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An evaluation of risk factors impacting project budget performance in New Zealand.

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Abstract

Purpose – There has been a lack of research, particularly within the New Zealand (NZ) context, focusing on the identification and assessment of risk factors for construction projects, leading to wide variation between design-phase elemental cost plans (ECPs) and the out-turn tender sums (OTS). Still to be investigated is how risks interact to produce such variability. This research therefore determines the risk-influencing factors, identified through risk measurement, during design development.

Design/methodology/approach – The study adopted literature review and online questionnaire survey. The literature review was used to identify the factors affecting project budgetary performance, which was used to design the questionnaire survey culminating in data analysis. The questionnaire was administered to 64 practising project managers (PMs) in NZ. Their responses were analysed using descriptive statistics, mean ranking analysis (MRA), degree-of-risk measure and correlational analysis, to find the top five risk factors impacting the variability observed, through ranking the mean and degree of risk values that produce such variability.

Findings – Significant risk factors were identified from the questionnaire survey analysis as: changes in project owner/stakeholder requirements, experience of project team, site condition information, competency of consultants and information flow and quality. These provided some insights in explaining the variability between the design-phase ECPs and OTS based on risk impacts from PMs' viewpoints.

Research implications – Findings revealed a drift of 23.86% in budgeted costs (inflated risks) which seems significant. Prioritising top risk factors may provide handy information for researchers on the variables that could be relied upon for the development of a forecasting model for application in NZ.

Practical implications – The study findings have implications for PMs seeking to provide information on mitigation strategies by using risk management approach, considering the influence of development-risks on building project delivery and, consequently the project owner's financial position. To guard against wide variation between design-phase ECPs and OTS, the main contribution of this study is to raise consultants' awareness of the important risk factors for their planning at the outset, thus assisting project managers in pro-actively managing their clients' budgets.

Originality/value – This study creates value by synthesising literature on construction project budgeting and highlights areas for further research. By giving adequate attention to key risks associated with budget overruns in commercial projects, variability between ECPs and OTS, a common phenomenon in NZ, can be controlled to achieve cost savings. Based on this, further study suggests the development of a model that could assist the stakeholders in NZ to more

reliably predict OTS from the design-phase ECP; and pro-actively avoid unfortunate budget/cost overruns, disputes, and even project abandonment.

Keywords: Elemental cost plan, New Zealand, Outturn tender sum, Project manager, Risk impact, Variability

Paper Type: Research paper

Introduction

In a construction project, the main obligations of a project manager (PM) towards the client are usually reduced to concerns around functional requirements, quality standards, worker safety, and delivery within an acceptable budget and time frame. Usually, for most clients, the budgetary/cost performance of a construction project tends to be the most important, owing to its direct economic impact. Thus, an elemental cost plan (budget), prepared during design development, can play a major role in supporting a decision to build or not to build, and frequently a benchmark for future performance measures. Ji *et al.* (2014) stressed that proper project budgeting continues to pose a challenge of serious concern to project stakeholders.

As suggested by Kirkham (2007), the objectives of cost planning are to generate an indication of a project's likely construction costs (initial and final) to assist the client in setting a budget, predict the final tender price, and manage the design so that it meets the budget. Meanwhile, Allan *et al.* (2008) held the view that the main challenge for project owners is achieving construction efficiency in terms of cost effectiveness, timeliness and quality. Of these concerns, the cost aspect tends to be of paramount importance. While it is widely held that a perfect cost plan is not achievable, and even the best possible usually contains risks, the goal of a forecaster is a practicable level of accuracy (Lowe *et al.,* 2006) through risk assessment. Risks are covered through the allocation of contingencies to cover both foreseen and unforeseen circumstances in the design-phase ECPs and tender sums (Odeyinka, 2010). If risks are properly identified and priced at the design stage, observed variance between the design-phase ECPs and OTS (initial contract sums) could be reduced. However, several construction management studies have established that it is difficult to find a project in which the OTS is the same as the cost plan estimate, for varied reasons (Akintoye, 2000; Aibinu and Pasco, 2008; Odusami and Onukwube, 2008; Enshassi *et al.,* 2013).

Research undertaken by Adafin *et al.* (2015) indicated disparity in budgeted costs between the ECPs and OTS in the region of -14% and +16%. These preceding issues led to examining the budgetary reliability of the design- phase ECP in building project procurement. Adafin *et al.* (2016) noted that with commercial projects, there could be a significant difference between the design-phase ECPs and OTS (-14.22% and +16.33%); while residential projects had a smaller, more reliably acceptable percentage deviation (-3.67% and +3.95%). Cost data from 20 completed traditionally-procured building projects in NZ were used to evaluate these disparities (see Tables 1 and 2). Tower and Baccarini (2008) suggested that such deviations could be associated with construction project developments' risks. Similar to Adafin *et al.* (2016), this research proposes that budget overrun could vary according to project/procurement types.

Related studies in Australia, Norway, Turkey, UK and USA showed that where cost plans are used, discrepancies between the ECPs and OTS are rife. Disparities in the region of +1% to 74% are mentioned in Morrison (1984), Ogunlana (1991), Flyvbjerg *et al.* (2002), Magnussen and Olson (2006), Oztas and Okmen (2004) and Terrill and Danks (2016). Morrison (1984) investigated this disparity in the UK by evaluating responses from seven separate quantity surveying firms on educational, housing and commercial developments. Morrison found that a mean deviation of 12% was obtained by these firms. Ogunlana (1991) analysed data from seven design offices in the UK and found that there were significant disparities between budget estimates and accepted tenders.

Others include Flyvbjerg *et al*. (2002) and they conducted a comparative study on budget and tender estimates in the United States. Their study found that tender prices of 258 infrastructure projects are averagely 28% higher than budget estimates. Magnussen and Olsson (2006) analysed 31 major public projects in Norway and concluded that there is a 74% drift between the initial estimates and the revised estimates. Evidence and arguments in construction management researches (Cantarelli et al., 2010; Terrill and Danks, 2016; Welde and Odeck, 2017) indicated budget variability during the planning and design development phases of infrastructure projects. For example, Terrill and Danks (2016) observed that the early cost estimates are subjected to averagely 25% increases in Australia. The basis for establishing budget estimates are reviewed as projects develop and more information becomes available (Love *et al*., 2019). These studies confirm that design/preconstruction issues are significant risk factors responsible for the variations observed (see Table 3).

Given these inherent risk factors and how they interact to produce the deviations observed between design-phase ECPs and OTS is the focus of this research. There is little such research in NZ, which has limited research information to assist industrial practice. A knowledge gap is noted in the research about the risks impacting budget overruns in NZ construction. As risk analysis is an essential part of project management (Xia *et al.,* 2017), project managers' (PMs') viewpoints were considered regarding the expected value (extent and impact) of risk occurrence. Due to their involvement with project evaluation and monitoring, and perception that risk identification and assessment is critical for good project management (Baloi and Price, 2003); PMs can provide researchers with information on development-risks (design- and construction-related) in building project delivery and their client's subsequent financial position (Rostami and Oduoza, 2017). This research aimed to assess the degree of such risks influencing variation between design-phase ECPs and OTS. It sought to determine and evaluate the most important risk factors, identified through risk measurements during design development. Linked to this, the objectives are:

- to identify the risk factors affecting the variation between design-phase ECPs and OTS, from project managers' perspectives;
- to evaluate these risk factors through determining the average risk estimate (degree of risk), and by using Spearman's rho, to establish the most significant. As criteria for ranking identified risks, it determined the extent and impact of risk occurrence.

Literature review

Cost planning and observed variations in context

The Royal Institution of Chartered Surveyors' New Rules of Measurement [RICS NRM] 1 (2012) defined cost planning as a budget distribution process performed during the design stages of a building project. Arguably, Smith and Jagger (2007) affirmed the performance of cost planning techniques up to the tender documentation phase of development process. In practice, project managers refer to cost planning as the cost prediction process involving application of economic principles to project development. In Rawlinsons' (2011) opinion, cost planning frequently refers to the process of designing to, or within, a pre-calculated cost, determined by the finances available to obtain an optimum value for money. This suggests that the sooner cost planning is introduced into the design process, the greater the measure of control that can be exercised. This agrees with the views of several recent authors: Ashworth (2004), Ashworth and Hogg (2007), Kirkham (2007), and Ashworth (2008). They suggested that cost planning seeks to offer a control mechanism during design development and is not just a pre-tender estimating method.

In view of this, and within the context of this study, cost planning describes any method for distributing budget to reflect upon design development. Likewise, a design-stage ECP is prepared during design development (pre-contract) to give project owners value for money, and is a strategy that operates within design-stage cost-control phenomenon based on elemental cost analysis. ECP provides a budget in an elemental form. It represents the final ECP amendment before tenders are invited; OTS describes the initial contract sum or accepted tender sum.

According to Odeyinka (2010), despite a great deal of care and effort at the preparation stage of a design-stage ECP, deviations between that and the OTS can be significant. With procurement methods where cost plans are used, there are often deviations between the cost plans and final tender sums, as found by relevant researches in the UK, Middle East, Asia and Africa. The major attributable factor for such deviations could be the inherent risks in construction project developments, as claimed by Odeyinka (2007). Significant deviations, causative factors and plausible solutions are mentioned in Morrison (1984), Odeyinka and Yusif (2003), Magnussen and Olsson (2006), Aibinu and Pasco (2008) and Oladokun *et al.* (2011) (see Table 3). Despite the inherent risks that manifest discrepancies between ECPs and OTS, effective management requires proper determination and integration of risks in the estimation of construction costs, rather than intuition and loose rules. A rather mitigation strategy using risk management approach (deterministic- approach to risks) should minimize budget/cost and schedule/time overruns (Trost and Oberlender, 2003).

Risk and risk factors impacting budget overrun

Flanagan and Norman (1993) noted that the environment within which decision-making takes place can be divided into three parts: (1) certainty, (2) risk, and (3) uncertainty. Certainty exists only when one can specify exactly what will happen during the period of time covered by the decision. Bennette and Ormerod (1984) concluded that this situation is rare in the construction industry. However, uncertainty is endemic in construction (Olsson, 2007), representing a clear threat to projects (Hillson, 2004), and needs to be explicitly recognised by construction managers. According to Chapman and Ward (1997), decisions are concerned with variables, which are normally classified as risks or uncertainties. Risks are unknown, and the probability of an occurrence can be assessed by statistical means; uncertainties are also unknowns, but the probability of the occurrence of something unknown cannot be assessed. As claimed by Hillson (2004), a connection exists between uncertainty and risk that indicates: "Risk is uncertainty measured, and uncertainty is a risk that cannot be measured". Therefore, project activities are exposed to many uncertainties, with an aim to identify, analyse, evaluate and operate on risks. In view of this, Creedy (2006) submitted that a construction business operates in an environment where uncertainties are converted to risks; risk is the more relevant term in the building industry.

It is thus obvious from the foregoing (Hillson, 2004; Creedy, 2006; Olsson, 2007) that the definition of risk embraced is that of the possibility of an adverse event depending on circumstances (Mills, 2001). This is because adverse consequences (threats) are likely to occur more often than opportunities, and may cause huge losses and undermine a project's anticipated benefits (Ameyaw *et al.,* 2015). The Association for Project Management (APM, 2006) in the UK defined risk as an uncertain circumstance, and while occurring will have an impact (either positive or negative) on the achievement of one or more project objectives (cost, time, quality, etc.). Therefore, to support the regular usage of the word *risk*, this research holds the view that the extent (or frequency) and impact (or consequence) of adverse occurrences causing a construction project to exceed its predicted budget or ECP sum (Burtonshaw-Gunn, 2009; Larkin *et al.,* 2012; Odeyinka *et al.,* 2012) can be expressed as:

$$R = P \times I \qquad \text{Equation (1)}$$

Where R = the average risk estimate (degree of risk); P = probability/extent of risk occurrence and I = the consequence or perceived impact on a project. This relates to the nature of risk that can be ascertained to determine the degree of risk (Smith, 2006), otherwise referred to as the risk exposure, expected value or average risk estimate (Odeyinka *et al.,* 2012). This method of risk measurement has a well-established place in the decision theory domain (Odeyinka *et al.,* 2012), and has been employed in this study to determine significant risk factors. Through this, the research connects with the realities of practice.

Much construction management literature suggests that various factors identified by authors such as Akintoye (2000), Chapman (2001), Ling and Boo (2001), Hansen and Vanegas (2003), Trost and Oberlender (2003), Serpell (2005), Enshassi *et al*. (2005), Liu and Zhu (2007), Zuo *et al.* (2007), Tower and Baccarini (2008), Aibinu and Pasco (2008), Enshassi and Mosa (2008), Odusami and Onukwube (2008), Farinloye *et al.* (2009), Odeyinka *et al.* (2009, 2010), Doloi (2011), Oladokun *et al.* (2011), Chileshe and Yirenkyi-Fianko (2012), Enshassi *et al.* (2013), Ji *et al.* (2014) and Adafin *et al*. (2018: 2, 3 and 5), have caused significant deviations of pre-tender cost estimates from outturn tender sums in construction projects (see Figure 1). Cost estimating factors analysed by Akintoye (2000) formed the basis of the current study, since Akintoye's research (published in the UK) was relevant to developed economies such as that in NZ. Consequently, the outcome of this review produced 36 risk factors (see Figure 1) that influence the budgetary performance of construction projects in developed countries. Therefore, qualitative definitions of risks were used to summarise project managers' activities and notions of risk, based on studies concerning project risk management (Jaafari, 2001; Raisbeck, 2008). The current assessment proposes that these could provide fundamental evidence of risks affecting budget overrun. Thus, proper risk analysis could at least partially solve this problem, by lowering the variation between construction project design-phase ECPs and their OTS.

From the above review, the studies evaluated multitudinous factors that affect variability between design-phase ECPs and OTS. Their authors believe that, despite similarities, their lists may not necessarily apply in other settings, as each construction project and each construction industry is unique, but such lists provide useful knowledge. Without NZ-specific research on this topic, their relevance and the extent to which they are applicable in NZ awaits review.

How these risk-influencing factors interact to influence the observed variations still needs investigation. The lack of NZ studies focusing on the budgetary performance (pre-contract) of construction projects is obvious. Importantly, quantitative project-data is accessible, to establish why OTS are often so different from ECPs. The relevant risks need examination, especially from New Zealand PMs' perceptions of risk occurrence. This is where this study finds its significance.

Research methodology

This study adopted a two-stage approach (literature review and questionnaire survey) culminating in data analysis. The literature review was carried out to identify the various factors affecting project budgetary performance. Based on expert judgments, the outcome of the review produced and classified 36 risk factors, and their relevance to the NZ construction industry was discussed with 5 construction consultants. The use of expert judgment has been extensively noted for risk identification (Kassem *et al.*, 2019). Consequently, a pilot study including 32 participants (i.e. NZ-based architects, QS and PMs) was conducted in line with Nworgu (2006), to ensure clarity of the questionnaire and the relevance of the risks explored to NZ construction. Thus, a criticality cut-off point of 3.00 (Fellows and Liu, 2008) on a 6-

point Likert scale was employed to prioritise the top 16 critical risks out of the 36 risk factors. Adafin et al. (2016) suggested that risk factors, with overall mean scores of 3.00 and above, had significant impacts on variability and viewed to have potential impacts on budgetary performance of construction projects. This procedure prioritised 16 risk factors, and these 16 significant factors formed the basis of a refined questionnaire administered to the study participants (PMs).

The survey gathered the opinions of NZ project managers (private consultancies) to bring together the PM's management experience and notions of risk in the areas of project design, cost and risk management (Baloi and Price, 2003), thus creating a resource for the assessment of risks causing variation between design-phase ECPs and OTS. It used a simple random sampling approach, suggested by Fellows and Liu (2008); samples resulting from this procedure are held to be unbiased as they are representative of the study population (Nworgu, 2006). The 284-member database of the New Zealand Institute of Building (NZIOB) provided the sampling frame. 120 randomly selected, registered project managers (financially valid members of NZIOB) received a survey request (including the web link) from the NZIOB membership services officer, in January/February 2017. Of the 120, 96 were willing to complete the questionnaire, and 72 complete surveys were received, however, only 64 related to traditionally procured commercial projects (Table 5). This research therefore relies on this sample size (64 responses) fit for analysis (a response rate of 67 per cent) and considered adequate according to Moser and Kalton (1981). They stated that the result of a survey is thought to be worth little when the return rate is less than 40 per cent.

As suggested by Nworgu (2006), the questionnaire was therefore the main instrument and basis of inquiry for data collection and analysis. This was corroborated by Blaxter *et al.* (2006) that questionnaire survey is one of the most extensively used social research instruments. Key sections in the questionnaire included: questionnaire introduction; project-specific questions including risk factors on the observed variation (probability and impact); demographic information and, conclusion and feedback. A Likert-type scale of 0-5 was adopted on which the study participants scored their responses, which assesses the risk-occurrence probability, and its perceived impact, as identified in completed or ongoing building projects (Fellows and Liu, 2008). To avoid the centrality problem that respondents commonly encounter, the 6-point Likert-type scale was used. A smaller than 6-point Likert scale was used in some previous project risk studies (Hwang *et al.,* 2016; Zhao *et al.,* 2016). In contrast, an earlier study by Chileshe and Yirenkyi-Fianko (2012), considered a mid-point evaluation in survey questionnaires. The double-dimension scaling questionnaire used in this study was defined following Xia *et al.* (2017) as a Likert scale of 0 (no likelihood of risk occurrence) to 5 (very high level of risk occurrence); and 0 (no risk impact) to 5 (very high-risk impact). This interval scale was adopted and capable of analysing the data gathered from the questionnaire surveys for statistical analyses (Chuing Loo *et al.,* 2013; Taroun, 2014). The participants' responses were therefore analysed using descriptive statistics (Naoum, 2007); mean ranking analysis (MRA) (Park, 2009) to generate mean scores (MS) as defined by Equation (2), and were further rated 1-16 (see Table 6) to ascertain the significance rating of the variables considered.

The average risk estimate (degree-of-risk) used for ranking the identified risk variables was suggested by Larkin *et al.* (2012) and is expressed in Equation (1). Spearman's coefficient of correlation (rho ρ̇), expressed in Equation (3), was applied to ascertain the degree of agreement and/or disagreement among the study participants, in their assessment of each of the variables (El-Sayegh and Mansour, 2015). It is a non-parametric measure of correlation among the respondents using the ranks rather than the actual values (Kottegoda and Rosco, 1997; El-Sayegh, 2008).

$$\textit{MRA mean score} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1 + 0n_0}{(n_5 + n_4 + n_3 + n_2 + n_1 + n_0)} \qquad \text{Equation (2)}$$

Where: MS = mean score; n_0 - n_5 indicate the number of participants that scored the responses as 0 - 5 respectively.

$$\dot{\rho}\ (rho) = 1 - \frac{6 \sum d_i^2}{n(n^2-1)} \qquad \text{Equation (3)}$$

Where: d_i = the difference between probability and impact ranks for each of the identified variables; n = the number of identified variables

Data analysis

Demographic information of respondents

Table 4 indicates the background information of respondents in terms of designation, academic and professional qualifications and work experience. The demographic information shows that 100 per cent of the respondents are consultant project managers with tertiary level qualifications, and 94 per cent of them have professional qualifications. These respondents have an average of 26 years' consultancy work experience. This shows that the respondents have adequate knowledge and experience in project development, and budget development risks in NZ, enhancing the reliability of the survey data (Hwang *et al.,* 2016). 89 per cent of the overall respondents provided their opinions on traditionally procured commercial projects (see Table 5). In light of the above, the study is linked to NZ project managers' viewpoints on risks within traditionally procured commercial building projects.

Ranking of the risk factors affecting project budget development

Sixteen risk factors that influence issues related to project budgeting, and identified as associated with commercial construction projects, are listed in Table 6. It delineates the ranking of PMs' perceptions of risk probability, as in Equation (1). The table represents the top five risk variables PMs agree they occur most often. A scoring analysis of the probability of risk occurrence ranges between 1.68 and 3.82, indicating that only 'defective design and specification' has a low probability of occurrence (MS = 1.68; rank = 16^{th}). The top ten identified risk factors scored between 3.0 and 4.0 (up to and above the medium level of probability), with others falling between 1.0 and 3.0 (a very low and medium level of probability). In Table 7, the ranking of the current results was compared with those of Akintoye, 2000 (UK); Jackson, 2002 (UK); Odusami and Onukwube, 2008 (Nigeria) and Enshassi *et al.,* 2013 (Gaza, Palestine).

Table 6 also reveals the ranking of PMs' perceptions of risk effects on budgetary performance, as expressed in Equation (1). It shows the five key risk variables that they agree affect budget overruns. Mean analysis of their perception of the impact of risk occurrences ranges from 1.81 to 3.88; and only 'client type' has a low impact of occurrence (MS = 1.81; rank = 16^{th}). The top eleven risk factors scored between 3.0 and 4.0 (i.e. critical and very critical effects on budgetary performance); with the rest falling between 2.0 and 3.0 (fairly critical and critical effects).

Table 6 further evaluates PMs' opinions about the 'degree-of-risk' measurement of commercial construction-project budgetary performance, based on the 'average risk estimate' instrument mentioned in the methodology section. The risk estimate or measurement, as indicated in Equation (1), determines the top risk-influencing factors affecting project budgeting (ECPs and FTS), in traditionally procured commercial construction (from a project manager's perspective). Column 6 of Table 6 shows the 'average risk estimate' (degree-of-risk) values of the identified risk factors ranging from 3.95 to 14.82, calculated using Equation (1). These top five risk factors require further research on risk modelling: changes in project owner/stakeholder requirements, experience of professional team, site condition information, competency of cost consultants, and information flow and quality.

Measuring PMs' agreement using correlational analysis of risk impacts

A software (*Statistical Package for the Social Sciences SPSS)* was employed to enable Spearman's correlation analysis [IBM (International Business Machines Corporation) 2015]. Survey data was analysed using two different benchmarks (risk probability MS and impact MS), both ranked separately, indicating their 'degree-of-risk' scores. Table 6 represents the statistical findings from this analysis and shows that 0.93 (*rho*>0 and *rho* near 1) is the value of Spearman's rho (coefficient) for the survey responses. This indicates a significant value for Spearman's coefficient, thus shows a strong agreement among the participants judging each of the risk variables. Positive correlation exists in ranking the risk variables that affect construction project budgeting (i.e. variability between design-stage ECPs and OTS). Therefore, the top five risk-influencing factors are reliable for forecasting modelling.

Estimated variation between ECPs and OTS

From the sample size of 64 respondents, 36 PMs completed the survey questionnaire that produced ECPs and OTS data from 36 case study projects. Table 8 shows an approximate drift of +23.86% in budgeted costs (i.e. between design-stage ECPs and OTS) for commercial projects, which is the focus of this study. Table 6 shows the risk-influencing factors that are generally responsible for the deviations observed. The secondary data was analysed to achieve an estimated relationship between the variables and the variances. This analysis gives further insight into the top five risk factors that require focusing on future forecasting modelling. These factors will be discussed according to their order of relative importance (Table 6).

Discussion of results

The participants' opinions of the most important risk factors for the variation observed in their selected commercial projects are examined here. The most important survey question had the participants score and identify risk factors on a Likert scale of 0-5 for variation between ECPs and FTS. The criterion for ranking was rating the extent and impact from risk occurrences, the summary being shown in Table 6. The following results have been aligned with previous researches on risks in tendering and estimating process.

Changes in project owner/stakeholder requirements

The participants ranked this factor first (see Table 6), revealing that a project owner's change in requirements (project scope definition) can have considerable effect on the budgets of commercial projects at the pre-construction segment of development process in NZ. This complies with related studies that assert that cost plan estimate accuracy heavily depends on what details and scope definition are available. The UK (Odeyinka *et al.,* 2010) and Ghana (Ameyaw *et al.,* 2015), ranked this as a critical risk factor, at 2^{nd} and 4^{th} respectively. In contrast, Nigeria and Gaza (Palestine) found this variable to be irrelevant, as the aforestated results are found to be at variance with those of Odusami and Onukwube (2008) and Enshassi *et al.* (2013). This risk factor is design- and scope-related, and arises within the pre-contract phase of project budget development, as observed by Odeyinka *et al.* (2010). Design quality therefore requires reasonably available design information. As more information becomes available during design and tender development, an architect may necessarily make adjustments to the initial design or scope definition. Knowledgeable clients may understand design and construction realities, and wish to alter or enhance plans, to ensure their aims are met. Clients or PMs could also suggest altering the scope definition. Design-phase ECPs and

OTS are based on the available pre-contract information, so it is therefore not unusual to have significant variation between the cost plan and outturn tender sum.

Experience of project team

Ranked 2nd by the participants, and generally, this variable refers to how much experience professional team members have in traditionally procured commercial construction projects. This variable is therefore a key risk affecting project budgetary performance in NZ. Findings from previous studies by Trost and Oberlender (2003), Odusami and Onukwube (2008) and Enshassi *et al.* (2013), ranked this variable second, third and third, respectively. However, the professional team's previous knowledge of the construction type hardly alters cost planning practice in the UK, according to Akintoye (2000). Whereas, Odusami and Onukwube (2008) thought that if project team members were highly experienced in a proposed type of construction project, one could see that in the details of their designs and estimates. The cost consultant could therefore ensure that every item in the project is considered in their estimate to enable cost planning accuracy, omitting nothing.

Site condition information

Ranked 3rd by the respondents, this factor generates a significant impact. Investigation of site and sub-soil conditions could well affect design and construction (Ameyaw *et al.,* 2015). Thus, the degree of available site information (or lack thereof) for elemental cost plan preparation is vitally important in attaining cost plan accuracy in NZ. Zou *et al.* (2007), similarly identified soil condition information as a key risk in China. Odeyinka *et al.* (2012) also deemed it critical and ranked it 4th in the UK. In Ghana however, Ameyaw *et al.* (2015) ranked it 7th, because of their geological conditions, while it ranked much lower, at 29th, in Gaza (Enshassi *et al.,* 2013). Ameyaw *et al.* (2015) insisted that inadequate soil survey information produces deficient designs that impact negatively on foundation construction, as did Odeyinka *et al.* (2009) in a

UK study. Inadequate site investigation information could deliver defective designs and foundations. It could also, as Odeyinka *et al.* (2009) affirmed, badly affect a project's budgetary performance and, the client's financial position.

Competency of consultants

The sample score ranked the expertise of cost consultants 4th, meaning the experience and capability of the cost consultant in estimating. It is therefore very important in arriving at an accurate cost plan. These cost consultants must have the relevant professional skills and knowledge to provide an accurate cost plan. Odusami and Onukwube's (2008) and Enshassi *et al.*'s (2013) findings affirmed this factor, being placed in the top five in their studies and ranked 1st and 4th, respectively. However, Akintoye (2000) ranked expertise of consultants 23rd out of 24 identified and evaluated risk factors. In NZ, it seems convincingly significant and appropriate to accuracy in project budgeting. This result further reveals that the level of the estimator's knowledge and skill greatly affects the accuracy of a design-stage ECP. Enshassi *et al.* (2013) suggested that risks would be substantially reduced if an estimator were very competent in project budget (cost plan) development. Producing high-quality and reliable budget (cost plan) depends heavily on having an experienced estimator.

Information flow and quality

'Information' refers to the amount/quality of design detail and cost data available for a project, according to Odusami and Onukwube (2008). Quality of information, (ranked 5th), is fairly significant in NZ for the estimating performance of commercial projects, during pre-construction. Akintoye (2000) ranked this 15th, indicating it is less vital in the UK context. This finding, however, affirms Ling and Boo's (2001) assertion that drawings are vitally necessary to convey the designers' intentions, as devised by the project client. Project administration scheme may include generating information on performance that is critical for project cost planning and monitoring. Therefore unavailable, poor quality, incomplete or inadequate design information could impact negatively on the budgetary performance of commercial projects at the preconstruction phase. The most significant means to ensure cost planning accuracy, according to Ling and Boo (2001), is to determine that enough good design/cost information is available for cost planning. Accumulated assumptions and estimates made to accommodate huge risks (unknown items) in a design, can result from insufficient information. Thus, more accurate and reliable budget (cost plan) is achieved with more detailed information/pre-contract design/cost data.

Conclusion and further research

Construction projects are prone to experiencing significant budget/cost overrun, particularly from the establishment of a design-phase ECP and the OTS. Findings revealed an approximate drift of 23.86% in budgeted costs (inflated risks) which seems significant, compared to other similar studies. This research establishes and prioritises risk factors contributing to this increase, and this may affect commercial project development budgeting in NZ. Within the confines of the data collected, mean scoring analysis revealed the top five risk variables in traditionally procured commercial projects that influence variability between design-stage ECPs and OTS: changes in project owner/stakeholder requirements, experience of project team, site condition information, the competency of consultants, and information flow and quality. Results showed that these are preconstruction risk factors which have a high bearing on client's expenditure. A high level of agreement amongst survey participants, found through a Spearman's correlation analysis, identified the rank order of the relative importance of these factors. This reveals the existence of a significant variation between ECPs and the OTS in commercial projects, corroborating Winch's (2010) findings that as greater information is available at the pre-contract phase of project development, the lesser the amount of risk at the construction phase.

The idea of looking at discrepancies between ECPs and OTS provides significant insights into the economic behaviour of commercial projects. Analysis presented in this paper provides empirical evidence and in-depth insights into the changing dynamics of cost-risk behaviour throughout the preconstruction phase of project development. In addition, the findings of this paper can help in suggesting a theoretical framework that classifies risk-influencing factors, assesses the impacts of risks, and allows for a better and reliable decision-making under uncertainty. Further evaluation of results could help develop a forecasting model such as Monte Carlo, to estimate cost growth and generate variables for modelling impacts of risks associated with commercial projects for the first time in the NZ building industry. This could help decision makers/stakeholders in taking reliable decisions under uncertainty.

As a main contribution, this study broadens awareness of researchers in the global construction community regarding the relationship between construction costs and various risk variables, particularly for those countries where this problem is under-researched. The knowledge also provides proper risk analysis (guidelines) that could assist the PMs in measuring cost risks and managing practical risk control. Thus, PMs are more able to accurately conduct risk analysis to identify potential threats at an early stage of the project and to maximize the project-budget benefits by creating a cost risk mitigation plan.

Since this study focused on traditionally procured building projects, future research could explore the development of models for assessing risk impacts on the variability between design-stage ECPs and OTS in other procurement methods, such as 'design and build' procured projects, with the aim of comparing the outcome with the present study.

Owing to the time constraints for this research, responses were limited to project managers registered with the New Zealand Institute of Building (NZIOB). Further research should be conducted to investigate whether stakeholders from different but related disciplines such as architects, quantity surveyors and engineers hold discrepant opinions on risk factors impacting on project budget performance. The risk factors from this study can be used as parameters for any forecasting or project cost estimating model that should be developed for NZ construction industry; this is suitably suggested for further research.

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Table 1. Budgetary reliability measures for residential building projects

Project Code	Elemental Cost Plan Sum (NZ$)	Outturn Tender Sum (NZ$)	Cost Difference (NZ$)	Percentage Difference (%)	Year	Project Location	Procurement System Adopted
P01	7,210,250.80	6,859,266.32	-260,984.48	-3.67	2013	AKL	Traditional
P02	794,456.98	815,257.68	20,800.70	2.62	'12-13	ChC	Traditional
P03	905,500.00	924,680.00	19,180.00	2.12	'12-13	ChC	Traditional
P04	1,914,848.40	1,878,417.15	-36,431.25	-1.90	2013	AKL	Traditional
P05	1,034,360.00	1,075,210.00	40,850.00	3.95	'12-13	ChC	Traditional

Source: Adafin et al. (2016); Note: AKL = Auckland, ChC = Christchurch

Table 2. Budgetary reliability measures for commercial building projects

Project Code	Elemental Cost Plan Sum (NZ$)	Outturn Tender Sum (NZ$)	Cost Difference (NZ$)	Percentage Difference (%)	Year	Project Location	Procurement System Adopted
P11	1,985,000.00	2,085,369.83	100,369.83	5.06	'12-13	AKL	Traditional
P12	31,000,000.00	26,593,185.00	-4,406,815.00	-14.22	2012	ChC	Traditional
P13	33,225,000.00	38,650,125.00	5,425,125.00	16.33	'11-12	ChC	Traditional
P14	2,850,000.00	3,058,252.85	208,252.85	7.31	'12-13	AKL	Traditional
P15	28,245,000.00	31,285,225.00	3,040,225.00	10.76	2010	AKL	Traditional

Source: Adafin et al. (2016); Note: AKL = Auckland, ChC = Christchurch

Table 3. Some previous studies on project risk identification and assessment in extant literature

Researchers	Context	Findings	Plausible solutions
Morrison (1984)	Data collected and analysed from 7 separate quantity surveying firms in the UK	A mean deviation of 12% between cost plan estimates and accepted tenders Causative factors: variability of lowest tenders; source of cost data used in estimating; inherent error attached to the estimating technique; and the suitability of cost data	Quantity surveyors should use previous cost data and a single source of cost data from previous projects
Odeyinka and Yusif (2003)	Survey of 24 quantity surveying firms and analysis of 40 building projects in Nigeria	The mean and standard deviations of the variance ratio were found to be 1.11 and 0.35 respectively, indicating that on average, quantity surveyors underestimated the lowest tender sum by 11% Causative factors: Time lag between preparation of estimates and invitation of tenders; lack of cost information; communication gap between architect and quantity surveyor; and political factors	Major methods of preliminary estimating suggested are superficial and approximate estimating. Other methods such as elemental cost planning can be embraced for better accuracy and consistency
Magnussen and Olsson (2006)	Survey of 31 major public building projects in Norway	A drift of 74% between the initial estimates and the revised estimates observed Causative factors: price escalation; government action; and labour strike action	Quality assurance from the early stages of the project development was suggested.
Aibinu and Pasco (2008)	Survey of 102 quantity surveying firms and results from 56 projects in Australia	Pre-tender cost estimating accuracy has not improved over time. Pre-tender building costs are frequently overestimated rather than are underestimated. Overestimation bias ranges from +0.97% to +31.88% with a mean of +10%, while underestimation bias ranges from -2.21% to -19.83% with a mean of -9%. Causative factors: project size; and principal structural material	Simulating past estimates and estimation of probability; reducing quantity surveying and cost engineering skill turnover; incorporating market sentiments into estimates; early involvement of the quantity surveyor at the brief stage; and proper documentation of experience gained in the estimation of projects, should help firms increase the accuracy of estimates for new projects.
Oladokun et al. (2011)	Survey of 81 building projects in Nigeria	Approximate underestimates of 34% obtained. Causative factors: estimating techniques used; and the variable quantity surveyor's experience	Regression modelling for improvement in final tender sum predictions was applied.

Table 4. Participants' Demographic Information

Characteristics	Number of Respondents	Percent	Cumulative Percent
Designation of Respondents			
Director / Partner	12	16.67	16.67
Principal PM	26	36.11	52.78
Senior PM	34	47.22	100.00
Total	72	100.00	
Academic Qualification of Respondents			
PhD	3	4.17	4.17
Master's Degree	25	34.72	38.89
Bachelor's Degree	27	37.50	76.39
PGD / Graduate Diploma	7	9.72	86.11
Diploma/ND/HNC/HND	10	13.89	100.00
Total	72	100.00	
Professional Qualification of Respondents			
Fellow membership, e.g. FNZIOB	17	23.61	23.61
Full membership, e.g. MNZIOB	51	70.83	94.44
None	4	5.56	100.00
Total	72	100.00	
Professional Experience of Respondents			
1-10 years	5	6.95	6.95
11-20 years	16	22.22	29.17
21-30 years	32	44.44	73.61
31-40 years	12	16.67	90.28
Over 40 years	7	9.72	100.00
Total	72	100.00	
Mean = 25.50 years			

Note: PM = project manager; PGD = postgraduate diploma; ND = national diploma; HNC = higher national certificate; HND = higher national diploma; FNZIOB = fellow, New Zealand Institute of Building; MNZIOB = member (full), New Zealand Institute of Building.

Table 5. Contractual Arrangement Adopted on Commercial Projects Surveyed

Procurement System	Number of Respondents	Percent	Cumulative Percent
Traditional	64	88.89	88.89
Design and Build	3	4.16	93.05
Management Contracting	1	1.39	94.44
Strategic Alliance	2	2.78	97.22
Project Management	1	1.39	98.61
Construction Management	1	1.39	100.00
Total	72	100.00	

Table 6. Project Managers' Opinion of Risk Occurrence in Commercial Construction Projects

Risk Factors	Risk probability MS (P)	Rank (A)	Risk impact MS (I)	Rank (B)	Degree of risk (P X I)	Rank	Spearman's correlation	
							d_i = (A-B)	d_i^2
Changes in project owner's requirements	3.82	1	3.88	1	14.82	1	0	0
Experience of project team	3.74	2	3.85	3	14.40	2	-1	1
Site condition information	3.72	3	3.82	5	14.21	3	-2	4
Competency of consultants	3.53	5	3.86	2	13.63	4	3	9
Information flow and quality	3.50	6	3.83	4	13.41	5	2	4
Tender documentation	3.56	4	3.76	8	13.39	6	-4	16
Design information	3.49	7	3.79	6	13.19	7	1	1
Project complexity	3.44	8	3.78	7	13.00	8	1	1
Provision of labour and materials	3.17	10	3.56	9	11.29	9	1	1
Property market condition	3.18	9	3.40	10	10.81	10	-1	1
Project type (residential, commercial, educational, etc.)	2.57	12	3.14	11	8.07	11	1	1
Extent of completion of pre-contract design	2.69	11	2.90	12	7.80	12	-1	1
Construction method	2.56	13	2.88	13	7.37	13	0	0
Project location	2.39	14	2.44	15	5.83	14	-1	1
Defective design and specification	1.68	16	2.56	14	4.30	15	2	4
Client type (private, public, government, agencies, NGOs, etc.)	2.18	15	1.81	16	3.95	16	-1	1
Total $\sum d_i^2$ =								46

$$\text{Spearman's correlation coefficient (rho)} = 1 - \frac{6 \sum d_i^2}{n(n^2-1)} = 1 - \frac{6 \times 46}{16(256-1)} = 0.93$$

Table 7. Comparison between current results and some previous studies on project risk factors impacting budget variability in other contexts

Authors	This study	Akintoye (2000)	Jackson (2002)	Odusami and Onukwube (2008)	Enshassi *et al.* (2013)
Purpose	*Risk factors that influence variability between design-stage ECPs and FTS*	*Factors influencing project cost estimating practice*	*Causes of budget overrun*	*Factors affecting the accuracy of pre-tender cost estimate*	*Factors affecting cost estimates*
Study area	*New Zealand*	*UK*	*UK*	*Nigeria*	*Palestine (Gaza)*
			Factors by ranking		
R1	Changes in project owner's requirements	Complexity of design and construction	Design change	Expertise of consultants	Materials (prices/availability/supply/quality/imports)
R2	Experience of project team	Construction scale and scope	Design development	Information flow and quality	Closure and blockade of borders
R3	Site condition information	Construction method	Information availability	Experience of project team regarding construction type	Experience of project team in the type of construction
R4	Competency of consultants	Tender period and market condition	Design brief	Period of tender and market condition	Competency of the consultant
R5	Information flow and quality	Site constraints	Estimating method	Extent of completion of pre-contract design	Availability of clear and detailed drawings and specifications
R6	Tender documentation	Client's financial situation and budget	Design team performance	Design and construction complexity	Information flow quality
R7	Design information	Type of client	Project management	Availability and supplies of labour and materials	Completeness of cost information
R8	Project complexity	Buildability	Time limits	Location of project	Accuracy and reliability of cost information
R9	Provision of labour and materials	Location of project	Site conditions	Form of procurement	Fluctuation of currency exchange
R10	Property market condition	Availability and supplies of labour and materials	Organisation	Method of construction	Conditions of contract

Note: R = Rank

Table 8. Estimated variation between ECPs and OTS

Case Study Project Nr.	ECPs (NZ$)	OTS (NZ$)	Variation	% Variation
1	924,680.00	950,500.00	25,820.00	2.7923
2	902,206.00	988,000.00	85,794.00	9.5094
3	48,833,750	54,768,250	5,934,500	12.1525
4	2,403,619.00	2,477,000.00	73,381.00	3.0529
5	26,795,275	31,250,000	4,454,725	16.625
6	1,730,000.00	1,960,000.00	230,000.00	13.2948
7	13,000,000	15,500,000	2,500,000	19.2308
8	794,456.98	815,257.68	20,800.70	2.6182
9	2,023,490.00	2,233,773.00	210,282.10	10.392
10	2,850,000.00	3,058,252.00	208,252.80	7.3071
11	2,645,200.00	3,065,000.00	419,800.00	15.8703
12	15,055,000	15,500,000	445,000.00	2.9558
13	34,922,850	38,628,000	3,705,150	10.6095
14	942,545.25	986,342.50	43,797.25	4.6467
15	1,985,000.00	2,085,369.00	100,369.80	5.0564
16	2,266,000.00	2,522,725.00	256,725.30	11.3295
17	10,100,000	10,300,000	200,000.00	1.9802
18	766,787.25	945,234.60	178,447.30	23.2721
19	68,350,000	74,500,000	6,150,000	8.9978
20	1,578,317.00	1,954,865.00	376,548.20	23.8576
21	1,034,360.00	1,075,210.00	40,850.00	3.9493
22	2,800,000.00	3,400,000.00	600,000.00	21.4286
23	28,245,000	31,285,225	3,040,225	10.7638
24	2,043,360.00	2,466,783.00	423,422.80	20.7219
25	842,065.25	982,361.50	140,296.20	16.661
26	34,280,000	37,525,060	3,245,060	9.4663
27	32,120,000	34,450,120	2,330,120	7.2544
28	998,650.00	1,094,000.00	95,350.00	9.5479
29	18,125,180	20,402,060	2,276,880	12.562
30	908,450.00	965,200.00	56,750.00	6.2469
31	986,687.00	1,056,750.00	70,063.00	7.1008
32	26,292,128	31,000,000	4,707,872	17.906
33	736,687.56	805,134.60	68,447.04	9.2912
34	33,225,000	38,650,125	5,425,125	16.3284
35	994,678.00	1,084,000.00	89,322.00	8.98
36	924,680.00	950,500.00	25,820.00	2.7923

Note: ECP = elemental cost plan; OTS = out-turn tender sum; NZ$ = New Zealand dollars

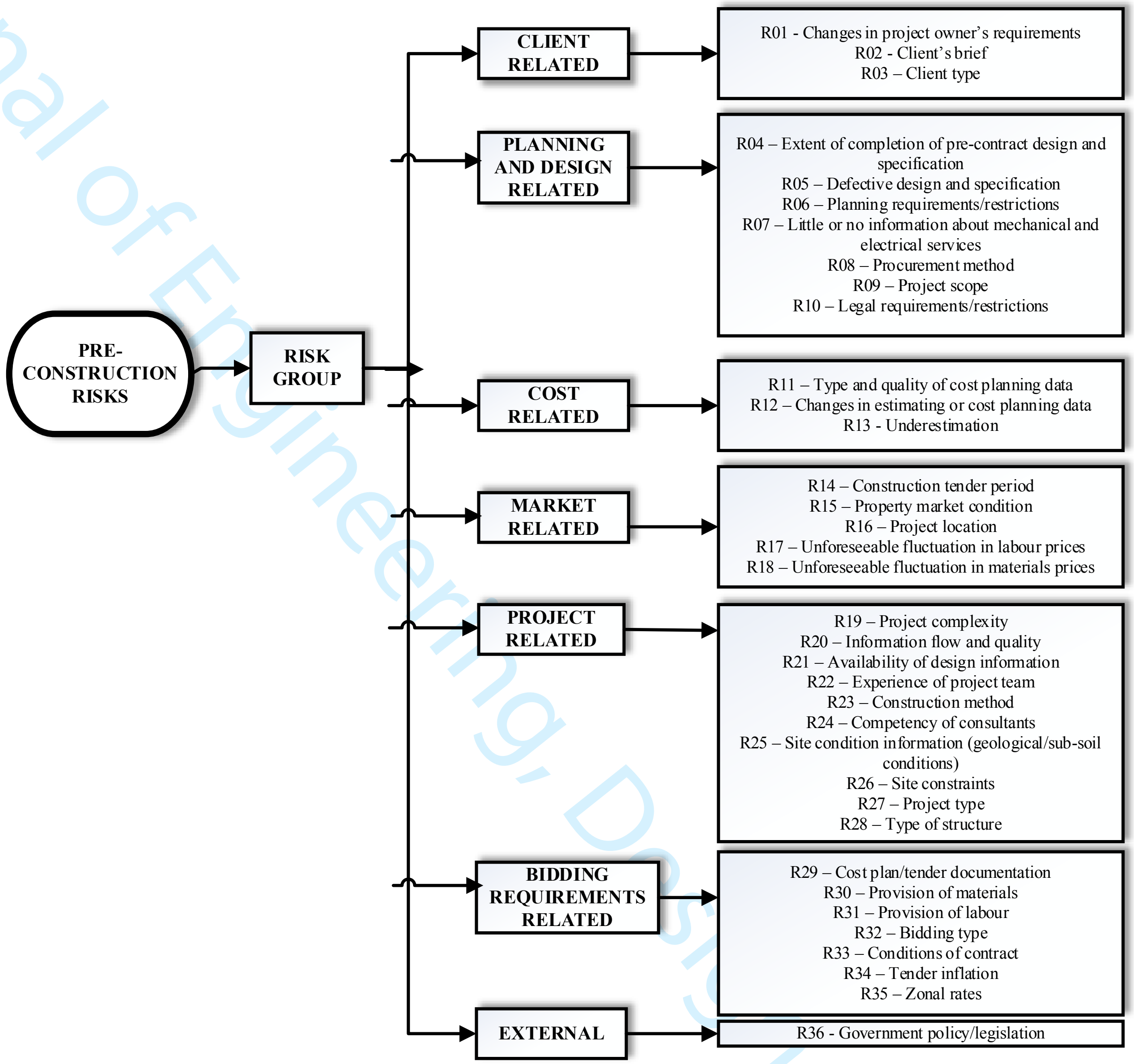

Figure 1. Pre-construction risks identified from previous studies (based on Adafin *et al.,* 2018)

References: 1 = Akintoye (2000); 2 = Ling and Boo (2001); 3 = Hansen and Vanegas (2003); 4 = Trost and Oberlender (2003); 5 = Ashworth (2004); 6 = Serpell (2005); 7 = Liu and Zhu (2007); 8 = Smith and Jaggar (2007); 9 = Tower and Baccarini (2008); 10 = Zou *et al.* (2007); 11 = Enshassi and Mosa (2008); 12 = Odusami and Onukwube (2008); 13 = Farinloye *et al.* (2009); 14 = Odeyinka *et al.* (2009); 15 = Odeyinka *et al.* (2012); 16 = RICS NRM 1 (2012); 17 = Enshassi *et al.* (2013); 18 = Ji *et al.* (2014); 19 = Ameyaw *et al.* (2015).

The JEDT
Author(s') Response to Reviewers Form

Manuscript ID: JEDT-03-2019-0056

Referee 1	
1. Title & Introduction: The title does not reflect the aim of the paper. While the paper assessed "risk factors impacting project budget performance" in New Zealand, the title reads "project budget development risks".	- Title has been revised accordingly. - Please see the revised Title.
2. The introduction focused only on researches conducted in NZ. It is not known whether attempts have been made outside NZ to address risk factors influencing budgetary performance. Demonstrating knowledge of works existing outside NZ in the introduction will help to justify the research problem early enough in the paper.	- Done. More citations from other countries included in the manuscript. - Please see paragraphs 4, 5 and 6 of the Introduction section of the paper. - Also, please check Table 3.
3. The gap which the research tried to fill relates more to non-existence of research addressing risk factors influencing budgetary performance in NZ. For this reason, it may be better to justify the decision to seek the PMs' perspectives in the methodology and hence, expunge "PMs' perspectives to" from the title.	- Done. Title revised - Please see the second paragraph (lines 1-4) of the Methodology section of the paper. - Please check the amended paper Title.
4. Literature Review: In the methodology, it was reported that 36 risk factors were identified/produced from the review of literature. On the contrary, however, how these 36 risk factors were identified/produced is not demonstrated in the literature review section.	- Revised. - Reference to the revised Literature Review section. - Please see the sub-section "Risk and Risk Factors impacting Budget Overrun", paragraph 3 and paragraph 4 (lines 9-13) for the demonstration.
5. Methodology: What is the justification for discussing the relevance of the 36 risk factors with only 5 construction consultants?	- Revised. - Please check the revised Methodology section, 1st paragraph (lines 3-9) for more explanation.
6. What is the justification for using simple random sampling?	- Done. - Please see the 2nd paragraph (lines 4-7) of the revised Methodology section for more explanation.
7. If it is possible, the author(s) may consider using factor analysis to identify hidden constructs in the risk factors. This will add more to the study's contribution/value.	- Revised. - Please see the 1st paragraph (lines 9-15) of the methodology section of the paper, to achieve the same purpose.
8. Results: It's more logical for Table 6 which delineates demographic information of respondents to be presented before Table 5 (PMs' opinion of risk occurrence).	- Done. - Please see the Tables, re-arranged. Also corrected within the text.

Thanks so much for your invaluable contributions to this paper.
Please expand table as necessary
Please include this completed table in your resubmission as a document for review

An evaluation of risk factors impacting project budget performance in New Zealand

Adafin J

2021-03-03