ACCURACY IN DESIGN STAGE ELEMENTAL COST PLANNING: AN ANALYSIS OF NEW ZEALAND DATA

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ABSTRACT

One aspect of client expenditure management that requires attention is the accuracy in design stage elemental cost planning which is a major concern for construction clients and practitioners in New Zealand. Several researches indicated that pre-tender estimating accuracies are significantly affected by the level of risk information available to the estimators. Proper risk analysis could offer at least a partial solution by reducing the variances between design stage elemental cost plans and final tender sums (contract sums) of construction projects. This study investigates the accuracy in design stage elemental cost planning with a view to identifying risk factors influencing the accuracy. Project data were obtained through interviews and thematic analysis identified the risk factors. Analysis of documents obtained from the archives of study participants (consultant quantity surveyors) complemented the responses from the interviews. Findings revealed deviations of elemental cost plans from final tender sums in the region of -14% and +13%. These results confirmed a significant disparity between elemental cost plans and final tender sums. It is conjectured in this study that the identified risk factors were responsible for the deviations observed. With this information, Quantity Surveyors are able to accurately forecast final tender sums of building projects from the cost plans through proper risk identification and subsequent further analysis, thus increasing accuracy.

Keywords: Accuracy, design stage, elemental cost plan, final tender sum, risk identification

INTRODUCTION

The construction industry, perhaps more than most others, is plagued by risk. Project risks in construction environments are often dealt with inadequately, being a contributory factor to the instances of poor performance of construction projects (Bryde & Volm, 2009; Jin *et al.*, 2007). These risks must be assessed and accounted for in tenders, otherwise, tenderers may suffer tremendous losses and eventually, failures (Laryea & Hughes, 2006; Odeyinka *et al.*, 2006; Onukwube *et al.*, 2009).

In a similar study, it was opined that reliable prediction of final tender sums (contract sums) of building projects from the cost plans has posed challenges for clients and practitioners in New Zealand. No matter how much care and effort is put into the preparation of design stage elemental cost plans, deviations are usually observed between these cost plans and the final tender sum (Adafin *et al.*, 2014). Such deviations in the region of +1% to +12% are also evidenced in a number of related previous studies by Skitmore and Picken (2000), Odeyinka and Yusif (2003), Aibinu and Pasco (2008) and Oladokun *et al.* (2011). According to Odeyinka (2007) the major attributable factors for these deviations are risk elements that are inherent in construction project developments. Other researchers who have analysed the factors that affect the accuracy of pre-tender cost estimates include Akintoye (2000), Enshassi *et al.* (2007), Zou *et al.* (2007), Odusami and Onukwube (2008) and Enshassi *et al.* (2013). Whilst it is recognized that risk factors exist during the design phase, the traditional way of dealing with them is to make a percentage or lump sum contingency allowance in cost plans and tender sums (Odeyinka, 2010). Bello and Odusami (2008) further explained that this conventional approach

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has been criticised and is a reason why so many projects are completed over budget. Thus, according to Baloi and Price (2003), Bello and Odusami (2008), Hlaing *et al.* (2008) and Tsai and Yang (2010) more analytical and scientific methods have evolved in construction risk assessment which could improve the quality of construction estimates.

This study investigates the accuracy in design stage elemental cost planning with a view to identifying risk factors influencing the accuracy and their respective measure of influences. From the review of past contributions of researchers in this area of study, there is a dearth of literature on cost and risk issues in the variability between the design stage elemental cost plan and final tender sum (contract sum). In other words, the deviation of cost plans from final tender sums in New Zealand is yet to be studied. This study therefore intends to close the gap, hence the need for the study.

LITERATURE REVIEW

Substantive research has been carried out in the field of pre-tender estimating for construction projects, a significant outcome of which is the identification of numerous risks that influence budgetary performance (Aibinu & Pasco, 2008; Akintoye, 2000; Odusami & Onukwube, 2008) and specifically the accuracy of design stage elemental cost plans and their respective measure of influences which is the focus of this study. Several researches (e.g. Akintoye, 2000; Enshassi *et al.*, 2005; Aibinu & Pasco, 2008; Odusami & Onukwube, 2008; Onukwube *et al.*, 2009; Oladokun *et al.*, 2011; Jafarzadeh, 2012) have indicated that pre-tender estimating accuracies are significantly affected by the level of risk information available to estimators, hence recognised by this study as a fundamental evidence of risk factors impacting variability between elemental cost plan and final tender sum.

This view regarding risk identification was further shared by Choy and Sidwell (1991), Ling and Boo (2001), Baloi and Price (2003), Hlaing *et al.* (2008) and Tsai and Yang (2010) in their studies. In this study, the disparity between design stage elemental cost plan and final tender sum received in competition for a project provides fundamental evidence on issues relating to the accuracy of pre-tender cost estimates which have been discussed in construction management literature over the decades as previously mentioned.

Risk and budget overrun

Burtonshaw-Gunn (2009) and Larkin *et al.* (2012) submitted that the general consensus in construction management literature is that when risks occur on construction projects, they impose detrimental effects on the main project objectives of cost, time and quality. However, Chapman (2001) argued that this submission ignored the possibility of a positive outcome hence defined risk as an event which if it occurs will have a positive or negative impact on the achievement of project objectives. Chapman's (2001) definition was corroborated by an argument which emanated from Healey (1982) and Perrry and Hayes (1985) that risk is an exposure to economic loss or gain arising from an involvement in construction process. In the light of these definitions (Healey 1982; Perry & Hayes 1985; Chapman 2001), Odeyinka *et al.* (2006) concluded that risk can be viewed as a psychological phenomenon that is meaningful in terms of human reaction and experience. The effect of risk on a project objective can be either positive or negative. Therefore, in order to embrace the common practice usage of the word risk, this research embraces the view that the benefits of positive impacts of risk on project objectives will be achieved by minimising risk occurrence and its detrimental impacts.
Odeyinka *et al.* (2010) explained that the budgeted cost established by the consultant Quantity Surveyor at the pre-contract stage forms the basis for the assessment of the tender sums submitted by bidding contractors. The successful tender therefore becomes the final tender sum (contract sum) for the project. Potts (2008) suggested that most clients work within tight pre-defined budgets which are

usually part of a larger overall scheme. If a budget or cost plan is exceeded, the whole scheme may fail. Pre-contract estimating produces the original budget or cost plan and this forecasts the likely expenditure for the client. Odeyinka *et al.* (2012) submitted that this budget or cost plan should be used positively to make sure that the design stays within the scope of the original scheme. Moreover, from a pre-tender view, it is concluded that the observable deviation between the design stage elemental cost plan and final tender sum is due to risk factors which are not only hard to predict but also difficult to manage. Thus, many budget overruns are due to circumstances observed as risk factors and an important issue is the ability to predict such factors and the impact they have on the project (Odeyinka *et al.,* 2010).

Akintoye (2000) maintained that the most important factors influencing project cost estimating practice in the UK include: (1) complexity of design and construction, (2) scale and scope of construction, (3) method of construction, (4) tender period and market condition, (5) site constraints, (6) client's financial position, (7) type of client, (8) buildability, (9) project location and (10) availability and supplies of labour and materials; but Akintoye's (2000) work only focused on contractors' perspective. Similarly, Odusami and Onukwube (2008) reported seven most important factors that affect the accuracy of pre-tender cost estimate in Nigeria, based on the experience of consultant Quantity Surveyors, which include: (1) expertise of cost consultants, (2) quality of information and flow requirements, (3) project team's experience of the construction type, (4) tender period and market conditions, (5) extent of completion of pre-contract design, (6) complexity of design and construction, and (7) availability and supplies of labour and materials. Other numerous factors impacting the accuracy of preliminary cost estimates/design stage cost estimates/pre-tender cost estimates in the UK, Australia, Palestine and Nigeria were identified in the studies conducted by Ogunlana and Thorpe (1991), Trost and Oberlender (2003), Odeyinka and Yusif (2003), Elhag *et al.* (2005), Aibinu and Pasco (2008), Pasco and Aibinu (2008), Oladokun *et al.* (2011) and Enshassi *et al.* (2013).
Knowledge of how risk factors combine to influence the accuracy of design stage elemental cost plans and their respective measure of influences is required but yet to be investigated. This then is the concern of this study with the overall aim of developing a model to improve the accuracy of final tender sum predictions from cost plans in New Zealand.

METHODOLOGY

The study approach collated data on elemental cost plans and final tender sums from completed building projects in New Zealand. Access was obtained to project records held by three quantity surveying firms in Auckland. A thorough examination of their project files within the limitations of the Privacy Act was undertaken. Data were sourced from five NZ-based consultant Quantity Surveyors of three randomly selected firms through interview sessions held over a period of two months April-May 2013. Initially 10 out of 17 registered quantity surveying firms were contacted by telephone after a random internet search limited to the website of New Zealand Institute of Quantity Surveyors (NZIQS). Ten firms were preferred owing to the fact that project cost planning/pre-tender estimating falls within their areas of concentration in practice. From these, three firms replied that they were willing to participate in the research. Meanwhile, five senior partners within the three firms were subsequently communicated with via telephone and e-mail requests for 30 minutes' one-on-one interviews. As viewed by Gibson and Brown (2009), documentary analysis is a method that refers to the process of using documents as a means of social investigation and involves exploring records that individuals, professionals and organizations produce. In this study, the use of documentary analysis helped to justify the theoretical conclusions generated from the review, regarding risk identification in the real world examples. Table 1 shows the project information for five commercial and three educational building projects located in Auckland, Christchurch and Wellington, New Zealand. These project details were analyzed to achieve the research objective.

Meanwhile, interview was chosen as a data collection tool for this study because it is an effective method for gaining an insight into people's experiences in particular scenarios as opined in (Taylor & Bogdan, 1984). Face-to-face interview was undertaken using a structured interview schedule. This eventually graduated to face-to-face interview in a free or unstructured format. Zuo (2010) suggested this method as facilitating a detailed understanding that emanates from directly observing people and listening to what they have to say at a particular scene. The interview was aimed at exploring the interviewees' general knowledge about cost and risk issues with a focus on the risk factors responsible for the disparity between design stage elemental cost plans and final tender sums in the selected commercial and educational building projects. Thematic analysis was used to analyze interview data by pinpointing, examining and recording patterns within them (Gibson & Brown, 2009). This method was useful in identifying themes and theme occurrence within the data collected, as well as the comparison of theme frequencies. Simple descriptive analysis was used to express the influence of risks on the observed disparity (Nworgu, 2006).

PRESENTATION AND DISCUSSION OF FINDINGS

The demographic information collected regarding the study participants include their designation, academic and professional qualifications, and work experience. The respondents hold tertiary education at HNC/HND/Bachelor's degree levels in quantity surveying, while one of them holds an MBA in addition. They are senior partners in their individual firms and are professionally qualified (three full members and two fellows) with the New Zealand Institute of Quantity Surveyors (NZIQS). The participants have an average of 28 years of work experience as consultants in the construction sector. This demographic information indicates that the participants are competent, experienced and capable of exercising sound judgment in responding to the interview questions. Therefore, responses provided by them could be relied upon for this study.

Table 1 provides a summary of the project details collected from study participants (consultant quantity surveyors) on five commercial and three educational building projects located in Auckland, Christchurch and Wellington, New Zealand. The table shows that disparity between design stage elemental cost plans and final tender sums is in the region of -14% and +13%. The risk factors generally influencing the disparity observed in this study include: Market conditions, client's change, design enhancements/variations, site investigation information, co-ordination errors, documentation errors/omissions, incomplete design information, incomplete documentation for cost plan, inadequate tender documentation, while improvement in design cost planning functions and improvement in market conditions are opportunities representing savings made on two different projects (see PN02 and PN05).

Specifically, PN01 (Project Number 01) recorded a budget overrun of +7% as a result of such risks as client's change, inadequate tender documentation, incomplete design information and site investigation information. PN03 registered a budget overrun of +10% and the risk factors responsible were market conditions, inadequate tender documentation, documentation errors/omissions, client's change and site investigation information. Another budget overrun of +7% was noted on PN04 while the risk factors found in the archives were late client's changes, incomplete documentation for cost plan, co-ordination errors at tender documentation stage and incomplete design information. Similarly, PN06 attracted a budget overrun of +7% consequent upon incomplete design information, market conditions, client's change, and site investigation information. Also, PN07 recorded an overrun of +13% as a result of client's change, design variations, market conditions and site investigation information as the evident risk factors. Moreover, PN08 overran +7% while the risk factors responsible were late client's changes, design enhancement, market condition and site investigation information. In the light of these findings, the generality of interviewees opined that the final tender sum is usually higher than the elemental cost plan on building projects based on their experience.

For the two building projects (PN02 and PN05) on which the final tender sum is lower than the cost plan sum (-14% and -2% respectively), the participants interviewed explained that this was consequent upon an improvement in design cost planning functions by the professional team and an improvement in market conditions (opportunities). This study suggests that the risk factors identified by the cost consultants constitute the reasons for the disparity. Market conditions, client's change and site investigation information appeared as the risks with the highest frequency of occurrence in the study. In total, nine risk factors causing a negative impact on the budgetary performance of the selected building projects were identified.

The conditions in the property market including situations with project resources within the cost planning / tender period resulted in the significant cost difference observed on PN03, PN06, PN07 and PN08 in an upward trend. The result is justified as it involves an increase in the cost of construction materials between different dates of elemental cost plans and the estimated date of tender which is usually extended. Akintoye (2000) emphasised that the quantity surveyor must take into account the trends in market conditions and the implications on the costs of project resources. This view in connection with tender period was shared by Odusami and Onukwube (2008) and Enshassi *et al.* (2005). Elemental cost plans prepared for a project is an attempt to forecast the successful contractor's final tender sum; hence consultant Quantity Surveyors must take into account the trends in market conditions between the two specified periods and the implications on project performance from inception. This factor mainly has to be considered by the consultant Quantity Surveyors while preparing design stage elemental cost plan.

It is actually not a surprise that early changes in design or design variations/enhancements and client's change impact on the budgetary performance of most of the projects (CS01, PN03, PN04, PNO6, PN07 and PN08) at this pre-contract stage. Given the fact that these risk factors occurred during the pre-construction phase and are design-related, the quality of the design needs to be as good as the design information available. However, within the cost planning and tender action stages (pre-contract phase) as more information are available, Architects may see the need for changes to the original design. Also, clients who are equally getting the grasp of design and construction realities may wish to suggest changes or enhancements so as to ensure that their objectives are met. In some cases, they may also suggest changes to the scope of works. Since the design stage elemental cost plan and final tender sum are based on pre-construction information available, it is therefore not a surprise that significant variability exists between the cost plan and final tender sum.

Site investigation information reveals the site conditions, nature of the soil, sub-ground or geological conditions that may affect design and construction. The level of information available while preparing an elemental cost plan is shown to be significant to the disparity between the cost plans and final tender sums in this study. From Table 1, PN01, PN03, PN06 PN07 and PN08 projects had experienced significant impacts by risks associated with site conditions. This agreed with the work of Zou *et al.* (2007) that site investigation information is one of the key risks in construction projects in China. Zou *et al.* stressed that inadequate site information (soil tests and survey report) leads to uninformative designs and further could negatively affect the progress of excavation and foundation construction. This view was shared by Odeyinka *et al.* (2009) through a study conducted in the UK that lack of site investigation information could lead to defective design and consequently to foundation problems. Hence, failure or deficiency in the site investigation impacts significantly on a project's budgetary performance and consequently the client's cash flow position.

Lack of effective communication and co-ordination among members of the project team is a typical source of risk which brings about co-ordination errors. The emergence of co-ordination errors bred documentation errors or omissions which partially affected the budgetary performance of PN03 and PN04 in an upward direction. Ling and Boo (2001) stressed the importance of effective communication and co-ordination among project team members as it improves cost planning accuracy if there are smooth flow of information and a synergy of ideas/solutions from project participants. Once failure or deficiency is experienced in setting up a communication and co-ordination model at project inception, this generates documentation errors and project participants are unable to have a clear idea of their expected roles and responsibilities, as well as expected performance in relation to project design and cost planning functions.

The project information in this study comprised availability of design information, quality of the design information and the extent of completion of pre-contract design in the face of cost planning accuracy and reliability. Early studies cited in Ling and Boo (2001) submitted that drawings are instrumental in the communication of the architect-engineers' intentions concerning the structure they have conceived and designed (Enshassi *et al.,* 2005). Hence, project implementation strategies must include procedures for collecting information on project performance which is vital for project planning and control. This explains why incomplete or inadequate design information has partially influenced the variance recorded on the budgetary performance of PN01, PN04 and PN06 at the pre-contract phase of the project. As opined in Akintoye (2000) since consultants supply most of the information required for the cost planning/estimating functions, the expertise available within the consultant organizations could have a bearing on the amount of detailed design available during design development and tender stages, the quality of information provided and the efficiency of flow of such information. The information here means the amount of design details and cost data available for the project.

It is important to have adequate and proper cost plan and tender documentation as well as information management in order to improve cost planning/estimating accuracy. Incomplete documentation for cost plan and inadequate tender documentation have partly explained the reasons for the disparity between the design stage elemental cost plan and final tender sum in this study (see Table 1 for information on PN01, PN03 and PN04). Besides making estimates more accurate, adequate documentation could go a long way to reduce problems such as variations and claims at the construction stage.

CONCLUSION

The aim of this study was to investigate the accuracy in design stage elemental cost planning in building project procurement through an analysis of New Zealand data. Extant literature, interviews and project data have indicated that risks have an impact, first on the preparation of design stage elemental cost plan, and secondly on the accuracy of design stage elemental cost plans. The assessment of these risk elements could assist in determining the final tender sum from cost plans. The study suggests that the essence of having an elemental cost plan as a reliable budgetary tool for building projects is secured if the risk elements are properly evaluated while preparing the design stage elemental cost plan. With this information, Quantity Surveyors are able to accurately forecast final tender sums of building projects from the cost plans through proper risk identification and subsequent further analysis, thus increasing accuracy. This study provides further insight into the relationship between construction costs and various risk variables in terms of the benefits to researchers and experts in the broader global construction community. The approach envisaged in the later part of the study when further data are collected and analysed will provide information for the development of a predictive model for application in New Zealand.

Table 1: Project information on commercial and educational buildings in Auckland, Christchurch and Wellington, New Zealand

Projec t Nr. (PN)	Project Type	Elemental Cost Plan Sum (NZ$)	Final Tender Sum (NZ$)	Cost Difference (NZ$)	Percentag e Differenc e	Year	Project Location	Procureme nt System Adopted	[illegible]
PN01	Commercial building	2,850,000.00	3,058,252.85	+208,252.85	+7%	2012-13	Auckland	Traditional	Client change, inadequate tender documentation, incomplete design information and site investigation information
PN02	Commercial building	20,263,080.00	18,193,180.0 0	-2,069,900.00	-14%	2013	Wellington	Traditional	Improvement in market conditions and improvement in design cost planning functions (opportunities)
PN03	Commercial building	998,650.00	1,094,000.00	+95,350.00	+10%	2013	Auckland	Traditional	Market movement, documentation errors/omissions, client change, site investigation information and inadequate tender documentation
PN04	Educational building	3,740,518.00	3,989,698.00	+249,180.00	+7%	2013	Auckland	Traditional	Late client changes, incomplete documentation for cost plan and co-ordination errors at tender stage, incomplete design information
PN05	Educational building	3,986,000.00	3,904,300.00	-81,700.00	-2%	2013	Wellington	Traditional	Improvement in market conditions and improvement in design cost planning functions (opportunities)
PN06	Educational building	48,833,750.00	52,468,250.6 5	+3,634,500.65	+7%	2012	Christchurch	Traditional	Incomplete design information, market conditions, client change and site investigation information
PN07	Commercial building	31,790,000.00	35,790,100.0 0	+4,000,100.00	+13%	2010-11	Christchurch	Traditional	Market conditions, design variations, client change and site investigation information
PN08	Commercial building	28,245,000.00	30,285,225.0 0	+2,040,225.00	+7%	2010	Wellington	Traditional	Late client changes, design enhancements, market conditions and site investigation information

Data analysis without GST or value added tax (VAT)

Exchange rate: NZ$1.00 = US$0.85 = AU$0.91 = £0.51 sterling (2014).

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