changes. However, this process often fails in optimizing the project schedule that is resulting in uncertainty time wastage i.e. increases TCs.

Third, the TCE perspective assumes that TCs can be minimized when they are moved within a single firm. Although this is an important issue, it is the individuals within the firm who sometimes behave opportunistically. These actions lead to increase in TCs. Therefore, it is important to compare the total costs of delivery systems when implementing such strategies for reducing TCs.

Last, when applying the TCE perspective in choosing an appropriate procurement system, the focus is usually on cost, quality, and time. Although, these factors are important in construction management there are other factors that also important such as the client priorities, level of involvement, and flexibility of the construction process. These factors may be more important for the client in some cases than the total project costs. Thus, it is important to include the owner's role in the transaction and then TCs because of this involvement when developing a model for the procurement selection process.

7.7 Concluding Remarks

Construction projects are described as unique, complex, uncertain, and high-risk. In such an environment, questionable decisions on planning and design can be made in the pre-contract phase, and disagreements, change orders, claims, conflicts, and disputes can occur in post-contract phase. In addition, because of the one-off production operation in construction, the procurement process has to begin from scratch every time the client purchases a good or service. These problems contribute to increase TCs in project procurement.

Many researchers have attempted to assess the impact of TCs on the procurement decision in different topics in construction. For example, in evaluating the project organization and determine the most suitable governance structure; in investigating construction contracting and sub-contracting; in determining the most applicable delivery system; and in measuring and evaluating transaction costs in construction projects. Although, previous work on applying the TCs concept in construction provide useful information, but there have been only a few studies attempting to quantify TCs in construction. This research established through relevant literature a thorough compilation of the definition of client-borne TCs in project procurement by joining the views of previous researches, and an empirical study was conducted to find the impact of procurement systems on TCs. The overall aim was investigating the linkage between procurement systems and TCs in the New Zealand construction industry. Issues around estimating TCs in project procurement were systematically addressed through a mixed methodological approach.

The research project is a unique study in New Zealand that quantifies TCs in construction procurement, and there has been no research before empirically estimate TCs of construction procurement. This study looks outside traditional construction practices to other fields of study especially organization theory. A better balance of best practices with insightful theories would benefit the construction industry. Also, the current research estimates TCs at the individuals level, different from Dudkin and Valila (2005) in the UK infrastructure projects and Whittington (2008) in the US infrastructure projects.

The findings of this research support Williamson's (1998) proposition that human and environmental uncertainties are the main contributors to higher TCs. It was found that TCs in the Traditional systems amounts to **18.5%** of the annual salary cost of a project manager. That represents **11.1%** at the pre-contract phase, and **7.4%** at the post-contract phase. While in the Design-Build systems it amounts to **14.5%** of the annual salary cost of a project manager. That represents **6.7%** at the pre-contract phase, and **7.8%** at the post-contract phase. The findings also in line with Wittington's (2008) and Dudkin's (2005) findings. It will provide useful information for decision-makers on TCs in project procurement.

Accordingly, the client can minimize the TCs through: *Firstly,* simplify the construction operation by items standardization. *Secondly,* verify the design as complete as possible before the construction begins; hence reduce uncertainties in the construction operation. *Thirdly,* minimize professionals' involvement in the procurement process. *Fourthly,* confirm the contract as complete as possible by account for contingencies. *Lastly,* efficient and effective project management practices through strong leadership, decision-making, administration, and conflict management.

It is anticipated that reducing transaction costs may contribute to improve cost estimate for the project. Also, improve the procurement process through better contractual agreements, enhance long-term strategic procurement approaches, improve cost estimation, and defining the most feasible contractual approach under certain circumstances. This will help in improving the performance for construction projects and contribute to the 20% target of productivity improvement for the construction industry in New Zealand by the year 2020.

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Appendices

APPENDIX A1: Ethical Approval

A U T E C
S E C R E T A R I A T

22 March 2013

John Tookey
Faculty of Design and Creative Technologies

Dear John

Ethics Application: 13/33 Impact of procurement system on transaction cost economics: Future organisational structure in the construction industry.

Thank you for submitting your application for ethical review. I am pleased to advise that the Auckland University of Technology Ethics Committee (AUTEC) approved your ethics application at their meeting on 18 March 2013.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

I look forward to hearing from you,

Yours sincerely

Executive Secretary
Auckland University of Technology Ethics Committee

Cc: Mohammed Rajeh mrajeh@aut.ac.nz

APPENDIX A2: Participants' Information Sheet

Participant Information Sheet

Date Information Sheet Produced:

13 Feb. 2013

Project Title

Impact of Procurement System on Transaction Cost Economics: Future Organisational Structure in the Construction Industry

An Invitation

My name is Mohammed A. Rajeh. I am a doctoral student with the School of Engineering, Faculty of Design and Creative Technologies, Auckland University of Technology. The interest area for my doctoral research is to investigate the relationship between procurement systems and transaction costs (Overhead costs) in construction.

Procurement systems implemented on any project have a significant impact on the transaction costs associated with pre and post-contract phases. These costs may be determined through evaluating the time spent by professionals in conducting procurement activities during various project phases. I am interested in two common forms of procurement for comparison: Traditional and Design–Build. The intent of the research is to determine transaction costs for different procurement systems. Thereafter to develop a model to help with the selection of the most appropriate procurement system that minimizes transaction costs.

I would like to invite you to participate in my research by completing a questionnaire online at https://www.surveymonkey.com/s/mrajeh. Please note your participation in this survey is voluntary and by completing this questionnaire you are consenting to participate in the survey.

What is the purpose of this research?

This project aims to investigate the relationship between procurement systems and transaction costs, and its impact on the procurement selection process in construction. Traditional and Design–Build systems will be used for the purpose of comparison. The magnitude of transaction costs will be measured by the time spent by professionals in conducting procurement activities during project phases. These include phases such as concept, development, early implementation, full implementation, and project close.

How was I identified and why am I being invited to participate in this research?

You have been selected randomly from key personnel within the construction industry. You are requested to provide your views about procurement process, transaction costs, and organisational structure in your construction firm.

What will happen in this research?

This project investigates the linkage between procurement systems adopted and transaction costs associated with this adaptation in the New Zealand construction industry. The procurement process provides opportunities for cost reduction and value enhancement to project owners. Moreover the selection of appropriate procurement systems for a construction project may influence its success or failure. There is a current and pressing need to examine the relationship between the procurement system and transaction costs in the New Zealand construction industry. Recent studies have shown that the New Zealand construction industry has poor productivity. Broadly, this recognition has led to extensive efforts to achieve a 20% increase in productivity by 2020. Since productivity is a function of cost versus revenues, developing and improved the understanding of the basis of costs offers the potential to affect construction productivity. With an appropriate transaction cost-based framework, procurement could be improved by evaluating the hidden costs of managing contractual relationships.

A questionnaire is being conducted among New Zealand construction professionals who are dealing with project management as well as with procurement management. You have been identified as a person who can provide valuable information for this research, and your observations will be critical to the success of this project.

What are the discomforts and risks? How will these discomforts and risks be alleviated?

The only “discomfort and risk” associated with this research are limited to privacy and confidentiality. All responses will be treated in strict confidence and the information you provide will be used solely for this research. The survey is anonymous, and I will never know who you are. Also you don’t have to answer any question you do not wish to.

What are the benefits?

The findings from this project will allow the determination of transaction costs for different procurement systems. Long term it may lead to the possibility of establishing a better measure of total transaction costs in procurement. Understanding transaction costs will allow clients to make “smarter” decisions in their selection of procurement system. This will enhance the performance of the construction industry. Some other contributions include:

- A structured mapping and quantification of transaction costs associated with construction processes.
- Understanding of a firm’s motivation to choose among alternative procurement systems.
- Guidance procedures that will help clients and project managers to reduce costs of procurement.
- Improved operational practices to mitigate potential risk and improve operational performance.
- A framework model explaining the relationship between transaction costs and procurement systems.

The research is in partial fulfilment of a PhD award to the researcher on completion of this project.

How will my privacy be protected?

This research does not seek to gather personal information from participants. The questionnaire is anonymous.

What are the costs of participating in this research?

The cost associated with your participation is the time involved. The questionnaire will take between 10 and 12 minutes to complete.

What opportunity do I have to consider this invitation?

Please take a few days to consider this invitation. If you require further information or clarification on any aspect of the research, contact Mohammed Rajeh (021) 2600195, email: mrajeh@aut.ac.nz

Please do remember that your participation in this research is voluntary.

How do I agree to participate in this research?

If you decide to participate in this research please complete the questionnaire at https://www.surveymonkey.com/s/mrajeh. Your completion of the questionnaire will be considered as your consent.

Will I receive feedback on the results of this research?

A summary report of the findings will be available on request. However the full report will be available as a thesis accessible at the AUT library.

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 Supervisors, Associate Professor John Tookey, Construction Management Programme, School of Engineering, Auckland University of Technology, ph. (09) 921 9512, email: john.tookey@aut.ac.nz and Dr. James Rotimi, Construction Management Programme, School of Engineering, Auckland University of Technology, ph. (09) 921 9512 email: jrotimi@aut.ac.nz

Concerns regarding the conduct of the research should be notified to the Executive Secretary AUTEC, Dr Rosemary Godbold, rosemary.godbold@aut.ac.nz, ph. (09) 921 9999 ext 6902

Whom do I contact for further information about this research?

Researcher Contact Details:
Mohammed Rajeh Construction Management Programme, School of Engineering, Auckland University of Technology, ph. (021) 2600195, email mrajeh@aut.ac.nz

Project Supervisor Contact Details
Professor John Tookey, Construction Management Programme, School of Engineering, Auckland University of Technology, ph. (09) 921 9512, email: john.tookey@aut.ac.nz

Dr. James Rotimi, Construction Management Programme, School of Engineering, Auckland University of Technology, ph. (09) 921 9512, email: jrotimi@aut.ac.nz

Approved by the Auckland University of Technology Ethics Committee on *March 2013*, AUTEC Reference number 13/33.

APPENDIX A3: Participants' Consent Form

Consent Form

For use when focus groups are involved.

AUT UNIVERSITY TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

Project title: ***Impact of Procurement System on Transaction Cost Economics: Future Organisational Structure in the Construction Industry***

Project Supervisor: ***Prof. John Tookey***

Researcher: ***Mohammed A. Rajeh***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated *dd/ mm/ yy*
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that identity of my fellow participants and our discussions in the focus group is confidential to the group and I agree to keep this information confidential.
- ○ I understand that notes will be taken during the focus group and that it will also be audio-taped and transcribed.
- ○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- ○ If I withdraw, I understand that while it may not be possible to destroy all records of the focus group discussion of which I was part, the relevant information about myself including tapes and transcripts, or parts thereof, will not be used.
- ○ I agree to take part in this research.
- ○ I wish to receive a copy of the report from the research (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 March 2013* AUTEC Reference number 13/33**

APPENDIX B1: Survey to Focus Group

Questionnaire

Section A: General questions

Note: For questions 1-9, please tick

1. *What is your company's main area of activity?*

- ☐ Housing
- ☐ Commercial
- ☐ Industrial
- ☐ Infrastructure

2. *What is your professional role in the construction process?*

- ☐ Architect
- ☐ Engineer
- ☐ Surveyor
- ☐ Project Manager
- ☐ Construction Manager
- ☐ Client

3. *Do you have any professional accreditations?*

- ☐ None
- ☐ BRANZ
- ☐ PMI
- ☐ CIOB

4. *How many years have you been in the construction industry?*

- ☐ 0-5 years
- ☐ 6-10 years
- ☐ 11-20 years
- ☐ 21-30 years
- ☐ 30^+ years

5. *On how many projects have you been involved in the procurement process?*

- ☐ One
- ☐ Two
- ☐ Three
- ☐ Four
- ☐ More; please specify:………..

6. *What is the most common contract value for the project as a whole that you usually work on?*

- ☐ Less than $1 million
- ☐ $2 - $5 million
- ☐ $6 - $10 million
- ☐ $11 - $20 million
- ☐ $21 - $30 million
- ☐ $30⁺ million

Please indicate your agreement level for the following statements:

~~7. *The current procurement process adds significantly more time onto procurement compared with a more traditional route.*~~ ***Deleted***

- ~~☐ Strongly agree~~
- ~~☐ Agree~~
- ~~☐ Neutral~~
- ~~☐ Disagree~~
- ~~☐ Strongly disagree~~

8. *The current procurement process is ineffective and should be changed?*

- ☐ Strongly agree
- ☐ Agree
- ☐ Neutral
- ☐ Disagree
- ☐ Strongly disagree

9. *If you could change one aspect of the current procurement process, what would it be?*

10. *Please add any further comments/clarifications that you feel necessary.*

Section B: Transaction costs and Procurement Systems

Note: The aim is to evaluate the overhead costs (TCs) incurred during the procurement process. TCs are information costs, administration costs, procurement costs, and enforcement costs.

A. Please evaluate how much time is spent daily in executing procurement activities relative to other project activities, comparing Traditional and Design – Build contracts.
Please rate on Likert-Scale of 1-5 (1: very low, 2: low, 3: neutral, 4: high, and 5: very high)

1. *Attending Meetings*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Attending Meetings	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

2. *Communicating (Phone calls, letters, reports, e-mails, etc.)*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Communicating	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

3. *Information gathering for market, technical, supplier, and legal*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Information Gathering	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

4. *Translation of client's needs*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Translation of Client's needs	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

5. *Training*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Training	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

6. *Project preliminary design*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Preliminary Design	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

7. *Conflict resolution*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Conflict Resolution	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

8. *Transition observation*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Transition Observation, such as; changes to procedures, roles, and responsibilities	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

9. *Verifying compliances*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Verifying Compliances, For example, the time spent on inspection and translation of Client's needs	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

10. *Decision-making*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Decision-Making, such as; dealing with contractors problems, making policies, and coordinating with local and central	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

Authorities			

11. *Enforcement*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Enforcement, such as; Monitoring and control and contract enforcement mechanisms	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

12. *Site visits*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Site Visits, This could be for coordination, inspection, resolve dispute and other interactions	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

13. *Administration*

Procurement Activity	**Project phase**	**Traditional**	**Design – Build**
Administration, This could be contract and change orders and claims administration	Concept		
	Development		
	Early Implementation		
	Full Implementation		
	Close Project		

Please click to select
B. *In your opinion what are the most important cost drivers?*

Cost Driver	Very low impact	Low impact	Medium impact	High impact	Very high impact
Search	☐	☐	☐	☐	☐
Information	☐	☐	☐	☐	☐
Bargaining	☐	☐	☐	☐	☐
Decision	☐	☐	☐	☐	☐
Policing	☐	☐	☐	☐	☐
Enforcement	☐	☐	☐	☐	☐

C. *What is your recent project value as a whole?*

☐ Less than $1 million
☐ $2 - $5 million
☐ $6 - $10 million

☐ $11 - $20 million
☐ $21 - $30 million
☐ $30^{+} million

D. *What is your recent project Duration?*

Please specify Months

APPENDIX B2: Research Survey

Section A: General questions

Note: For questions 1-8, please tick

1. What is your company's main area of activity?

- ☐ Housing
- ☐ Commercial
- ☐ Industrial
- ☐ Infrastructure

2. What is your professional role in the construction process?

- ☐ Architect
- ☐ Engineer
- ☐ Surveyor
- ☐ Construction Manager
- ☐ Project Manager
- ☐ Contractor
- ☐ Client
- ☐ Others; please specify:..........

3. Do you have any professional accreditation?

- ☐ None
- ☐ BRANZ
- ☐ PMI
- ☐ CIOB
- ☐ Others; please specify:...........

4. How many years have you been in the construction industry?

- ☐ 0-5 years
- ☐ 6-10 years
- ☐ 11-20 years
- ☐ 21-30 years
- ☐ 30+ years

5. On how many projects have you been involved in the procurement process?

- [ ] One
- [ ] Two
- [ ] Three
- [ ] Four
- [ ] More

6. What is the most common contract value for the project as a whole that you usually work on

- [ ] Less than $1 million
- [ ] $2 - $5 million
- [ ] $6 - $10 million
- [ ] $11 - $20 million
- [ ] $21 - $30 million
- [ ] $30+ million

7. The current procurement process adds significantly more time onto procurement compared with a more traditional route.

- [ ] Strongly agree
- [ ] Agree
- [ ] Neutral
- [ ] Disagree
- [ ] Strongly disagree

8. The current procurement process is ineffective and should be changed?

- [ ] Strongly agree
- [ ] Agree
- [ ] Neutral
- [ ] Disagree
- [ ] Strongly disagree

Section B: Transaction costs and Procurement Systems

Note: The aim is to evaluate the overhead costs i.e. transaction costs (TCs) incurred during the procurement process. TCs are information costs, administration costs, procurement costs, and enforcement costs.

I. Please evaluate how much time is spent daily in executing procurement activities relative to other project activities, comparing Traditional and Design – Build contracts.
Please rate on likert scale of 1-5 (1: very low, 2: low, 3: neutral, 4: high, and 5: very high)

How much time is spent daily in attending meetings relative to other project activities?

9. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

10. Design-Build Contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

How much time is spent daily in communication i.e. phone calls, letters, reports, e-mails, etc. relative to other project activities?

11. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

12. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

How much time is spent daily in information gathering i.e. market, supplier, and legal requirements relative to other project activities?

13. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

14. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

How much time is spent daily in translation of Client's needs relative to other project activities?

15. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

16. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

How much time is spent daily in Training relative to other project activities?

17. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

18. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

How much time is spent daily in Project preliminary design relative to other project activities?

19. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

20. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

How much time is spent daily in Conflict resolution relative to other project activities?

21. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

22. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

How much time is spent daily in Transition observation i.e. changes to procedures, roles, and responsibilities relative to other project activities?

23. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

24. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

How much time is spent daily in Verifying compliances i.e. time for inspection and translation relative to other project activities?

25. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

26. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

How much time is spent daily in Decision-making i.e. dealing with contractors problems, making policies, and coordinating with local and central Authorities relative to other project activities?

27. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

28. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

How much time is spent daily in Enforcement i.e. monitoring and control and contract enforcement mechanisms relative to other project activities?

29. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

30. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

How much time is spent daily in Site visits i.e. coordination, inspection, resolve dispute, and other interactions relative to other project activities?

31. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

32. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	◯	◯	◯	◯	◯
Development	◯	◯	◯	◯	◯
Early Implementation	◯	◯	◯	◯	◯
Full Implementation	◯	◯	◯	◯	◯
Close Project	◯	◯	◯	◯	◯

How much time is spent daily in Administration i.e. contract and change orders and claims administration relative to other project activities?

33. Traditional contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

34. Design-Build contracts

	Very Low	Low	Neutral	High	Very High
Concept	○	○	○	○	○
Development	○	○	○	○	○
Early Implementation	○	○	○	○	○
Full Implementation	○	○	○	○	○
Close Project	○	○	○	○	○

II. Please evaluate the impact of Environmental factors on Procurement Cost, Information Cost, Administration Cost, and Enforcement Cost?

35. Traditional Contracts

	Very Low	Low	Neutral	High	Very High
Political/Legal/Social	○	○	○	○	○
Economy	○	○	○	○	○
Competition	○	○	○	○	○
Technology	○	○	○	○	○
Corporate Culture	○	○	○	○	○
Finance and Ownership	○	○	○	○	○
Project Location	○	○	○	○	○
Information System	○	○	○	○	○

36. Design-Build Contracts

	Very Low	Low	Neutral	High	Very High
Political/Legal/Social	○	○	○	○	○
Economy	○	○	○	○	○
Competition	○	○	○	○	○
Technology	○	○	○	○	○
Corporate Culture	○	○	○	○	○
Finance and Ownership	○	○	○	○	○
Project Location	○	○	○	○	○
Information System	○	○	○	○	○

III. Please Evaluate the Transaction Costs Drivers

37. In your opinion what are the most important overhead cost i.e. TCs drivers?

	Very Low	Low	Neutral	High	Very High
Search	○	○	○	○	○
Information	○	○	○	○	○
Bargaining	○	○	○	○	○
Decision	○	○	○	○	○
Policing	○	○	○	○	○
Enforcement	○	○	○	○	○

APPENDIX B3: Survey for Cases

Questionnaire

AUT UNIVERSITY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

Please note by completing this questionnaire you are indicating your consent to participate.

Section A: General questions

1. *What is the project's main area of activity?*

- ☐ Housing
- ☐ Commercial
- ☐ Industrial
- ☐ Infrastructure

2. *What is your professional role in the project?*

- ☐ Architect
- ☐ Civil Engineer
- ☐ Surveyor
- ☐ Construction Manager
- ☐ Project Manager
- ☐ Client

3. *How many years of experience do you have?*

- ☐ 0-5 years
- ☐ 6-10 years
- ☐ 11-20 years
- ☐ 21-30 years

☐ 30$^+$ years

4. What is the project name?

Please specify:………………………………………………

5. What is the project budget?

Please specify:………………………………………………

6. What is the project duration?

Please specify:………………………………………………

7. What is the contract type for the project?

☐ Traditional
☐ Design-Build

Section B: The aim is to determine the overhead costs i.e. transaction costs (TCs). TCs are information costs, administration costs, procurement costs, and enforcement costs.

Please specify <u>how many hours you spent daily in performing the following procurement activities</u>.

1. *Attending Meetings*

Please specify:………………………………………………

2. *Communicating (Phone calls, letters, reports, e-mails, etc.)*

Please specify:………………………………………………

3. *Information gathering (market, technical, supplier, and legal requirements}*

Please specify:………………………………………………

4. *Translation of client's needs*

Please specify:………………………………………………

5. *Training*

Please specify:………………………………………………

6. *Project preliminary design*

Please specify:………………………………………………

7. *Negotiation (Bargaining a contract or sale, find out buyer or seller true position)*

Please specify:………………………………………………

8. *Conflict resolution*

Please specify:………………………………………………

9. *Transition observation (Change procedures, roles, and responsibilities)*

Please specify:………………………………………………

10. *Verifying compliances (inspection time and translation of client's needs)*

Please specify:………………………………………………

11. *Decision-making (dealing with contractors problems, making policies, and coordinating with local and central Authorities).*

Please specify:………………………………………………

12. *Enforcement (Monitoring and control and contract enforcement mechanisms)*

Please specify:………………………………………………

13. *Site visits (for coordination, inspection, resolve disputes, and other interactions)*

Please specify:………………………………………………

14. *Administration (such as contract, change orders, and claims)*

Please specify:………………………………………………

APPENDIX C: Preliminary Data Analysis

Correlations of Constructs

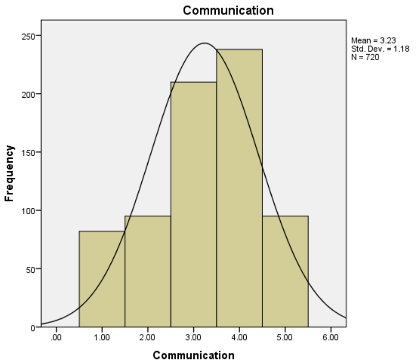
	IG	CM	AM	TN	TR	PD	TO	SV	AD	DM	CR	VC
IG	1.0	.67	.58	.67	.34	.34	.38	.45	.43	.51	.34	.38
CM	.62	1.0	.73	.72	.43	.42	.32	.52	.46	.62	.48	.37
AM	.58	.73	1.0	.65	.39	.38	.30	.43	.41	.52	.33	.29
TN	.67	.72	.65	1.0	.41	.53	.43	.53	.51	.70	.50	.50
TR	.34	.43	.39	.41	1.0	.47	.24	.34	.33	.35	.45	.31
PD	.34	.42	.38	.53	.47	1.0	.34	.27	.39	.48	.41	.40
TO	.38	.32	.30	.43	.24	.34	1.0	.38	.39	.43	.37	.62
SV	.45	.52	.43	.53	.34	.27	.38	1.0	.70	.67	.56	.45
AD	.43	.46	.41	.51	.33	.39	.39	.70	1.0	.63	.47	.37
DM	.51	.62	.52	.70	.35	.48	.43	.67	.63	1.0	.52	.48
CR	.34	.48	.33	.50	.45	.41	.37	.56	.47	.52	1.0	.41
VC	.38	.37	.29	.50	.31	.40	.62	.45	.37	.48	.41	1.0
EF	.48	.47	.36	.48	.31	.30	.51	.57	.47	.55	.56	.45
PLS	.12	.03	.00	.12	.02	-.04	.11	.06	-.06	.03	-.03	.17
ECO	.17	.00	-.02	.02	-.14	-.02	.20	.11	.04	.11	-.03	.14
COP	.15	.00	0.01	.05	-.19	.02	.17	.06	.09	.07	-.03	.11
TCH	.13	.09	.05	.20	.15	.18	.05	.17	.16	.13	.16	.21
CC	.14	.14	.06	.28	.22	.28	.19	.35	.37	.30	.34	.32
FO	.17	.13	.04	.23	.18	.24	.16	.32	.36	.27	.33	.25
PL	.13	.07	.03	.14	-.06	.14	.20	.17	.21	.21	.09	.16
IS	.11	.17	.08	.28	.26	.23	.14	.26	.28	.23	.27	.28

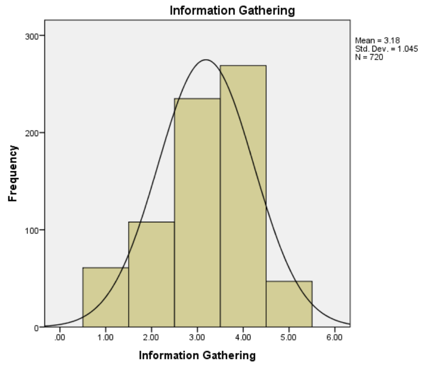
IS	PL	FO	CC	TCH	COP	ECO	PLS	EF
.11	.13	.12	.14	.13	.15	.17	.12	.48
.17	.07	.13	.14	.09	.00	.00	.03	.47
.08	.03	.04	.06	.05	.01	-.02	.00	.36
.28	.14	.23	.28	.20	.05	.02	.12	.48
.26	-.06	.18	.22	.15	-.19	-.14	.02	.31
.23	.14	.24	.28	.18	.02	-.02	-.04	.30
.14	.20	.16	.19	.05	.17	.20	.11	.51
.26	.17	.32	.35	.17	.06	.11	.06	.57
.28	.21	.36	.37	.16	.09	.04	-.06	.47
.23	.21	.27	.30	.13	.07	.11	.03	.55
.27	.09	.33	.34	.16	-.03	-.03	-.03	.56
.28	.16	.25	.32	.21	.11	.14	.17	.45
.23	.13	.23	.22	.18	.10	.17	.13	1.0
.28	.09	.03	.01	.45	.12	.65	1.0	.13
-.02	.26	.06	.03	.12	.61	1.0	.65	.17
-.17	.48	.15	.14	-.06	1.0	.61	.12	.10
.75	.16	.50	.57	1.0	-.06	.12	.45	.18
.71	.50	.86	1.0	.57	.14	.03	.01	.22
.63	.50	1.0	.86	.50	.15	.06	.03	.23
.18	1.0	.50	.50	.16	.48	.26	.09	.13
1.0	.18	.63	.71	.75	-.17	-.02	.28	.23

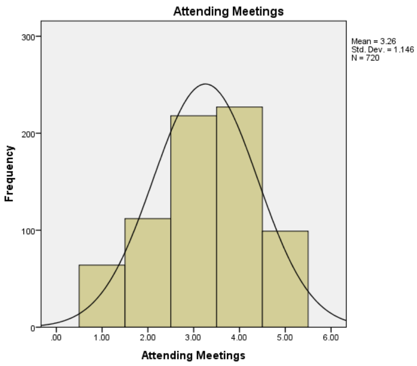
Tests of Normality

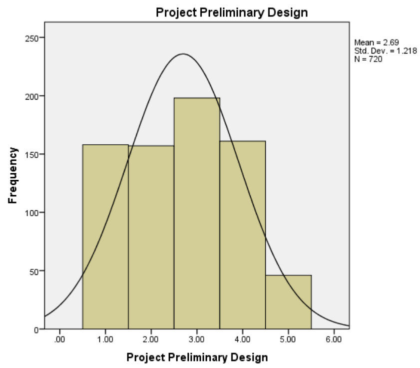
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Information Gathering	.221	720	.000	.888	720	.000
Communication	.204	720	.000	.900	720	.000
Attending Meetings	.195	720	.000	.908	720	.000
Translation of Client's Needs	.204	720	.000	.906	720	.000
Training	.230	720	.000	.883	720	.000
Project Preliminary Design	.162	720	.000	.901	720	.000
Transition Observation	.212	720	.000	.901	720	.000
Site Visits	.176	720	.000	.905	720	.000
Administration	.166	720	.000	.912	720	.000
Decision Making	.219	720	.000	.896	720	.000
Conflict Resolution	.204	720	.000	.869	720	.000
Verifying Compliances	.207	720	.000	.905	720	.000
Enforcement	.188	720	.000	.910	720	.000
Pre-contract Transaction cost	.077	720	.000	.984	720	.000
Post-Contract Transaction Costs	.074	720	.000	.982	720	.000
Political/Legal/Social	.323	720	.000	.818	720	.000
Economy	.399	720	.000	.723	720	.000
Competition	.271	720	.000	.858	720	.000
Technology	.198	720	.000	.912	720	.000
Corporate Culture	.225	720	.000	.872	720	.000
Finance and Ownership	.248	720	.000	.872	720	.000
Project Location	.280	720	.000	.856	720	.000
Information System	.258	720	.000	.873	720	.000

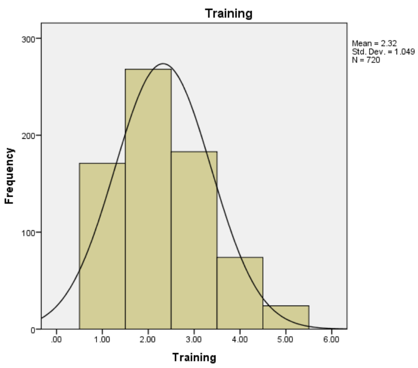
Histograms

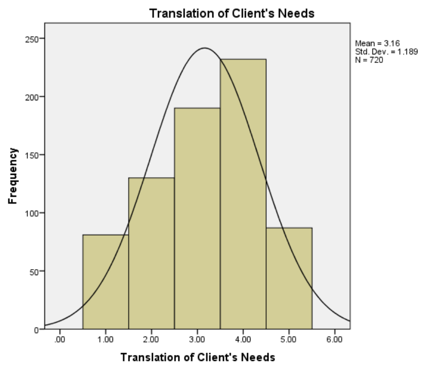


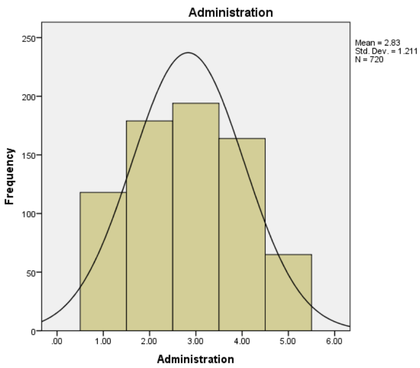




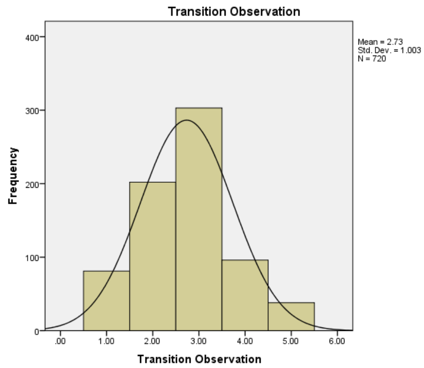


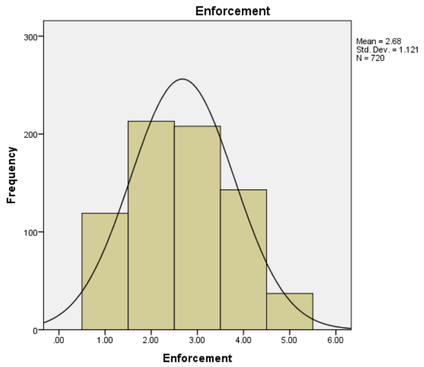


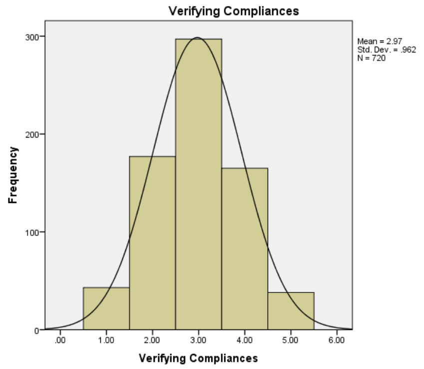


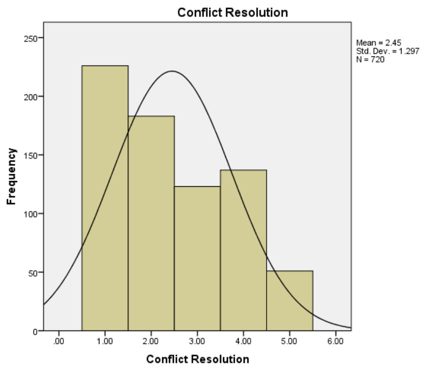


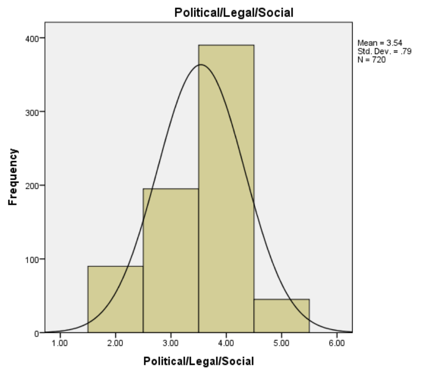
Site Visits

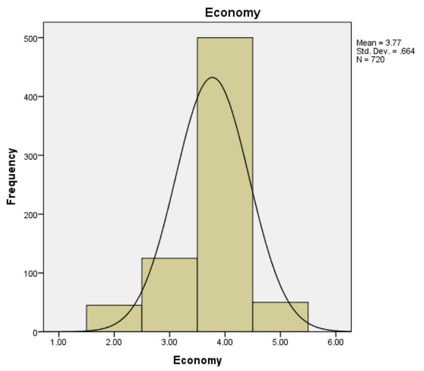


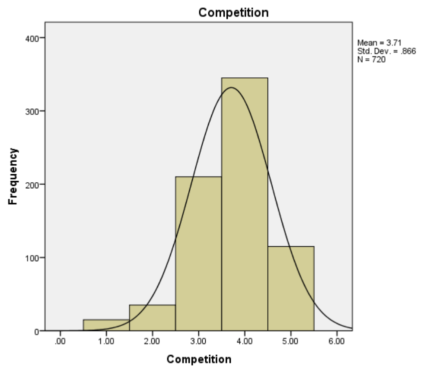

Enforcement
Mean = 2.68
Std. Dev. = 1.121
N = 720
Frequency
Enforcement

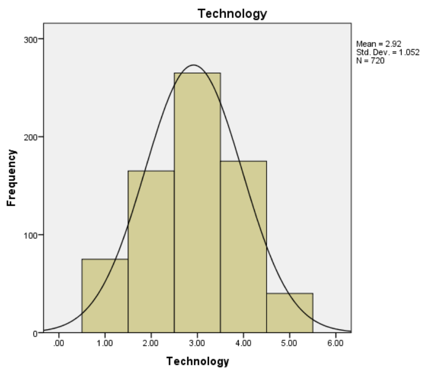

Verifying Compliances
Mean = 2.97
Std. Dev. = .962
N = 720
Frequency
Verifying Compliances

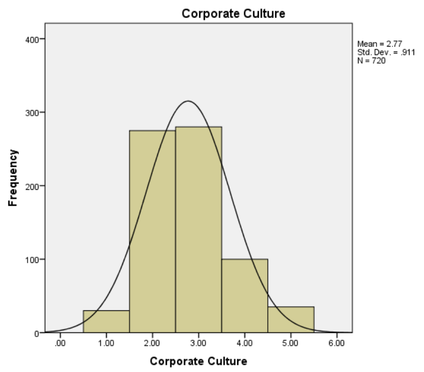

Conflict Resolution
Mean = 2.45
Std. Dev. = 1.297
N = 720
Frequency
Conflict Resolution

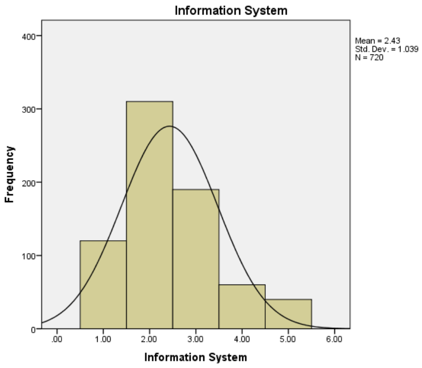

Political/Legal/Social
Mean = 3.54
Std. Dev. = .79
N = 720
Frequency
Political/Legal/Social

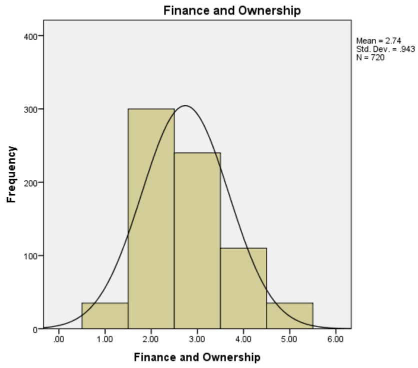

Economy
Mean = 3.77
Std. Dev. = .664
N = 720
Frequency
Economy

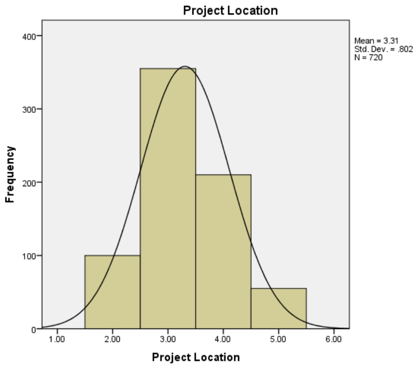

Competition
Mean = 3.71
Std. Dev. = .866
N = 720
Frequency
Competition


Technology
Mean = 2.92
Std. Dev. = 1.052
N = 720
Frequency
Technology


Corporate Culture
Mean = 2.77
Std. Dev. = .911
N = 720
Frequency
Corporate Culture


Information System
Mean = 2.43
Std. Dev. = 1.039
N = 720
Frequency
Information System


Finance and Ownership
Mean = 2.74
Std. Dev. = .943
N = 720
Frequency
Finance and Ownership


Project Location
Mean = 3.31
Std. Dev. = .802
N = 720
Frequency
Project Location

APPENDIX D: Exploratory Factor Analysis

Rotated Component Matrix

	Procurement Cost	Environmental Uncertainties	Administration Cost	Information Costs	Enforcement Costs
Site Visits	.869				
Administration	.809				
Decision Making	.782				
Enforcement	.748				
Communication	.709			.445	
Information	.679				
Translation of Client's Needs	.655			.515	
Attending Meeting	.590			.463	
Conflict Resolution	.429				
Corporate Culture		.915			
Finance and Ownership		.887			
Information System		.868			
Technology		.782			
Competition			.814		
Project Location		.424	.642		
Transition Observation	.415		.467		
Training			-.404		
Project Preliminary Design				.784	
Verifying Compliances	.410			.433	
Political/Legal/Social					.870
Economy			.507		.701

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization

Reliability

Case Processing Summary

		N	%
Cases	Valid	360	100.0
	Excluded[a]	0	.0
	Total	360	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.934	.929	43

Item-Total Statistics

	Item-Total	Cronbach's
Project Phase	.283	.935
Information Gathering Traditional	.491	.932
Information Gathering Design-Build	.666	.931
Communication Traditional	.608	.931
Communication Design-Build	.714	.930
Attending Meetings Design-Build	.555	.932
Attending Meetings Traditional	.519	.932
Translation of Client's Needs Traditional	.598	.931
Translation of Client's Needs Design-Build	.722	.930
Training Traditional	.439	.933
Training Design-Build	.550	.932
Project Preliminary Design Traditional	.429	.933
Project Preliminary Design Design-Build	.588	.931
Transition Observation Traditional	.343	.933
Transition Observation Design-Build	.551	.932
Site Visits Traditional	.612	.931
Site Visits Design-Build	.627	.931
Administration Traditional	.603	.931
Administration Design-Build	.634	.931
Decision Making Traditional	.659	.931
Decision Making Design-Build	.629	.931
Conflict Resolution Traditional	.587	.931
Conflict Resolution Design-Build	.608	.931
Verifying Compliances Traditional	.433	.933
Verifying Compliances Design-Build	.546	.932
Enforcement Traditional	.575	.932
Enforcement Design-Build	.669	.930
Political/Legal/Social Traditional	.191	.934
Economy Traditional	.150	.934
Competition Traditional	.126	.935
Technology Traditional	.387	.933
Corporate Culture Traditional	.514	.932
Finance and Ownership Traditional	.406	.933
Project Location Traditional	.203	.934
Information System Traditional	.505	.932
Political/Legal/Social Design-Build	.093	.935
Economy Design-Build	.067	.935
Competition Design-Build	.025	.935
Technology Design-Build	.320	.934
Corporate Culture Design-Build	.525	.932
Finance and Ownership Design-Build	.522	.932
Project Location Design-Build	.284	.934
Information System Design-Build	.506	.932

KMO and Bartlett's Test[a]

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.863
Bartlett's Test of Sphericity	Approx. Chi-Square	10092.178
	df	210
	Sig.	.000

a. Based on correlations

Total Variance Explained

Component		Initial Eigenvalues			Extraction Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Raw	1	9.491	40.701	40.701	9.491	40.701	40.701
	2	2.876	12.335	53.036			
	3	1.656	7.101	60.138			
	4	1.321	5.665	65.803			
	5	1.195	5.125	70.929			
	6	1.136	4.872	75.801			
	7	.797	3.416	79.217			
	8	.644	2.762	81.979			
	9	.618	2.651	84.630			
	10	.537	2.304	86.934			
	11	.482	2.067	89.001			
	12	.445	1.907	90.909			
	13	.365	1.563	92.472			
	14	.318	1.364	93.835			
	15	.315	1.351	95.186			
	16	.291	1.247	96.434			
	17	.260	1.114	97.548			
	18	.233	1.000	98.548			
	19	.181	.775	99.323			
	20	.087	.371	99.694			
	21	.071	.306	100.00			
Rescaled	1	9.491	40.701	40.701	7.434	35.399	35.399
	2	2.876	12.335	53.036			
	3	1.656	7.101	60.138			
	4	1.321	5.665	65.803			
	5	1.195	5.125	70.929			
	6	1.136	4.872	75.801			
	7	.797	3.416	79.217			
	8	.644	2.762	81.979			
	9	.618	2.651	84.630			
	10	.537	2.304	86.934			
	11	.482	2.067	89.001			

	12	.445	1.907	90.909			
	13	.365	1.563	92.472			
	14	.318	1.364	93.835			
	15	.315	1.351	95.186			
	16	.291	1.247	96.434			
	17	.260	1.114	97.548			
	18	.233	1.000	98.548			
	19	.181	.775	99.323			
	20	.087	.371	99.694			
	21	.071	.306	100.00			

Extraction Method: Principal Component Analysis.

a. When analyzing a covariance matrix, the initial eigenvalues are the same across the raw and rescaled solution.