PRICING RISKS AND MANAGEMENT STRATEGIES FOR ESTIMATORS IN THE RESIDENTIAL CONSTRUCTION INDUSTRY

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ABSTRACT

A construction estimator is responsible for estimating the cost of a construction project. The process itself has many risks involved and has always been an important area of research. Numerous studies have been carried out in the past which only looked at risks in construction project in general; very little research has been done on the topic of 'pricing risks' from the construction estimators' perspective and certainly in New Zealand residential construction context. The aim of this research is to examine the question – What are the perceived pricing risks and practical management strategy amongst construction estimators in the Auckland residential construction sector? Data were collected through semi-structured interviews with questionnaire to collect survey data includes demographic information about the estimator and its company; perception of pricing risks in terms of their level of importance and frequency of occurrence; number, level of details, sources, reliability and purposes of cost data.

The result showed that overall, the top pricing risks were 'site related issues', 'project complexity' and 'change in scope of work' and the most common method used to deal with the risks is use of Provisional Sum. Furthermore, it is concluded that the estimators interviewed had low number of cost data because many of the cost items are quoted. This is confirmed by the estimators that the most frequently used cost data is the 'subcontractors' / suppliers' quote'. The result also showed that the most reliable source of cost data is the 'in-house rate buildups' and the biggest problem when collecting or applying cost data originate from the subcontractors. Methods such as back costing; ask the subcontractors to include specific items; understand and raise questions on quotation received or make arrangements with the subcontractors to fix the price for a period of time are used to manage those risks.

Possible areas for further researches include whether the number of cost items relates to a company's annual turnover and vice versa; how do large, medium and small construction companies or how do construction companies that specialise in different types of project compared in respond to risk and management of cost data.

CONFIDENTIALITY STATEMENT

The author has agreed that all personal and company names of participants in this research will be kept confidential.

The interview and questionnaire responses were kept anonymous and the responses presented in this report cannot be linked to the interviewees involved. The interviewees are referred to by labels (i.e. EST01, EST02...) and not by anything else that could possibly identify their names and companies that they work for.

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LIST OF ABBREVIATIONS

AS/NZS	Australian/New Zealand Standard
CIOB	Chartered Institute of Building
CPI	Consumer Price Index
EV	Expected Value
EST01	Estimator Number 1
GST	Goods & Services Tax
NZ	New Zealand
NZS	New Zealand Standard
PC Sum	Prime Cost Sum
P Sum	Provisional Sum
RBNZ	Reserve Bank of New Zealand
RIBA	Royal Institute of British Architects
RICS	Royal Institute of Chartered Surveyors
SoQ	Schedule of Quantities
UK	United Kingdom

1. INTRODUCTION

1.1 Introduction

This chapter provides an overview of the research topic with an explanation of why the current research is important.

Cost estimation is one of the most important activities of a construction project (Leng, 2005 & Akintoye, 2000). A construction estimator is responsible for estimating the total cost of a construction project and with many risks involved during the estimating process itself (i.e. the pricing risk), the perceived risk factors considered by the estimator while pricing for a construction project and their decision on arriving at the final figure of construction cost become an important area for estimators (and contractors) to understand.

Numerous studies have been carried out in the past which only looked at risks in construction project in general, very little research has been done on the topic of 'pricing risks' and from the construction estimators' perspective. In addition, despite the fact that the value of residential building work put in place in New Zealand is nearly always over and above the value of non-residential work, research into residential construction estimator's perception on pricing risks, is virtually non-existent. Therefore the aim of this research is to examine the question – What are the perceived pricing risks and practical management strategy amongst construction estimators in the Auckland residential construction sector? Auckland has been selected for the study because it is the largest city in New Zealand and is the area that has the majority of construction activity

This study will add to the body of knowledge in the field of cost estimating and risk management strategy within the New Zealand construction industry because no other research specific to the residential construction industry in New Zealand has been carried out in the past. The research is valuable to the estimators within the residential construction industry and helps them to understand the risks that are perceived to be critical in the estimation process and the management of such risks.

1.2 Report structure

Chapter 2 presents a review of the literature in two parts. The first part looks at construction risks in general and then more specifically the pricing risks. A summary of pricing risks, their relative level of importance and frequency of occurrence are also presented. The second part of the literature review looks at risk management strategies that were available to the estimators and then focus the research on the strategy that could possibly cover the greatest amount of risks.

Chapter 3 presents a review of the research methodology used in order to answer the research questions. The selection of research method and why, data collection instrument, procedure and design are also explained. Reliability, validity and ethics considerations are also discussed.

Chapter 4 presents the data collected including result from questionnaire and responses from the interview questions.

Chapter 5 discusses the findings from data collection with relation to the literature and research topic.

Chapter 6 concludes the key research findings. Limitations and possible topics for further research are also presented.

Appendix A includes a copy of the questionnaire and interview questions used during the semi-structured interviews.

2. LITERATURE REVIEW

2.1 Introduction

It is widely acknowledged that risk is inherent in construction project from inception to completion and is the main reason why the final project cost exceeds the initial budget estimated. Various stakeholders in a construction project are exposed to different level of risks.

A construction contractor's cost estimator is responsible for estimating the total cost of a construction project which involves the process of reviewing information available such as drawings and specifications and based on this information, make decision and prepare a summary of all the cost items that the contractor must provide in order to complete the project.

According to Leng (2005) & Akintoye (2000), cost estimation is one of the most important activities of the entire project duration. An over-estimate could lead to tender not being accepted by the client and losing potential work. On the other hand, an under-estimate could lead to contractor losing money.

It is defined in the Code of Estimating Practice (Chartered Institution of Building, 2009) as the technical process of predicting the costs of construction. Kwakye (1994) as cited in Akintoye (2000, p78) has similar definition by defining the cost estimating as the "technical process or function undertaken to assess and predict the total cost of executing an item(s) of work in a given time using all available project information and resources".

An accurate cost estimating is a challenging and difficult task due to the fact that each project is unique and varies in level of complexity. Like in many processes in other industries such as manufacturing and engineering, construction cost estimating involves various unknown and unexpected risks which are frequently undesirable and often unpredictable (Akintoye & MacLeod, 1997). As explained by Akintoye (2000, p78), "the estimating department within a construction company, while

preparing the cost estimate, takes an overview of the project and considers factors that may have an impact on pricing for the project".

Therefore, the risks involved in the estimating process itself (i.e. the pricing risk), the perceived risk factors considered by the estimator while pricing for a construction project and their decision on arriving at the final figure of construction cost become an important area for estimators to understand.

Despite this, majority of past research has focused on finding out factors influencing construction cost from either the construction managers' or consulting quantity surveyors; perspective. Very little research has been done from the construction estimators' perspective and many have failed to investigate factors considered by estimators in arriving at an estimate and how they deal with these risks involved. This is supported by Akintoye (2000, p 78) who noted that "an important element of the tendering process, namely that dealing with factors influencing the cost estimating process, has not received much attention".

Therefore, the aim of this research is, to examine the question – What are the perceived pricing risks and practical management strategy amongst construction estimators in the Auckland residential construction sector?

The residential construction sector has been selected because most of the previous studies conducted around the world focused on non-residential (commercial or civil) works. Despite the fact that the value of residential building work put in place in New Zealand is nearly always over and above the value of non-residential work (Statistics New Zealand, 2011), research into residential construction estimators' perceptions, is virtually non-existent. Auckland has been selected for the study because it is the largest city in New Zealand and is the area that has the majority of construction activity.

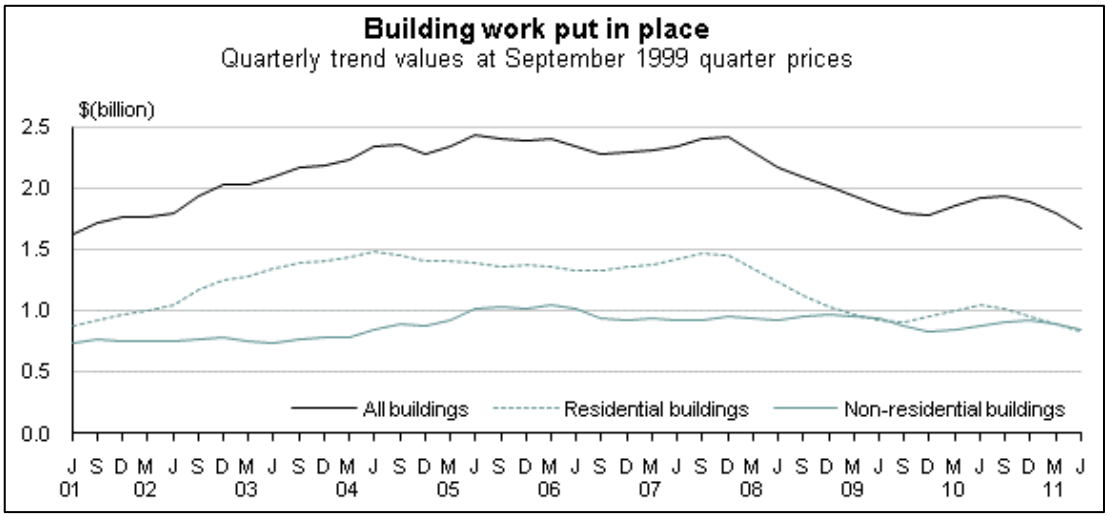

Figure 1 – Building work put in place (June 2011 quarter)

Source: (Statistics New Zealand, 2011)

The first part of the literature review considers various studies around the world from various perspectives (e.g. project management, risk management, cost estimating, tendering…etc.) on risk factors that were perceived to have an influence on the construction project. The risk factors that were particularly related to the construction estimators' pricing risk have been identified and summarised in a matrix table form. A summary of pricing risks, their relative level of importance and frequency of occurrence are also presented.

The second part of the literature review addresses the methods or strategies that estimators employ for managing the perceived pricing risks. Despite a lot of literature on identifying pricing risk factors, very little research appears to have been done to address methods or strategies employed in managing these risks. The literature review then focused on the strategy that could possibly cover the greatest amount of risks.

2.2 Risk and risk perception defined

2.2.1 Risk in construction context

Risk in a broader context, as defined by the AS/NZS 4360:2004 (2004, p4), is "the chance of something happening that will have an impact on objectives". Smith (1999,

p4) defines risk as “a decision which has a range of possible outcomes”.

In the construction context, Odeyinka, Oladapo & Akindele (2006, p1) defines risk in construction as “a variable in the construction process whose variation results in uncertainty as to the final cost, duration and quality of the project”. However, Cooper & Chapman (1987) as cited in Olupolola, Agnes & Adeniyi (2009, p228) sees risk as both an threat and opportunity: “exposure to the possibility of economic or financial loss or gain, physical damage or injury, or delay, as a consequence of the uncertainty associated with pursuing a particular course of action”. Akintoye & MacLeod (1997) confirm the same result from their survey that risk could either adversely affect the successful completion of the project in terms of cost, time and quality, or be perceived as an opportunity to make profit and does not always have an adverse effect.

2.2.2 Perception of risk

Risk has different meanings to different people and roles, seeing a risk from different angle will influence an individual’s perception of risk. The perception of risk is defined by Odeyinka, et al. (2006, p1) as “a psychological phenomenon that is meaningful in terms of human reaction and experiences and as an objective phenomenon that may or may not be recognized in terms of human reaction and experience”.

The Royal Society, as cited in Akintoye & MacLeod (1997, p32) draws a similar conclusion and goes further by saying that risk perception “cannot be reduced to a single subjective correlated of a particular mathematical model, such as the product of probabilities and consequences because this imposes unduly restrictive assumptions about what is an essentially human and social phenomenon.” Rohrmann (2008, p1) defines risk perception as “people’s judgments and evaluations of hazards they (or their facilities, or environments) are or might be exposed to. Such perception steer decisions about the acceptability of risks and are a core influence on behaviour”.

Therefore, it can be concluded that perception of risk varies between individuals. This is because it is influenced by internal factors such as educational background, cognitive characteristics, cultural background, value, norm, belief, viewpoint, attitude, judgment, feelings and experience (Akintoye & MacLeod, 1997; Odeyinka, et al., 2010; Olupolola, et al., 2009; Rohrmann, 2008); or by external factors such as information available, peer group influences, economic and market conditions, competition and society (Akintoye & MacLeod, 1997; Rohrmann, 2008).

2.3 Risk factors in construction

It is widely acknowledged that risk is inherent in construction project from inception to completion and is the main reason why the final project cost exceeds the initial budget estimated. Risks in construction industry, in general, can be grouped into several categories including, but not limited to: physical, design, logistics, natural/environmental, financial/economical, legal/regulatory, political, construction and operational (Smith & Bohn, 1999; Odeyinka et al., 2006; Odeyinka et al., 2010 and Ahmed & Azhar, 2004).

A large number of researches have identified the risk factors affecting cost of construction project from different angles. Some researchers identified the risk factors that had critical impact on construction cost in general; others studied the reasons for the inaccuracy or difference between the estimated construction cost and final project cost.

However, as said earlier, most literature identified risk factors involved in a construction projects from construction managers' or consulting quantity surveyors' perspective, very little research has been done in identifying the pricing risk from the construction estimators' perspective.

In the following sections, this study will look at those risk factors influencing the cost of a construction project which have been identified by various researches and

then focused on the risk factors that could influences and can be managed by the construction estimators.

2.3.1 UK studies

Akintoye (2000) investigated factors considered by construction contractors' estimators when estimating a construction project. He identified 24 risk factors from literature that have the potential to influence cost estimating. From the analysis of 84 responses, he identified that overall, the top factors influencing construction cost estimating including 'complexity of design and construction', 'scale and scope of construction', 'method of construction (or construction technique)', 'tender period and market condition', 'site constraints (access and storage limitation) ', 'type of client', 'buildability', 'location of project and availability and supplies of labour and material', 'extend of completion of design', 'type of structure', 'project team's experience and capability', 'quality of information', 'form of procurement and contractual arrangement and amount of special work

Akintoye & Fitzgerald (2000) approached the problem in terms of inaccuracy in cost estimating and identified several risk factors which were particularly relevant to pricing risk factors. These include 'insufficient time for estimating', 'poor tender documentation', 'insufficient tender document analysis', 'lack of understanding of project requirement', 'poor communication between project team', 'lack of cost estimate review by management', 'poor comprehension of site requirement', 'poor feedback on accuracy of previous estimate', 'pressure from management', 'removal of estimate padding by management', 'poor project cost feedback', 'lack of due diligence by estimators', 'lack of adequate estimating guideline', 'inaccurate cost data used in estimating', 'lack of historical data on past estimate', 'poor analysis of cost data' and 'frequent request for changing of estimate'.

Akintoye & Fitzgerald (2000) also identified shortcomings in skills, knowledge and data for cost estimating which may be considered as potential factors of pricing risk. This includes lack of site knowledge and construction process by estimator, poor

tender documentation, insufficient time to prepare tender, variability in subcontractors' prices, inaccurate quotation, relying on subcontractors to provide the specialist knowledge, poor understanding on how specialist trades are costed, lack of actual costs feedback, price variation and lack of training.

Elhag, Boussabaine and Ballah (2005) identified 67 factors affecting pre-tender construction cost estimates through literature and interviews with quantity surveyors in North England. In the pilot study, 218 quantity surveyors were asked to rank these factors in terms of level of influence and significance. The study concluded that 52 out of the 67 factors identified are regarded by quantity surveyor as highly relevant for forecasting contract price with 'late changes to the design', 'suitability, experience and performance of management team', 'priority on construction time/deadline requirement', 'completeness and timeliness of project information (e.g. design, drawings and specification)', 'variation orders and additional work' and the 'complexity and intensity of building services' are the top factors.

Other not so highly rated risks include 'project brief', 'buildability', 'quality of design and specification', 'current workload', 'experience on similar projects', 'level of communication within the contracting organisation', 'estimation methods and cost control technique (accuracy and reliability) ', 'mark up policies and percentage', 'number of subcontractors', 'percentage of main contractor direct work and percentage of subcontracted work', 'type of contract', 'method of procurement', 'spread of risk between construction parties', 'resource (labour, material and plant) availability', 'weather condition', 'number of bidders', 'interest rate/inflation rate', 'stability of market condition' and 'project characteristics (type, location, complexity, site condition and access)'.

A number of other studies investigated the reasons for the inaccuracy of estimating or for the difference between final project cost and the initial budget estimate or cost overruns. Jackson's (2002) study done in UK identified the main reasons as to why construction projects exceed the initial cost estimate from experienced cost estimating professionals. The study collected a large number of perceptions (a total

of 341 reasons) from 114 respondents. The results were then categorised into 15 categories of reasons.

Further analysis on the result reveals that ‘client driven design change’, ‘lack of detail and definition, badly developed, incomplete or incorrect design brief’, ‘general lack of information’, ‘incomplete design at tender’, ‘design variation’, ‘too much design development’, ‘lack of information at tender stage’, ‘designer attitude, input, whims, understanding of cost and value’, ‘poor cost advice’ and ‘inadequate contingency allowance or assessment of risk’ were the top 10 factors. Other factors that are relevant to pricing risks are ‘estimating method’, ‘inadequate cost control’, ‘unrealistic design development periods’, ‘limited time to carry out realistic budges or cost control’, ‘unrealistic construction period’, ‘unforeseen site conditions’, ‘constraints and restriction’, ‘inadequate surveys and investigation of existing site condition’, ‘inexperience’, ‘wrong contract used’, ‘inappropriate allocation of risk in contract document’ and ‘changes in pricing conditions, indices, inflation and market trends’.

Similarly, Odeyinka, Weatherup, Cunningham, McKane & Larkin (2010) identified 28 risk factors that had the potential to influence the variability between final account and tender sum from literature review and conducted survey on private quantity surveyors, project managers and construction managers. Based on 21 private quantity surveyors out of 30 respondent, the perception of extent of risk occurrence and their impact on all project types concludes that ‘change in design’, ‘variation by the client’, ‘change in scope of works’, ‘unexpected site conditions’, ‘inadequate programme scheduling’, ‘poor management ability of contractor’, ‘defect in design, delay by third party’ and ‘under-estimation’ were perceived to be the top risk factors.

Al-Hasan, Ross & Kirkham (2006) identified 6 factors affecting accuracy of estimating process through semi-structured interviews with senior estimators in UK. Of these, ‘insufficient time for estimate’, ‘inadequate specifications’, ‘incomplete drawings’, ‘lack of historical cost data’ and ‘lack of confidence in structured site feedback’ were regarded as sources of pricing risks.

Odeyinka, Lowe & Kaka (2008) approach the problem from cash flow forecasting perspective with UK contracting organisations and identified 26 risk factors including ‘change to initial design’, ‘labour shortage’, ‘underestimating / estimating error’, ‘inflation and change in interest and exchange rate’ and ‘shortage of key plant and material’ were relevant to pricing risks.,

Olawale & Sun (2010), conducted survey with 250 construction project organisations in UK identified factors inhibiting cost control including, in order of ranking: ‘design changes’, ‘ risk and uncertainty associated with projects’, ‘inaccurate evaluation of project duration’, ‘non-performance of subcontractors and suppliers’, ‘complexity of work’, ‘conflict between project parties’, ‘discrepancies in contract documentation’, ‘contract and specification interpretation disagreement’, ‘inflation of prices’ and ‘financing and payment for completed works’ as the top ranking factors.

2.3.2 Nigerian studies

Although Nigeria is a developing country which has different economic, cultural and political environment compared to New Zealand, some of the risk factors identified are still relevant and therefore included in this study.

Olupolola, Agnes & Adeniyi (2009) investigated the perception on risk inherent in building project in Nigeria from 55 building professionals’ perspective (including 27 quantity surveyors).Based on 28 risk factors identified from the literature review that had critical impact on construction cost, the study found that the quantity surveyors perceived that, in the order of probability and importance that ‘under-estimation’ being the highest risk factor; followed by ‘change in scope of work’, ‘completion delay’, ‘inadequacy of cashflow’ and ‘defective design’. Other relevant pricing risks were also identified including ‘poor site investigation’, ‘market fluctuation’, ‘delay in material supply’, ‘inadequate specification’, ‘labour shortage’ and ‘feasibility of construction method’

Odeyinka (2007) identified 28 risk factors encountered at the project level in traditionally procured building project based on literature and discussion with industry practitioners in Nigeria. The risk factors including ‘under-estimation’, ‘poor site investigation’, ‘change in scope of work’, ‘fluctuation in market demand’, ‘defective design’, ‘delay in material supply’, ‘inadequate specification’, ‘exchange rate fluctuation’, ‘shortage of resource’, ‘use of inappropriate plan’ and ‘feasibility of construction method’ are particularly relevant to the pricing risk.

Windapo & Martins (2010) also identified factors perceived to be critical to the construction firm in Nigeria. Out of the 28 risks, ‘differing site condition’, ‘consultant competence’, ‘under-estimating’, ‘unrealistic construction programme’, ‘resource availability’, ‘competency of workforce’, ‘change in scope of work’, ‘defective design’, ‘inaccurate project definition’, ‘inflation’, ‘complexity’ and ‘site access’ were relevant to pricing risks.

Another study done in Nigeria by Onukuwbe, Adenuga & Enang (2009) investigated 60 construction professionals (including 11 quantity surveyors) on the frequency of occurrence and degree of impact of risk factors in contractors’ pricing and identified that ‘material availability’ is the most influential factor, followed by ‘type of client and their financial capability’, ‘risk involved in the project’ and ‘complexity of the project’ are the top factors that contractors must consider when pricing building project. Other risk factor including ‘condition of the contract’, ‘location of the site’, ‘likely trend in material cost and wage’, ‘availability of resource’ and ‘competency of subcontractors’ are particularly relevant to pricing risks.

Oladokun, Ikediashi, Adewuyi & Oladokun (2010) also identified risk factors on residential building project in Nigeria, those that relates to pricing risk include: ‘change in work’, ‘unforeseen site condition’, ‘delay of drawing supply’, ‘inappropriate risk allocation’, ‘exchange rate fluctuation and inflation’, ‘quantity variation’, ‘poor definition of scope’, ‘conflicts in documents’, ‘deficiencies in specification and drawings’ and ‘defective design and inflation’.

2.3.3 Australian Studies

Zou, Zhang & Wang (2007) investigated risks associated with construction project from project stakeholder and life cycle perspective with 60 construction practitioners in Australia, and identified key risks including those that are relevant to pricing risks such as ‘tight project schedule’, ‘design variation’, ‘variation by client’, ‘incomplete or inaccurate cost estimate’, ‘unavailability of resources’, ‘inadequate or insufficient site information’ and ‘price inflation of construction material’.

Another study done in Australia by Towner & Baccarini (2007) based on structured interviews and survey with construction personnel identified that, in order of significance, ‘design and documentation error’, ‘resource availability’, ‘buildability’, ‘subcontractor/supplier ability’, ‘incomplete design’, ‘estimation error’, ‘site access’, ‘complexity’, ‘price inflation’, ‘change of scope’, ‘unforeseen ground conditions’ and ‘lower labour productivity’ as the most significant risks when pricing tender.

2.3.4 Other areas

Chan, Chan, Lam, Yeung & Chan (2010) identified key risk factors and their relative significance in target cost and guaranteed maximum price project in Hong Kong. Out of the 34 risks identified in the survey, those related to pricing risk include ‘change in scope of work’, ‘insufficient design’, ‘unforeseen design development’, ‘error and omission in tender document’, ‘inflation and price fluctuation’, ‘unforeseen ground condition’, ‘under-estimation’, ‘buildability’, ‘inaccurate site information / investigation’, ‘complexity’ and ‘availability of resources’.

Serpell (2004), through literature review, survey and interviews with Chilean contractors, identified factors affecting the accuracy of estimates including ‘experience of design’, ‘estimating and project team’, ‘consistency of scope’, ‘project complexity’, ‘availability and reliability of historical information’, ‘availability and reliability of current information’, ‘change in market condition’, ‘inflation’, ‘labour productivity’, ‘error and omission in estimate’ and ‘time available for estimate’.

However, no ranking were given in regards to the significance of risks to these factors.

2.3.5 Summary of identified risks

From the literatures review above, it can be concluded that although studies are conducted in different parts of the world with different cultural, economic and political backgrounds and from different perspective, similar pricing risk factors can be identified. As a result, a total of 29 risk factors that might be the potential pricing risk were identified and are summarised and categorized in a table matrix format as shown in Table 1.

These factors were further reduced to 14 risk factors as shown in Table 2 due to similarity between them and the fact that some of the factors that the estimators has no direct control of and are dictated by the management or design team including unrealistic construction timeframe, experience and competency of project team, current workload, number of competitors tendering the same job, poor communication between project team…etc.

In addition, other subcontractor-related factors that were identified as shortcomings for cost estimating in the study done by Akintoye & Fitzgerald (2002) including ‘delay in receiving subcontractors’ quote’, ‘unfamiliarity or poor understanding of specialist trades and its costing’ and ‘reliance on subcontractors to provide specialist knowledge’ were considered important because no single construction company can carry out all the items of work in a project and will have to rely on the subcontractors to complete the project.

	Total number of times that the risk is identified	Al-Hasan, Ross & Kirkham (2006)	Akintoye (2000)	Elhag, Boussabaine & Ballal (2005)	Odeyinka, Weatherup, Cunningham, McKane & Larkin (2010)	Akintoye & Fitzgerald (2000)	Jackson (2002)	Olawale & Sun (2010)	Odeyinka, Lowe & Kaka (2008)	Chan, Chan, Lam, Yeung & Chan (2010)	Towner & Baccarini (2007)	Zou, Zhang & Wang (2007)	Onukwube, Adenuga & Enang (2009).	Odeyinka (2007)	Windapo & Martins (2010)	Olupolola, Agnes & Adeniyi (2009)	Oladokun, Ikediashi, Adewuyi & Oladokun (2010)
Country of study conducted		**UK**	**UK**	**UK**	**UK**	**UK**	**UK**	**UK**	**UK**	**Hong Kong**	**Australia**	**Australia**	**Nigeria**	**Nigeria**	**Nigeria**	**Nigeria**	**Nigeria**
Total number or risk factors identified in study		6	24	52	28	20	15	20	26	34	23	10	21	28	28	28	38
Design																	
Poor definition of scope	3						4			3							28
Insufficient / incomplete design information / specification	12	2	11	10	11	2	2			2	5			13	21	9	2
Design change/ change in scope of work	12			1	1		1	1	1	1	11	2		6	19	2	1
Defective design / conflict / discrepancies	10			7	8		3	7		4	1			11	21	5	3
Delay in providing design information	3			4.5			3										18
Project complexity / Buildability	9		1	8				5	9	25	3		5		26		19
Lack of understanding of project requirement	1					4											
Little involvement of contractor in design stage	1									20							
Estimation																	
Incapability/inexperience of estimators	3		13	13			7										
Estimating error / under estimation	9				10				10	7	6	9		1	9	3	26
Availability and reliability of historical cost data	2	4				15											
Insufficient time for estimate	3	1				1	8										
Poor analysis of cost data	1					17											
Insufficient tender document analysis	2					3	10										
Poor project cost feedback	2	6				9											
Pressure from management	1					10											
Lack of adequate guideline for estimating	1					14											
Site Conditions																	
Unforeseen site condition	7			14	4		8		8	6	19						9
Inadequate site investigation	7					8	8			19		7		5	6	7	
Location of site / site constraints /access issues	6		5	26							7		13	27			31.5
External factors																	
Inflation / price fluctuation / exchange rate	13			54	20		15	9	16	5	8	6	9	16	24	15	13.5
Availability of resources (Labour, plant and material)	10		10	17	14				4		2		1	18	14	11	17
Market fluctuation	6		4	33	23		15							16		10	
Number of competitors	2			49									20				
Construction																	
Unrealistic construction timeframe / program	7		19		6		8	3				1			10		15.5
Experience & competency of project team	9		13	2	7		7	11		8	4				2		17
Current workload	2			40									10				
Other																	
Unsuitable contract	4		18	46			14						7				
Inappropriate risk allocation	2						14										22

Table 1 - Matrix of all risk factors identified in Literature studies

2.4 Pricing risk factor analysis

Table 2 shows the pricing risk factors and number of times each factor were identified in the literature, the pricing risk factors that were identified most frequently throughout the literatures were 'site related issues', followed by 'insufficient or incomplete design information' (2=), 'market and price fluctuation' (2=), 'change in scope of work' (3=), 'inexperience of estimator" (3=), 'availability of resources' and 'project complexity'.

Pricing Risk Factors	Number of times such risk were identified in the literatures
Design	
Insufficient or incomplete design information	13
Change in scope of work	12
Project complexity	9
Estimation	
Inexperience of estimator	12
Availability of cost data	2
Reliability of cost data	1
Insufficient time for estimate	3
Poor analysis / inappropriate use of cost data	1
Pressure from management	1
Estimator's lack of understanding of project requirement	2
Site Conditions	
Site related issues	14
External factors	
Market and price fluctuation	13
Availability of resources (Labour, plant and material)	10
Other	
Unsuitable or unconventional contract strategies	4
Subcontractors	
Unfamiliarity or poor understanding of specialist trade and their costing	-
Delay in receiving contractors' quote	-
Reliance on subcontractors to provide specialist knowledge	-

Table 2 – Pricing risk factors and the number of times each risk were identified in the literatures

Note that Table 2 are analysed in terms of number of times such risks were identified by the literature studies on the assumption that if such risk is identified several times through the studies, this must be important. The reason for this analysis is because although several studies do identify the level of impact and frequency of occurrence for each of risks, a conclusion of the combined impact from all studies cannot be made because the total numbers of risks identified by each study were different and the studies focused on different aspect of construction risks.

In addition, in order to enable comparison between literature review and the intended study to be carried out, a possible method to identify each risk's importance is by finding out the number of times each pricing risk factors were identified as top risk factors by different studies. As shown in Table 1, a number were assigned to each risk according to its ranking in each study (if identified). The risks that were perceived as the most important factor from the study will receive a score of 5; the second most important factor will receive a score of 4 and so on. A mean score is then calculated using mean ranking analysis (see formula in p. 43) and the result of this analysis is shown in Table 3.

As shown in Table 3, the risk factor that were identified as the most important is 'change in scope of work', followed by 'insufficient or incomplete design information', 'insufficient time for estimating', 'availability of resources', 'project complexity', inexperience of estimator', 'availability of cost data"(7=), 'estimators' lack of understanding of project requirement' (7=), 'reliability of cost data' (9=), 'pressure from management' (9=), 'site related issues', 'market and price fluctuation', and 'unsuitable or unconventional contract strategies'

Pricing Risk Factors	Score	Rank
Design		
Insufficient or incomplete design information	1.250	2
Change in scope of work	2.688	1
Project complexity	0.625	5
Estimation		
Inexperience of estimator	0.563	6
Availability of cost data	0.375	7=
Reliability of cost data	0.313	9=
Insufficient time for estimate	0.813	3
Poor analysis / inappropriate use of cost data	0.000	14
Pressure from management	0.313	9=
Estimator's lack of understanding of project requirement	0.375	7=
Site Conditions		
Site related issues	0.250	11
External factors		
Market and price fluctuation	0.188	12
Availability of resources (Labour, plant and material)	0.688	4
Other		
Unsuitable or unconventional contract strategies	0.125	13
Subcontractors		
Unfamiliarity or poor understanding of specialist trade and their costing	-	-
Delay in receiving contractors' quote	-	-
Reliance on subcontractors to provide specialist knowledge	-	-

Table 3 – Pricing risk factors and their relative importance score

2.5 Practical risk management strategy

2.5.1 Alternative estimating methods

Apart from the standard estimating method found in textbooks or standards (such as Standard Method of Measurement), there are many different estimating techniques available to the estimators including both quantitative and qualitative methods.

The quantitative method are often probabilistic and often involve complex statistical simulation or calculation including 'simple arithmetic formula' and 'range estimating (based on probabilistic technique)' as identified by Akintoye & Fitzgerald (2000) and 'parametric estimating' and 'operational estimating' as identified by Al-Hasan, Ross & Kirkham (2004).

The qualitative technique, on the other hand, are often deterministic and is based on estimators' experience, intuition and gut-feeling Other not so common qualitative techniques identified in the study done by Akintoye & Fitzgerald (2000) includes 'comparison with similar projects based on documented facts' and 'comparison with similar projects based on personal experience', 'shared information with subsidiary of the firm' and 'shared information from other construction companies'.

However, despite the fact that most construction estimators are aware of the availability of the quantitative methods, most contractors in practice do not perform any or perform limited forms of statistical or probabilistically modeling or formalized risk management strategies to determine allowance for risks (Laryea, 2008; McNamee & Perera, 2010; Smith & Bohn, 1999; Tah et al.., 1994, Wood & Ellis, 2003).

Instead, the most predominant method for assessing and apportioning risk in the construction industry is the application of their intuition, judgment, experience and gut-feeling (Ahmed & Azhar, 2004; Akintoye & MacLeod, 1997; Laryea, 2008; Lyons & Skitmore, 2004; McNamee & Perera, 2010; Tah et al., 1994; Towner & Baccarini, 2007 and Wood & Ellis, 2003).

In the study done by Towner & Baccarini (2007), all interviewees agreed that experience and intuition are very important (more so than any procedures or tool), some of the comments from interviewees were "each completed project builds a company's understanding of risks and how to approach future tender with regard to risk. Many times you can't really tell the magnitude or likelihood of a risk until you have experienced its consequences", "Pricing of risk cannot be too scientific, therefore it comes down to intuition to strike the balance between risk acceptance and competitiveness"

However, the method of using intuition, judgment, experience and gut-feeling to deal with risks received much criticism because of many flaws (Thompson & Perry, 1992). Firstly, the method is arbitrary and subjective which may not be appropriate for the specific project due to difference in project scope, complexity, location…etc. Secondly, it is difficult to justify and determine if potential argument and litigation arises, and finally does not encourage estimator to see risk as an opportunity and hinder the creativity of estimator in discovering new methods in dealing with risks.

2.5.2 Cover risk with contingency

As defined by Bello & Odusami (2008, p2), contingency is "a specific provision of money or time in an estimate for undefined items which statistical studies of historical data have shown will likely to be required".

This is by far, the most common method to cover the risks associated with estimating and project Bajaj (2001) and subject to wide research including Bajaj (2001), McNamee & Perera (2010), Akintoye & MacLeod (1997), Towner & Baccarini (2007), Smith & Bohn (1999); Onukwube et al. (2009) to name a few.

Akintoye & MacLeod (1997) suggested that the premium placed for each of the source of risk could depend on the risk exposure faced by individual, the company, the likelihood of occurrence, the experience of the individual and company, the

attitude to risks and the extent of impact posed by the source. The RICS New Rules of Measurement (2009) point out the importance that the risk allowance (contingency) is not to be standard percentage addition but a property considered assessment of risk taking account of the risks involved in a particular project

2.5.3 Adjust rate or unit cost to suit project

According to Smith & Bohn (1999), some risks are difficult to estimate because they are new knowledge to the construction estimators or they have no basis from which they could be estimate on. Therefore, rather than include a contingency, the estimators adjust their rate or unit cost to reflect the anticipated difficulties. This view is also supported by Onukwube et al. (2009) and Laryea (2008) who suggested that when pricing, contractors intuitively adjust either the quantities or unit rates or both to reflect their uncertainty resulting from the unknown scope of works. The unit cost can also be adjusted to accommodate future price increase by referring to current and anticipated economic condition and adjust using price or cost index.

2.5.4 Knowledge / Information Management system

Bajaj (2001), in his survey of 41 contractors in Sydney, highlight the importance of having an information system for successful risk management of project during the estimating and tendering stage. It is suggested that a computer based database system that stores historical information about past projects with regular recording and updating can provide a more accurate range of values for the contractors' estimators thus reducing the level of pricing risks.

Another author, White (2000) as cited in Jackson (2002) reported on major contractor investment in an internet based knowledge management system, which contains information on where a project went well, how problems were overcome or could have been avoided and allows staff access to this information.

Similarly, Wilson & Kusomo (2004, p3) suggested that price estimates for tendering can be optimised through a knowledge management and risk management system

which would “provide rigorous, efficient risk identification and assessment and the formulation of an optimum mitigation plan”

In addition, a “systematic and comprehensive documentation of project histories designed to consistently capture and explicate contextually all the knowledge required to optimise tender cost estimate” (p5)

Al-Hasan, Ross and Kirkham (2006) also identified that a systematic, realistic and structured recording of a company’s historical data derived from site feedback or work-study exercise is one of the reliable sources of information for estimating as this will minimize the estimator’s reliance on their own judgment and experience when it comes to estimating the construction cost, and leads to a more accurate result. However, as pointed out by Smith (1999) and Lyon & Skitmore (2004) such systems must be updated regularly to capture the risk event, site and cost feedback information to justify its reliability and increased usage by estimators.

2.5.5 Other methods

Some other methods of reducing the risks include:

- Ensure as much design as possible is done; implementing and incorporating design change management procedure before the commencement of the project. (Olawale & Sun, 2010)
- Capturing all design change on a register with corresponding cost and schedule implication for discussion during project team meeting and review these frequently and make available to all relevant personnel. (Olawale & Sun, 2010)
- Negotiating prices with supplier or contractors to fix the price for certain period of time which in term reduce the risk of price inflation in labour and material cost.
- Seek expert advice - when dealing with items of work that the estimators are not familiar or have no experience with, expert advice can be obtained from the specialist and subcontractors. The contractor can transfer these risks to the

specialist and obtain a quote to be included in the tender. (Olawale & Sun, 2010)

- Exclude high risk items in contract through clauses or specification - In terms of dealing with design and scope change, it is suggested by RICS (2009), Oladokun, et al. (2010), Onukwube et al. (2009) and Smith & Bohn (1999) to exclude these risk by including proper contract clause. Other work item(s) that often associate with high risks or uncertainties such as groundwork can be excluded completely from contract specification.

2.6 Proposed optimisation method - cost data management

Because there is no single strategy that can possibly cover all the risks, therefore it is only sensible to focus on the method that could possibly cover the greatest number of risks. It is concluded that, whichever method of risk management technique is used will require reference to the cost data, whether it is applied to alternative estimating methods; adjustment of rate or unit costs; allocation of contingency for risks; methods (both qualitative and quantitative) of calculating risk allowance; implementation of knowledge and information systems or making allowance for risks based on intuition, gut feeling, or experience.

The above conclusion is supported by Flanagan & Norman (1993) which states that the construction cost estimates can only be as good as the data on which they are based. McNamee & Perera (2010) also identify that, the lack of application of proper technique together with absence of reliable cost data used by the estimators inflates the problem of uncertainties and cost overruns even further.

Kirkham (2009, p200) also supported this by saying that “The root of all forecasting and control activity is the need for cost data to supplement the numbers, areas, volumes etc….It is this data that is crucial in determining whether or not an estimate is reliable”. He then goes further by stating that the term “Garbage In – Garbage Out” demonstrates and reinforces the importance of correct cost data in any form of modeling for accurate results.

Skitmore & Marston (1999) also comment that the present methods of estimating used by estimators often produce inaccurate and unsatisfactory results and suggested that "the greatest scope for improving upon present estimating performance lies in the selection, manipulation and application of cost data" (p. 457). This is also supported by Ashworth (2010), who states that "the collection, analysis, publication and retrieval of cost and price information together comprise a very important facet of all sectors of the construction industry." Also, Smith & Jaggar (2006) states that "a pre-requisite of any kind of cost management system, including cost planning is the need for reliable cost data in the form of cost information which reflects the range of cost management being undertaken" (p. 122).

Therefore, a rational optimisation to manage the pricing risks lies within the availability, collection, analysis, application and adjustment of cost data. Without accurate cost data being applied, none of the risk management methods mentioned in previous section will be effective. Based on this finding, the focus of this study regarding to cost data management is to investigate the following issues concerning residential construction estimators in the Auckland area:

- Number of cost data currently exist in residential construction company
- The levels of detail (structure) of cost data
- The sources of cost data, its frequency of usage and perceived reliability
- The uses of cost data
- The difficulties experienced by estimators when applying the construction cost data

2.6.1 Number of cost data

Managing thousands of cost items in the cost data is not practical and very time consuming. This is because although the New Zealand Standard (NZS 4204:1996) – Standard Method of Measurement of Building Works requires the estimators to measure down to the detail of hardware and fixings such as number of nuts, bolts and

nails, research in literature has found that this is not the case in the practical sense. According to Ashworth (2010), it is concluded that by measuring and pricing approximately 100 major cost items of work will be sufficient to achieve optimum estimating performance, the accuracy will hardly be increased by more detail pricing. Ashworth & Skitmore (1983) supports this by saying that "many of the items included in a bill of quantities for a building project are of little cost significance. A suggestion has been made that "somewhere in the region of 80% of the cost of a project is represented by only 20% of the bill items" (p. 427). It has been concluded that these items with low cost significance are rarely estimated but are priced in a very "subjective way on an ad-hoc basis".

2.6.2 Structure of cost data

Cost data exist in many different forms and various levels of detail. This is because different groups of cost data is required to estimate a construction project from the inception to the tender stage which reflects the amount of information available to the estimators at different stages of cost planning.

As more design details are being developed, cost data with different levels of details are being used. Smith (1999) as cited in Al-Hasan et al. (2006) reported that the collection of past project data and the structuring of the data that are used to estimate future project, is an important component of any estimating system.

Kirkham (2009) categorised cost data into five levels of detail including, from the lowest level of detail to highest, cost per functional unit; cost per square meter for various types of building; elemental unit rates; all-in unit rates applied to abbreviated quantities and bill of quantity rates. Similarly, Smith & Jaggar (2006) present similar hierarchical structure for the cost data according to the RIBA plan of work which shows the nature of cost data required for various stages in the design cost management process (Figure 1).

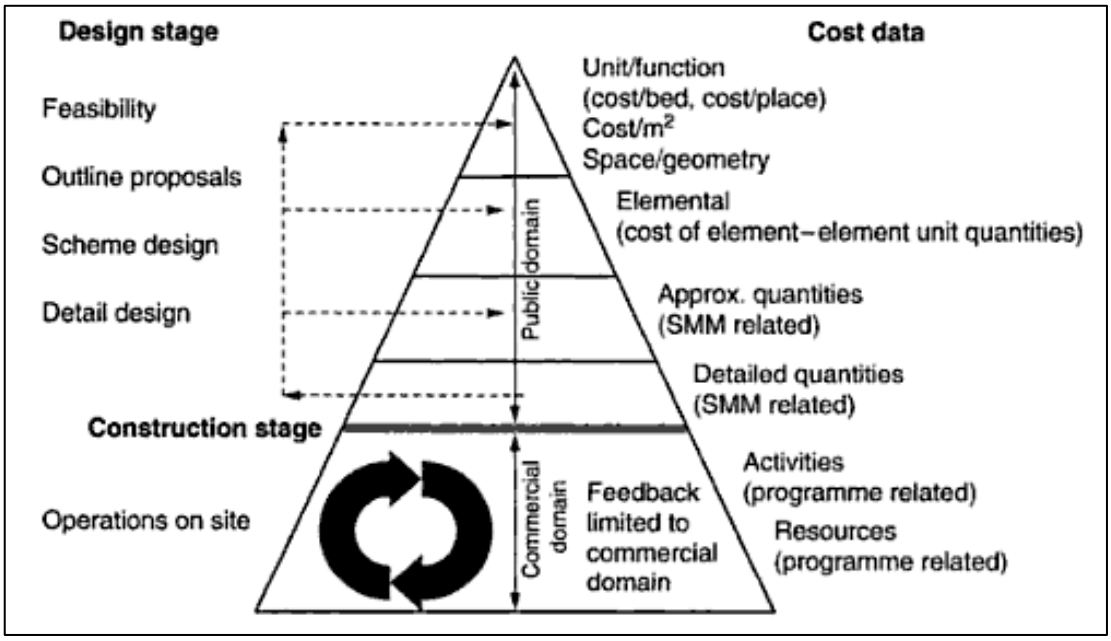

Figure 2 – RIBA plan of work and its relationship to cost data (Smith & Jaggar, 2002, p. 59)

2.6.3 Sources of cost data

Estimator's cost data come from many different sources. Kirkham (2009) identified several sources including contractor's own historical data and published data including technical press (i.e. journals and magazines), builder's price book (i.e. Rawlinson's Construction Handbook), Government literatures and specialist contractors and consultants.

Ashworth (2010) identified similar sources of cost data including contractor's own generated data (priced bill of quantities) and published data including price books, public sector price guides, monthly journals and commercial publications and third parties. Akintoye et al. (1992) also identified that analysed successful contractors' tenders, technical press, colleagues, information service and market survey (including quotations from specialist contractors, enquiry from reputable builders merchant, manufacturer catalogue or quotations and trade union agreement for labour rates) as the main sources of cost data.

Brook (2008), also identified that company database, cost information from previous tenders (both successful and unsuccessful tenders), building cost information

services, assistance of client and consultant and publications as the main sources of cost data.

Morrison (1984)'s research found that the sources of cost data includes standard schedule of prices, rates taken from a single previous bill, price books, specialist subcontractors and suppliers and other priced bills.

According to Kirkham (2009) and Ashworth (2010), the contractors' own historical data is considered as the preferable and reliable source because the background information (such as location, market conditions, complexity, etc.), problem associated with the project during construction (which has an influence on price and project outcome) and other important features of the project are known to the construction estimators and therefore can be applied with greater confidence. This is supported by Al-Hasan (2006), who suggested that one of the reliable sources of information should be from recorded company data derived from site feedback or work study exercise.

Published data, according to Ashworth (2010) are generally considered as back up source by the estimators and its accuracy is often questioned because the lag time between the date that the cost data were collected and the date that it is published "may be anything up to six months behind times" (p. 216). The cost data of this type suffers from being rapidly out of date especially in the time of high inflation. Another shortfall of cost data is that it usually relates to a "typical building" at a "typical location" and therefore may not be applicable to buildings in other areas.

However, the published cost data may be used for other purposes such as a backup source when an estimator's own cost data is not available, as a tool for price check, getting a second opinion for the estimators or used in matters of urgency (Ashworth, 2010). Kirkham (2009), suggest that "it is probably the primary role of published information to provide data which enables practitioners to check on their own knowledge and to provide a context for their own decision-making" (p. 216)

2.6.4 Uses of cost data

Kirkham (2009) has identified some of the uses of cost data including forecasting of cost, comparison of costs, balancing of costs and analysis of cost trend.

- Forecasting of cost refer to the estimation of future construction cost and control during the project stage to ensure the cost is closely adhered to the tender.
- Comparisons of costs - in this context, meaning "comparing between items with similar function or buildings of different design to decide which is the better choice" (p. 202)
- Balancing of costs – refers to "allocating sums of money to the various major components of the building" (p. 203) in accordance with the client's requirement
- Analysis of cost trend – this is described by the author as "of paramount importance in any prediction technique" (p. 203) because the estimators will be able to produce a more reliable prediction of what the actual construction cost would be when the job eventually goes out to tender by looking at the trends that cost item(s) changes. However, despite the advantage it offers, this analysis is usually not practiced. The reason for this might be because the lack of time and resources for the quantity surveyors to perform such analysis.

Akintoye et al. (1992) investigated the same issue and the study shows that all quantity surveyor uses cost information to forecast future construction cost, follow by negotiating unit rate with contractors (79%), monitoring/controlling contract prices (69%); cost comparison of different construction type (41%), design cost planning (particularly cost checking) (28%), monitoring / knowledge of general cost trend (17%) and preparation of valuation for insurance (7%).

Ashworth (2010) also identified the purposes for having access to cost information including cost planning during design, contract estimating for tendering purposes, agreement of variation in final accounts, calculation and settlement of contractors'

claim, loss adjustment valuations and maintenance management.

2.6.5 Difficulties in collecting and applying cost data

Perfect cost data does not exist in practice because no two exactly similar projects are built in practice. Therefore, difficulties are nearly always experienced in collecting and applying cost data to an estimate.

Ashworth (2010) identified several difficulties while applying cost data to an estimate. This includes:

- Potential error contained within the Bill of Quantities
- Insufficient number of cost data
- Cost data too diverse
- Conflicting cost data
- System of operation is difficult to use
- Process of application is slow.
- Variability in cost data
- Lack of confidence in the site recording system
- Information not compatible with future estimating needs

Akintoye et al. (1992) investigated the constraints on collection of realistic cost information which includes insufficient relevant data, little design information, fluctuation in prices of materials, external influences, poor office organisation, pricing problem of bill of quantities and professional inexperience. Akintoye & Fitzgerald (2000) also identified shortcomings in skills, knowledge and data for cost estimating and identified that lack of actual cost feedback and regional price variation are the shortcomings relating to cost data.

Very little information regarding the difficulties experienced when collecting and applying cost data can be found apart from the literatures discussed above. Since most risk management strategies mentioned above ultimately relied on the cost data

used by the estimators, it is important to find out the difficulties experienced by estimators and come up with a solution.

2.7 Summary

This chapter reviewed the literatures relating to the aim of this research, which is to examine the question – What are the perceived pricing risks and practical management strategy amongst construction estimators in the Auckland residential construction sector?

The literature review consists of two parts. The first part of the literature review considers various perspectives (e.g. project management, risk management, cost estimating, tendering…etc.) around the world on risk factors that were perceived to have an influence on the project outcome. The risk factors that appeared particularly related to the construction estimators' pricing risk have been identified and they are:

- Estimating error by estimator
- Due diligence of estimator (i.e. lack of understanding of project requirement)
- Inexperience of estimators
- Pressure from management
- Insufficient time for estimating
- Delay in receiving contractors' quote
- Unfamiliarity or poor understanding of specialist trades and their costing
- Reliance on subcontractors to provide specialist knowledge
- Availability, accuracy and reliability of cost data used in estimating
- Poor analysis / inappropriate use of historical cost data
- Insufficient or incomplete design information
- Change in scope of work
- Project complexity
- Site related issues
- Availability of resources (labour, plant and material)
- Unsuitable or unconventional contract strategies

- Market and price inflation

The second part of the literature review addresses the methods or strategies that estimators employ for managing the perceived pricing risks. Despite a lot of literature on identifying pricing risk factors, very little research appears to have been done to address methods or strategies employed in managing these risks. Some strategies to manage these risks includes alternative estimating methods (both qualitative and quantitative); allocation of contingency for risks; adjustment of rate or unit costs; implementation of knowledge and information systems or making allowance for risks based on intuition, gut feeling, or experience.

It is concluded that there is no single strategy that can possibly cover all the risks and whichever method of risk management technique is used will require reference to the cost data.

Therefore, a rational optimisation lies within the availability, collection, analysis, application and adjustment of cost data. Without accurate cost data being applied, none of these risk management methods mentioned above will be accurate or effective in terms of dealing with the pricing risks. Based on this, the focus of this study in regards to the management strategy of pricing risk is to investigate the current practice of cost data management by the residential construction estimators in Auckland including issues on:

- Number of cost data currently exist in residential construction company
- The levels of detail (structure) of cost data
- The sources of cost data, its frequency of usage and reliability
- The uses of cost data
- Risks in applying cost data to an estimate.

3. METHODOLOGY

3.1 Introduction

The purpose of this chapter is to provide an overview of the research design and methodology implemented in order to answer the question "What are the perceived pricing risks and practical management strategy amongst construction estimators in the Auckland residential construction sector?"

The chapter begins with a brief description of research methodology available and the methodology employed in this study. This is followed by identification of the research method and an outline of the reasons for employing such method. The data collection instrument used for collecting data and its content, structure, wording and scale of measurement are also discussed.

The chapter continues with discussion on the sampling method and the rationale for adopting the selected sampling method, followed by an outline of the data collection procedure. The chapter then focuses on a discussion of the reliability and validity of the research method employed and ethical considerations for the research.

3.2 Research design

The focus of this research is in two parts. The first part concerns the question "What are the construction estimators' perceptions of pricing risks in the Auckland residential construction sector?" with the sub-question focused on how cost data, being considered as the most critical pricing risk management strategy are being used and managed by the estimators.

The objective of the first question can be achieved by asking the construction estimators currently practicing in the Auckland residential construction industry to rate, in terms of importance and frequency of occurrence, the pricing risk factors summarised from the literature review. The second part of the question involves the researcher investigating the experiences and views of the construction estimators on

issues of cost data management also identified in the previous Chapter.

3.3 Research methodology

According to Fellows & Liu (1997), research methodology can be categorised into quantitative, qualitative or a mixed method research. A quantitative approach is usually used in scientific or social science studies where the researcher collects quantitative data (i.e. numbers or other measurable data) systematically in order to find facts about a question, generate models or test theories and hypotheses. (Fellows & Liu, 1997; Naoum, 2007)

A qualitative approach, on the other hand, seeks to gain insights and in-depth understanding of people's perceptions and the underlying reasons for these perceptions by asking why and how a decision is made and explore individuals' attitudes, opinions, behaviours and experiences regarding a particular topic (Fellows & Liu, 1997; Naoum, 2007). The data collected is often rich and detailed which helps the researcher to interpret or better understand the topic. However, the analysis of collected data is often more difficult than for quantitative data.

A mixed approach, as identified in Denscombe (2007, p. 108) as use of both "qualitative and quantitative approaches within a single research project". This method is used when the research aims to get a more complete picture of the question being studied and is "problem driven in the sense that it treats the research problem – more specifically answers to the research problem – as the overriding concern" (Denscombe, 2007 p. 108)

A mixed method is employed for this research. This is because the quantitative method enabled the researcher to collect data in regards to the ranking of the importance and frequency of occurrence of pricing risk factors and can be easily measured, statistically analysed and compared with the previous researches to see whether the same perception exists or is there a particular pattern in the New Zealand construction industry context. The same method has been used in several of the

sources studied including Bello et al. (2008); Onukwube et al. (2009); Olupolola et al. (2009); Akintoye (2000); Akintoye et al. (1992); Odeyinka (2007); Windapo & Martins (2010); Odeyinka et al. (2010): Oladokun et al. (2010), Elhag et al. (2005); Odeyinka (2007) and Odeyinka et al. (2010)

The qualitative method, however, allows the researcher to collect descriptive data on the estimators' perceptions, opinions and experiences on cost data management through a series of open questions and which helps the researcher to gain more diversity in response and in-depth understanding of the issues investigated. This approach is also used in other literature reviewed including Akintoye & Fitzgerald (2000), Akintoye (2000), Jackson (2002) and Akintoye & MacLeod (1997).

3.4 Research methods

According to Denscombe (2007) there are several methods for conducting research including surveys, case studies, experiment, ethnography and action research. A survey tends to be empirical, has a wide and inclusive coverage and provides a snapshot of the topic under study at a specific point in time (Denscombe, 2007). The aim of this study is to provide a snapshot of the perception of pricing risks amongst construction estimators and current practice on how cost data are being used and managed by the estimators to reduce pricing risks; the survey approach therefore, is appropriate and has been selected for this study.

There are two types of survey, namely the analytical and descriptive survey. The analytical survey "aims to establish relationship and association between the attributes/object" (Naoum, 2007, p. 44). The descriptive survey, on the other hand, "deals with counting the number of respondents with certain opinion/attitudes towards a specific object" (Naoum, 2007, p. 44). In addition, Burns (2000, p. 566) defines the descriptive survey as one which "aims to estimate as precisely as possible the nature of existing condition" which coincides with the aim of our study.

A survey can be conducted in different forms depending on the aims of the research.

It can be carried out as an interview (face-to-face or telephone), questionnaire (postal or web-based), documents or observations (Denscombe, 2007).

An interview is a face-to-face interaction between the researcher and the interviewee in which the researcher "asks respondents questions designed to elicit answers pertinent to the research hypothesis" (Naoum, 2007, p55). An interview is suitable when the interviewees are homogeneous and share the same characteristics (in this case, residential construction estimators).

Questionnaires, as defined by Denscombe (2007, p. 155), "rely on written information supplied directly by people in response to questions asked by the researcher". This information tends to be factual information or opinions. According to Naoum (2007), the questionnaire is the most commonly used data collection technique for descriptive and analytical surveys in order to find out the respondent's opinion, views on the research topic. Also, almost all questionnaires have "close-ended" questions that require a specific response such as 'yes' or 'no' or ranking the importance of factors" (Naoum, 2007, p. 53). There are several advantages of a questionnaire including:

- Less expensive - ability to collect large amount of information with less resource (in terms of finance, human and other requirement)
- Offer greater anonymity as there is no face-to-face interaction
- Respondents have more time to think about the answers to the questions
- Standardised data therefore easier to analyse
- Most popular technique so comparison with previous studies is much easier

However, the questionnaire method is also subject to several disadvantages including:

- Low response rate due to lack of motivation to complete and return the survey and most respondents do not have time for a survey

- Lack of interaction between the researcher and respondent means there is no opportunity to clarify misunderstanding, misinterpretation and ambiguity.
- Response to a question may be influenced by other questions because the respondent can read all the questions before answering
- May receive incomplete or poorly answered questionnaires

The disadvantages of a questionnaire method described above can be overcome by interviews. For example, the lack of interaction and therefore no opportunity to clarify misunderstanding, misinterpretation and ambiguity can be overcome because interviewer is there to answer any questions that the respondent may have or finds hard to understand. (Bryman, 2004; Naoum, 2007)

In addition, the disadvantages that a researcher may receive incomplete or poorly answered questionnaires can also be overcome in an interview where the researcher can ask additional questions and make sure the right set of data is obtained. There are also opportunities for the researcher to ask probing questions to assist the interviewee to elaborate the answer and add depth to the answer provided (Bryman, 2004; Naoum, 2007). Other advantages of using interview include that the researcher knows that answers are obtained from the right person; the quality of information is rich and deep and it does not require larger number of samples to provide usable data.

Denscombe (2007, p. 174) emphasised that "when the researcher needs to gain insights into things like people's opinions, feelings, emotions and experiences, then interviews will almost certainly provide a more suitable method". Therefore, an interview approach was used for the purpose of this research because it focuses on finding out the perception of pricing risks from the construction estimators and their opinion and experience on data cost management.

As suggested by Naoum (2007), interviews can be unstructured, semi-structured and structured. An unstructured interview has no pre-determined set of questions and is

the most difficult type of interview to conduct because it is guided by the interviewee and the interview has the risk of becoming too conversational therefore resulting long interviews and researcher fail to gather useful information from it (Tenenbaum & Driscoll, 2005). On the other hand, a structured interview requires the researcher to adhere to a particular set of rule, the same questions must be asked at the same order with all interviewees. This method is suitable for interviews conducted by multiple researcher and the responses are easier to compare between interviews. (Tenenbaum & Driscoll, 2005).

Both the unstructured and structured interview are not suitable for this research because they are either too rigid (structured interviews) which does not allow probing questions to be asked to obtain more in-depth information or understanding; or too relaxed (unstructured interviews) which has the risk of not able to collect useful information and depend highly on the skills of the researcher (Tenenbaum & Driscoll, 2005).

A semi-structured interview, however, consists of a set of questions to be asked or issues to be explored by the researcher, which is used as an guide or checklist to ensure that all information are obtained from the interviewees during the course of the interview. The questions are not asked in a specific order nor are they asked with fixed wording (Naoum, 2007; Burns, 2000; and Tenenbaum & Driscoll, 2005).

The semi-structured interview is considered more appropriate for this research because it "offers better flexibility and the researcher is free to probe a particular area or can phrase the question in a way that the interviewees are better to understand, it also offers a more valid response on the interviewee's perception of reality" (Burns, 2000. p. 427) with the aim to find out as much as possible on the specific topic under study.

Therefore, it is concluded that for the purpose of this study, the collection of data consists of a semi-structured interview with questionnaire which were given to the interviewees to complete at the beginning of the interview and questions were asked

depending on the answers provided by the interviewees.

The questionnaires were used to obtain answers for the closed questions which can be easily analysed and compared with the literature. The questionnaire asked the interviewees to rank a set of pricing risks in the order of importance and frequency of occurrence as well as the sources of cost data and their perceived reliability. Similar approaches have been used in several projects reviewed in this research including Jackson (2002), Odeyinka (2007), Olupolola et al. (2009), Onukwube et al. (2009), Oladokun et al (2010), Odeyinka et al. (2010) and Bajaj (2001).

The open questions were asked using interview method. This includes questions concerning the issue of cost data usage and management. Similar method is also adopted by Al-Hasan et al. (2006), Towner et al. (2007); Windapo et al. (2010); Oladokun et al. (2010).and Elhag et al. (2005).

3.5 Data collection instrument design

3.5.1 Open and closed questions

There are two types of questions – open and closed questions. Open questions allow the respondent to express their opinion without setting boundaries to what they can answer and the researcher can benefit from gaining insights from the responses that are not identified in the previous studies. However, open questions take longer to answer; subject to wide spread of answers; and are more difficult to analyse and interpret (Naoum, 2007 and Fellows & Liu, 1997).

On the other hand, closed question allow a more direct response which takes less time to answer and is easier to analyse. However, the respondent is forced to answer within the options set out by the researchers and often the researcher will not get an in-depth response which adds to the knowledge of the research (Naoum, 2007).

3.5.2 Questionnaire design

Since the research method adopted a combination of interview and questionnaire, a

questionnaire and a list of interview questions were developed. The questionnaire has been designed to ask closed type of questions which are quick, simple and straightforward to answer. The focus of the questionnaire is to obtain data such as demographic information of the estimator and its company, the perception of pricing risks, number of cost data, level of details of cost data, the ways cost data were used and sources of cost data and their perceived reliability from the interviewee. The content of the questionnaire was developed from the result of literature review.

The questionnaire was designed in five separate parts; the first part includes instructions to complete the questionnaire which was explained to the interviewee at the beginning of the interview. This is followed by a consent form which required a signature from the interviewee.

The third part (Section A) collects general information such as years of experience that the estimators have, number of residential construction projects carry out annually, annual turnover and type of building project that the company carry out. The reasons for asking these questions are first to establish rapport with the interviewees and second to have easy answered questions at the beginning of the interview so that the interviewees feel comfortable about carry on the interview.

The fourth section focused on the estimator's perception of pricing risks which asked the interviewee to identify the level of impact of each of the risk factor and then indicates how often the risk has occurred on projects they have been involved or are aware of. The interviewees also have the opportunity to add other factors that were not included in the list provided.

A total of 17 pricing risks were identified in the literature review. The interviewees were asked to score each pricing risk on a Likert scale of 1-5, on the order of importance and frequency of occurrence. The Likert scale used is identified as follows:

1 – Very low importance and very low probability of occurrence
2 – Low importance and low probability of occurrence
3 – Medium importance and medium probability of occurrence
4 – High importance and high probability of occurrence
5 – Very high importance and very high probability of occurrence

The fifth section focused on the question regarding cost data management. Questions includes the number of cost data, level of details, sources of cost data and their reliability and the ways and how often cost data were used.

A list of sources of cost data were compiled from the literature review and included in the questionnaire which asked the interviewees to score in a Likert scale in terms of frequency of usage and its reliability in the same scale as described above. However, questions regarding the ways cost data is used and how often they were used have an additional option "0 – Never" available to the interviewee to choose.

3.5.3 Questionnaire pretesting

A questionnaire pretesting (or pilot study) provides an opportunity for the researcher to gain feedback in regards to the length of the questionnaire; wording, layout, sequence, clarity and format of the questions; questions that could be added or deleted as well as to identify ambiguities, appropriateness and conflicts between question asked (Fellows & Liu, 1997; Naoum, 2007) so that the researcher has the opportunity to modify the question prior to taking them to the interview. The questionnaire was reviewed several times by the supervisor with another supervisor providing opinion regarding the content of the questions prior to the approval of questionnaire and interview questions.

3.5.4 Semi-structured interview questions design

A list of interview questions is included in Appendix B. The questions asked in the interview consist of mainly open questions. The open questions were asked depending on the answers provided by the interviewees. For example, if a source of

cost data is frequently used but has low reliability, why do the estimators uses them? And if a source of cost data is not used frequently but is very reliable, why do estimators not using them? These questions were developed before the interview to cover the possible responses but some questions may not be asked, all of which depend on the answer provided by the interviewee.

Because the fact that this is a semi-structured interview, additional probing or check questions may be asked. According to Denscombe (2007), this is one of the major advantages of interviews because the purpose of probing question is to gain a deeper understanding of a topic and the check question aims to confirm what has been said and the interviewee can correct it if there is any misunderstanding.

3.6 Sampling

The objective of sampling, according to Fellows & Liu (1997), is to provide a practical means of collecting data from a sufficient number of samples of the entire population. The selection of research sample is very important because the researcher must ensure that the sample must be a representation of the entire population under study (Naoum, 2007) and ensure that the characteristics of the sample are the same as its population in order to generate a reliable and valid finding.

The research aims to represent the views of construction estimators in the residential construction sector in the Auckland region. This encompasses hundreds of companies and therefore not feasible to contact all of these estimators within these companies. The population is therefore the estimators within the residential construction companies in Auckland area and a sample, being a representation of this population, is the number of interviewees selected to allow data to be collected.

In general, the method of sampling can be categorised into probability sampling (in which every element in the entire population has an equal chance of being selected) and non-probability sampling (selection of sample is based on convenience or judgment) (Fellows & Liu, 1997).

For this research, the decision was to use the non-probability purposive sampling technique (sometimes called judgment sampling) which the researcher selects interviewees who are considered to be typical of the wider population based on the researcher's knowledge and judgment.

The purposive sampling method is suitable for this research because the population that the researcher want to collect data from has already been identified, that is, the construction estimators within the Auckland residential construction companies. This is the main advantage of purposive sampling and no time will be wasted on picking other individuals other than residential construction estimators in Auckland. According to Denscombe (2007), the selection of sampling method depends on the overall aim of the research and if the aim is to seek in-depth understanding of a particular situation then it is appropriate to choose key players in the field.

For the purpose of this research, the samples were selected by first compiling a list of residential construction companies in the Auckland region. A telephone call to the construction companies asked whether they have an in-house estimator and whether they use any sort of cost data for their estimate. The researcher then explained the purpose of the research and the estimators were asked whether they are willing to participate in this research. If the estimator agreed to participate, the researcher then scheduled an agreed time and venue for carrying out the interviews.

3.7 Data collection procedure

The interview began with a brief introduction to the topic followed by how the interview will be conducted and how will information be recorded. The questionnaire was given to the interviewee at the beginning of interview which includes the consent form that the interviewees are required to sign.

Once the interviewees signed the consent form, they can continue to complete the rest of the questionnaire and interview questions were be asked based on the answer

provided either after or at the completion of each section.

The interviews were recorded on digital recorder which should have been transcribed at the end of interview date. However, due to the limitation of time for this research, a full transcript of the interviews was not produced. Instead, only the themes, key points, phrases and/or statements that related to the interview questions were transcribed and these are presented in Chapter 4

3.8 Data analysis

3.8.1 Quantitative data - questionnaire

The quantitative data obtained from the questionnaire was analysed using mean ranking analysis. This is used in order to determine the relative importance and frequency of occurrence of the pricing risks, the frequency of each source of cost data was and it's perceived reliability and ways cost data were used in the study. The mean score is determined by the following formula:

$$Mean\ Score = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1 + 0n_0}{(n_5 + n_4 + n_3 + n_2 + n_1 + n_0)}$$

Where: n_5, n_4, n_3, n_2, n_1 and n_0 are the number of respondent who score the level of importance and probability of occurrence as 5, 4, 3, 2, 1 and 0 respectively.

This method is used by many studies including Bello et al. (2008); Onukwube et al. (2009); Olupolola et al. (2009); Akintoye (2000); Akintoye et al. (2000); Odeyinka (2007); Windapo et al. (2010) and Odeyinka et al. (2010). The mean score is also referred to by some studies as severity index score (e.g. Oladokun et al., 2010, Elhag et al., 2005, Odeyinka, 2007 and Odeyinka et al. 2010)

In addition, the perception of pricing risks were analysed using the formula below. According to Odeyinka et al. (2010), many risk management perceive risk as the product of probability of a system goes wrong and its consequences and risk was

measured using the formula of:

$$R = P \times I$$

Where R = the degree of risk, P = the frequency of occurrence of the risk factor and I = the level of impact of the risk factor.

The same method is also referred to by Akintoye et al. (2000) as the risk exposure or expected value (EV) and by Tweeds (1996) as cited in Odeyinka (2007) as average risk estimate.

3.8.2 Qualitative data - interviews

The qualitative data obtained from open-ended questions were analysed by using the method described by Naoum (2007) as "exploratory data analysis", this is described by the author as the best way to analyse open-ended questions which uses a coding technique to categorise a large number of answers to a few general categories which can be assigned a numerical code. This method is also called content analysis where the researcher looks for common themes or responses as well as the extremes.

Denscombe (2007) made a similar suggestion to identify each theme with a unique serial number (indexing) for reference purposes. This not only retains confidentiality of data, but also makes it easier for the researcher to refer back to the raw data collected.

Denscombe (2007) suggested a series of four tasks when interpreting the data. The first step requires codes to be attached to the raw data to link the data to an idea relating to the study or the question asked. The second step involves grouping these codes into separate categories or key headings. This is then followed by identifying key themes and relationships between the codes and categories, and finally develops some general conclusions about the findings. An illustration of these steps is represented in Figure 2

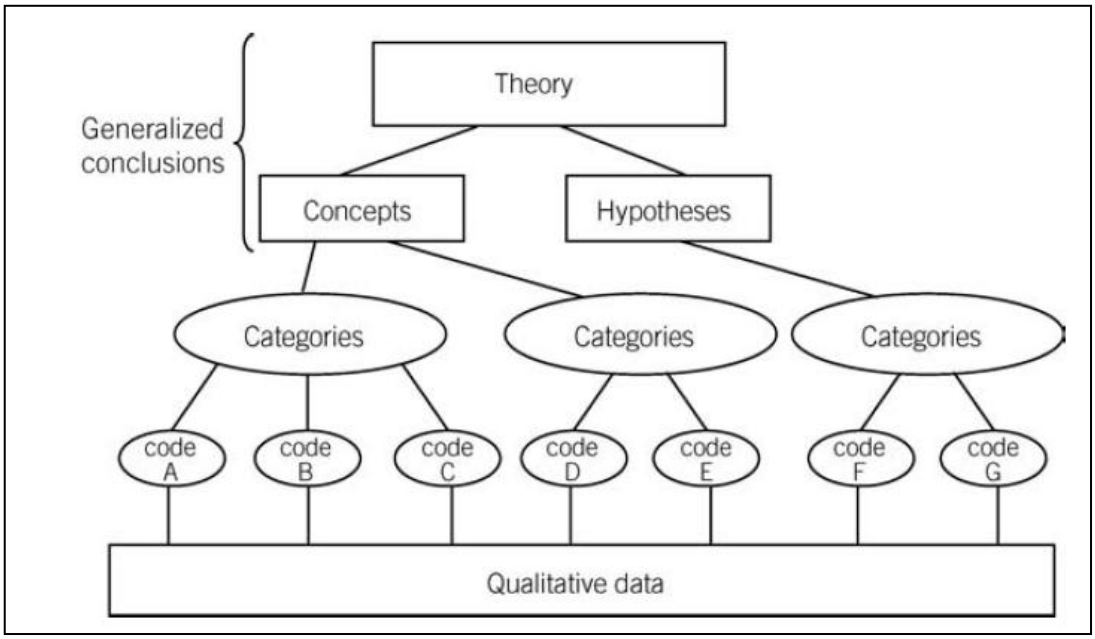

Figure 3 - The analysis of qualitative data (Denscombe, 2003, p. 294)

The categorised results were presented in tabulated form which simply listed the categories and recorded the number of responses (frequency) to each (Naoum, 2007). As suggested by the same author, due to the limited numbers of interviews, it is more appropriate to represent the tabulated result to show the frequency rather than percentage because presenting them in percentage form could be potentially misleading as the reader can assume a larger number of samples are being presented and yield the same result.

3.9 Reliability and validity

Whatever method of research is followed, it is always critical to examine the reliability and validity of the research (Bell, 2007). Reliability refers to whether a research methodology would produce the same result if it were repeated with all other things being equal (Denscombe, 2007). Validity refers to the accuracy and precision of data and whether the data are appropriate for the purpose of the research and have they been measured correctly (Denscombe, 2007)

To ensure reliability, all interviews were conducted by the researcher and all

interviews were audio recorded using the same instrument. Also, the same set of questionnaires was given to the interviewee throughout the data collection process. Because the nature of a semi-structured interview, interview questions were asked depending on the answers provided by the interviewee and reliability is therefore, hard to achieve. However, one way of increase the reliability of the semi-structured interview is to have an interview schedule that listed all the questions that could possibly be asked (Denscombe, 2007). A list of interview questions was and is available in Appendix B.

To ensure validity was achieved, the questionnaire and list of interview questions was peer reviewed by two supervisors to ensure that the right questions were asked with the right measuring scales in order to gain accurate response from the interviewees.

Another way to ensure validity is avoid concluding finding based on one interview and look for the themes from a number of interviews instead. This recurrence of themes amongst different interviewees indicates that the idea or issue is common and therefore a valid conclusion.

3.10 Ethics consideration

Regardless of what type of research method a researcher took, the issue of ethics always exists. The aim of ethics consideration is to ensure that the interviewees participated in the research are not subject to unnecessary risk of physical, psychological, social or commercial harm.

The research method undertaken in this study is both quantitative and qualitative research using a questionnaire as a tool for collecting data, supported by semi-structured interviews. A copy of the questionnaire, interview questions, information sheet and consent form together with ethics approval form has been approved before conducting this research.

The following ethical issues were addressed in order to address the ethical issues:

3.10.1 The researcher and supervisor

The name of the researcher and the name of the supervisor were disclosed to the interviewee, and if required by the interviewee, the contact detail of the researcher, the supervisor and the Unitec Ethics Committee will be made available. This is important because if the interviewee has any concern regarding any issues of the interview, he can then direct those concerns to the appropriate parties.

3.10.2 Privacy and confidentiality

Privacy and confidentiality is important to ensure that no harm will be done to the interviewees as a result of their participation.

The information provided by the interviewees was used solely for the purpose of this research only. The interviewees were explained of how the information will be collected and used in the research as well as explained who may have access to this information and the information will not be disclosed to a third party without permission unless it is a moral or legal requirement.

The identity of interviewees (name and the company that they work for) were kept anonymous by coding the interviewees as EST01, EST02…etc. so that none of the code correlates to the interviewees' name or the name of the company they work for.

3.10.3 Right to access

This is important to make sure that the researcher has the right to access the interviewees' workplace as a venue for conducting an interview. For the purpose of this research, access to project or construction sites was not required. Access to staff on company premises or during work hours were dealt with when making appointments with the interviewee.

3.10.4 Data collection and storage

Questionnaires were used as an instrument for data collection. The interviews were recorded by an electronic device. Again, the only people that have access to the data are the researcher and supervisor.

In regards to the storage of data, the data will be stored both in paper form (return questionnaire) and electronically (content of report). Under the Unitec's Research Ethics Committee requirement, the data will be kept for five (5) years after completion of the research project. The interview recordings and other electronically scanned or copied document will be password protected and stored in researcher's private computer. This is to ensure that access to this information by others will no be possible in order to protect the interviewees from any harm.

3.10.5 Consequence of participation and non-participation

The interviewees had the right to withdraw at any time before or after giving consent and there were no negative consequences for non-participation. The interviewee will be sent a copy of the research report at the end of research for their knowledge gain as one of the benefit of participating in the research.

3.11 Summary

A mixed approach were adopted in order to collect data concerning the perception of pricing risks amongst Auckland residential construction estimators and how cost data, being the essential element of managing the pricing risks, are being used and managed by the estimators to reduce the pricing risks.

The survey method allows the researcher to utilise both questionnaires and semi-structured interviews to collect the data required. The questionnaire was designed to collect quantitative data including demographical information as well as other closed questions to enable analysis of collected data. The semi-structured interview was used to gather qualitative data which will be analysed by looking at common themes, patterns or extremes of responses.

Non-probability purposive sampling was adopted. Samples were selected by first listing residential construction companies in Auckland area followed by telephone calls to each of them.

4. DATA ANALYSIS

4.1 Introduction

This chapter presents the data obtained from the semi-structured interviews with questionnaires given to the interviewees to complete during the interview. The questionnaire was used to collect general information about the interviewees, perception of pricing risks in terms of level of impact and frequency of occurrence as well as sources, numbers, level of details and purposes of cost data. Interview questions were asked based on the interviewee's responses and are also represented in this chapter.

4.2 Responses

A telephone call to all potential interviewees was made. A total number of 32 estimators working within a residential construction company in Auckland area were contacted and 8 agreed to participate in the interview. This corresponds to a response rate of 25%. The response rate is considered low and some of the reasons given by the estimators for non participation includes that they are too busy; don't think they have enough knowledge to contribute, or simply refuse to participate without giving reasons.

The interview procedure was explained to all interviewees before conducting the interview and all interviewees read and agreed to the consent information contained at the beginning of the questionnaire. All interviewees answered all questions in the questionnaire and five interviewees added other answers for additional risk factors and source of cost data.

4.3 Questionnaire responses

4.3.1 Demographic analysis

Section A of the questionnaire consists of questions to gather the demographic information about the interviewee and its company. These include how long the

interviewee has been working in the construction industry, number of projects that the company do a year; the company's annual turnover as well as types of building project carried out by the company.

As shown in Table 4, the number of years the interviewees had worked in the construction industry ranged greatly from 0 – 4 years to over 15 years. The majority (6 out of 8) of interviewees had an experience of over 15 years and only one interviewee had an experience of less than 5 years.

Years worked in the industry	N
0 – 4 Years	1
5 – 9 Years	1
10 – 14 Years	0
15+ Years	6

Table 4 – Number of years worked in the industry & number of responses to each category

As for the number of projects that the companies do per year (Table 5), all companies do over 20 residential construction projects per year and half the companies interviewed carried out over 60 residential construction projects per year.

Number of projects per year	N
0 - 19	0
20 - 39	2
40 - 59	2
60+	4

Table 5 – Number of projects per year & number of responses to each category

The annual turnover of companies that the interviewees work for also ranges greatly from 0 – 4 million to over 15 million (Table 6). Half of those had an annual turnover of more than 15 million, two in the range of 10 – 14 million, one in the range of 5 – 9 million and one in the range of 0 – 4 million.

Annual turnover	N
0 – 4 million	1
5 – 9 million	1
10 – 14 million	2
15+ million	4

Table 6 – Annual turnover of estimators' company & number of responses to each category

As for the type of building project that each company does, all companies does new build with two companies also do addition and alteration and two companies do development type of project. None of the company does renovation and refurbishment type of project (See Table 7).

Type of building project	N
New Build	8
Addition/Alteration	2
Renovation/Refurbishment	0
Development	2

Table 7 – Type of building project and number of responses to each category

4.3.2 Perception of pricing risks

Question B1 asked the residential construction estimators' perception of pricing risks in terms of their level of impact and frequency of occurrence. The question asked the interviewees to rate each pricing risk using a scale of 1 – 5 (1 = very low, 2 = low, 3 = medium, 4 = high and 5 = very high).

The mean score and ranking of each pricing risk in terms of level of impact and frequency of occurrence is shown in Table 8. With a mean score of 3.63, the risk factor perceived to have the highest level of impact amongst the estimators is 'site related issues', followed by 'project complexity' (3.25), with 'insufficient time for estimating' (3.13), 'availability of cost data' (3.13), 'reliability of cost data' (3.13) and 'reliance on subcontractors to provide specialist knowledge' (3.13) being third

equal. ‘Inexperience of estimators’ is perceived to have the lowest level of impact (2.13) amongst the residential construction estimators.

In terms of frequency of occurrence, the result varies greatly compared to the perception of the level of impact. The pricing risk factors that were perceived to have highest level of occurrence is ‘change scope of work’ with a mean score of 3.50, followed by ‘site related issues’ (3.38), ‘project complexity’ (3.25), ‘insufficient or incomplete design information’ (3.00) with ‘insufficient time for estimating’, ‘delay in receiving contractor’s quote’ and ‘reliance on subcontractors to provide specialist knowledge’ being fifth equal with a mean score of 2.88. However, the pricing risk factor that is perceived to have the lowest frequency of occurrence (1.63) amongst the residential construction estimators is also ‘inexperience of estimators’. This reflects and is consistent with the background information gathered which has the majority of estimators having over 15 years of experience.

Table 8 also shows the ranking in terms of risk impact score (degree of risk) for the pricing risk factors. Overall, the pricing risk factor that has the highest ranking is “site related issues’ with a score of 12.23, followed by ‘project complexity’ (10.56), ‘change in scope of work’ (9.19), ‘insufficient or incomplete design information’ (9.00), ‘insufficient time for estimating’ and ‘reliance on subcontractors to provide specialist knowledge’ (8.98 =), ‘delay in receiving contractors’ quote’ (8.63), ‘pressure from management’ (7.91), and ‘availability of cost data’ and ‘reliability of cost data’ being equal with a mean score of 7.81. The risk factor that has the least overall impact is ‘inexperience of estimators’ (3.45), ‘poor analysis / inappropriate use of historical cost data’ (4.78) and ‘estimator’s lack of understanding of project requirement’ (4.92).

Other additional risk factors suggested by the estimators include:

- Customer sees a display home with a different specification (high impact but low frequency of occurrence)

- Sales consultant fails to describe customer requirements fully in tender offer (medium impact, low frequency of occurrence)
- Design requirement for building consent (high impact and high frequency of occurrence)
- Customer involvement (i.e. variation) (low impact and low frequency of occurrence)
- Specialised subcontractors or materials (very high impact but low frequency of occurrence)
- Inexperience of site manager or sales representatives (high impact but low frequency of occurrence)

Pricing Risk Factors	Level of Impact Mean Score (I)	Rank	Frequency of Occurrence Mean Score (P)	Rank	Degree of risk (I x P)	Rank
Site related issues	3.63	1	3.38	2	12.23	1
Project complexity	3.25	2	3.25	3	10.56	2
Change in scope of work	2.63	12 =	3.5	1	9.19	3
Insufficient or incomplete design information	3	7 =	3	4	9	4
Insufficient time for estimating	3.13	3 =	2.88	5 =	8.98	5
Reliance on subcontractors to provide specialist knowledge	3.13	3 =	2.88	5 =	8.98	5=
Delay in receiving contractors' quote	3	7 =	2.88	5 =	8.63	7
Pressure from management	2.88	10 =	2.75	8	7.91	8
Availability of cost data	3.13	3 =	2.5	9 =	7.81	9=
Reliability of cost data	3.13	3 =	2.5	9 =	7.81	9=
Market and price fluctuation	2.88	10 =	2.5	9 =	7.19	11
Unfamiliarity or poor understanding of specialist trades and their costing	3	7 =	2	15	6	12
Availability of resources (labour, plant and material)	2.63	12 =	2.13	13 =	5.58	13
Unsuitable or unconventional contract strategies	2.38	15	2.25	12	5.34	14
Estimator's lack of understanding of project requirement	2.63	12 =	1.88	16	4.92	15
Poor analysis / inappropriate use of historical cost data	2.25	16	2.13	13 =	4.78	16
Inexperience of estimators	2.13	17	1.63	17	3.45	17

Table 8 - Level of impact, frequency of occurrence and overall degree of risk and ranking for each pricing risks

4.3.3 Sources of cost data

Part C of the questionnaire concerns issues around cost data including how many cost items are currently available in the estimator's database, level of detail of the existing cost data, sources of cost data and its frequency of usage and reliability as well as purposes of cost data usage.

Question C1 asked how many cost items are currently available in the estimator's database. As shown in Table 9, 4 out of 8 interviewees have a database of between 0 – 1000 cost items, 2 out of 8 interviewees have between 3001 – 4000 cost items and only one interviewee has a database of 1001 – 2000 cost items and only one interviewee has over 4000 items. The estimator that has the most cost items only has detailed prices in their cost data.

Number of cost items	Number
0 – 1000	4
1001 - 2000	1
2001 – 3000	0
3001 – 4000	2
4001+	1

Table 9 – Number of cost items in database and number of responses

Question C2 asked what level of detail of the cost data is available to the estimators. As shown in table 10, all interviewees have detailed prices as cost data for their estimate. 6 out of 8 interviewees have elemental unit rate and only 5 interviewees have building cost per square meter rate and all-in unit rate in their database. Two interviewees identified 'quotation' as another level of details of cost data which may have rates that includes supply and installation of items from the subcontractors.

Level of detail	Number
Building cost per square meter	5
Elemental unit rate	6
All-in unit rate	5
Detailed prices	8
Other: Quotation	2

Table 10 – Level of detail of cost data and number of responses

Question C3 concerns some of the sources of cost data and the interviewees were asked to rank in terms of frequency of usage and reliability. The result is shown in table 11. The most frequently used source of cost data by the residential construction estimators is 'subcontractors' and/or suppliers' quote' with a mean score of 4.25. This is followed by 'in-house rate buildups' (4.13), 'colleagues' (2.75) with 'priced schedule of quantities' and 'manufacturer's catalogue' being fourth equal with a mean score of 2.38. The least frequently used source of cost data is the Government literature (1.63) and technical press (journals & magazines) with a mean score of 1.75.

Sources of cost data	Frequency of usage Mean Score	Rank	Reliability Mean Score	Rank	Overall	Rank
Priced SoQ from past projects	2.38	4 =	2.38	6	5.64	5
Technical Press (Journals & Magazines)	1.75	7	2.25	7	3.94	8
In-house rate buildups	4.13	2	4.38	1	18.05	1
Colleagues	2.75	3	3.13	3	8.59	3
Subcontractors' / Suppliers' Quote	4.25	1	3.75	2	15.94	2
Published price book (e.g. Rawlinsons)	2.00	6	2.00	8	4.00	7
Manufacturer catalogue	2.38	4 =	2.75	5	6.53	4
Government literature (e.g. Statistics NZ, RBNZ)	1.63	8	2.88	4	4.67	6

Table 11 – Sources of cost data, ranking of its frequency of usage, reliability and overall score

However, in terms of reliability, the most reliable source of cost data amongst the residential construction estimators is ‘in-house rate buildups’ with a mean score of 4.38, followed by ‘subcontractors’ and/or suppliers’ quote’ (3.75), ‘colleagues’ (3.13) and Government literature (2.88). The least reliable source of cost data is from published price book with a mean score of 2.00, followed by technical press (journals and magazines) with a mean score of 2.25 and priced schedule of quantities from past projects (2.38).

One estimator stressed the importance of cost data and in-house rate buildup to his estimating by commenting that “if you can master cost data, everything else you can sort out, that is the key” and continued to say that “I don’t believe any of the rates (are credible) because it is all subject to specification, the only thing you can rely on is build up rates” and “everything changes your price, so you need to focus on detail prices” (EST03)

Overall, the residential construction estimators considered ‘in-house rate buildup’ to be the main source and most reliable cost data with an overall score of (18.05), followed by ‘subcontractors’ / suppliers’ quote’ (15.94) and ‘colleagues’ (8.59). Sources of cost data from ‘technical press’ had the lowest overall score of 3.94 preceded by ‘published price book’ (4.00)

Other sources of cost data identified by the estimators included ‘standard plan bill of quantities priced by head office for all branches’ (high usage, medium reliability) and ‘merchant trade rates’ (high usage, high reliability). Another source of cost identified by another interviewee is ‘client documentation’ which has a medium usage but high reliability.

Question C4 outlined some of the purposes of cost data usage and the interviewees were asked to rank how frequently the cost data were used for each particular purpose.

Purposes of cost data	Mean Score	Ranking
Forecasting future construction projects	3.75	1
Negotiate rates with suppliers & subcontractors	3.38	3
Monitoring / controlling construction cost	3.50	2
Cost comparison of different construction types	2.88	5
Design cost planning (cost checking)	3.13	4
Preparation of valuation for insurance	2.25	6

Table 12 – Purposes of cost data and its ranking in terms of frequency of usage

The result is shown in table 12. The most frequent use of cost data is to 'forecast future construction projects' with a mean score of 3.75. This is followed by 'monitoring/controlling construction cost' (3.50) and 'negotiate rates with suppliers & subcontractors' (3.38). The result also shows that the estimators rarely use the cost data for preparation of valuation for insurance (2.25) and cost comparison of different construction projects (2.88).

4.4 Interview responses

4.4.1 Pricing risk management – interview responses

The first two interview questions concerns the risk factors that were rated high or very high impact or frequency of occurrence, and how they were managed by estimators.

The responses were that, most estimators use the specification to make clear on what elements are included, excluded or tagged to minimise their level of risks. Another common approach to minimising the pricing risks is the use of a Provisional Sum in the contract. Or increase their level of contingency to reduce the impact of risks. Some of the comments from the estimators are:

> "We generally tag our tender pretty heavily or tag our inclusions and exclusions" (EST01)

"In specification, use tag or exclusions to cover ground conditions"; "Specification is a key component to minimise the risks" (EST02)

"Use PC Sum to minimise the risks"; "List the inclusions and exclusions and do a precise contract" (EST03)

"Most of the risks that will impact on the cost that could affect our margin greatly are handled with PC Sums"; "The biggest risks certainly are anything in the ground and we cover that off by PC Sum and that is reconciled once we finish the job" (EST05)

"If we can't get it quoted, we put in a PC Sum" "For something unusual, rather than get a price for it, which slows the process down, we put in a PC Sum (allowance) for it" (EST05)

"Project complexity - it's a general consultation between branch manager, site manager, housing coordinator, sales rep and myself (QS), it's a group discussion of how to best resolve these issues" (EST06)

"Project complexity – we break it down, somebody looks after sitework, and somebody looks after civil work and others look after the homes, into various steps of work and put together as an estimate" (EST07)

"Increase the contingency to reduce the impact of risk"; "change price structure – change P Sum and put P Sum on high risk area and establish it based on historical data so you don't need to wait for subcontractor to come back with a price" (EST08)

Other responses include:

"If the architect has drawn something that can't be built, we notify the architect" (EST01)

> “When we price up a house, we started with a price for a standard house and we modify that price” we “minimise risk by the way we price, we know what our costs are before we start the job” (EST05)

> “We have their (subcontractors’) rate; we tell them what they will get paid” (EST05)

> “Monitoring prices and quotes from subbies and suppliers, if margin is low, adjust contingency percentage” and “Constantly checking the data you get” (EST08)

However, one estimator pointed out that PC Sum is not used in their contract and note that “Instead of using P Sum, what we say is that ground condition is X, so we will be using .....” It “protect us from risk but also give the client a base rather a dollar value and know what this is based on” because “clients usually are uneducated on (Provisional Sum)”. Other measures identified by the same estimator includes “Visit the site and highlight any issues we may face and try to give an estimate”, “contact the council to find any council requirement” and **“**Drag along the subcontractor or excavation guy on site to see if there is any impact “(EST07)

4.4.2 Cost data management

This interview question concerns whether having more items in cost data helps to reduce the pricing risks, and received mixed responses. Some of the comments were:

> “It’s only going to improve your estimate if it is formulated into a rate; cost data formulated into a usable format is fine” (EST01)

> “Yes and no, having more cost data makes your data more accurate but a lot more detail in quotation is required’ (EST02)

> “Yes, but small stuff just can’t allocate too much time because it’s not making

much difference" (EST03)

"Not really, there are only so many items in the house and several of them are quoted, for example, foundation, prenail and roof" (EST04)

"No, I don't think it does, if I have more, it takes longer to estimate, it's too cumbersome" (EST05)

"Not really"; "basically, everything is quoted" and "most of subcontractors and suppliers are with us for a long period of time" (EST06)

"No, these cost data are established during the years of operation of the company"; "we try to combine the items as a package rather than doing it individually"; doing this "not only minimises waste but also, in some cases, reduces cost" (EST08)

4.4.3 Sources of data that has high reliability but low frequency of usage

Estimator 3 identified that "Manufacturer catalogue" has very high reliability but very low frequency of usage because "all that you will find from the manufacturers' catalogue is their recommended retail price, so for us the facts of it is not particularly useful, we want what is our trade price" so "for a retail price it is very reliable but for our price, you never know"

He also identified that "Government literature" has high reliability but very low frequency of usage and his explanation for this is that "I am sure they are very reliable but not of anything useful for us"

Estimator 4 identified that "Colleagues" has high reliability but low frequency of usage and commented that "I tend to use it only when we are looking at comparison of product…..there are three other quantity surveyors in our company, if I need a figure for an item, I will rely on that but I don't have to use them that often, it's more

of a comparison". The same estimator also identified that "Government literature" has high reliability but very low frequency of usage

4.4.4 Sources of data that has low reliability but high frequency of usage

Only one interviewee identified that "Priced SoQ from past project" has low reliability but high frequency of usage (EST07). His responses to this is that "say we use project from a year ago, instantly there is a GST component, instantly there is CPI, there is rate changes" so "the whole process from first estimate to project completion is 9+ months, so if I rely on the estimate we did right at the beginning for a job, we did after we complete it, its 10 month minimum. There is a good chance that price has increased" (EST07). However, the Priced Schedule of quantities received high frequency of usage is because they are "brilliant as a guide but dangerous to price a whole project based on that" (EST07)

4.4.5 Difficulties when collecting and applying cost data and methods used to overcome them

Most estimators do not experience major difficulties when collecting and applying cost data. However, the difficulties experienced by the estimators interviewed when collecting and applying cost data relate to the management of cost data and sub-contractor. Some of the comments were:

> "The biggest problem with estimating is keeping your cost data (rates) up to date" "It's a big task to manage your data" (EST01)

One interviewee noted that the difficulty of collecting cost data is "Getting it in, you have to code it to link to suppliers' prices, it is a nightmare", he goes on and state that "There is always a difficulty because no one is going to give it to you the way you want it, everything has got to be setup, it's only going to improve your estimating if it is formulated into a rate (useable format)"

In terms of applying the cost data, the same interviewee noted that "the biggest

problem with estimating is keeping your cost data (rates) up to date" and also noted that "Interface is an issue, everyone has got different system" and 'it's a big task to manage your data".

Another problem with applying cost data is the reliability of historical cost data, one estimator noted that:

> "we will price based on subcontractor and supplier's quote, and our in house rate build-ups, once we have a price, we let it sit around for a day and then we sit down with our guys again and go through and check the rate we initially have" (EST07)

Also, different estimators have pointed out one common difficulty while collecting cost data is from the suppliers and subcontractors. One interviewee noted that "Subcontractors are terrible at getting back to you due to small size of subcontractor's company, however suppliers, less difficult". One other estimator noted that "Subcontractors are a problem – some people are useless". One estimator pointed out that "Subcontractors charge other prices that they haven't told you or discussed – such as additional items applied to your trade". Other estimator pointed out the main difficulty experienced is "Time and tags - subcontractors exclude things in quotes"

Therefore, in response to the problem identified above, some of the methods that estimators use to overcome these difficulties include

> "Go to historical data for indicative price" and "Rely on historical information heavily"
> (EST02)

> "Back costing – have to look at what we have been charged and why and negotiate new rates" "Back costing to reduce risk to know what's going on on the job and allow for it"

"in our standard request for pricing, we got a good feeling of generally what these tags are and say (to the subcontractor), you should price and allow for ....so it's an inclusive price" (EST03)

"Understand the information when you get it" and "if there is anything unusual and we can't get a price on, I will relate it to a previous job and get the actual cost out and meet with project manager to see what was actually involved, how long ago it was done, what effects like inflation and price increase had on that and I will made a call on what estimate we should do" (EST07)

"You don't need to get a price from them, you give them the price" or "absorb the cost or put in high contingency" (EST08)

"To make arrangement with the subcontractor to fix the price and set up a contract and period of that the price is valid for" (EST08)

4.5 Summary

This chapter presented a summary of result and analysis of the data obtained from the responses to the questionnaire and interview questions. The first section represent the result of the residential construction estimators' perception on pricing risks, these were ranked and analysed using both mean ranking score and risk impact score. Section 2 represent the findings regarding the number of cost data, level of details, sources and its reliability and usage of cost data.

Interview question regarding the management of risk that were perceived to be high or very high are presented in section three. Questions on whether estimator think that having more cost data helps to reduce pricing risk; why are some sources of cost data that have low reliability but are infrequently and vice versa; difficulties when collecting and applying cost data and methods to overcome these difficulties are also represented in this section. These findings will be discussed in Chapter 5.

5. DISCUSSION

5.1 Introduction

This chapter discusses the findings represented in Chapter 4. Section one discussed the demographic information gathered from the interview, followed by an in depth discussion on the perception of pricing risks (in terms of level of impact, frequency of occurrence and overall risk impact) amongst the residential construction estimators interviewed. The findings are compared with the results in the literature review. This is then followed by section three which is a discussion around issues of cost data including numbers, level of details, sources (and its reliability) and purposes of cost data. The results are also compared with the literature review. The responses of Interview questions were also discussed and represented in relation to each appropriate section of the discussion.

5.2 Demographic information

As shown in Table 4 to 7, the most significant thing to note from the demographic information gathered is that the majority of interviewees that agreed to participate are highly experienced (over 15 years) and does a high number of projects (over 40 construction projects per year). How does this affect the data collected and how do the responses from estimators in a larger construction company compared to the smaller construction companies are outside the scope of this study and further study is required to identify whether any relationship exists between them.

The fact that the estimators interviewed were highly experienced and does a larger number of projects does not mean that the data collected are biased, invalid or undependable because as mentioned in previous chapter, a total of 32 construction companies in Auckland were contacted and this includes a mixture of large to small construction companies. The respondent that agreed to be interviewed (and therefore the profile of his/her company) was outside the control of the researcher. This is supported by the fact that the interviewees had a mixture and wide rang of level of experience and number of projects per years as shown in Table 4 and 5.

Another point to note is that all companies build new build project and no company does renovation or refurbishment project which is generally considered to have a higher risk than other building project because there are many unknowns that are hidden and will not be revealed after actual construction begin. Whether this influences the perceived pricing risks is unknown and requires further study to be able to reach a conclusion.

5.3 Perception of pricing risks

The result from the questionnaire showed that the pricing risk factor that has the highest overall risk amongst the residential construction estimators in Auckland is 'site related issues'. It received the highest ranking in terms of level of impact and second highest in terms of frequency of occurrence. However, the literature review shows that although 14 out of 18 studies identified this as a potential risk, it was not amongst the top ranking factors. In fact, none of the literature identified this as the number one risk factor. The top ranking risk factor identified in the literatures, instead, is 'change in scope of work' which will be discussed later in this Chapter.

The reason as to why 'site related issues' was not amongst the top ranking factors in the literature is unknown. However, it is certainly considered the highest overall risk amongst the residential construction estimators interviewed. As noted by one estimator "the biggest risk certainly is anything in the ground" and "most of the risks that will impact on the cost that could affect our margin greatly…will be in ground related because once you get above that, you sort of know what you're building for"

The risk factor that received the second highest overall risk ranking is 'project complexity'. This is because things are more likely to go wrong if the project is complex or require more input to be spent investigating the details as well as arranging different subcontractors to make these elements work together. Another possible reason may be that, as suggested by one interviewee "certain aspects of building now are getting more specialised now", some of the building components or

technologies have become more advanced and more options are becoming available to the customer (for example, in-ground heating, solar power and water heating) which tends to increases project complexity.

The risk factor that received the third overall risk ranking is ‘change in scope of work’. This risk factor received the highest ranking in terms of frequency of occurrence, but only received 12= ranking in terms of level of impact. This is different from the literature review, where out of 18 studies, 13 identified this as a potential risk and 7 identified that this is the biggest risk in construction project and is ranked as the number 1 risk factor in terms of ranking (See Table 3, p. 18). In other words, the literature identified that this risk factor had both high level of impact and frequency of occurrence, but in fact this study, it shows that it has high level of occurrence but relatively low level of impact.

This difference may be because majority (5 out of 8) residential construction company interviewed does only new build construction project and nearly all companies has a large selection of standard plans for the client to choose from. The construction project and its estimate may have been developed from one of those standard plans or a modification of such which minimised the level of impact because the estimators are familiar with these plans and its costing. As one interviewee noted that “when we price up a house, we start with a price for a standard house and we modify that price”. The above reason may explain why this pricing risk factor received high level of occurrence (because customers rarely choose to build a standard plan without any modification) but were considered to have a low level of impact because the main component of the house structure remains the same and the estimators are familiar with the costing involved.

Another possible reason for the result may be because most design were completed and key design decisions were made and finalised before the construction company and the client went to contract. Any changes after this stage of work are dealt with by variation therefore it has little effect affect the estimator’s initial estimated cost of project.

‘Insufficient or incomplete design information’ was perceived to be the fourth most significant pricing risk amongst the estimators. This is also ranked highly in the literature review with 13 out of 18 studies identified this as a potential risk factor and 4 of these studies identified this as the second most significant risk factor and received number 2 overall risk ranking of all the risk factors identified in Table 3 (p. 18). In fact, three (out of 8) different estimators interviewed that added factors that were perceived to be important to the list are related to insufficient or incomplete design information in certain degrees which further confirmed the significance of such risk.

One estimator added “sales consultant fails to describe customer requirement fully in tender offer”, for the situation where the customer had discussed and agreed something with the sales consultant before contract signing but this information was not disclosed or transferred across to the estimator which created disruptions later in the construction process due to disputes and the construction company may have to end up paying for the extras. Another estimator had a similar comment and stressed that ‘inexperienced sales representative’ needed to be added to the list. The level of impact of such risk can be high or low depending on what was discussed between the sales consultant and the client but the frequency of occurrence of such risk is perceived to be low by the estimators.

One other estimator also pointed out that “design requirement for building consent” was important because council requirements change on a “monthly to monthly basis” and there is always additional information required to be submitted to the council before building consent is approved. Both the level of impact and frequency of occurrence of this risk factor were considered to be high.

The pricing risk factors that were equal in fifth place were ‘insufficient time for estimating’ and ‘reliance on subcontractors to provide specialist knowledge’. In fact, both were also considered to be third equal in terms of level of impact and fifth equal in terms of frequency of occurrence.

‘Insufficient time for estimating’ was perceived to be the most significant risk factor that caused inaccuracy in cost estimating in the study done by Akintoye & Fitzgerald (2000). The interviewees’ responses in regard to this risk factor was not surprising because by looking at the number of project that the majority of the estimators have to estimate (i.e. 3 projects per month), there is certainly not enough time for the estimators to do all these works.

Although the pricing risk factor “reliance on subcontractors to provide specialist knowledge” was not identified in any of the literature as a potential risk factor, it was identified as a shortcoming when estimating in Akintoye & Fitzgerald (2000). Some of the comments from the estimators regarding this risk factor include: “we rely on lots of things to be bulk quotation on a regular basis” (EST04) and “we do rely on our subbies to keep up with the play” and “certain aspects of building now are getting more specialised” (EST05).

Another estimator identified that specialised subcontractors or material suppliers has a very high level of impact because there is virtually no competition in the market so the estimator has to rely on whatever price they have been given and rely on the specialist to supply and install that particular product.

Another point to note from the interview questionnaire is that both ‘availability of cost data’ and ‘reliability of cost data’ were ranked third equal in terms of level of impact score but ninth equal in the frequency of occurrence score, the overall risk impact for both risk factors are ninth equal.

The fact that these risk factors were perceived to have relatively high level of impact but low level of occurrence may be because having cost data available and having reliable cost data are important for the estimators to produce an accurate estimate but because most estimators interviewed were highly experienced and the company they are currently working for has been building for some time, therefore the pricing systems, structures and database have already been set up and are revised, maintained and archived on a regular basis, hence these risks were perceived to have

low frequency of occurrence.

The pricing risk factors perceived to have both the lowest level of impact and lowest frequency of occurrence are ‘inexperience of estimator’, followed by ‘poor analysis / inappropriate use of historical data’ (second lowest ranking). Again, this may be due to the fact that most estimators interviewed are highly experienced and a pricing system, structure and database has already been set up and maintained. Another contributing factor might be due to the fact that historical data are not frequently used by the estimators, further investigation confirms this because the cost data source “priced Schedule of Quantities from past projects” (as shown in Table 11) only received low frequency of usage and low reliability.

5.4 Management of pricing risks

In terms of management of pricing risks that were perceived to have the top overall level of risk including ‘site related issues’, ‘project complexity’, ‘change in scope of work’ and ‘insufficient and incomplete design information’. One common response comes up repeatedly from different estimators is use of Provisional Sum and reconcile this figure once the costing related to that Provisional Sum has been finalised.

The responses from the estimators above coincides with the finding from the literature review including Bajaj (2001), McNamee & Perera (2010), Akintoye & MacLeod (1997), Towner & Baccarini (2007), Smith & Bohn (1999) and Onukwube et al. (2009) which identified that contingency is by far the most common method to cover the risks associated with estimating.

Another point to note is that one estimator made a comment that they do not use Provisional Sum to minimise the risk but “instead of using P Sum, what we say is that ground condition is X, so we will be using .....”. Use of such methods “protect us from risk but also give the client a base rather a dollar value and know what this is based on” because “clients usually are uneducated on (Provisional Sum)”

One other method commonly identified by the estimators is to use specification to list (or tag) carefully what was included and what was excluded in the contract price. This method is also identified by RICS (2009), Oladokun, et al. (2010), Onukwube et al. (2009) and Smith & Bohn (1999) which suggested that work item(s) that are often associated with high risks or uncertainties such as groundwork can be excluded completely from contract specification or by excluding these risks using proper contract clauses.

Other comments regarding managing pricing risks includes reference to historical cost data for an indicative price and adjust to suit current project or refer to previous job to get the actual cost and then meet with the project manager of that job to discuss what was actually involved and then adjust accordingly. Another response to reduce risk is to visit the site and drag alone the subcontractors to the site, highlight any issues that the project may face, access its potential impact and factor these issues in the estimate

In regards to management strategy to deal with the risk of 'insufficient time for estimating', one response was to "prioritise the work load and if there is still a conflict there, unfortunately the only way to deal with this is to put more man hours on because we are trying to keep estimation in-house".

Other responses in terms of dealing with various pricing risks that came up during the interview includes break down a large project into various stages of work and have it managed by the people that best to manage the works; back costing to compare what happened on the job with what was originally estimated and make allowance for these risks in future estimates; increase contingency (and therefore contract price) to reduce the impact of risks and request more information (from owner, suppliers, subcontractors, people that have previous experience). The later strategy was also suggested by (Olawale & Sun, 2010), which is to seek expert advice from the specialist and subcontractors. And the risk can be transferred to the specialist or subcontractor by obtain a quote and getting them to carry out all the

work. (Olawale & Sun, 2010)

5.5 Cost data management

5.5.1 Number of cost items in database

Questions were asked regarding cost data including how many cost items are currently available in the estimator's database, level of detail of the existing cost data, sources of cost data and its frequency of usage and reliability and purposes of cost data usage.

In regards to the number of cost items in the database, half of the estimators have cost items between 0 – 1000 and one estimator has between 1001 – 2000 cost items. Two have between 3001 – 4000 items and only one estimator has over 4001 items. This result shows that the number of cost items is leaning towards the lower end of the scale. The reason for this may be that most estimators frequently use quotations for their estimate.

One estimator commented that many of the items in the house are quoted on, for example, foundations are mostly quoted at a square meter rate, everything included; pre-nail and roofing are also quoted on with everything such as nails, fixings and flashings included and all of that is represented by one cost item in the estimate. He further indicated that this could be the same for several other things in a construction project estimate. This is also confirmed by the data shown in Table 11 which shows that 'subcontractors' / suppliers' quote' are the most frequently used cost data amongst the estimators.

If there are some items that they cannot get a price on, as mentioned previously, a Provisional Sum and/or specification that lists all the inclusions and exclusions was used to help reduce the risk. Therefore these estimators do not require a great deal of cost data available to them to put together an estimate.

Another point that was noted by the estimator may also explain the low number of cost data amongst the estimators. The estimator mentioned that they "try to combine the items as a package (i.e. having supply and install quotation or rate) rather than doing it individually" which might seem to increase the building cost in some cases, is in fact cheaper in a practical sense because they minimised other costs and overheads such as transport, deliver, travel, project management (organisation of material supply and labour), cost data management (time spent on measuring, updating and maintaining cost data), wastage and disposal.

An interesting point to note, which may not always be the case but something to examine further is that the estimators with a higher number of cost items tend to have lower annual turnover (except in one case that had a high number of cost items and high annual turnover) and vice versa. As shown in Table 13, out of five estimators that have a lower number of cost data (between 0 – 1000 and 1001 – 2000), two had an annual turnover of 10 – 14 million and three had an annual turnover of over 15 million. Out of three estimators that had a higher number of cost data (between 3001 – 4000 and 4000+), two had a lower annual turnover of between 0 – 4 million and 5 – 9 million. Whether this is due to the amount of time spent on estimating or it is purely due to the amount of work available to the company or other reasons is unknown.

	Annual Turnover (million)	**Number of cost items (numbers)**
Estimator 1	0 – 4	4001 +
Estimator 2	15 +	0 – 1000
Estimator 3	10 – 14	1001 – 2000
Estimator 4	15 +	0 – 1000
Estimator 5	10 – 14	0 – 1000
Estimator 6	5 – 9	3001 – 4000
Estimator 7	15 +	3001 – 4000
Estimator 8	15 +	0 – 1000

Table 13 – Estimators' company annual turnover in relation to number of cost items

By examining the number of cost items that different estimators had in their data base, we can conclude that different estimators price their estimates very differently, some trying to minimise the number and level of details by having combined rates, others believe that the rates within an estimate have to be built up from detail prices and therefore require large number of cost data available to him while other estimators have a variety of levels of detail including building cost per square meter, elemental unit rate, all-in unit rate and detail prices.

One of the interview questions asked the estimators' opinion on whether having more (or less) items in cost data would help to reduce the pricing risks. The question received mixed responses. Most of the estimators are satisfied with the amount of cost data currently exist in their system by commenting that having more cost data would not improve their estimate. Some of the comments include: many of the items in a building were quoted; it takes longer to do the estimate and maintaining the cost data (too cumbersome); estimators cannot allocate too much time for small items because it does not make much difference; cost data needs to be formulated into a rate or a usable format and the fact that the estimators try to minimise the number of items

5.5.2 Level of details

As for the level of detail of cost data that the estimators had in their system, all estimators had detailed prices in their existing cost data systems. Four estimators had cost data for every level of detail and only one estimator relies solely on detail prices for his estimate.

The estimator that only has detailed prices is also the estimator that has the largest number of cost data. His explanation for this difference is "I don't believe that any of these rates (building cost per square meter, elemental unit rate and all-in unit rate) apply because they are all subject to specification, the only thing you can rely on is build-up rates.....everything changes your price, so you need to focus on detail prices".

In addition, two other interviewees identified ‘quotation’ as another level of detail of cost data which may have rates that include supply and installation of items from the subcontractors. The frequent identification of this source of cost data further confirmed that estimators tend to rely frequently on quotations provided by suppliers or subcontractors.

5.5.3 Sources of cost data

The most frequently used cost data amongst residential construction estimators was the ‘subcontractors’ / suppliers’ quote’. It also received second highest ranking in terms of reliability. However, the most reliable source of cost data amongst the estimators was the ‘in-house rate buildups’ which received second highest ranking in terms of frequency of usage. Overall, ‘in-house rate buildups’ received the highest overall score, followed by ‘subcontractors’ / suppliers’ quote’, ‘colleagues’ and ‘manufacturer catalogue’.

This result showed that the estimators interviewed had very different view when compared with the literature review. Several authors, including Kirkham (2009), Ashworth (2010) and Al-Hasan (2006) identified that the contractors’ own historical data is considered to be the preferable and reliable source of cost data due to the fact that the estimators knows the background information, problems associated with the project during construction and other important features of the project. The result of the interviews showed that ‘priced schedule of quantity from past project’ only has a fifth overall ranking (out of a total of 8) in terms of frequency of usage and reliability. In fact, only one estimator indicated that they rely on historical information heavily for their estimate.

The fact that the ‘priced schedule of quantities from past project’ did not receive high ranking compared to the literature may be due to several reasons. First, as indicated by one of the estimators that ‘priced schedule of quantities from past project’ is based on a different specification which may affect several other cost items in the estimate

and therefore it is difficult to analyse and apply to new projects. Another reason might be that, as another estimator indicated "the whole process from first estimate to project completion is 9+ months, so if I rely on the estimate we did right at the beginning for a job we did after we completed it, its 10 months minimum. There is a good chance that prices have moved" and therefore historical prices are "brilliant as a guide but dangerous to price a whole project base on that".

Therefore, when compared with other sources of cost data such as 'subcontractors' / suppliers' quote' and 'in-house rate buildups', these sources of cost data are more 'current', more specific and relevant to the current project and specification were given directly by the subcontractors and suppliers and therefore more reliable and were used more frequently. In fact, one estimator noted the importance of in-house rate build-ups by commenting that "the only thing you can rely on is build up rates".

Other sources of cost data were considered by the estimators as a backup or a tool for checking the estimate. The estimators felt that there is nothing wrong with other sources of cost data but caution must be taken to understand the background information that these prices were based on and its intended purpose. For example, while there is nothing wrong with Rawlinson's Construction Handbook prices, they are based on larger quantities and therefore more suitable for commercial applications; 'manufacturer's catalogues' are usually targeted for the general public so rather than list the trade prices, retail prices are usually shown, therefore the catalogues are rarely used and are only used for indicative prices or reference. These opinions were on the same line as the studies done by Ashworth (2010) and Kirkham (2009), which suggested that "it is probably the primary role of published information to provide data which enables practitioners to check on their own knowledge and to provide a context for their own decision-making" (Kirkham, 2009, p. 216)

The least frequently used source of cost data is the 'Government literature' and 'technical press (journals & magazines)' and in terms of reliability, the least reliable source of cost data is considered to be from 'published price book' and 'technical

press (journals and magazines)'. This may be because that technical press is a medium for the manufacturer to showcase their product and what has been written in these publications cannot be rely on. The low usage of 'technical press' coincides with the literature finding from Akintoye et al. (1992), which identified that information from the technical press is the least comprehensive and least trusted source of construction information. Government literature were considered relatively reliable but are not used often, this may be because they are only used occasionally when the estimator carry out updates and adjust their cost data. One estimator's comment was "I am sure they are very reliable but not of anything useful for us"

Interview question were also asked in regards to why some sources of cost data that were considered to have low reliability but are used often and vice versa. Sources that were identified to have high reliability but low frequency of usage by the estimators include 'manufacturer catalogue', 'Government literature' and 'colleagues'.

'Manufacturer catalogue' was identified because the reasons discussed previously. In fact, the construction companies often buy their products through their suppliers instead of direct from manufacturer, therefore, different companies will have different trade prices and discount applied to the product depending on their relationship and quantities ordered, these prices in manufacturer catalogue is therefore, not often used by the estimators.

Data sources from 'colleagues', was considered to have high reliability but low frequency of usage because in this particular case, the estimator are one of the branch of the much larger residential construction group, and there are three other estimators that is working within the group so the estimator can contact them if he need a figure for an item and were often relied on. However, these cost data were not used very often and were used for comparison and checking prices.

The only source of data that was identified by one estimator to have low reliability but high frequency of usage is the "Priced SoQ from past project". The main concern

for this source of cost data is the potential error contained within them including price and rate changes therefore cannot be relied on. However, the same estimator also indicated that this data is excellent as a guide but dangerous to price the whole project based on this.

5.5.4 Purposes of cost data usage

The most frequent use of cost data is to 'forecast future construction projects', followed by 'monitoring/controlling construction cost' and 'negotiate rates with suppliers & subcontractors'. However, it is rarely used for 'preparation of valuation for insurance' and 'cost comparison of different construction types'.

As shown in Table 14, when compared with the study done by Akintoye et al. (1992), it can be concluded that the purpose of cost data usage does not differ much since this study and the purpose of cost data usage does not differ much even though Akintoye study is done in Nigeria which has a very different economic, cultural and political background.

Purposes of cost data	Mean Score	Ranking	Akintoye's Study
Forecasting future construction projects	3.75	1	1
Negotiate rates with suppliers & subcontractors	3.38	3	2
Monitoring / controlling construction cost	3.50	2	3
Cost comparison of different construction types	2.88	5	4
Design cost planning (cost checking)	3.13	4	5
Preparation of valuation for insurance	2.25	6	6

Table 14 – Purposes of cost data, its mean score and ranking and comparison with Akintoye's study

However, it is acknowledged that some differences do exist in terms of other purposes. The estimators interviewed. For example, when compared 'negotiate rates with suppliers an subcontractors' and 'monitoring / controlling construction cost', the

estimators interviewed put less focus on ‘negotiate rates with suppliers and subcontractors’ may be because, as suggested by some estimators interviewed, that the rates are given by the estimators to the subcontractors instead of the other way around and the rates given by the suppliers are often fixed for a period of time and reviewed at the end of fixed period.

And while compared ‘cost comparison of different construction types’ and ‘design cost planning (cost checking)’, the estimator interviewed put more focus on design cost planning. This may be due to the reason that the estimators simply do not have time to do cost comparisons of different construction type as one estimator commented that “I would like to do that if I have time”.

5.5.5 Difficulties in collecting and applying cost data

The construction estimators were asked whether they have experienced any difficulties when collecting and applying cost data for their estimate. As described in previous chapter, most estimators do not experience major difficulties, and if any, most of the difficulties experienced by the estimator, relates to the management of cost data and sub-contractor who provided the cost data.

One interviewee noted that managing cost data is a big task and the biggest difficulty of collecting cost data is actually ‘getting it in’. He also commented that coding and linking the system to the cost data provided by the suppliers and subcontractors is “a nightmare” because “no one is going to give the cost data to you the way you want it” and everyone uses different estimating system which causes interface issues. Therefore, everything has to be setup to a usable format (i.e. rate) to improve the estimate. In terms of applying cost data, the biggest difficulty experienced by the same estimator is keeping the cost data up to date.

A comment from another estimator relates to the point made by Ashworth (2010) that there is the potential error contained within the Schedule of Quantities. His comment was “say we use project from a year ago, instantly there is a GST component,

instantly there is CPI, there is rate changes" which may also explain why Schedule of Quantities only received fifth overall ranking of all sources of cost data in terms of frequency of usage and reliability because there are potential errors contained within them.

The most common difficulty, as pointed out by several estimators, happens while collecting cost data from the suppliers and subcontractors. This is mainly due to delays in getting quotes back from the suppliers and subcontractors; subcontractors charge other prices that they fail to disclose to the estimator during the discussion (for example additional items applied to the trade) and subcontractors deliberately tag things in their quote so if the estimator did not factor this in their estimate and exclude from the contract, potential overrun can occur as a result.

Other difficulties when applying cost data to an estimate identified in Ashworth (2010) were not mentioned or identified by the interviewees including insufficient number of cost data, cost data too diverse, process of application is slow and system of operation is difficult to use were not perceived to be a problem by the interviewees due to the number of cost data they have in their system and are generally satisfied with the system and number of cost data they are working with.

In response to the problem identified above, some of the methods that estimators use to overcome these difficulties include reference to historical cost data; ask the subcontractors to price and include specific items in their quotes so there will be no surprises; understand the information in quotation when received the quotes and gather a second opinion either from another subcontractor, project manager or other estimator that has previous experience.

Other method including back costing to look at what have been charged and why and what was going on on the job and make allowance for this in future estimates; negotiate new rates with the subcontractor, and if necessary, fix this rate or a contract for a period of time. Also, other methods such as give the subcontractor the price they will be work for instead of getting a quote from them and raise contingency can

also be used.

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5.6 Summary

This chapter discussed the findings represented in Chapter 4. Both the qualitative and quantitative data obtained from the interviews were discussed and compared with literature findings to provide more explanation and in-depth understanding of the results.

In regards to the perception of pricing risks amongst the estimators, the research showed that overall, the biggest pricing risk is ‘site related issues’, followed by ‘project complexity’ and ‘change in scope of work’. This differs from the literature findings which ‘change in scope of work’ was perceived to be the biggest risk, followed by ‘insufficient or incomplete design information’ and ‘insufficient time for estimating’.

As noted by one estimator, the biggest risk is certainly anything underground and could affect the margin greatly because the estimators generally knows what they are building for above ground. The reason that ‘project complexity’ perceived to have higher ranking than in literature may be due to the fact that certain aspect of building are getting more specialized now (for example, in-ground heating, solar power and water heating). The estimators therefore have to rely on the subcontractor or specialist to provide quotations and the services in order to complete the estimate and the project. This is confirmed by the fact that ‘reliance on subcontractors to provide specialist knowledge’ received third overall ranking in terms of level of impact and fifth equal in overall ranking.

Change in scope of work received lower overall risk ranking in this study may be due to that most construction companies interviewed does only new build project and nearly all companies has a large selection of standard plans to choose from and the design of the project may have been developed from one of those standard plans or a modification of such which minimised the level of impact because the estimators are

familiar with these plans and its costing.

‘Insufficient or incomplete design information’ was perceived to be the fourth most significant pricing risk amongst the estimators and was the second biggest risk in literature. This is supported by the research finding in which 3 (out of 8) different estimators interviewed that added factors that were perceived to be important to the list are related to this in certain degrees including ‘sales consultant fails to describe customer requirement fully in tender offer’, ‘inexperienced sales representative’ and ‘design requirement for building consent’.

In terms of cost data and its management, it is concluded that the generally low number of cost data is related to the fact that the estimators relies on subcontractors to provide quotations or to provide a full package of services so that the number of estimate as well as cost data that is required for the estimators is reduced. The result also shows that most estimators has more than one level of detail of the cost data except one estimator rely totally and only on detail prices because he believes that any of other rates do not apply and are subject to specification.

In regards to the frequency of usage and reliability of cost data, the interview result shows that the most reliable source of cost data is the ‘in-house rate buildups’ and the most frequently used cost data is the ‘subcontractors’ / suppliers’ quote’ which differ from the literature review that shows contractors’ own historical cost data is the preferable and reliable choice. It is concluded that this may be due to the fact that the estimators interviewed believe that there are many potential errors contained in the historical cost data due to difference in specification and therefore in-house rate buildups and quotations are perceived more current, more specific and relevant to the current project. Other sources of cost data were generally considered by the estimators as a backup or a tool for checking the estimate which does coincides to the literature findings.

The interview result also shows that, the biggest problem when collecting or applying cost data originate from the subcontractors’ quote. This is mainly due to

delay in getting quotes back from the suppliers and subcontractors and the fact that they leave things or discussion out in their quote and then came back to claim for the costs on relevant works performed. Methods to deal with this difficulties includes back costing so the estimator knows what to allocate additional allowance for the works; ask the subcontractors to quote and include specific items; understand the quotation received and raise questions or make arrangement with the subcontractors to fix the price for a period of time.

6. CONCLUSIONS

6.1 Introduction

This chapter represents a summary of important findings and conclusions drawn from this research. Limitations and suggestions for further research are also discussed in this Chapter.

6.2 Conclusions

The result obtained from the interview regarding the perception of pricing risk showed that, overall the top three pricing risks were ‘site related issues’, ‘project complexity’ and ‘change in scope of work’. This differs from the literature findings which ‘change in scope of work’ was perceived to be the biggest risk, followed by ‘insufficient or incomplete design information’ and ‘insufficient time for estimating’.

The possible explanation for this result is that ‘site related issues’ is generally the biggest unknown to the estimators which constitute a large portion of cost in their estimate, any problem arise from this will easily cause overruns in projects.

The reason that ‘project complexity’ were perceived to have higher ranking than in literature may be due to the fact that certain aspect of building are getting more specialized now. The estimators therefore have to rely on the subcontractor or specialist to provide quotations and the services in order to complete the estimate and the project. This is confirmed by the fact that ‘reliance on subcontractors to provide specialist knowledge’ received third overall ranking in terms of level of impact and fifth equal in overall ranking.

However, ‘change in scope of work’ received lower overall risk ranking in this study may be due to that most construction companies interviewed does only new build project and nearly all companies has a large selection of standard plans to choose from and the design of the project may have been developed from one of those standard plans or a modification of such which minimised the level of impact

because the estimators are familiar with these plans and its costing.

From the literature review, it was concluded that effective management of cost data can cover the greatest amount of risk because regardless of whichever method of risk management technique is used by the estimators will require reference to the cost data. Therefore, a rational optimisation to manage the pricing risks lies within the availability, collection, analysis and application of cost data.

It is concluded that the generally low number of cost data is related to the fact that the estimators relies on subcontractors to provide quotations or to provide a full package of services so that the number of estimate as well as cost data that is required for the estimators is reduced. The result also shows that most estimators has more than one level of detail of the cost data except one estimator rely totally and only on detail prices because he believes that any of other rates do not apply and are subject to specification.

In regards to the frequency of usage and reliability of cost data, the research showed that the most reliable source of cost data is the 'in-house rate buildups' and the most frequently used cost data is the 'subcontractors' / suppliers' quote'. This is different from the literature finding which shows 'contractors' own historical cost data' is the preferable and reliable choice. It is concluded that this may be due to the fact that the estimators interviewed believe that there are many potential errors contained in the historical cost data due to difference in specification and therefore in-house rate buildups and quotations are perceived more current, more specific and relevant to the current project. Other sources of cost data were generally considered by the estimators as a backup or a tool for checking the estimate which does coincides to the literature findings.

The interview result also showed that, the biggest problem when collecting or applying cost data are from the subcontractors' quote due to delay in getting quotes back from the suppliers and subcontractors and the fact that certain works are excluded from their quote and related claim of this work which causes overrun of the

project. Methods such as back costing, ask the subcontractors to quote and include specific items; understand the quotation received and raise questions or make arrangement with the subcontractors to fix the price for a period of time are used to manage those risks.

6.3 Limitations

As discussed in previous chapter, out of 32 companies contacted, only 8 agreed to participate which correspond to a response rate of only 25%. A bigger sample size and more interviews could improve the result and strengthen the research finding.

In addition, no interviewee's company does addition and renovation which might have different perception of pricing risk (for example, they might not need to do ground work and site related issues may not perceive to be a significant risk). This means that the results are not generalisable across the entire residential construction sector. However, the samples chosen did includes companies that do all types of building works, it was of pure coincidence that none of the interviewees agreed to participate does additional and renovation types of works.

6.4 Further researches

As mentioned in previous chapters, the estimators with a higher number of cost items tend to have lower annual turnover and vice versa. Whether this is due to the amount of time spent on estimating or it is purely due to the amount of work available to the company or other reasons is unknown. Further researcher to whether a relationship exists is required to be able to reach a conclusion.

Other future research topics identified from this study include how do larger construction companies respond to risk compared with smaller construction companies in terms of their perception of pricing risks and management of cost data. Another topic of interest subject to further research is whether the construction companies that do new build project compared with companies that do renovation or refurbishment projects perceived pricing risks and manage their cost data differently.

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APPENDIX A: COPY OF QUESTIONNAIRE

Pricing Risks & Management Strategies for Estimators in the Residential Construction Industry

Questionnaire - Instruction

Please read the Consent Form **FIRST** and sign at the end of Consent Form before you begin to fill out the Questionnaire.

Please answer **ALL** questions.

Questionnaire – Consent From

I understand that taking part in this project is voluntary and that I may withdraw myself or any information I have provided from the project at any time without penalty.

I understand that my participation in this project is confidential and no material that could identify me or my organisation will be used in any reports on this project. I understand that I may read the completed research report if I wish.

I also understand that the information I provide will be stored securely at Unitec for a period of 5 years. I agree that data I provide in this project may be used in the resulting research report and in any subsequent conference or academic journal papers based on this research.

I have had enough time to consider whether I want to take part.

UREC REGISTRATION NUMBER: 2009-937
This study has been approved by the UNITEC Research Ethics Committee from 2 March 2009 to 31 December 2011. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Committee through the UREC Secretary (ph: 09 815-4321 ext 7248). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

☐ **I give my consent to be involved in this project _____ (Signature)**

SECTION A - GENERAL INFORMATION

1. **How long have you worked in the construction industry?**
   ☐ 0 – 4 Years ☐ 5 – 9 Years ☐ 10 – 14 Years ☐ 15+ Years
2. **How many residential construction projects does your company do a year?**
   ☐ 0 – 19 ☐ 20 – 39 ☐ 40 – 59 ☐ 60+
3. **What is your company's annual turnover?**
   ☐ 0 – 4 million ☐ 5 – 9 million ☐ 10 – 14 million ☐ 15+ million
4. **What type of building project do you do? (Tick multiple boxes if applicable)**
   ☐ New Build ☐ Addition/Alteration ☐ Renovation/Refurbishment ☐ Development

SECTION B – PRICING RISK PERCEPTION

B1. The following table contains some of the pricing risk factors which can influence a residential construction cost estimate. Please identify the level of impact of each of the risk factors on the estimate and then indicate how often this risk has occurred on projects you have been involved with or are aware of.

Risk Factors	Level of Impact					Frequency				
	Very Low	*Low*	*Medium*	*High*	*Very High*	*Very Low*	*Low*	*Medium*	*High*	*Very High*
	✓	○	○	○	○	○	○	○	✓	○
Insufficient time for estimating	○	○	○	○	○	○	○	○	○	○
Change in scope of work	○	○	○	○	○	○	○	○	○	○
Project complexity	○	○	○	○	○	○	○	○	○	○
Pressure from management	○	○	○	○	○	○	○	○	○	○
Unfamiliarity or poor understanding of specialist trades and their costing	○	○	○	○	○	○	○	○	○	○
Delay in receiving contractors' quote	○	○	○	○	○	○	○	○	○	○
Availability of cost data	○	○	○	○	○	○	○	○	○	○
Reliability of cost data	○	○	○	○	○	○	○	○	○	○
Reliance on subcontractors to provide specialist knowledge	○	○	○	○	○	○	○	○	○	○
Poor analysis / inappropriate use of historical cost data	○	○	○	○	○	○	○	○	○	○
Insufficient or incomplete design information	○	○	○	○	○	○	○	○	○	○
Estimator's lack of understanding of project requirements	○	○	○	○	○	○	○	○	○	○
Inexperience of estimators	○	○	○	○	○	○	○	○	○	○
Site related issues	○	○	○	○	○	○	○	○	○	○
Availability of resources (labour, plant and material)	○	○	○	○	○	○	○	○	○	○
Unsuitable or unconventional contract strategies	○	○	○	○	○	○	○	○	○	○
Market and price inflation	○	○	○	○	○	○	○	○	○	○

SECTION B – PRICING RISK PERCEPTION Cont.

B2. Are there other pricing risk factors that you think should be included in the list above? Please add them in the space provided and identify the level of impact of each of the risk factors on the estimate and then indicate how often this risk has occurred on projects you have been involved with or are aware of.

Risk Factors	Level of Impact					Frequency				
	Very Low	*Low*	*Medium*	*High*	*Very High*	*Very Low*	*Low*	*Medium*	*High*	*Very High*
	✓	○	○	○	○	○	○	○	✓	○
	○	○	○	○	○	○	○	○	○	○
	○	○	○	○	○	○	○	○	○	○
	○	○	○	○	○	○	○	○	○	○

SECTION C – Cost Data Management

C1. How many cost items do you currently have in your cost database?

☐ 0 – 1000 ☐ 1001 – 2000 ☐ 2001 – 3000 ☐ 3001 – 4000 ☐ 4001+

C2. What is the level of detail of the cost data that is available to you? (Tick multiple boxes if applicable)

☐ Building costs per square meter (based on different building types)

☐ Elemental unit rate (based on different building types)

☐ All-in unit rate (applied to abbreviated quantities)

☐ Detailed prices

☐ Other: please specify _____

C3. The following are some common sources of cost data. For each one of these sources, please select your frequency of usage and your perception of its reliability.

Sources	Frequency of usage					Reliability				
	Very Low	*Low*	*Medium*	*High*	*Very High*	*Very Low*	*Low*	*Medium*	*High*	*Very High*
	✓	○	○	○	○	○	○	○	✓	○
Priced SOQ from past project	○	○	○	○	○	○	○	○	○	○
Technical Press (Journals & Magazines)	○	○	○	○	○	○	○	○	○	○
In-house rate buildups	○	○	○	○	○	○	○	○	○	○
Colleagues	○	○	○	○	○	○	○	○	○	○
Subcontractors' / Suppliers' quotes	○	○	○	○	○	○	○	○	○	○
Published price book (e.g. Rawlinsons)	○	○	○	○	○	○	○	○	○	○
Manufacturer catalogue	○	○	○	○	○	○	○	○	○	○
Government literatures (e.g. Statistics NZ, RBNZ)	○	○	○	○	○	○	○	○	○	○
Other: please specify _____	○	○	○	○	○	○	○	○	○	○

SECTION C – Cost Data Management cont.

C4. What are some of the ways your cost data is used and how often do you use them? (Tick multiple boxes if applicable)

Purposes	Frequency of usage					
	Never	*Very Low*	*Low*	*Medium*	*High*	*Very High*
Forecasting future construction projects	○	○	○	○	○	○
Negotiate rates with suppliers & subcontractors	○	○	○	○	○	○
Monitoring / controlling construction cost	○	○	○	○	○	○
Cost comparison of different construction types	○	○	○	○	○	○
Design cost planning (cost checking)	○	○	○	○	○	○
Preparation of valuation for insurance	○	○	○	○	○	○
Other: please specify _____	○	○	○	○	○	○

APPENDIX B: COPY OF INERVIEW QUESTIONS

Interview Questions:

B3. In regards to the risk factors that had high or very high level of impact, how do you manage them to reduce these risks?

B4. In regards to the risk factors that had high or very high frequency of occurrence, how do you manage them to reduce these risks?

Interview Questions:

C5. Do you think having more / less items in your data helps you reduce the pricing risks?

C6. With the data sources that have low reliability but are used often, why do you still use them if they are low reliability?

C7. With the data sources that have high reliability but are infrequently used, why are they not used more often?

C8. In your view, what are some of the difficulties you found when collecting and applying the cost data?

C9. In respect to the answer C8 above, what are the strategies / methods you took to overcome these difficulties?